UTKALA GOURAVA MADHUSUDAN INSTITUTE OF TECHNOLOGY
RAYAGADA, ODISHA- 765001

Lab Manual

PLC AND AUTOMATION LABORATORY

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Contents

INTRODUCTION

Introduction

This laboratory course is intended to enhance the learning experience of the student in topics encountered in Industrial Automation and Control, AEEB58. In this laboratory, students are trained to get hands-on experience on the usage of the Delta make DVP series Programmable Logic Controller(PLC, Human Machine Interface (HMI)) used in industrial automation andin interpreting the results of operations in terms of the concepts introduced in the Industrial Automation and Control course. The student performance in the lab depends on his/her preparation, participation, and teamwork. Each team member must participate in all aspects of the lab to insure a thorough understanding of the equipment and concepts. The student, lab as- sistant, and faculty coordinator all have certain responsibilities toward successful completion of the lab's goals and objectives.

Student Responsibilities

The student is expected to be prepared for each lab. Lab preparation includes reading the lab experiment and related textbook material. If you have questions or problems with the preparation, contact your faculty coordinator, but in a timely manner. Do not wait until an hour or two before the lab and then expect the faculty coordinator to be immediately available.
The students should wear lab apron and CLOSED TOE SHOES. The HAIR should be protected, let it not be loose. TOOLS, APPARATUS and COMPONENT sets are to be returned before leaving the lab. HEADINGS and DETAILS should be neatly written.

1. Aim of the experiment
2. Apparatus required
3. Theory/Background
4. Procedure
5. Theoretical Calculations
6. Circuit diagram
7. Tabulations/Waveforms
8. Result

The student after completing the experiment, the answer to post lab viva-voce questions should be neatly written in the worksheets and get it corrected by the faculty coordinator. After corrected by the faculty coordinator, upload in the college website under the same lab for final evaluation by the faculty.
Active participation by each student in lab activities is expected. The student is expectedto ask the faculty coordinator any questions they may have. **Do not make costly mistakes**

because you did not ask a question before proceeding.

A large portion of the student's marks are determined in the semester end lab examination (SEE), resulting in a requirement of understanding the concepts and procedure of each lab experiment for the successful completion of the lab class. The student should remain alert and use common sense while performing a lab experiment. They are also responsible for keeping a professional and accurate record of the lab experiments in the lab manual wherever tables are provided. Students should report any errors in the lab manual to the faculty coordinator.

Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each lab prior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week.Lab experiments should be checked in advance to make sure that everything is in working order.The Faculty should demonstrate and explain the experiment and answer any questions posed by the students.Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

Course Coordinator Responsibilities

The course coordinator is responsible fo rmaking any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations and any absence must be for a valid excuse and must be documented.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

Pre-Requistes and Co-Requisties:

The lab course is to be taken during the samesemester as AEEB58, but receives a separate grade. Students are required to have completed both AEEB15 and AEEB24 with minimumpassing grade or better grade in each.

Course Goals and Objectives

The PLC and industrial automation laboratory is designed to provide the student with knowl- edge on measurement systems and control of motors and other industrial processes. In addition,the student should learn how to record experimental results effectively and present these resultsin a written report.

More explicitly, the class objectives are:

1. The engineering skills by way of electrical circuit design with programmable logic circuits.
2. Simulation and testing of ladder diagram programs in control of devices.
3. The demonstration of basic use of analog and digital modules in PLC and use of HMI.

Use of Laboratory Instruments

One of the major goals of this lab is to familiarize the student in writing the ladder programs, wiring with Programmable logic controllers and use of HMI . Some understanding of the lab instruments is necessary to avoid personal or equipment damage. By understanding the device's purpose and following a few simple rules, costly mistakes can be avoided. In general, all devices have physical limits.

The following rules provide a guideline for instrument protection.

Instrument Protection Rules

1. Check the Relay ladder logic (RLL) program in simulator mode before it is uploaded to PLC.
2. Check whether the connections are properly given according to the RLL.

Data Recording and Reports

The Laboratory Worksheets or Observations

Students must record their experimental values in the provided tables in this laboratory manual and reproduce them in the lab worksheets. Worksheets are integral to recording the methodology and results of an experiment. In engineering practice, the laboratory notebook serves as an invaluable reference to the technique used in the lab and is essential when trying to duplicate a result or write a report. Therefore, it is important to learn to keep accurate data. Make plotsof data and sketches when these are appropriate in the recording and analysis of observations.

Note that the data collected will be an accurate and permanent record of the data obtained during the experiment and the analysis of the results. You will need this record when you are ready to prepare a lab report i.e worksheets.

The Laboratory Files/Reports

Worksheets are the primary means of communicating your experience and conclusions to other professionals. In this course you will use the lab worksheets to inform your faculty coordinator about what you did and what you have learned from the experience. Engineering results are meaningless unless they can be communicated to others. You will be directed by your faculty coordinator to prepare a lab report on a few selected lab experiments during the semester.
Your laboratory report should be clear and concise. The lab report shall be student hand written on a work sheets provided by the college. As a guide, use the format on the next page. Use tables, diagrams, sketches, and plots, as necessary to show what you did, what was observed, and what conclusions you can draw from this by using pencil and scale. Free hand diagramsand tables will reduce your marks. Even though you will work with one or more lab partners, your report will be the result of your individual effort in order to provide you with practice in technical communication.

Order of Lab Report Components

Cover page - Cover page must include lab name and number, your name, your lab partner's name, and the date the lab was performed.
Objective - Clearly state the experiment objective in your own words.
Equipment Used - Indicate which equipment was used in performing the experiment.
For Each Part of the Lab: Write the lab's part number and title in bold font.

Firstly, describe the problem that you studied in this part, give an introduction of the theory, and explain why you did this experiment. Do not lift the text from the lab manual; use your own words.

Secondly, describe the experimental setup and procedures. Do not follow the lab manual in listing out individual pieces of equipment and assembly instructions. That is not relevant information in a lab report! Instead, describe the circuit as a whole and explain how it works. Your description should take the form of a narrative, and include information not present in the manual, such as descriptions of what happened during intermediate stepsof the experiment.

Thirdly, explain your findings. This is the most important part of your report, because here, you show that you understand the experiment beyond the simple level of completingit. Explain (compare expected results with those obtained). Analyze (analyze experimen- tal error).

Finally, provide a summary of what was learned from this part of the laboratory ex- periment. If the results seem unexpected or unreliable, discuss them and give possible explanation.

Conclusions - The conclusion section should provide a take-home message summing up what has been learned from the experiment:

Briefly restate the purpose of the experiment (the question it was seeking to answer)

Identify the main findings (answer to the research question)

Note the main limitations that are relevant to the interpretation of the results

Summarize what the experiment has contributed to your understanding of the problem.

Probing Further Experiments - Experiments pertaining to this lab must be given to students fordoing themselves at the end of laboratory.

LAB-1 ORIENTATION

1.1 Introduction

In the first lab period, the students should become familiar with the location of equipment and components in the lab, the course requirements, and the teaching instructor.

1.2 Objective

To familiarize the students with the lab facilities, equipment, standard operating procedures, lab safety, and the course requirements.

1.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual.

1.4 Equipment needed

Lab manual

1.5 Procedure

1. During the first laboratory period, the instructor will provide the students with a general idea of what is expected from them in this course. Each student will receive a copy of the syllabus, stating the instructor's contact information. In addition, the instructor will review the safety concepts of the course.

2. During this period, the instructor will briefly review the equipment which will be used throughout the semester. The location of instruments, equipment, and components will be indicated. The guidelines for instrument use will be reviewed.

1.6 Further Probing Experiments

Experiments pertaining to this lab will be given to the students to get the indepth knowledge about the lab and these experiments are to be done by the students at home or in lab during their leisure time.

LAB-2 STAR-DELTA STARTER

2.1 Introduction

A three phase induction motor is started by using different types of starters such as Direct online (DOL) starter, star-delta starter, autotransformer starter etc. The selection of a particular type of starter depends on the rating of three phase motor and application. Generally a DOL starter is used for motors with below 5hp rating.

2.2 Objective

By the end of this lab, the student should learn the hardware connections and software implementation of star - delta starter using PLC.

2.3 Prelab Preparation:

Read the material in the textbook that describes about the components and operation of star -delta starter. Prior to coming to lab class, have glance of the Procedure.

2.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

2.5 Background

Most induction motors are started directly on line, but when very large motors are started that way, they cause a disturbance of voltage on the supply lines due to large starting current surges. To limit the starting current surge, large induction motors are started at reduced voltage and then have full supply voltage reconnected when they run up to near rotated speed. Star delta starter is the reduced voltage starting method. Voltage reduction during star-delta startingis achieved by physically reconfiguring the motor windings as illustrated in the figure below. During starting the motor windings are connected in star configuration and this reduces the voltage across each winding 3. This also reduces the torque by a factor of three. After a pe-riod of time the winding are reconfigured as delta and the runs normally. Star/Delta startersare probably the most common reduced voltage starters. They are used in an attempt to re- duce the start current applied to the motor during start as a means of reducing the disturbances.

The Star/Delta starter is manufactured from three contactors, a timer and a thermal overload. The contactors are smaller than the single contactor used in a Direct on Line starter as they are controlling winding currents only. The currents through the winding are 58% of the current in the line. There are two contactors that are close during run, often referred to as the main contractor and the delta contactor. These are AC rated at 58 % of the current rating of the motor. The third contactor is the star contactor and that only carries star current while the motor is connected in star. The current in star is one third of the current in delta, so this contactor can be AC3 rated at one third (33 %) of the motor rating.

2.6 Electrical Circuit Diagram

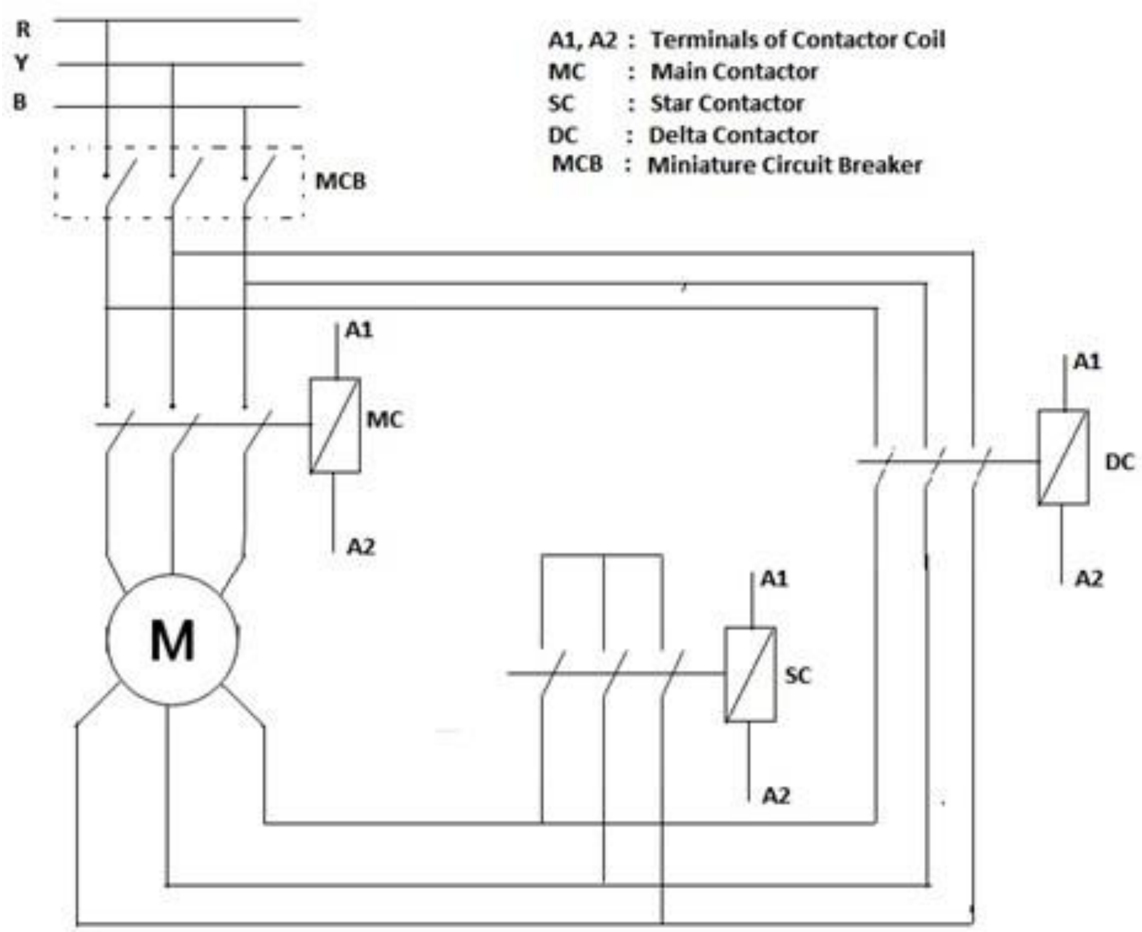

Figure 2.1 Electrical connection diagram.

2.7 PLC Connection Diagram

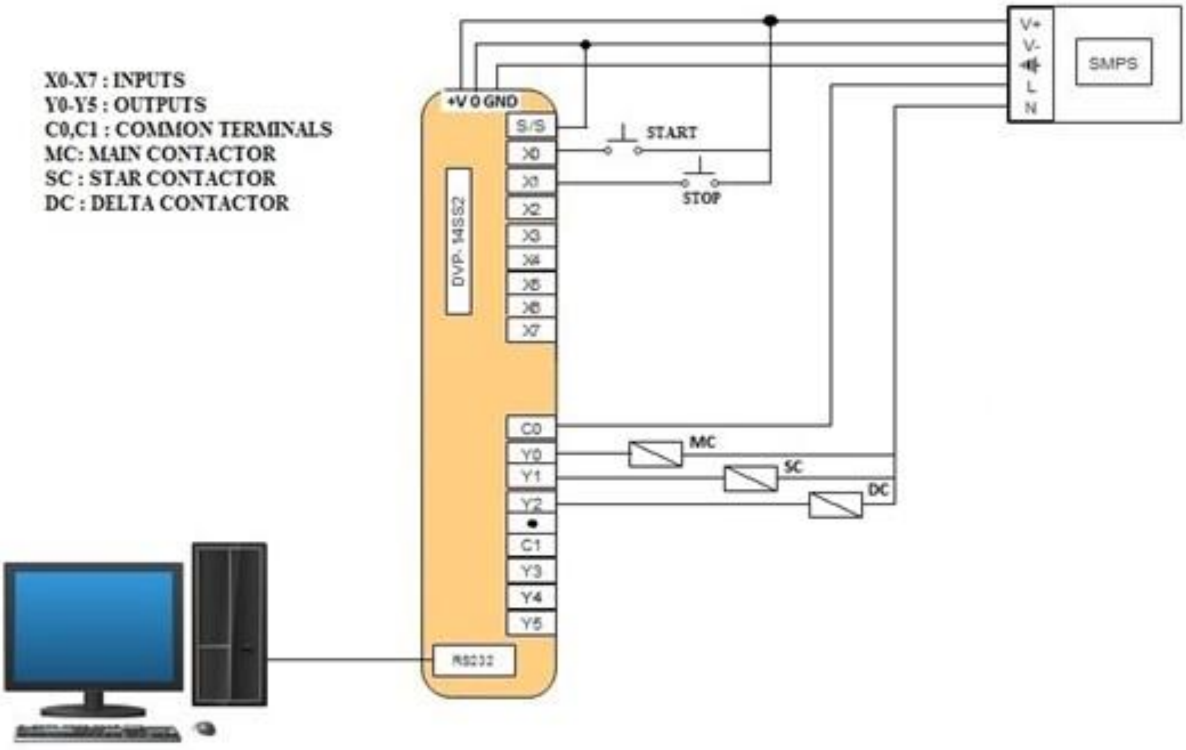

Figure 2.2 PLC connection diagram

2.8 Procedure

1. Give the hardware connections by observing the electrical connection diagram and PLC connection diagram shown in figures 2.1 and 2.2.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for DOL starter as shown figure 2.3.
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

2.9 Ladder Diagram Program

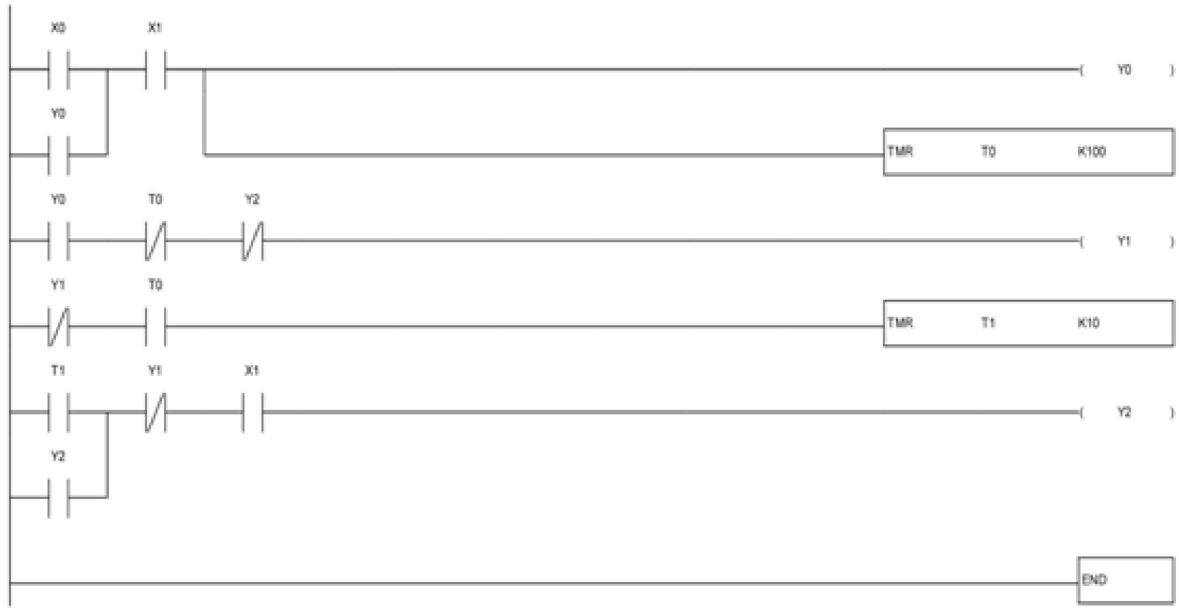

Figure 2.3 Star-Delta starter ladder diagram

2.10 Further Probing Experiments

1. Develop a PLC program for starting the three phase induction motor by autotransformer starter.
2. Write a PLC program to protect the motor from over currents and voltages.

LAB-3 AUTOMATIC FORWARD AND REVERSE CONTROL

3.1 Introduction

Induction motors are categorized by two types, one is single phase induction motor and another one is three phase induction motor. In case of three phase induction motor, they are self- started motor and the motor direction would be the direction of rotating magnetic field. For reversing the motor direction, we have to change the direction of rotating magnetic field. Thisis implemented by changing the supply phase sequence of the motor.

3.2 Objective

By the end of this lab, the student should learn the hardware connections and software implementation of automatic forward and reverse control of three phase induction motor using PLC.

3.3 Prelab Preparation:

Read the material in the textbook that describes about the forward and reverse control operation of three phase induction motor. Prior to coming to lab class, have glance of the Procedure.

3.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

3.5 Background

3-phase induction motor is the motor of the most popular or the most widely used in the propulsion, blowers etc. It was probably due to the induction motor by the motors of other types, such as; simple, durable, easy to maintain, and have a high efficiency. The direction of rotation of 3-phase induction motor is reversed by reversing the polarity of one of the incoming voltage to the motor.

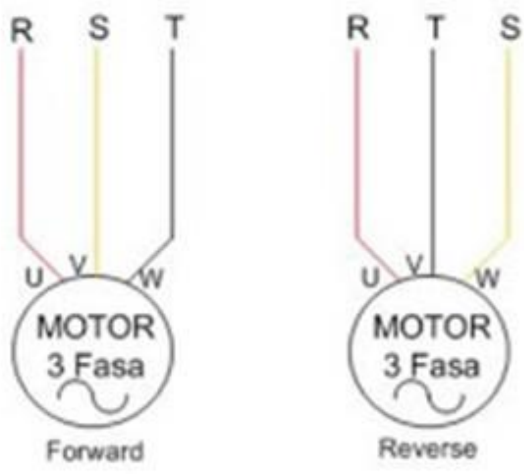

Figure 3.1 Three phase induction motor terminals for forward and reverse control

3.6 Electrical Circuit Diagram

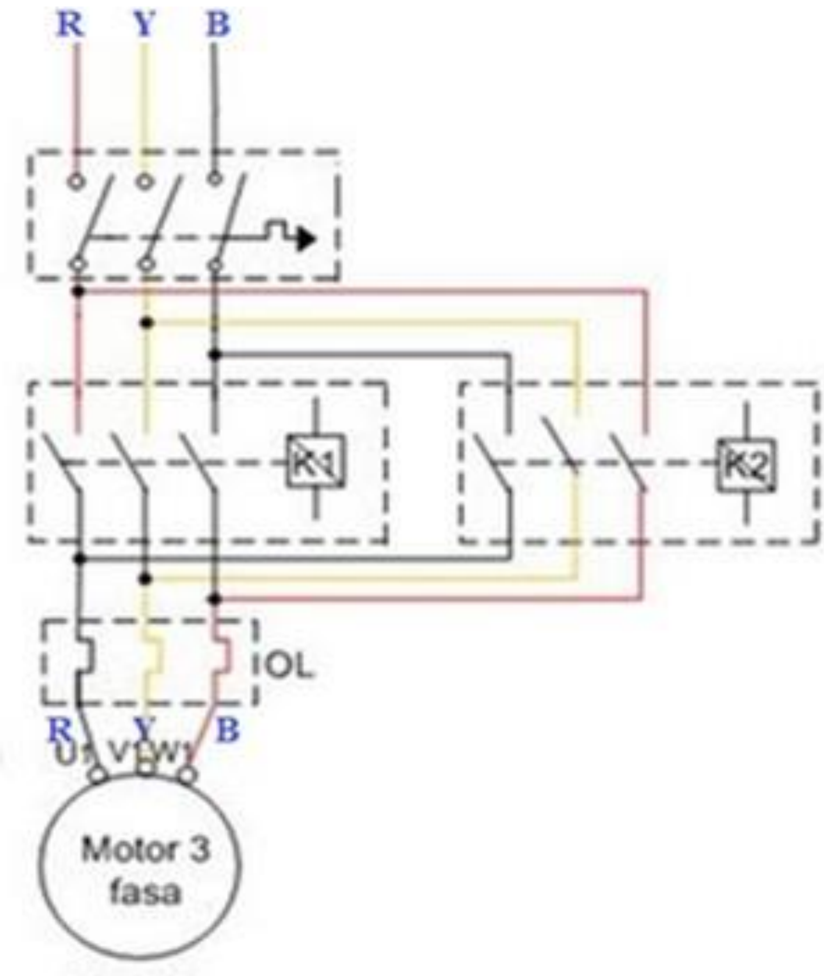

Figure 3.2 Electrical connection diagram.

3.7 PLC Connection Diagram

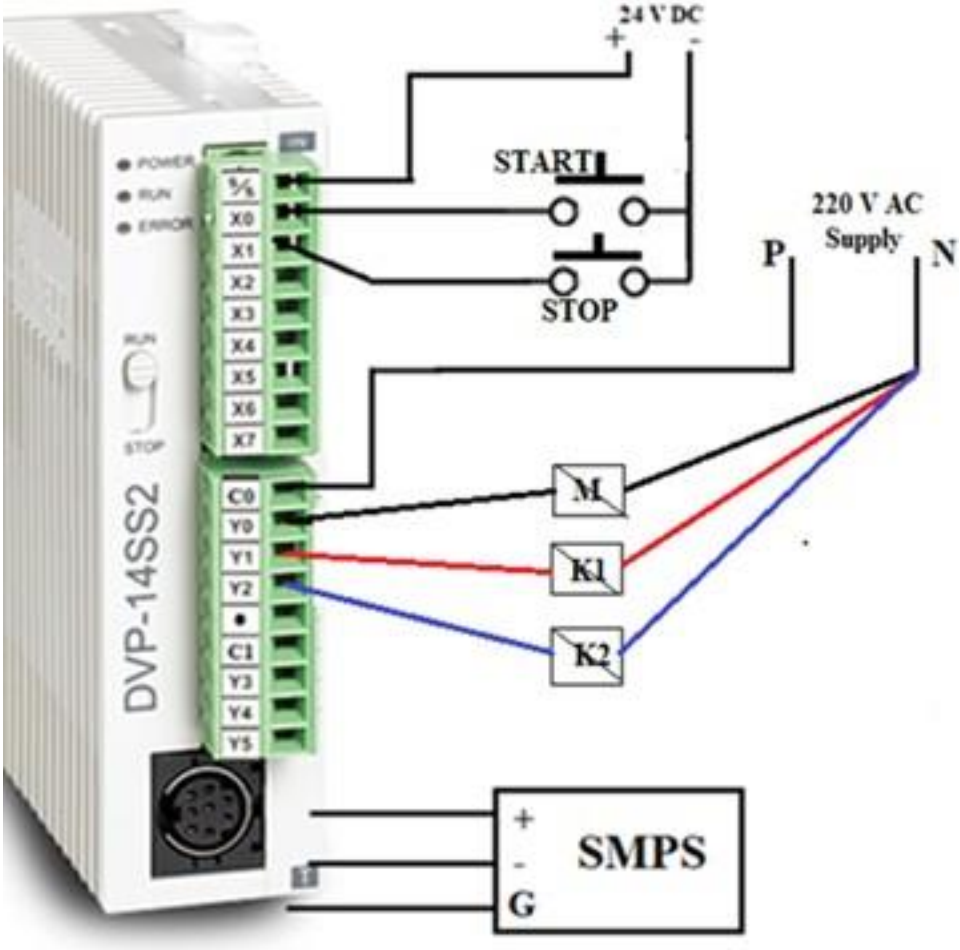

Figure 3.3 PLC connection diagram

3.8 Procedure

1. Give the hardware connections by observing the electrical connection diagram and PLC connection diagram shown in figures 3.2 and 3.3.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for Automatic forward and reverse control operation of motor as shown figure 3.4.
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

3.9 Ladder Diagram Program

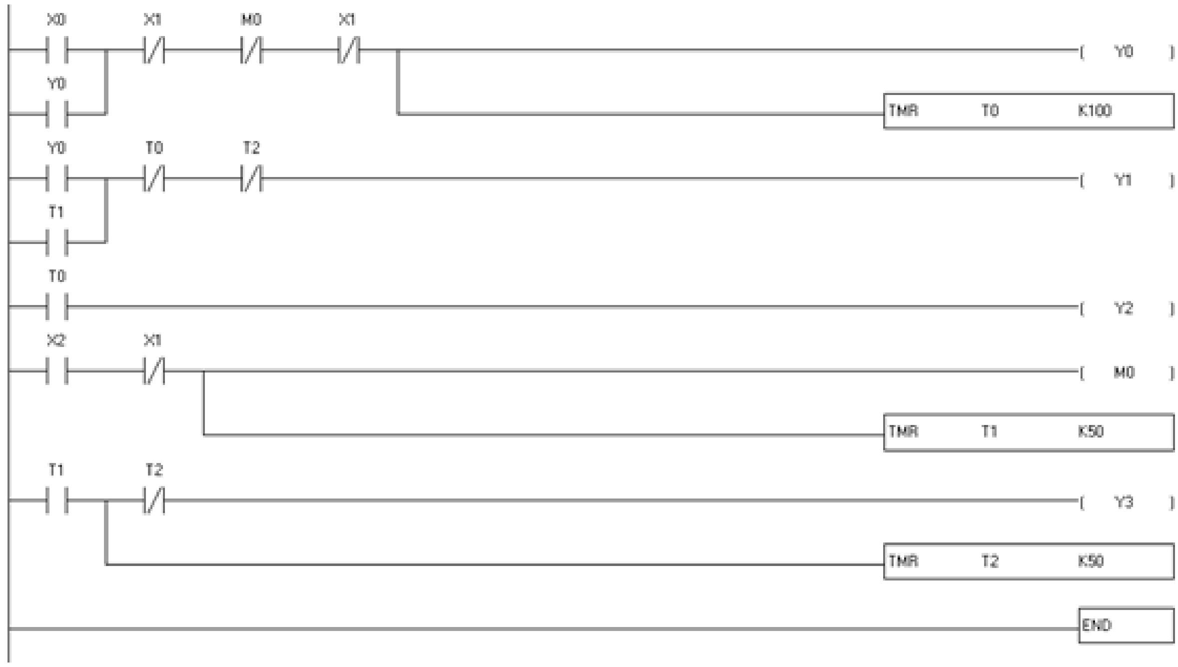

Figure 3.4 Ladder diagram of automatic forward and reverse control of motor

3.10 Further Probing Experiments

1. Write a PLC program for automatic forward and reverse control of DC motor.
2. Write a PLC program for stepper motor control.

LAB-4 FAULT ANNUNCIATION SYSTEM

4.1 Introduction

In a power system the power is transmitted to the large distance by overhead transmission lines. As the lines are exposed to atmosphere they are very much prone to faults. There are different types of faults occur on the power system which are over currents due to short circuit faults and over voltages due to sudden change in load etc.

4.2 Objective

By the end of this lab, the student should learn the hardware connections and ladder diagram program for detecting the power system faults using PLC.

4.3 Prelab Preparation:

Read the material in the textbook that describes about the different types of faults on power system. Prior to coming to lab class, have glance of the Procedure.

4.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

4.5 Background

Electrical powers system is growing in size and complexity in all sectors such as generation, transmission, distribution and load. Types of faults like short circuit condition in power system network results in severe economic losses and reduces the reliability of the electrical system. Electrical fault is an abnormal condition, caused by equipment failures such as transformers and rotating machines, human errors and environmental conditions. Theses faults cause interruption to electric flows, equipment damages, even cause death of humans, birds and animals.
Types of Faults: Electrical fault is the deviation of voltages and currents from nominal values or states. Under normal operating conditions, power system equipment or lines carry normal voltages and currents which results in a safer operation of the system. But when fault occurs, it causes excessively high currents to flow which causes the damage to equipments and devices. Fault detection and analysis is necessary to select or design suitable switchgear equipments, electromechanical relays, circuit breakers and other protection devices.
There are mainly two types of faults in the electrical power system. Those are symmetrical and unsymmetrical faults.
Symmetrical faults: These are very severe faults and occur infrequently in the power systems.

These are also called as balanced faults and are of two types namely line to line to line to ground (L-L-L-G) and line to line to line (L-L-L).

Unsymmetrical faults: These are very common and less severe than symmetrical faults. There are mainly three types namely line to ground (L-G), line to line (L-L) and double line toground (LL-G) faults.

4.6 Electrical Circuit Diagram

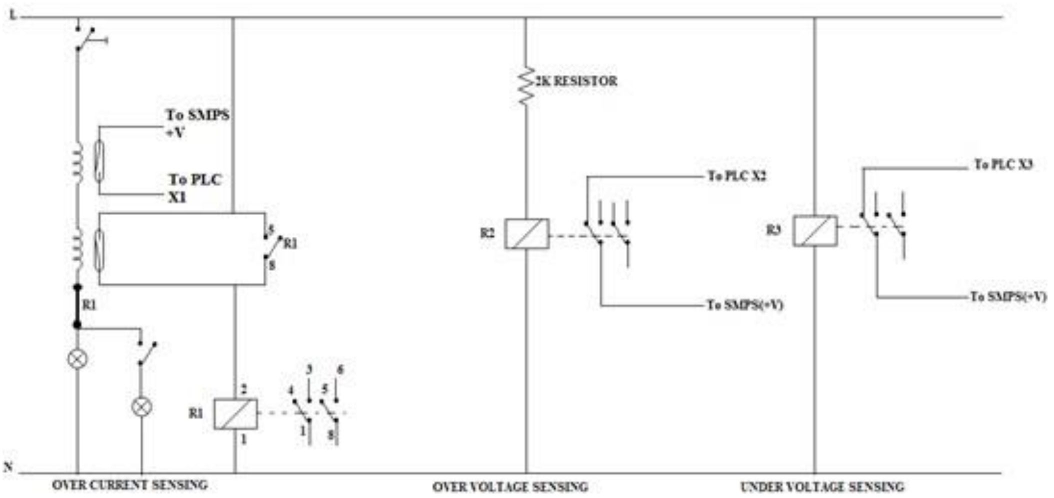

Figure 4.1 Electrical connection diagram.

4.7 PLC Connection Diagram

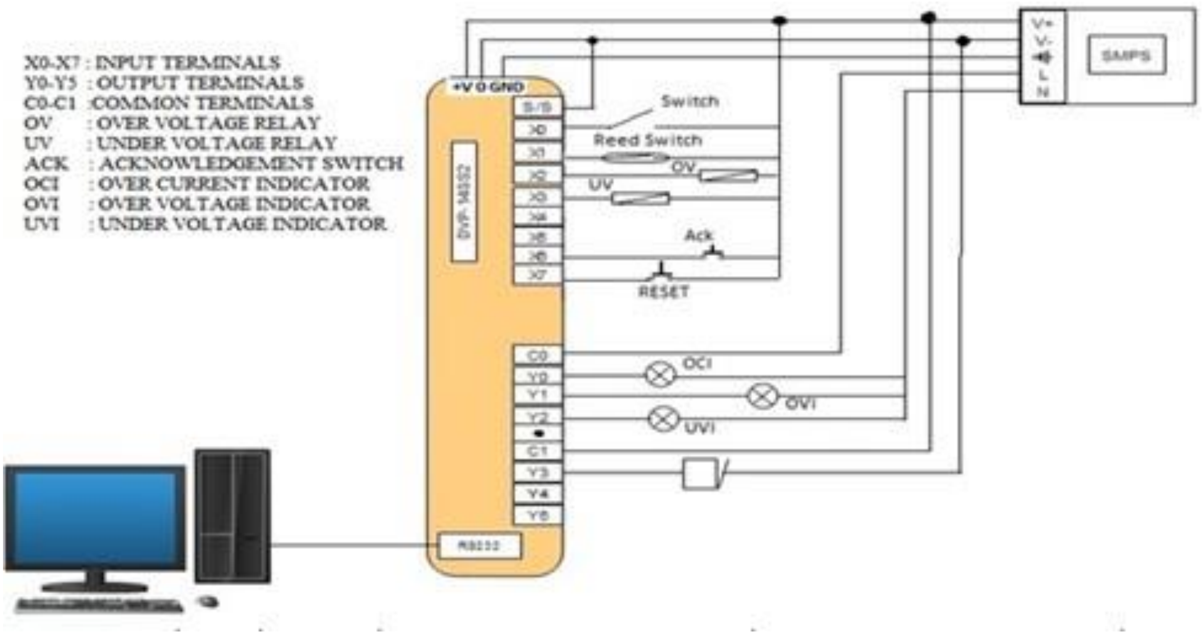

Figure 4.2 PLC connection diagram

4.8 Procedure

1. Give the hardware connections by observing the electrical connection diagram and PLC connection diagram shown in figures 4.1 and 4.2.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program as shown in figure 4.3 to detect the electrical faults.
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

4.9 Ladder Diagram Program

Figure 4.3 Ladder diagram program for Fault annunciation system

4.10 Further Probing Experiments

1. Write PLC control program to detect under and over frequency in a transmission system
2. Write a PLC program to protect the DC motor for abnormal faults.

LAB-5 TEMPERATURE CONTROL SYSTEM

5.1 Introduction

A temperature controller is an instrument used to control temperature calculating the differ- ence between a set point and a measured temperature. The controller takes an input from atemperature sensor and has an output that is connected to a control element such as a heateror fan.

5.2 Objective

By the end of this lab, the student should learn the hardware connections and software implementation of temperature control system.

5.3 Prelab Preparation:

Read the material in the textbook that describes about the components used and how to measure the temperature by different types of sensors. Prior to coming to lab class, have glance of the Procedure.

5.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

5.5 Background

To accurately control process temperature without extensive operator involvement, a temperature control system relies upon a controller, which accepts a temperature sensor such as a thermocouple or RTD as input. It compares the actual temperature to the desired control temperature, or set point, and provides an output to a control element. The temperature controller or thermostat is one part of the entire control system, and the whole system should be analyzed in selecting the proper equipment. There are three basic types of controllers: on-off, proportional and PID. Depending upon the system to be controlled, the operator will be able to use one type or another to control the process. An on-off temperature controller is the simplest form of control device. The output from the device is either on or off, with no middle state. Proportional temperature controls are designed to eliminate the cycling associated with on-off control. A proportional controller decreases the average power supplied to the heater as the temperature approaches setpoint. The third temperature controller type provides proportional with integral and derivative control, or PID control. This digital temperature controller combines proportional control with two additional adjustments, which helps the unit automatically compensate for changes in the system.

5.6 Electrical Circuit Diagram

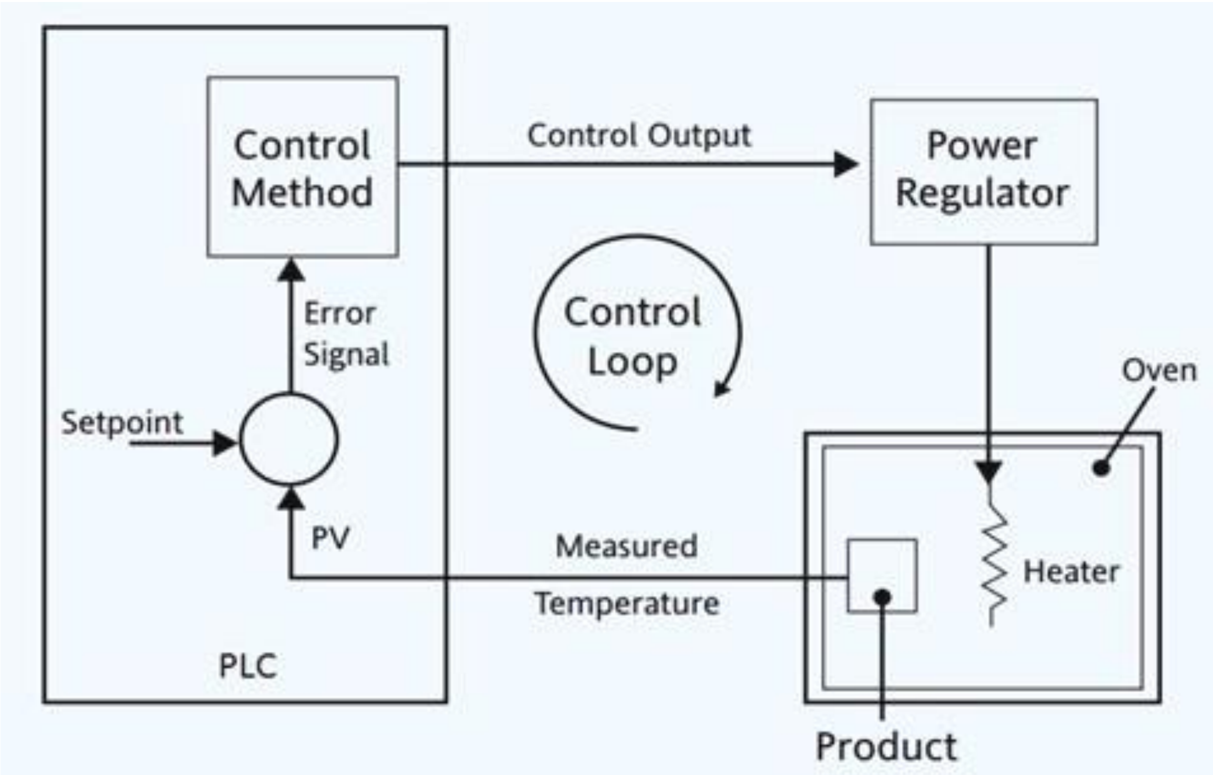

Figure 5.1 Block diagram of temperature control system.

5.7 Procedure

1. Give the PLC connections by observing the electrical connection diagram as shown in figure 5.1
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for temperature control as shown in figure 5.2.
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

5.8 Ladder Diagram Program

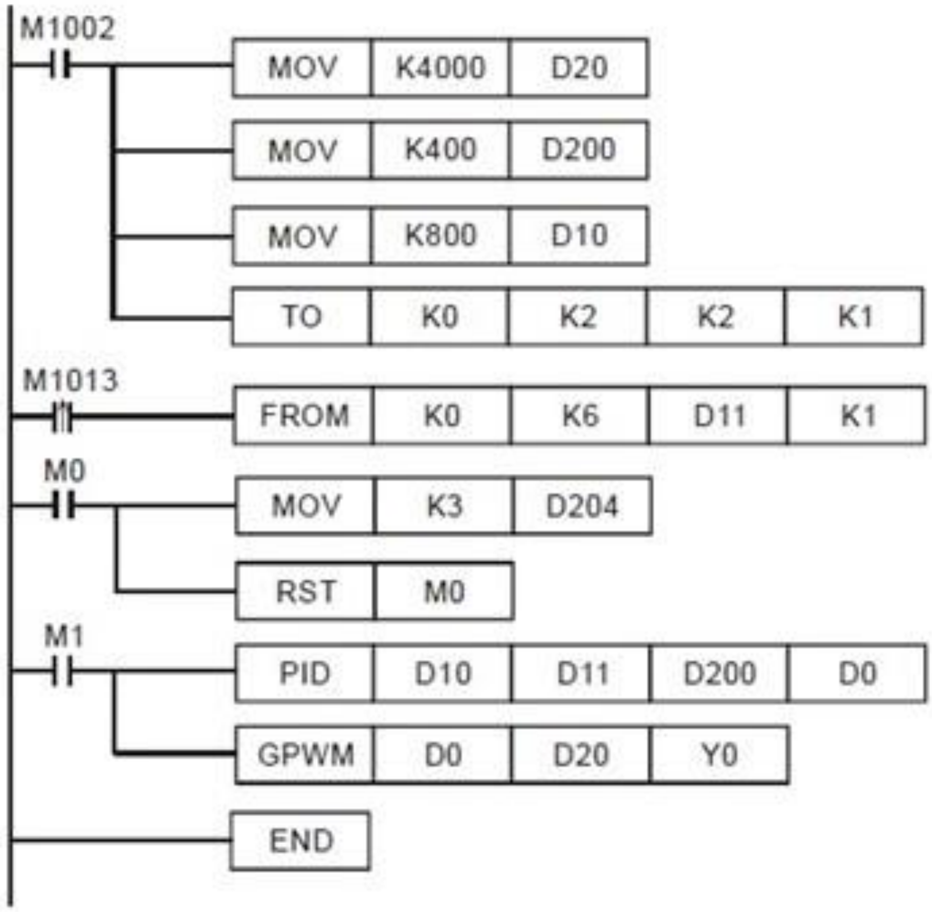

Figure 5.2 Ladder diagram for Temperature control system

5.9 Further Probing Experiments

1. Write a PLC program for controlling the temperature of a room using PT100 temperature sensor.

2. Write a PLC program for controlling the temperature of a room using thermistor.

LAB-6 PLUGGING

6.1 Introduction

There are generally three types of electrical braking for motors: regenerative braking, dynamic braking, and plugging. Of the three methods, plugging provides the fastest stop, but it can be harsh on both the electrical and mechanical components. Because of this, it's the least commonly used method of braking, but it is appropriate for some applications.

6.2 Objective

By the end of this lab, the student should learn the hardware connections and software implementation of most important breaking method; plugging of three phase induction motor using PLC.

6.3 Prelab Preparation:

Read the material in the textbook that describes about the braking methods of three phase induction motor. Prior to coming to lab class, have glance of the Procedure.

6.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

6.5 Background

Plugging — sometimes referred to as "reverse current braking" — is possible on both DC motors and AC induction motors. For DC motors, plugging is achieved by reversing the polarity of the armature voltage. When this happens, the back EMF voltage no longer opposes the supply voltage. Instead, the back EMF and the supply voltage work in the same direction, opposing the motor's rotation and causing it to come to a near-instant stop. The reverse current produced by the combined supply voltage and back EMF is extremely high, so resistance is placed in the circuit to limit the current.
For AC induction motors, the stator voltage is reversed by interchanging any two of the supply leads. The field then rotates in the opposite direction and the motor's slip (the difference between the speed of the stator's rotating magnetic field and the speed of the rotor) becomes greater than unity (s ¿ 1). In other words, the rotor spins faster than the rotating magnetic field in the stator. Torque is developed in the opposite direction of the motor's rotation, which produces a strong braking effect. When the motor speed reaches zero, if it is not disconnected from the supply, it will begin to reverse, or rotate in the opposite direction. In some applications,

reversal of the motor’s direction is the goal. But when plugging is used to brake the motor, a zero-speed switch or plugging contactor is used to disconnect the motor from the supply when its speed reaches zero.

One of the potential problems with plugging as a braking method (especially when the braking time is short) is that it can be difficult to brake the motor at exactly zero speed. Another drawback to plugging is that it can induce high mechanical shock loads on the motor and connected equipment, due to the abrupt stop that it causes. Plugging is also a very inefficient method of stopping and, therefore, generates significant heat. Despite these drawbacks, plugging is used in equipment such as elevators, cranes, presses, and mills, where a rapid stop of the motor (withor without reversal) is required.

6.6 Electrical Circuit Diagram

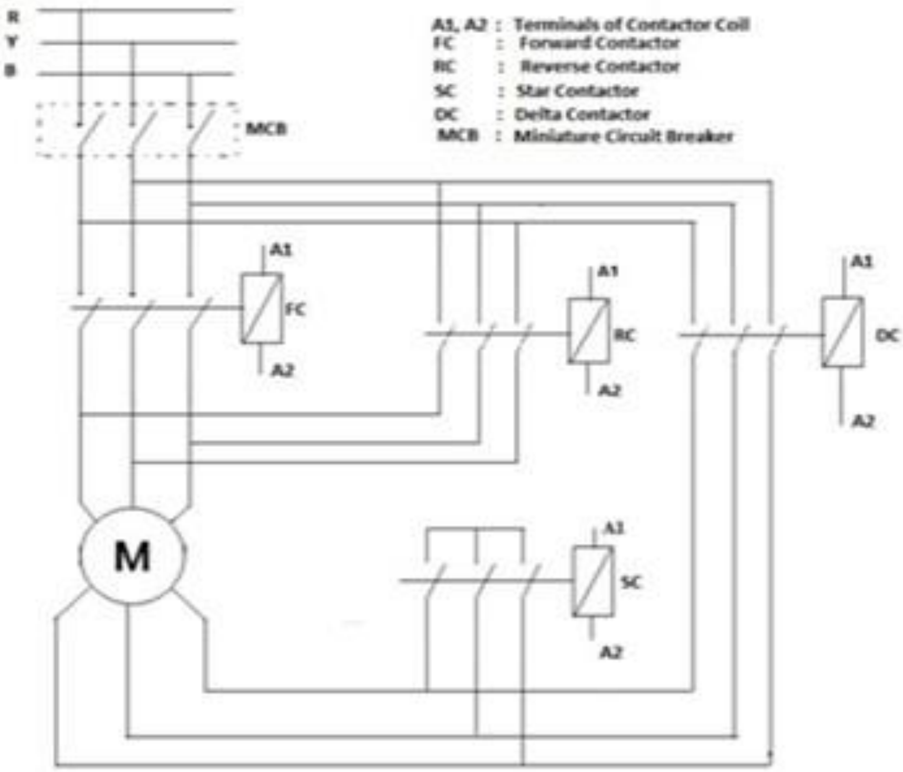

Figure 6.1 Electrical connection diagram.

6.7 PLC Connection Diagram

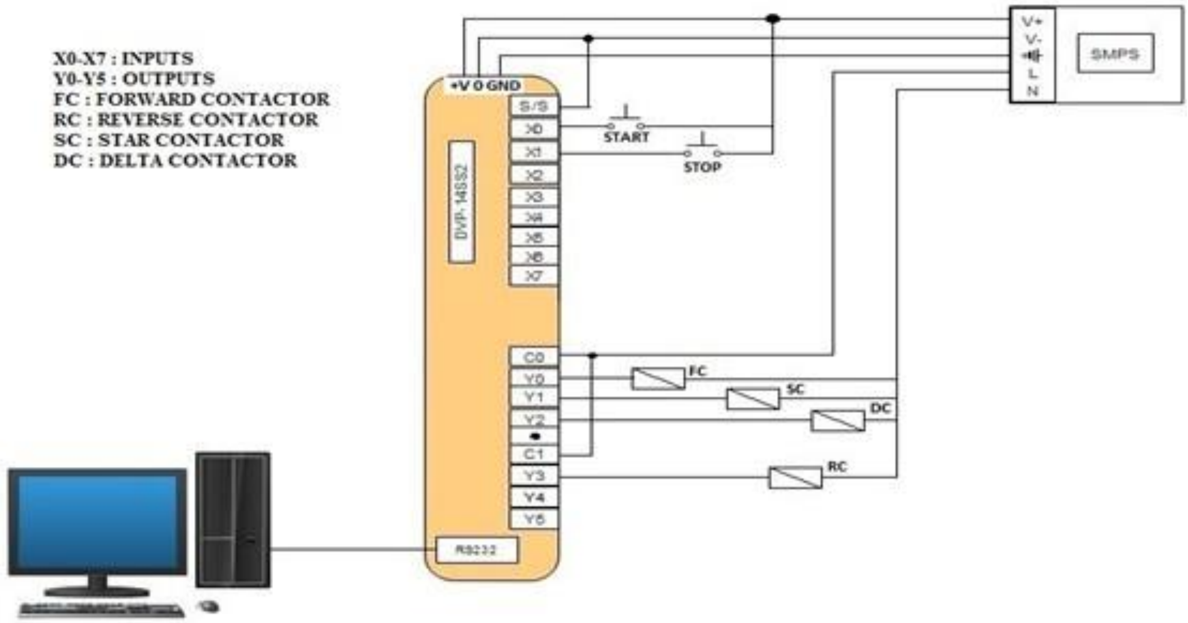

Figure 6.2 PLC connection diagram

6.8 Procedure

1. Give the hardware connections by observing the electrical connection diagram and PLC connection diagram shown in figures 6.1 and 6.2.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for plugging of motor as shown in figure 6.3.
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

6.9 Ladder Diagram Program

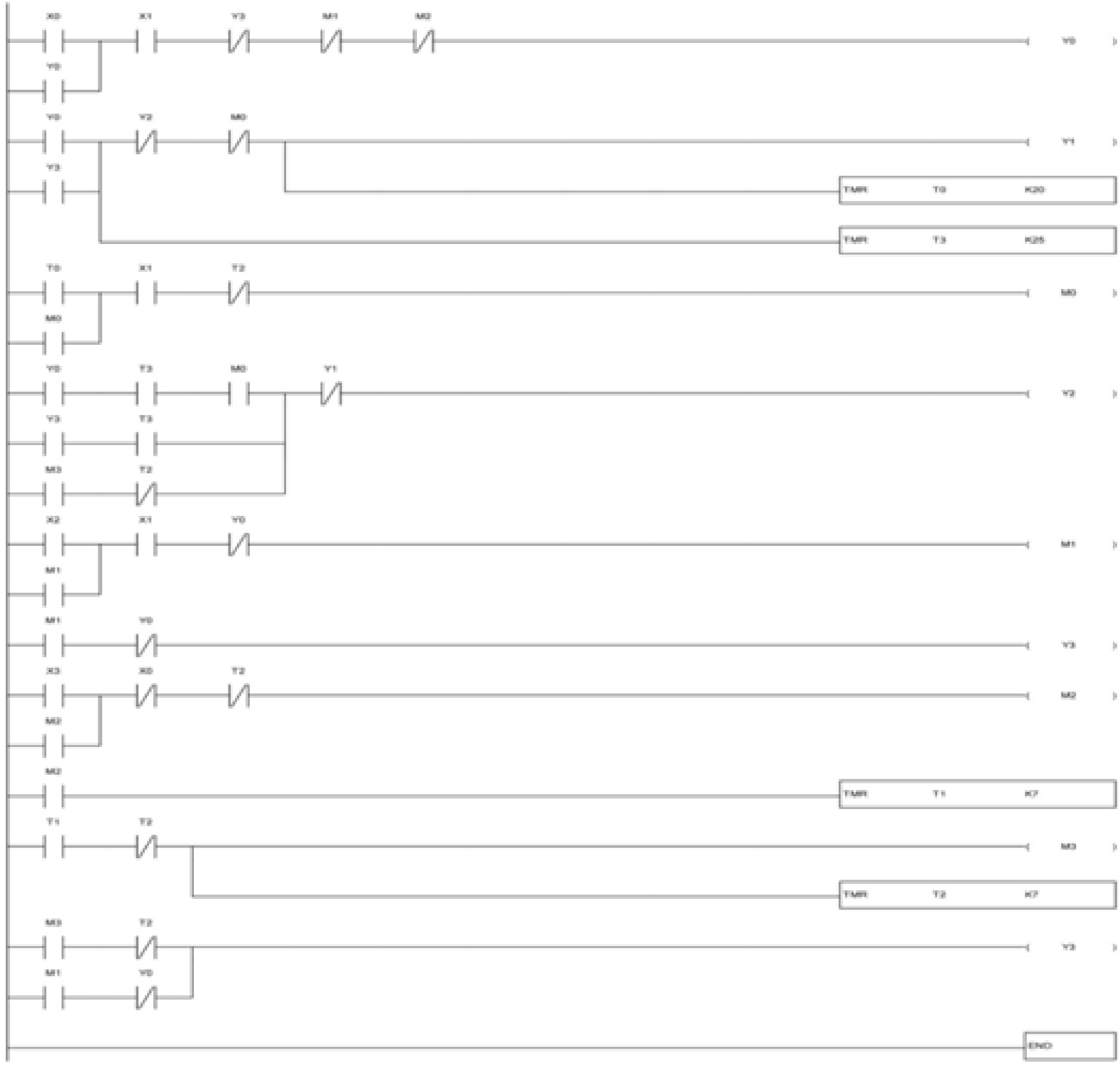

Figure 6.3 Ladder diagram of plugging method of braking the motor

6.10 Further Probing Experiments

1. Write a PLC program for dynamic braking of three phase induction motor.
2. Write a PLC program for regenerative braking of DC motor.

LAB-7 CONTROL OF LIFT

7.1 Introduction

A lift (or elevator) is a form of vertical transportation between building floors, levels or decks, commonly used in offices, public buildings and other types of multi-storey building. Lifts can be essential for providing vertical circulation, particularly in tall buildings, for wheelchair and other non-ambulant building users and for the vertical transportation of goods. Some lifts may also be used for firefighting and evacuation purposes.

7.2 Objective

By the end of this lab, the student should learn the hardware connections and software implementation of lift control using PLC.

7.3 Prelab Preparation:

Read the material in the textbook that describes about the operation of lift. Prior to coming to lab class, have glance of the Procedure.

7.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

7.5 Background

The working principle of an elevator or lift is similar to the pulley system. A pulley system is used to draw the water from the well. This pulley system can be designed with a bucket, a rope with a wheel. A bucket is connected to a rope that passes throughout a wheel. This can make it very easy to draw the water from the well. Similarly, present elevators use the same concept. But the main difference between these two are; pulley systems are operated manually whereas an elevator uses sophisticated mechanisms for handling the elevator's load.
Basically, an elevator is a metal box in different shapes which is connected to a very tough metal rope. The tough metal rope passes through a sheave on the elevator in the engine room. Herea sheave is like a wheel in pulley system for clutching the metal rope strongly. This system canbe operated by a motor. When the switch is turned ON, the motor can be activated when the elevator goes up and down or stops.
The elevator can be constructed with various elevator Components or elevator parts that mainly include speed controlling system, electric motor, rails, cabin, shaft, doors (manual and automatic), drive unit, buffers, and safety device.

7.6 Electrical Circuit Diagram

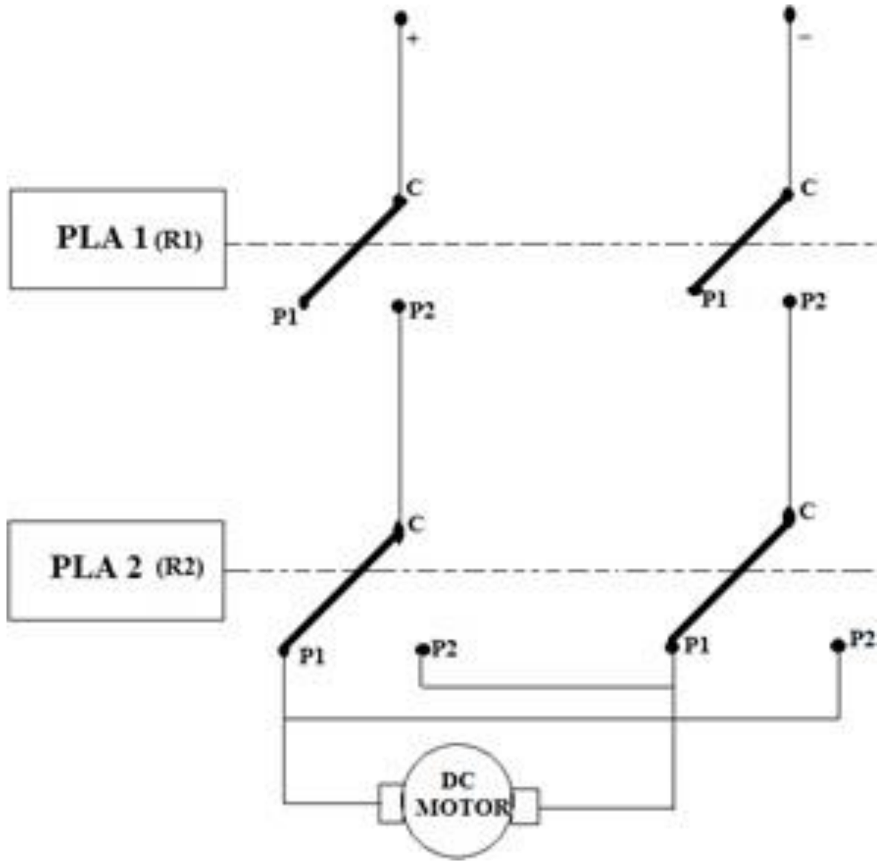

Figure 7.1 Electrical connection diagram.

7.7 PLC Connection Diagram

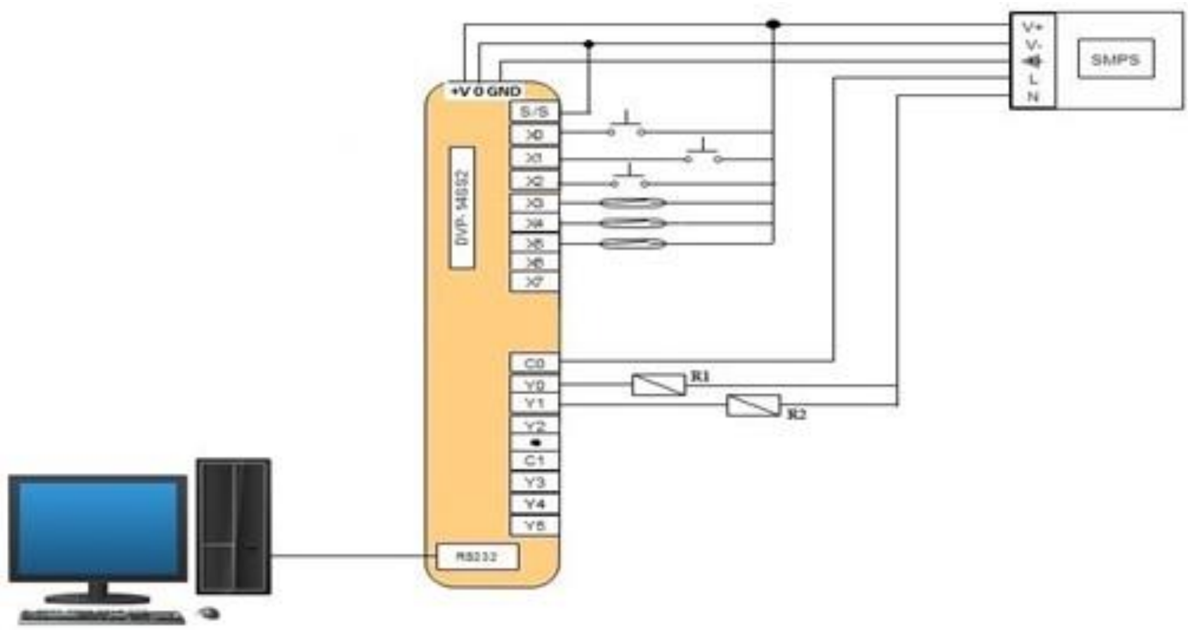

Figure 7.2 PLC connection diagram

7.8 Procedure

1. Give the hardware connections by observing the electrical connection diagram and PLC connection diagram shown in figures 7.1 and 7.2.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for lift control as shown in figure 7.3.
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

7.9 Ladder Diagram Program

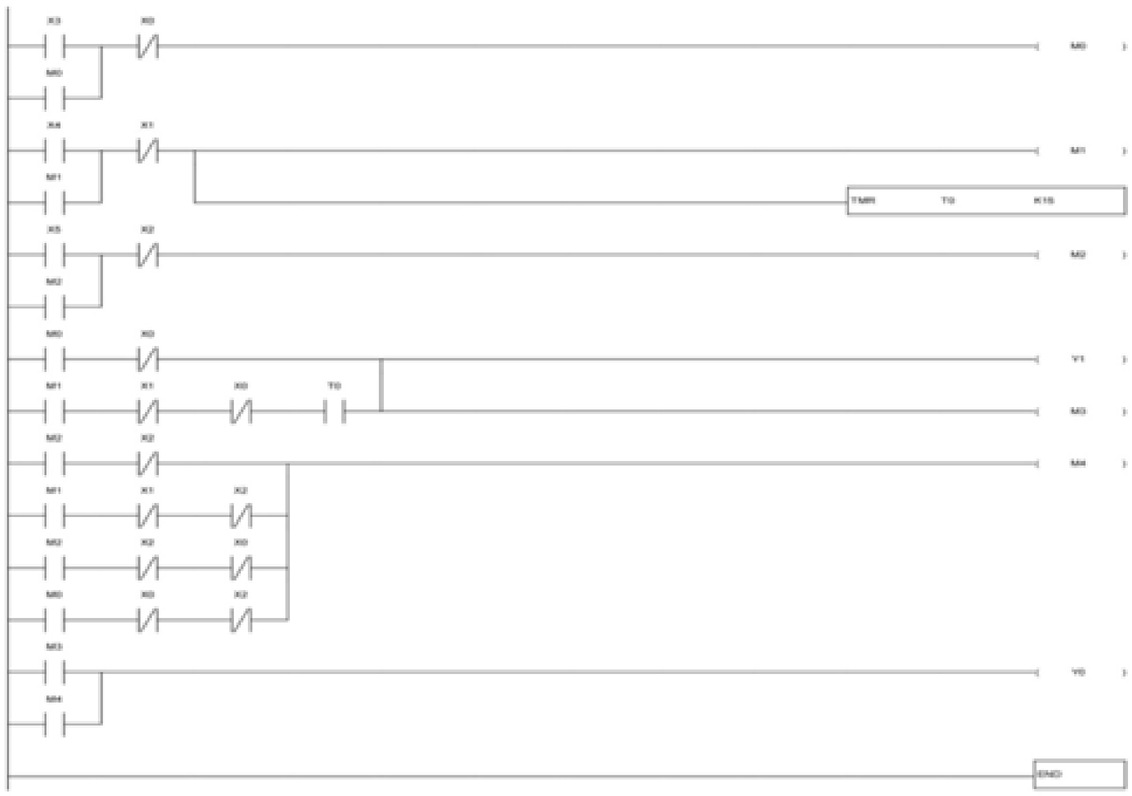

Figure 7.3 Ladder diagram of lift control operation

7.10 Further Probing Experiments

1. Write a PLC program to control the conveyor belt in manufacturing industry.
2. Write a PLC program to control the lift up to 5 floors.

LAB-8 CONTROL OF LIFT

8.1 Introduction

With the development of urbanization, the problem of urban traffic congestion has attracted more and more attention, and the traffic congestion has become a major problem restricting urban development. Cities have built high-speed road, main road, the subway to play its expected role, and the same sections in different periods of the traffic condition, how to adopt the suitable control method, the maximum advantage of one city road, reduce traffic congestionin peak road, has become a problem to be solved in the traffic control. It can be seen that improving traffic light control system and improving its flexibility and adaptability to realize intelligent traffic guidance is the trend of future development.

8.2 Objective

By the end of this lab, the student should learn the hardware connections and PLC ladder diagram program for a traffic signal control system.

8.3 Prelab Preparation:

Read the material in the textbook that describes about the traffic signal system and traffic signal rules. Prior to coming to lab class, have glance of the Procedure.

8.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

8.5 Background

Traffic lights were first invented in the year 1868 at London's House of Commons where traffic light signals were placed at intersections of George and Bridge Street. Later the traffic lights were developed in the year 1914 by an American Traffic Signal Company, which fixed green and red lights at corners of the 105th street and Euclid Avenue in Cleveland, Ohio. During this period traffic lights were controlled either by timing or by switching manually.

Traffic lights are also named as stoplights, road traffic lamps, traffic signals, stop-and-go lights which are signaling devices placed at road crossings, everyday pedestrian crossings and other locations to control competing flows of traffic. Traffic lights have been fixed allover the world in many cities. Traffic light control assigns a right way to the road users by using lights in normal colors (red – amber/yellow – green).Traffic light control system uses a worldwide color code (a specific color order to enable color recognition for those who are color blind).

In China, there were unsuccessful efforts to change the importance of “red” to “go” during the Cultural Revolution. Typically traffic lights consist of three types of colored lights such as red, orange and green. In a typical cycle, turning on of a green light allows traffic to continue in the way indicated. Similarly, lighting of the amber/orange light for a short time of transition represents a signal to prepare to stop, and the Illumination of the red signal disallows any traffic from going on.

8.6 Block Diagram

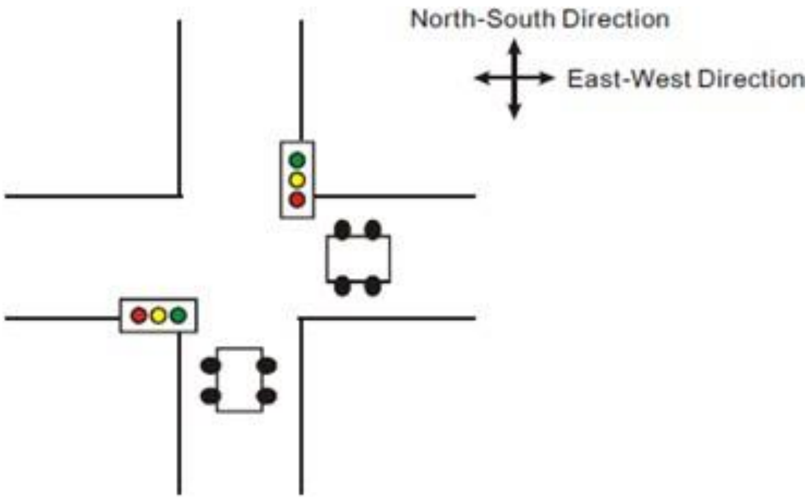

Figure 8.1 Traffic signal control system

8.7 PLC Connection Diagram

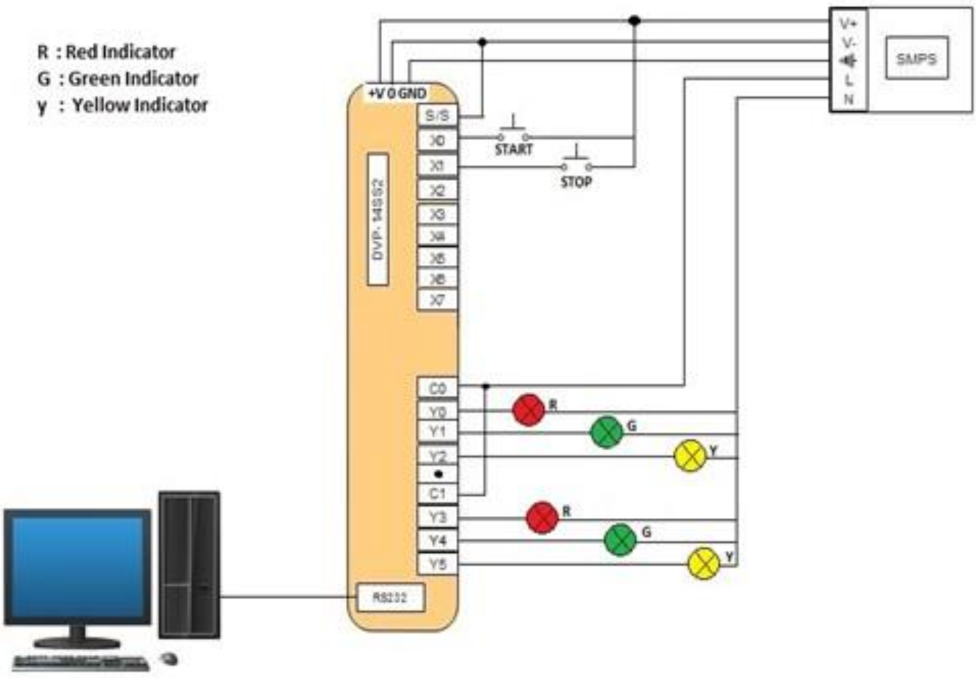

Figure 8.2 PLC connection diagram

8.8 Procedure

1. Observe the traffic light control system as shown in the figure 8.1 and Give the PLC connections to the all the three lights of each road as shown in the PLC connection diagram.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for traffic signal control system as shown in figure 8.3
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

8.9 Ladder Diagram Program

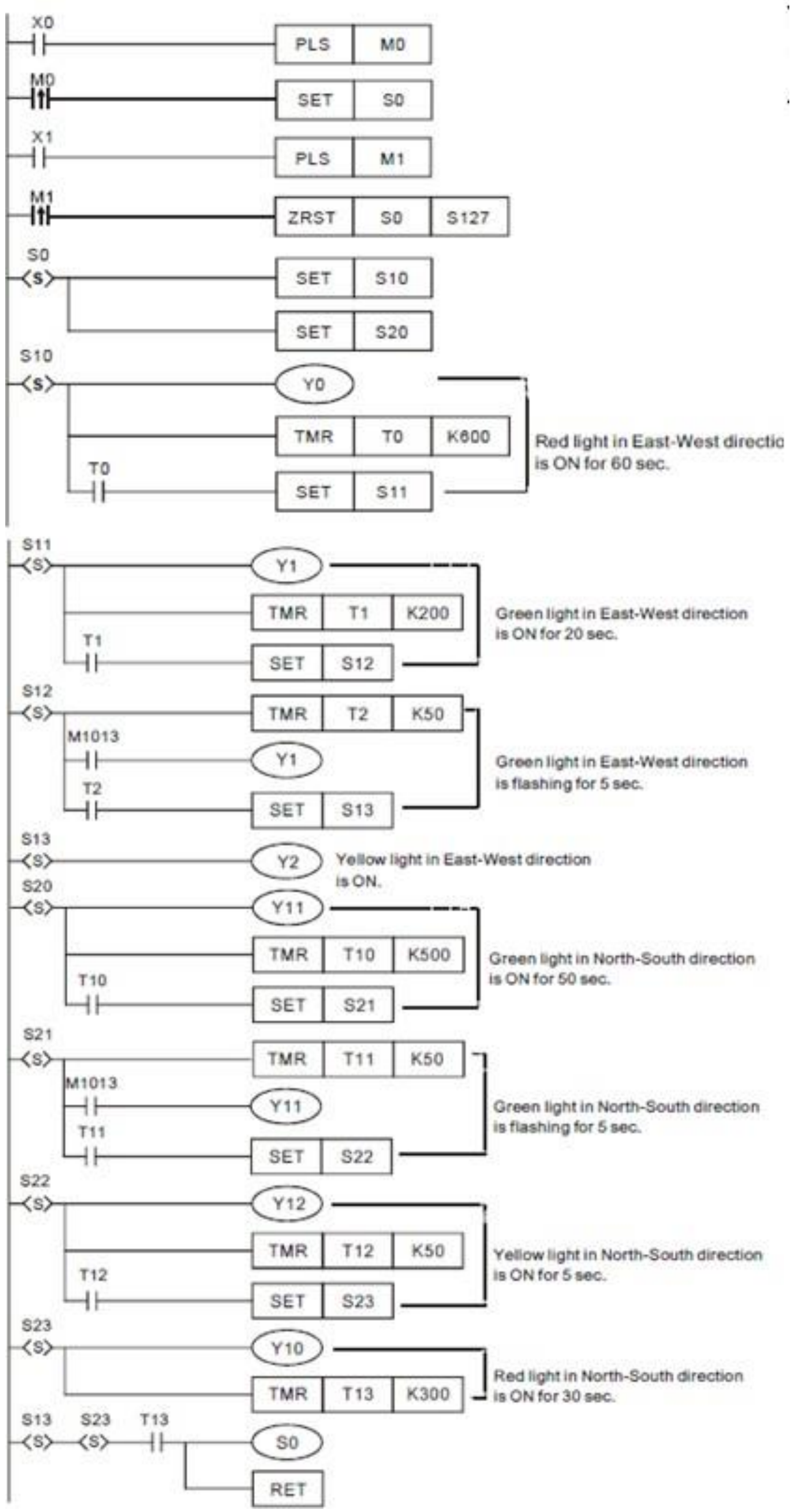

Figure 8.3 Ladder diagram for traffic signal system

8.10 Further Probing Experiments

1. Write a traffic signal control program for a 3-way road junction.
2. Write a traffic signal control program based on the crowd of vehicles at a junction.

LAB-9 IMPLEMENTATION OF TIMERS

9.1 Introduction

Timers are very important in controlling an industrial process according to the user defined norms. There are mainly three types of timers are available in PLC's such as ON delay andOFF delay timers. These timers can be used at any time depending on the control process.

9.2 Objective

By the end of this lab, the student should learn the implementation of ON delay timer and OFF delay timer.

9.3 Prelab Preparation:

Read the material in the textbook that describes the different types of PLC timers and their usage. Prior to coming to lab class, have glance of the Procedure.

9.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

9.5 Background

The units of the timer are 1ms, 10ms and 100ms and the counting method is counting up. When the present value in the timer equals the set value, the associated output coil will be ON. The set value should be a K value in decimal and can be specified by the content of data register D. The actual set time in the timer = timer resolution set value Ex: If set value is K200 and timer resolution is 10ms, the actual set time in timer will be 10ms*200 = 2000ms = 2 sec.
General Timer: The timer executes once when the program reaches END instruction. When TMR instruction is executed, the timer coil will be ON when the current value reaches its preset value. When X0 = ON, TMR instruction is driven. When current value achieves K100, the assocailte timer contact T0 is ON to drive Y0. If X0 = OFFor the power is off, the current value in T0 will be cleared as 0 and output Y0 driven by contact T0 will be OFF.

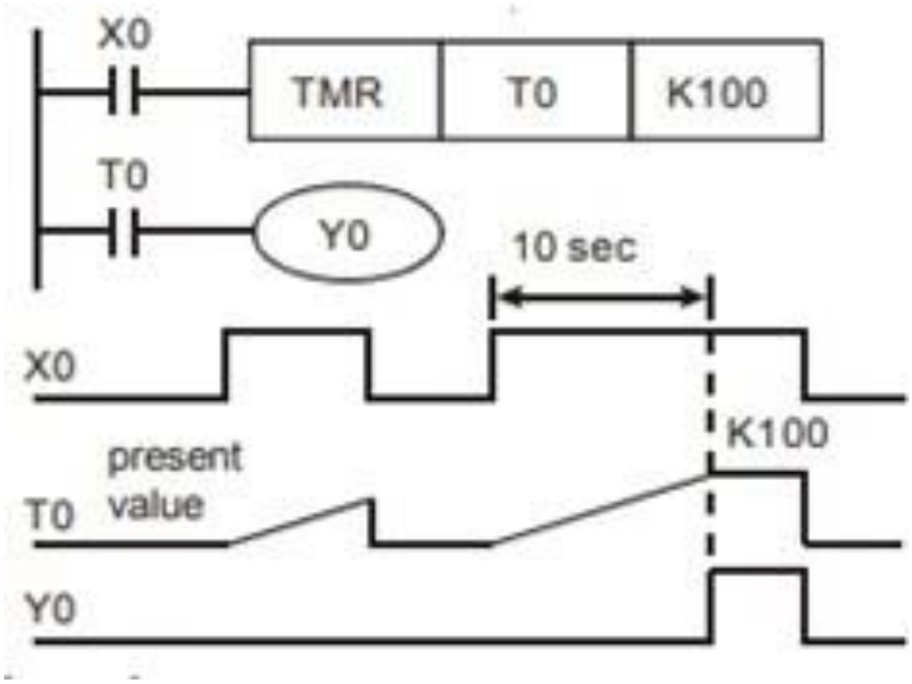

Figure 9.1 General purpose timer wave diagram

Accumulative Timer: The timer executes once when the program reaches END instruction. When TMR instruction is executed, the timer coil will be ON when the current value reaches its preset value. For accumulative timers, current value will not be cleared when timing is interrupted. Timer T250 will be driven when X0 = ON. When X0 = OFFor the power is off, timer T250 will pause and retain the current value. When X0 is ON again, T250 resumes timing from where it was paused.

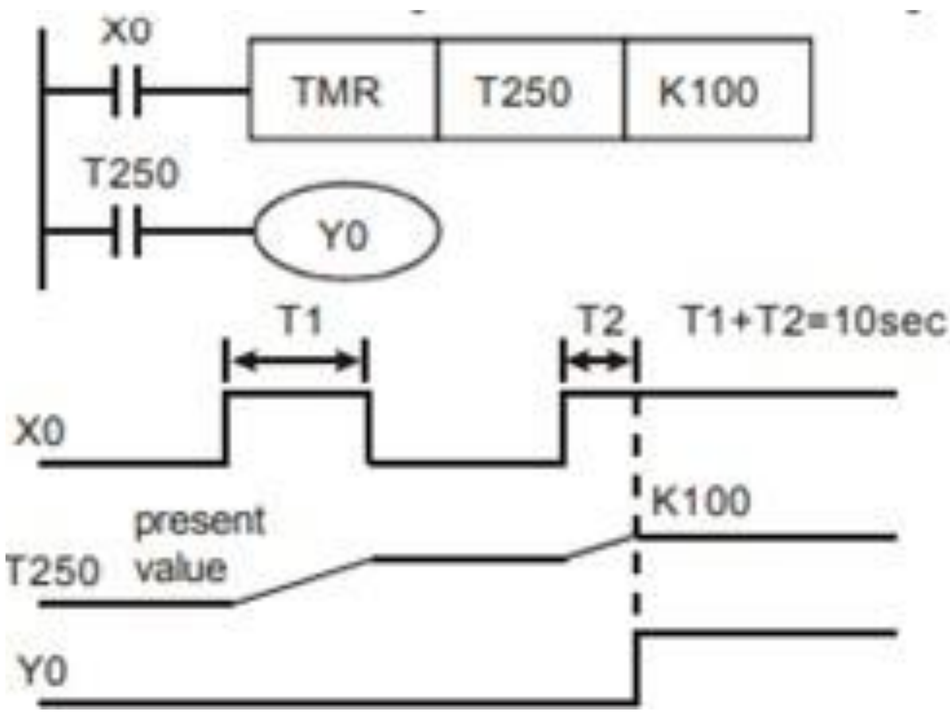

Figure 9.2 Accumulative timer wave diagram

Timers for Subroutines and Interrupts: Timers for subroutines and interrupts count once when END instruction is met. The associated output coils will be ON if the set value is achieved when End instruction executes. T184 T199 are the only timers that can be used in subroutines or interrupts. Generals timers used in subroutines and interrupts will not work if the subroutines or interrupts are not executing.

9.6 Procedure

9.6.1 OFF Delay Timer:

1. Open the WPLSoft software in desktop / laptop.
2. Select the proper model no. of PLC in the dialogue box and click on Ok.
3. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
4. Write the Relay Ladder Logic program for OFF delay timer as shown in figure 9.3.
5. Compile the program using Ctrl+F7 and if any errors correct the program.
6. Write the program to PLC using Ctrl+F8 and check the output.
7. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

9.6.2 ON Delay Timer:

1. Open the WPLSoft software in desktop / laptop.
2. Select the proper model no. of PLC in the dialogue box and click on Ok.
3. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
4. Write the Relay Ladder Logic program for ON delay timer as shown in figure 9.4.
5. Compile the program using Ctrl+F7 and if any errors correct the program.
6. Write the program to PLC using Ctrl+F8 and check the output.
7. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

9.7 Ladder Diagram Programs

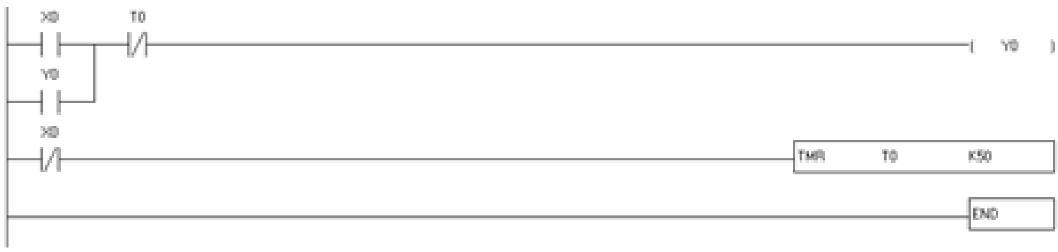

Figure 9.3 PLC Ladder Diagram for OFF Delay Timer

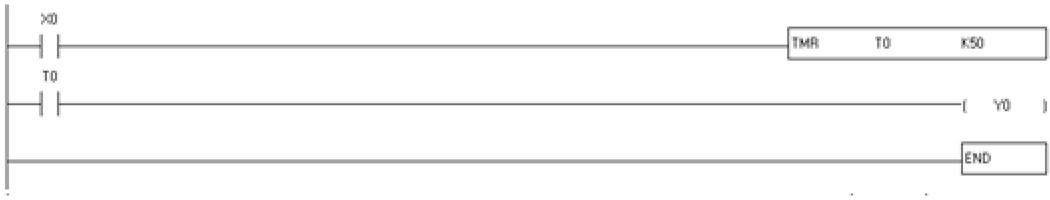

Figure 9.4 PLC Ladder Diagram for ON Delay Timer

9.8 Further Probing Experiments

1. Write a PLC ladder diagram program to switch ON the heater on pressing the ON push button and switch OFF automatically after 20minutes.

2. Write a PLC ladder program to ring the college bell for every one hour.

LAB-10 SOLAR TRACKING

10.1 Introduction

In photovoltaic systems, trackers help minimize the angle of incidence (the angle that a ray of light makes with a line perpendicular to the surface) between the incoming light and the panel, which increases the amount of energy the installation produces. Concentrated solar photovoltaicand concentrated solar thermal have optics that directly accepts sunlight, so trackers must be angled correctly to collect energy. All concentrated solar systems have trackers because the systems do not produce energy unless directed correctly toward the sun.

10.2 Objective

By the end of this lab, the student should learn the hardware connections and software implementation of solar tracking system using PLC.

10.3 Prelab Preparation:

Read the material in the textbook that describes about the components and operation of single axis or dual axis solar tracking system. Prior to coming to lab class, have glance of the Procedure.

10.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

10.5 Background

Solar Trackers direct solar panels or modules toward the sun. These devices change their orientation throughout the day to follow the sun's path to maximize energy capture. In photovoltaic systems, trackers help minimize the angle of incidence (the angle that a ray of light makes with a line perpendicular to the surface) between the incoming light and the panel, which increases the amount of energy the installation produces. Concentrated solar photovoltaic and concentrated solar thermal have optics that directly accept sunlight, so solar trackers must be angled correctly to collect energy. All concentrated solar systems have trackers because the systems do not produce energy unless directed correctly toward the sun.
Single-axis solar trackers rotate on one axis moving back and forth in a single direction. Different types of single-axis trackers include horizontal, vertical, tilted, and polar aligned, which rotate as the names imply. Dual-axis trackers continually face the sun because they can move in two different directions. Types include tip-tilt and azimuth-altitude. Dual-axis tracking is typically used to orient a mirror and redirect sunlight along a fixed axis towards a stationary receiver.

Because these trackers follow the sun vertically and horizontally they help obtain maximum solar energy generation.

10.6 Block Diagram

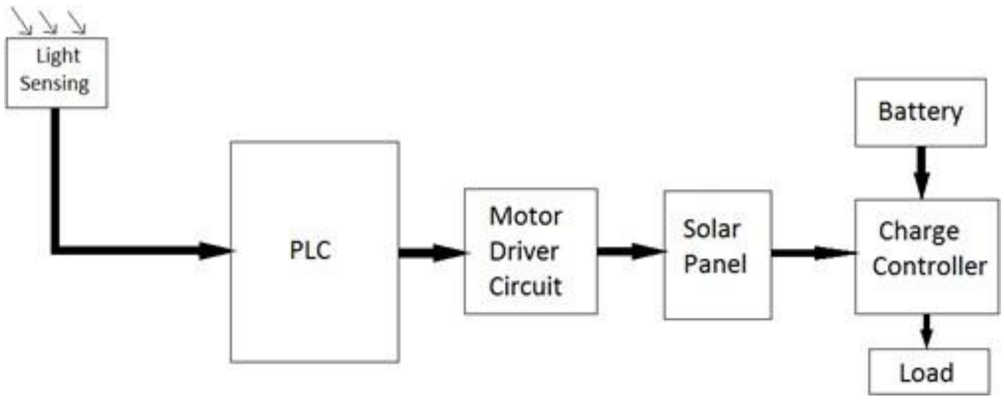

Figure 10.1 Block diagram of solar tracking system

10.7 PLC Connection Diagram

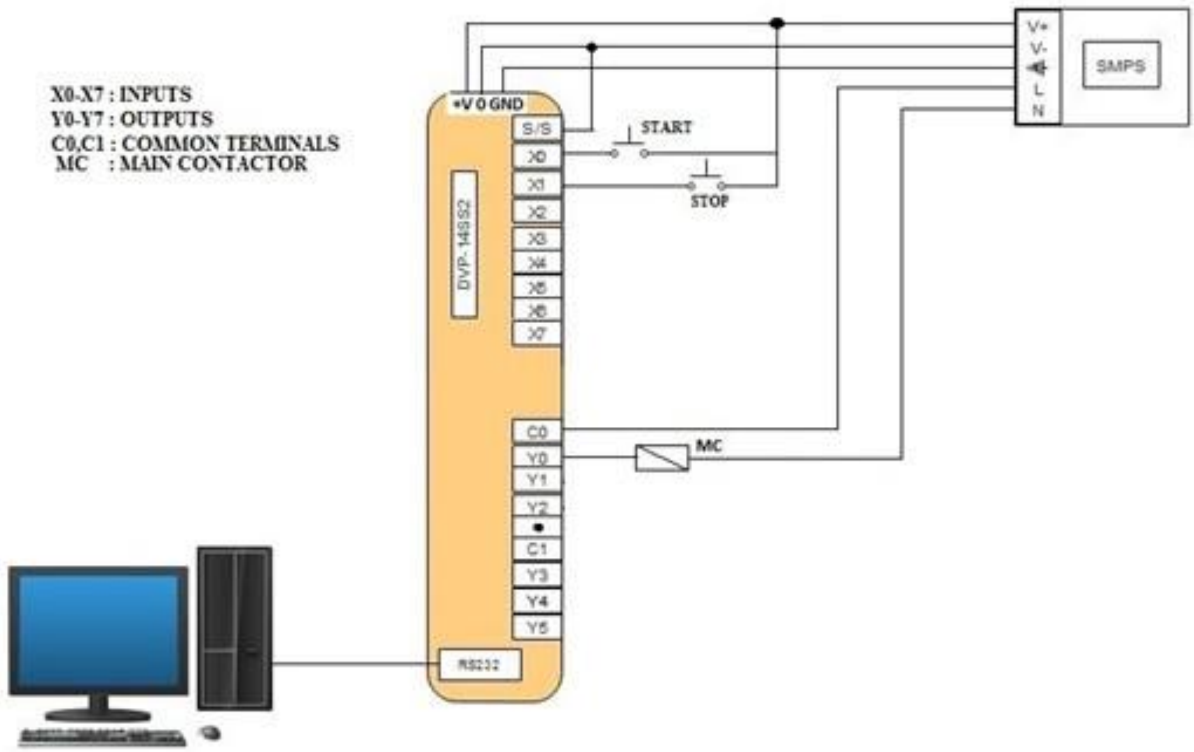

Figure 10.2 PLC connection diagram

10.8 Procedure

1. Give the hardware connections by observing the electrical connection diagram and PLC connection diagram shown in figures 10.1 and 10.2.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for solar tracking system as shown in figure 10.3
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

10.9 Ladder Diagram Program

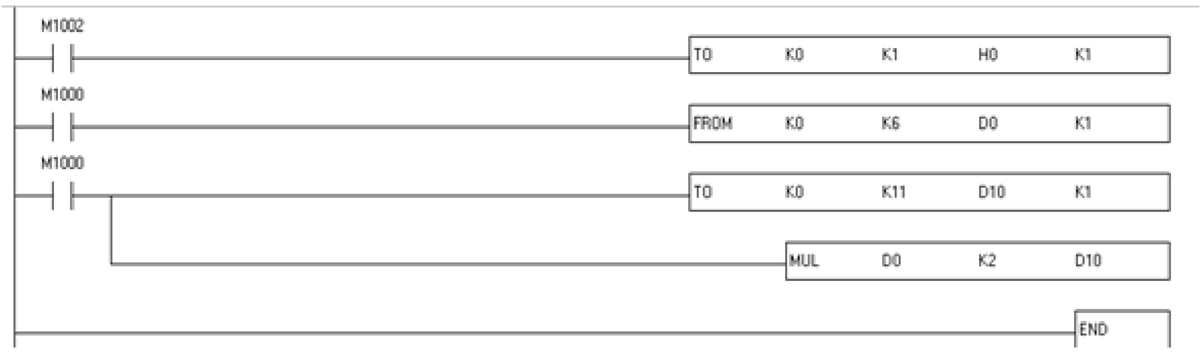

Figure 10.3 Ladder diagram for solar tracking

10.10 Further Probing Experiments

1. Write a PLC program to control the solar PV panel using dual axis solar tracking method.
2. Write a PLC program for Maximum power point tracking (MPPT) of a solar panel.

LAB-11 DIRECT ONLINE STARTER

11.1 Introduction

A three phase induction motor is started by using different types of starters such as Direct online (DOL) starter, star-delta starter, autotransformer starter etc. The selection of a particular type of starter depends on the rating of three phase motor and application. Generally a DOL starter is used for motors with below 5hp rating.

11.2 Objective

By the end of this lab, the student should learn the hardware connections and software implementation of DOL starter using PLC.

11.3 Prelab Preparation:

Read the material in the textbook that describes about the components and operation of Direct online starter. Prior to coming to lab class, have glance of the Procedure.

11.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

11.5 Background

A Direct On-Line (DOL) or across the line starter applies the full line voltage to the motor terminals. This is the simplest type of motor starter. A DOL motor starter also has protection devices and, in some cases, condition monitoring. Smaller sizes of direct on-line starters are manually operated; larger sizes use an electromechanical contactor (relay) to switch the motor circuit. Solid-state direct on line starters also exist. A direct on line starter can be used if the high inrush current of the started motor does not cause excessive voltage drop in the supply circuit. The maximum size of a motor allowed on a direct on line starter may be limited bythe supply utility for this reason. For example, a utility may require rural customers to use reduced-voltage starters for motors larger than 4KW (5HP). DOL starting is sometimes used to start small water pumps, compressors, fans and conveyor belts. In the case of an asynchronous motor, such as the 3-phase squirrel-cage motor, the motor will draw a high starting current until it has run up to full speed. This starting current is typically 6-7 times greater than the full load current. To reduce the inrush current, larger motors will have reduced voltage starters or variable speed drives in order to minimize voltage dips to the power supply, or series resistance and inductance can be added.

11.6 Electrical Connection Diagram

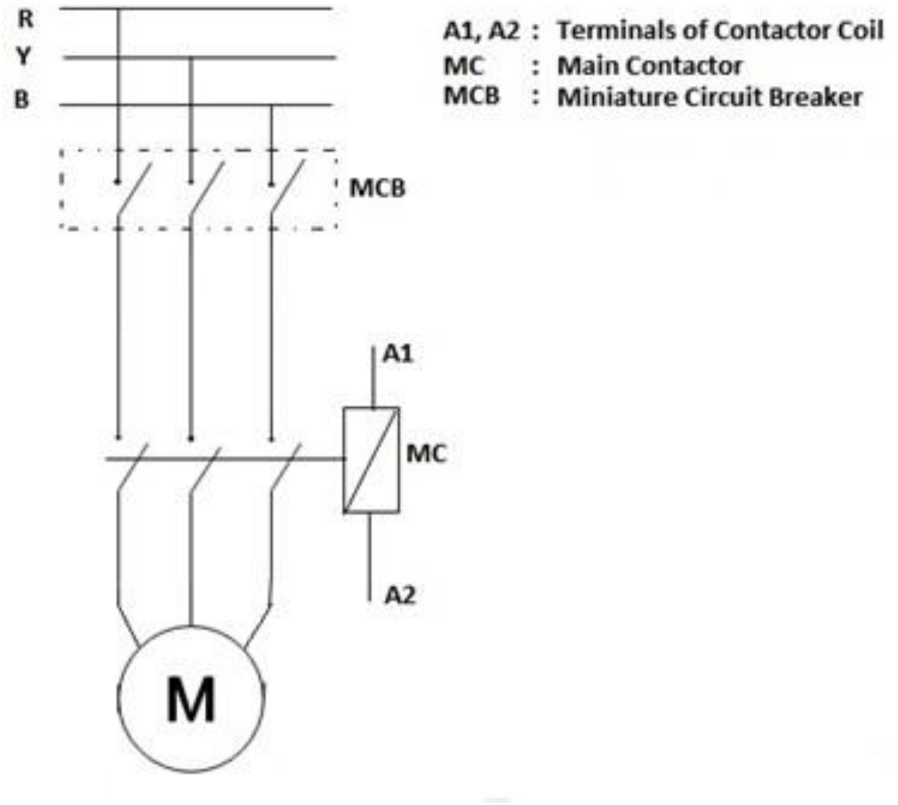

Figure 11.1 Electrical connection diagram

11.7 PLC Connection Diagram

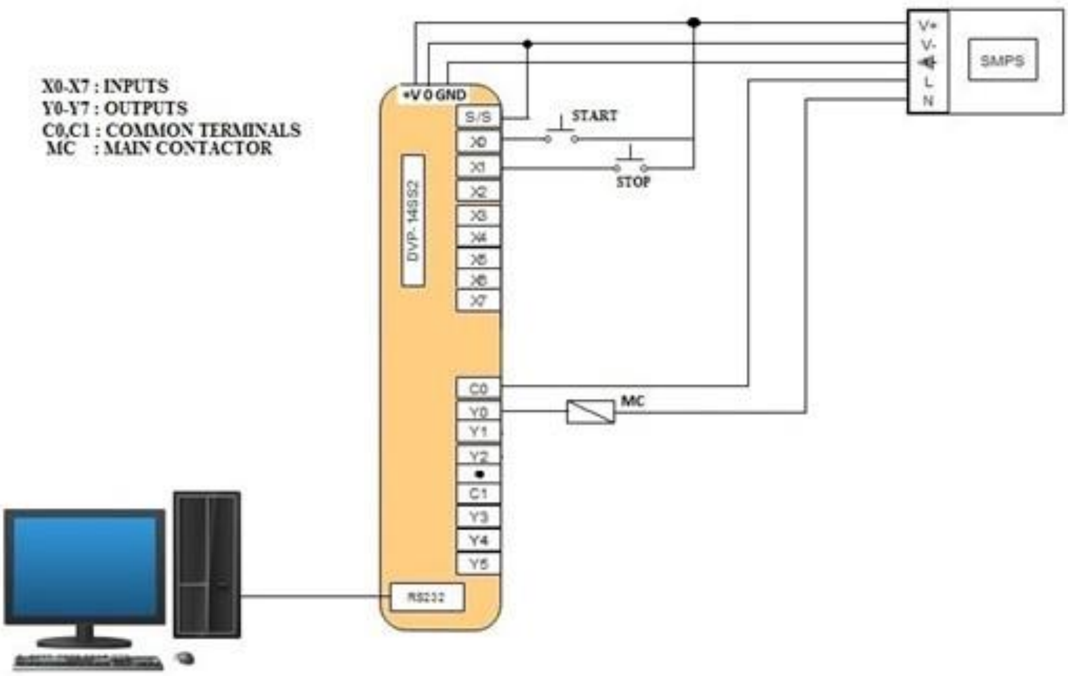

Figure 11.2 PLC connection diagram

11.8 Procedure

1. Give the hardware connections by observing the electrical connection diagram and PLC connection diagram shown in figures 11.1 and 11.2.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for Direct online starter as shown in figure 11.3
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

11.9 Ladder Diagram Program

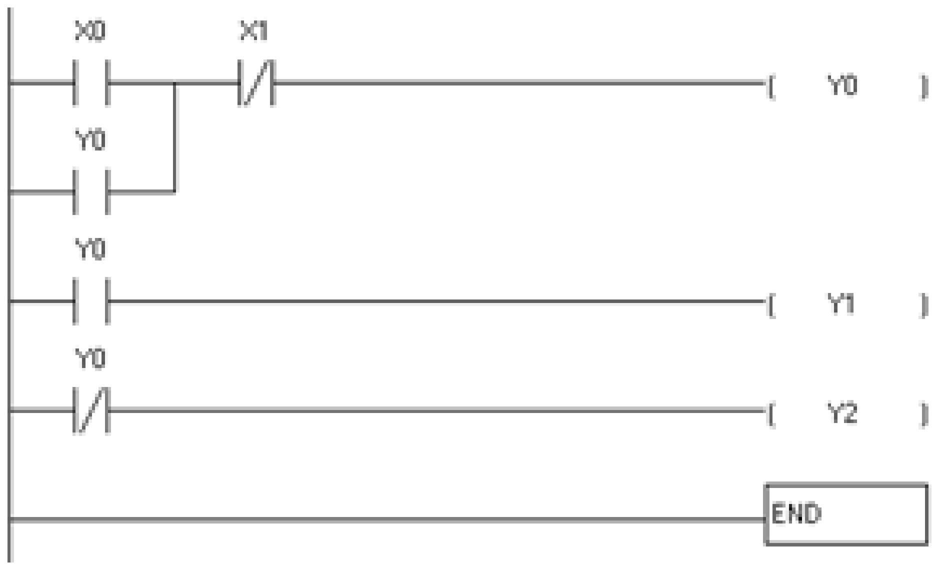

Figure 11.3 Ladder diagram for Direct online starter

11.10 Further Probing Experiments

1. Write a PLC ladder diagram program to start the induction motor by rotor resistance starter.
2. Write a control program to start/stop the induction motor by only one switch and to protect the motor from over currents.

LAB-12 UP DOWN COUNTER

12.1 Introduction

Counters are very important in counting the no. of products produced in an industry or to maintain or record the products in a warehouse. There are mainly two types of timers are available in PLC's such as Up counter and Up-Down counters. These counters can be used at any time depending on the control process.

12.2 Objective

By the end of this lab, the student should learn the implementation of UP Counter and Up-Down counter.

12.3 Prelab Preparation:

Read the material in the textbook that describes about the counters and their usage. Prior to coming to lab class, have glance of the Procedure.

12.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

12.5 Background

Counters will increment their present count value when input signals are triggered from OFF to ON.When X0 = ON, RST instruction resets C0. Every time When X1 is driven, C0 will count up (add 1). When C0 reaches the present value K5, output coil Y0 will be ON and C0 will stop counting and ignore the signals from input X1.

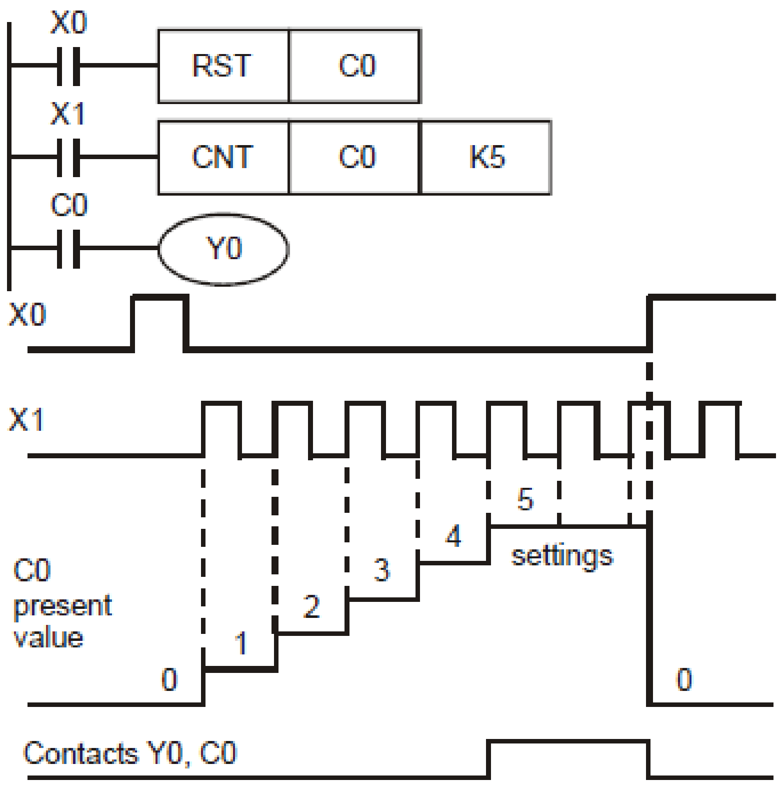

Figure 12.1 Counter Operation

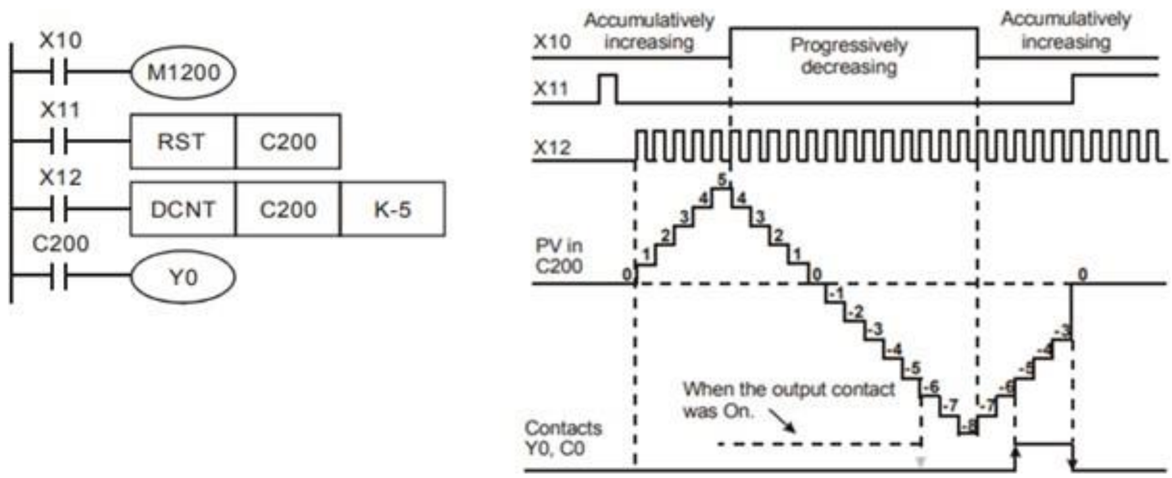

Figure 12.2 Up-down counter operation

X10 drives M1200 to determine counting direction (up / down) of C200. When X11 goes from OFF to ON, RST instruction will be executed and the PV (present value) in C200 will be clearedand contact C200 is OFF. When X12 goes from Off to On, PV of C200 will count up (plus 1)or countdown (minus 1). When PV in C200 changes from K-6 to K-5, the contact C200 will be energized. When PV in C200 changes from K-5 to K-6, the contact of C200 will be reset. If MOV instruction is applied through WPLSoft or HPP to designate a value bigger than SV to the PV register of C0, next time when X1 goes from OFF to ON, the contact C0 will be ON and PV of C0 will equal SV.

12.6 Procedure

12.6.1 UP Counter:

1. Open the WPLSoft software in desktop / laptop.
2. Select the proper model no. of PLC in the dialogue box and click on Ok.
3. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
4. Write the Relay Ladder Logic program for Up counter as shown in figure 12.3
5. Compile the program using Ctrl+F7 and if any errors correct the program.
6. Write the program to PLC using Ctrl+F8 and check the output.
7. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

12.6.2 UP-Down Counter:

1. Open the WPLSoft software in desktop / laptop.
2. Select the proper model no. of PLC in the dialogue box and click on Ok.
3. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
4. Write the Relay Ladder Logic program for UP-Down Counter as shown in figure 12.4
5. Compile the program using Ctrl+F7 and if any errors correct the program.
6. Write the program to PLC using Ctrl+F8 and check the output.
7. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

12.7 Ladder Diagram Programs

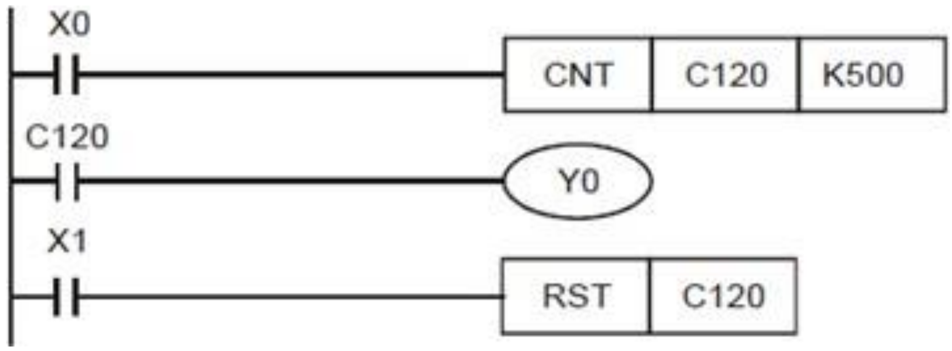

Figure 12.3 UP counter

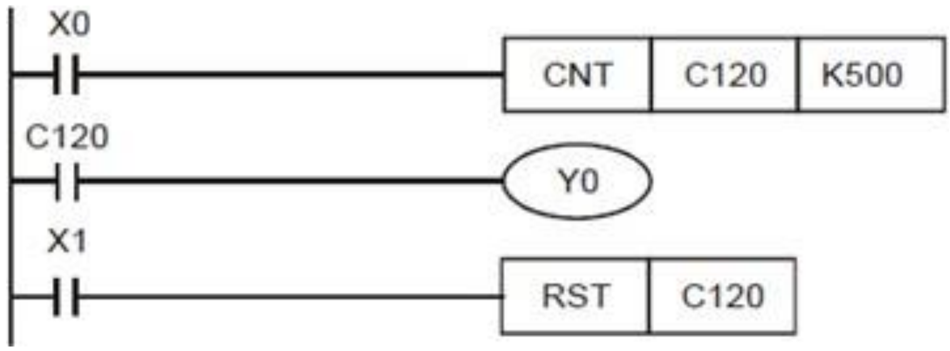

Figure 12.4 Up-Down Counter

12.8 Further Probing Experiments

1. Write a control program to count no. of products produced in a factory and start the packing machine for every 20 products produced.
2. Write a control program to keep tracking of vehicles in a parking station.

LAB-13 DIGITAL CLOCK

13.1 Introduction

The 24-hour clock, popularly referred to in the United States and some other countries as military time, is the convention of timekeeping in which the day runs from midnight to midnight and is divided into 24 hours. This is indicated by the hours passed since midnight, from 0 to 23. This system is the most commonly used time notation in the world today, and is used by the international standard ISO 8601.

13.2 Objective

By the end of this lab, the student should learn the hardware connections and PLC ladder diagram program for a 24hr digital clock using three PLC counters.

13.3 Prelab Preparation:

Read the material in the textbook that describes about the 24 hr clock. Prior to coming to lab class, have glance of the Procedure.

13.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

13.5 Background

There are two types of clock, 12-hour clocks and 24-hours clocks. In the 24-hour clock format, each day runs from midnight to midnight and is divided into 24 hours. 24-Hour Clock Time uses the numbers 00:00 (midnight) until 23:59 to tell the time. You don’t need to use am / pm with a 24-Hour Clock, as afternoon is indicated by a number bigger than 12. 24-Hour Clock Time is commonly used as a format on digital clocks. It differs from 12 hour time, which uses two cycles of 12 hours in the morning (am) and afternoon (pm). This runs from 1am to 12 noon and then from 1pm to 12 midnight. 12 hour time can be read on analogue clocks. These are clocks with a full clock face and three hands - an hour hand, a minute hand, and one to count the seconds.

Figure 13.1 24 hr digital clock

13.6 Procedure

13.6.1 UP Counter:

1. Observe the 24 hr digital clock system which is shown in figure 13.1.
2. Select the three counters C0, C1 and C2 for counting the seconds, minutes and hours respectively along with the 1second clock pulse register M1013 as in Table 1.

Device	Function
C0	count per second
C1	count per minute
C2	count per hour
M1013	1s clock pulse

Tablle 1: Counters selection for digital clock

3. Open the WPLSoft software in desktop / laptop.
4. Select the proper model no. of PLC in the dialogue box and click on Ok.
5. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
6. Write the Relay Ladder Logic program for 24 hr digital clock as shown in figure 13.2
7. Compile the program using Ctrl+F7 and if any errors correct the program.
8. Write the program to PLC using Ctrl+F8 and check the output.
9. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

13.7 Ladder Diagram Program

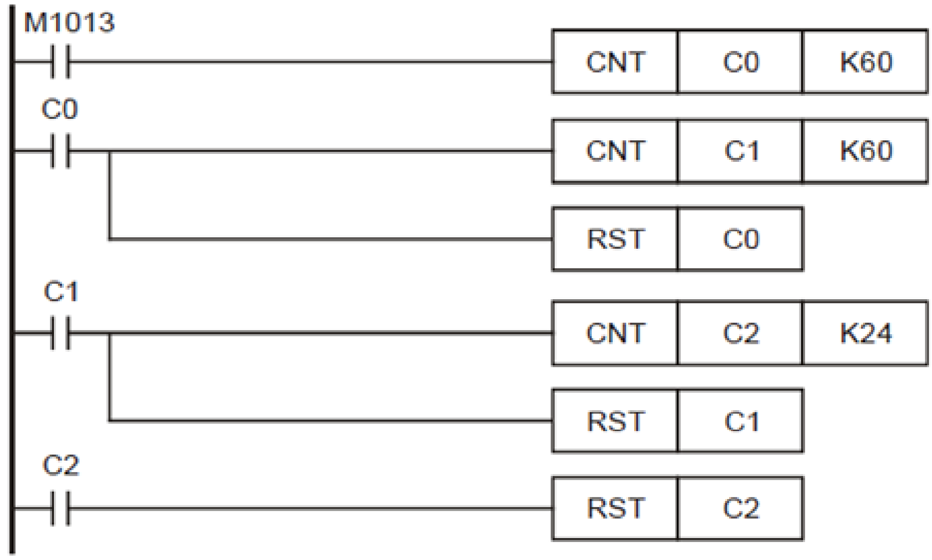

Figure 13.2 Ladder diagram for digital clock

13.8 Further Probing Experiments

1. Write a control program to count no. of products produced in a factory and start the packing machine for every 20 products produced.
2. Write a control program to keep tracking of vehicles in a parking station.

LAB-14 TIMERS

14.1 Introduction

Timers are very important in controlling an industrial process according to the user defined norms. There are mainly three types of timers are available in PLC's such as ON delay, OFFdelay timer and retentive timers. These timers can be used at any time depending on the control process.

14.2 Objective

By the end of this lab, the student should learn the implementation of ON delay timer, OFF delay timer and retentive timers.

14.3 Prelab Preparation:

Read the material in the textbook that describes the different types of PLC timers and their usage. Prior to coming to lab class, have glance of the Procedure.

14.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

14.5 Background

The units of the timer are 1ms, 10ms and 100ms and the counting method is counting up. When the present value in the timer equals the set value, the associated output coil will be ON. The set value should be a K value in decimal and can be specified by the content of data register D. The actual set time in the timer = timer resolution set value Ex: If set value is K200 and timer resolution is 10ms, the actual set time in timer will be 10ms*200 = 2000ms = 2 sec.
General Timer: The timer executes once when the program reaches END instruction. When TMR instruction is executed, the timer coil will be ON when the current value reaches its preset value. When X0 = ON, TMR instruction is driven. When current value achieves K100, the assocailte timer contact T0 is ON to drive Y0. If X0 = OFFor the power is off, the current value in T0 will be cleared as 0 and output Y0 driven by contact T0 will be OFF.

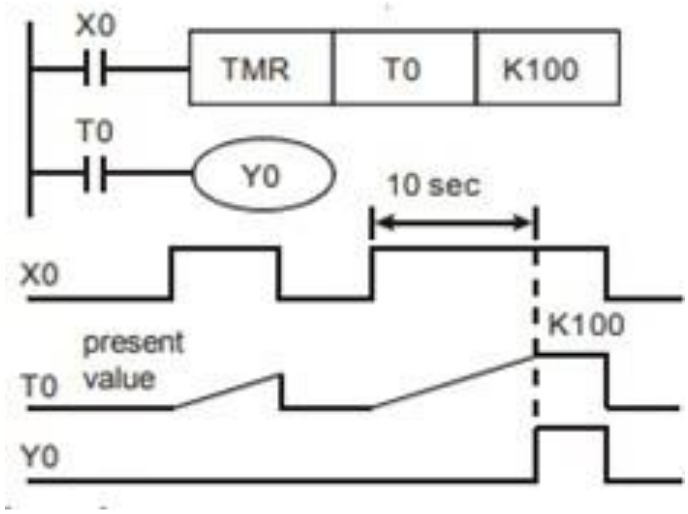

Figure 14.1 General purpose timer wave diagram

Accumulative Timer: The timer executes once when the program reaches END instruction. When TMR instruction is executed, the timer coil will be ON when the current value reaches its preset value. For accumulative timers, current value will not be cleared when timing is interrupted. Timer T250 will be driven when X0 = ON. When X0 = OFFor the power is off, timer T250 will pause and retain the current value. When X0 is ON again, T250 resumes timing from where it was paused.

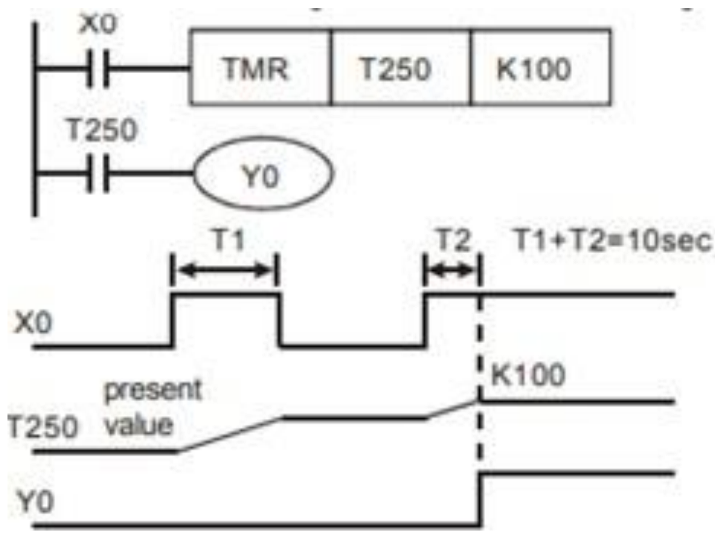

Figure 14.2 Accumulative timer wave diagram

Timers for Subroutines and Interrupts: Timers for subroutines and interrupts count once when END instruction is met. The associated output coils will be ON if the set value is achieved when End instruction executes. T184 T199 are the only timers that can be used in subroutines or interrupts. Generals timers used in subroutines and interrupts will not work if the subroutines or interrupts are not executing.

14.6 Procedure

14.6.1 OFF Delay Timer:

1. Open the WPLSoft software in desktop / laptop.
2. Select the proper model no. of PLC in the dialogue box and click on Ok.
3. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
4. Write the Relay Ladder Logic program for OFF delay timer as shown in figure 14.3.
5. Compile the program using Ctrl+F7 and if any errors correct the program.
6. Write the program to PLC using Ctrl+F8 and check the output.
7. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

14.6.2 ON Delay Timer:

1. Open the WPLSoft software in desktop / laptop.
2. Select the proper model no. of PLC in the dialogue box and click on Ok.
3. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
4. Write the Relay Ladder Logic program for ON delay timer as shown in figure 14.4.
5. Compile the program using Ctrl+F7 and if any errors correct the program.
6. Write the program to PLC using Ctrl+F8 and check the output.
7. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

14.7 Ladder Diagram Programs

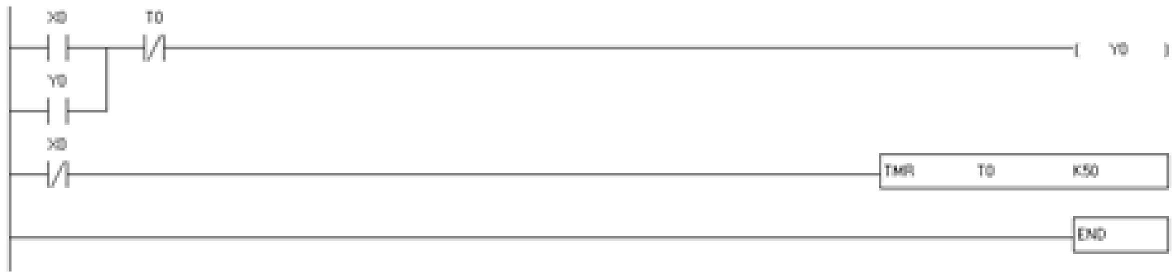

Figure 14.3 PLC Ladder Diagram for OFF Delay Timer

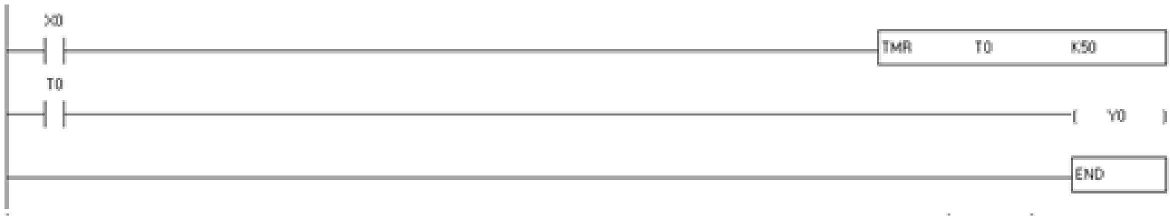

Figure 14.4 PLC Ladder Diagram for ON Delay Timer

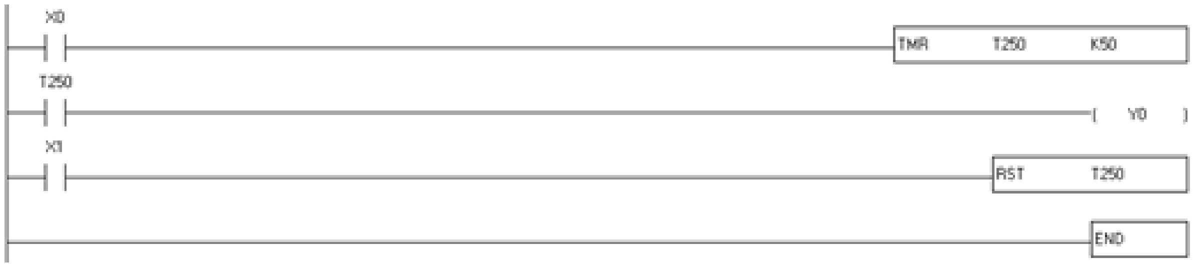

Figure 14.5 PLC Ladder Diagram for Accumulative Timer

14.8 Further Probing Experiments

1. Write a PLC ladder diagram program to switch ON the heater on pressing the ON push button and switch OFF automatically after 20minutes.
2. Write a PLC ladder program to ring the college bell for every one hour.

LAB-15 SEQUENTIAL CONTROL

15.1 Introduction

Programmable Logic Controller (PLG) is extensively used in industries for controlling sequence of actions of the process since last two decades. Hence we have decided to develop PLC based sequential batch process control system of our laboratory. The sequence of process flow is decided for controlling the parameters like level and temperature.

15.2 Objective

By the end of this lab, the student should learn the hardware connections and PLC ladder diagram program for a sequential control of three motors.

15.3 Prelab Preparation:

Read the material in the textbook that describes about the components importance of sequential control operation. Prior to coming to lab class, have glance of the Procedure.

15.4 Equipment needed

1. PLC Demo Kit
2. Laptop / Desktop with WPLsoft Software

15.5 Background

Programmable Logic Controller (PLG) is extensively used in industries for controlling sequence of actions of the process since last two decades. Hence we have decided to develop PLC based sequential control system to control the sequential on/off of three motors. The sequence of process flow is decided for controlling the parameters like level and temperature. The brain of the system is PLC. Appropriate hardware for interfacing the process to the controller is developed. For controlling sequence of actions ladder diagram is developed. Timer provides precise timings. Finally this system is factory programmable.

15.6 Electrical Connection Diagram

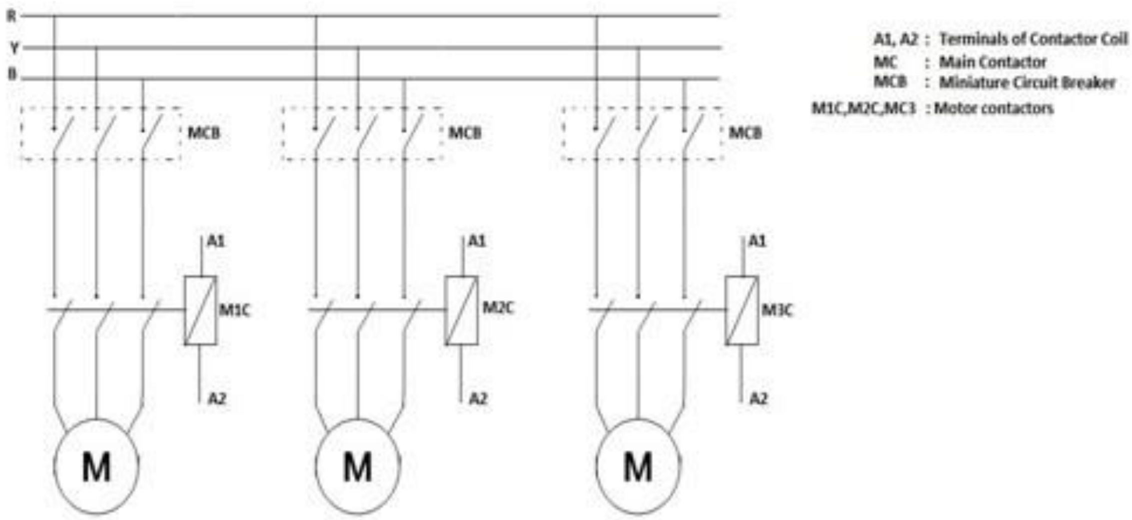

Figure 15.1 Electrical connection diagram

15.7 PLC Connection Diagram

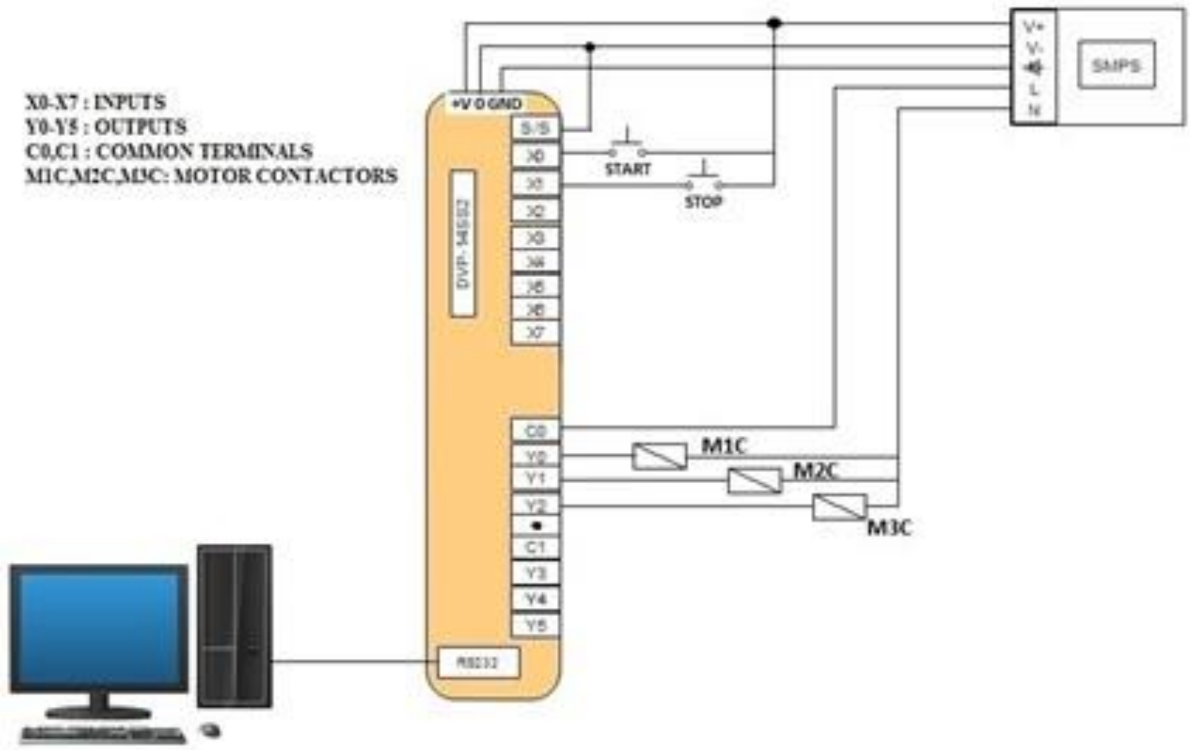

Figure 15.2 PLC connection diagram

15.8 Procedure

1. Give the hardware connections by observing the electrical connection diagram and PLC connection diagram shown in figures 15.1 and 15.2.
2. Open the WPLSoft software in desktop / laptop.
3. Select the proper model no. of PLC in the dialogue box and click on Ok.
4. Two windows Instruction list mode and Ladder diagram mode will appear on the screen and chose the Ladder diagram mode and maximize the window.
5. Write the Relay Ladder Logic program for sequential control of three motors as shown in figure 15.3
6. Compile the program using Ctrl+F7 and if any errors correct the program.
7. Write the program to PLC using Ctrl+F8 and check the output.
8. To observe the output on laptop/desktop itself, Select the simulator mode, then online mode, finally run the program using Ctrl+F11.

15.9 Ladder Diagram Program

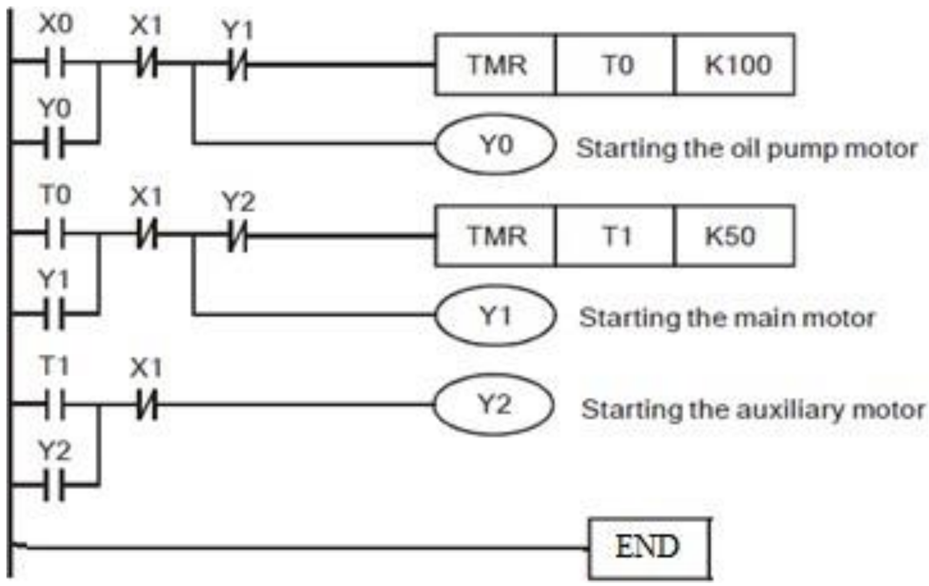

Figure 15.3 Ladder diagram for sequential control of three motors.

15.10 Further Probing Experiments

1. Write a control program to sequentially turn on the 5 LEDs and then to sequentially turn off the same LEDs and repeat the process.
2. Write a control program to count the no. of students entering and leaving a seminar hall from the single door.

Appendix A: References

1. John R. Hack Worth, Frederick D. Hack Worth, Jr., “Programmable logic controllers: programming methods and applications”, Pearson Education, 4th edition, 2008.
2. W. Bolton “Programmable logic controllers”, Newnes Elsevier , 4th edition, 2006.
3. Luis A. Bryan, E. A. Bryan, “Programmable Controllers theory and implementation”, American technical publisher, 4th edition, 2002.
4. Frank D. Petruzella, “Programmable logic controllers”, Tata McGraw hill, 3th edition, 2010.

Appendix B: Safety

- Never adopt a casual attitude in the workshop and always be conscious of the potentialhazards.
- Ensure that personal clothing is suitable to the lab conditions, e.g. Safety footwear with steel capping. Thongs or open footwear should not be worn in the lab area.
- Always wear eye protection when using power operated hand or machine tools or while performing physical tests that could lead to eye damage.
- Use protective clothing and devices appropriate to the type of operation being carried out, giving due consideration to the work being carried out in the vicinity.
- Never run in the laboratory.
- Never indulge in reckless behavior in the lab
- Always exercise care when opening and closing doors and entering or leaving the lab.
- Do not carry out any work in isolation in the lab; ensure that at least a second person is within call.
- Do not handle, store or consume food or drink in the lab.
- Do not store food or drink in a refrigerator, which is used to store lab materials.
- Do not smoke within any university building.
- Regard all substances as hazardous unless there is definite information to the contrary.
- Before any work is carried out in the lab, permission must be obtained from the lab Supervisor.
- Never undertake any work unless the potential hazards of the operation are known as precisely as possible, and the appropriate safety precautions are adopted. Any flame producing activity is not to commence until the immediate area has been cleared of dusts.
- Take additional care when carrying or moving any potentially hazardous material or sub-stance.
- Keep all fire-escape routes completely clear at all times.

Physiology of Injuries:

There are three main types of injuries: electrical shock during connections. These injuries are very painful and may cause loss of work time but are usually of a temporary nature. Other injuries may be indirectly caused by electrical accidents.

Source of Injuries:

Since electric shock is caused by an electric current through a part of the body, it is prevented by not allowing the body to become part of any electric circuit.

Protecting People and Equipment in the Laboratory:

Prevention of electric shock to individuals and damage to equipment in the laboratory can be done by strict adherence to several common-sense rules summarized below:

Protecting People:

1. When hooking up circuit, connect to the power source last, while power is off.
2. Before making changes in a circuit, turnoff or disconnect the power first, if possible.
3. Wear safety gloves while operating specimen from electric furnace to work area.
4. Avoid touching hot specimen with bear hands that may have hot burn.
5. Follow correct tool holding procedures in order to avoid hand injuries.

The above rules and the additional rules given below also serve to protect instruments and other circuits from damage.

Protecting Equipment:

1. Set the scales of measurement instrument to the highest range of calibration. 2. When usinga sharp tool, do not leave them un noticed for long periods of time. Doing so can hurt yourselfand your team members. 3. Never handled specimen from electric furnace with your bear hands.
4. Do not removes the burrs of GI sheet with your bear hands use respective burr remover

Types of Equipment Damage:

Excessive currents and voltages can damage instruments and other circuit elements. A large over-current for a short time or a smaller over-current for a longer time will cause overheating, resulting in insulation scorching and equipment failure.

After Accident Action:

Since accidents do happen despite all efforts to prevent them, plans for appropriate reaction to an accident can save time and lives. Such a plan should include immediate availability of first aid material suitable for minor injuries or for injuries that are likely because of the nature of the work. Knowledge of how to obtain trained assistance such as Emergency Medical Services(EMS) should be readily available for everyone.

Immediate Steps after Electric Shock:

Shut off all power and remove victim from the electric circuit. If the power cannot be shut off immediately, use an insulator of some sort, such as a wooden pole, to remove victim from the circuit. Attempts to pull the victim from the circuit with your hands will almost always result in your joining the victim in the electric shock. Investigations are always made after accidents. As an engineer, you will be involved as a part of the investigating team or in providing information to an investigator. Information obtained and notes written immediately after the emergency will aid the investigation and assist in preventing future accidents of a similar nature.

Emergency Numbers:

Fire / EMS: 101
Administrative office: 040-29705852, 29705853, 29705854
Principal office: 8886234501, 8886234502
EEE Department Office: 8886023000