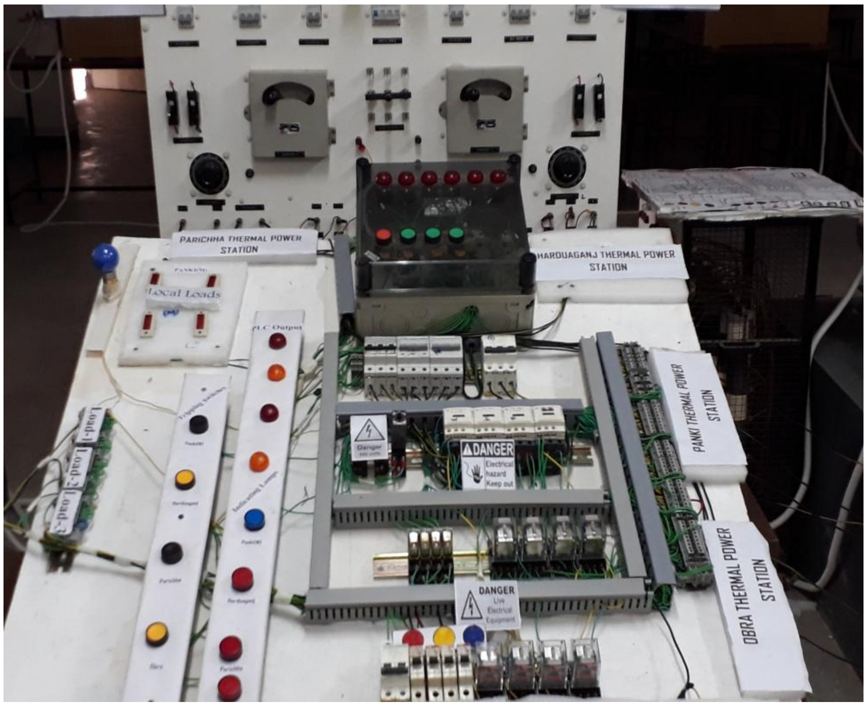
PARICHHA THERMAL POWER STATION
HARDUAGANJ THERMAL POWER STATION
Local Loads
PLC Output
PANKI THERMAL POWER STATION
OBRA THERMAL POWER STATION
DANGER
Electrical hazard Keep out
DANGER
Live Electrical Equipment

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1.1 Overview

The project uses four distant power sources for simplicity the four sources are being named after four distant thermal power plants as follows:-Obra, Panki, Parichha & Harduaganjganj. The main purpose of our project is to provide continuity of supply to most delegated loads. Let us consider a metro load, delay of even one second can cause heavy loses. Here in the project this load is Industrial load and load of Hospital.

So as to make the project more practical we connected local loads across each source. The local load configuration is as follows

- Harduaganjganj-Commercial Loads
- Parichha-Irrigation Load
- Obra-Residential Load
- Panki-Local Loads

The Industrial load runs through Panki supply by default with the help of PLC program. The local loads are runned by their respective sources as shown above. Here the fault is shown by NC switch. By pressing the NC switch connected across Panki load. Panki stops supplying power to Industrial Load. The PLC program automatically switch the Industrial Load on Harduaganjganj source thus the industrial load keeps running without any break hence causing no loss. There is one more concept used in the project & it is the concept of overloading. When load shifts from Panki to Harduaganjganj, in practical life overloading will occur on Harduaganjganj since it has Industrial load and Commercial load on it. Therefore in order to avoid overloading of generator when the Industrial load is shifted on Harduaganjganj, it disconnects its local load that is it disconnects Commercial load.

When the NC switch across Harduaganjganj is activated the PLC program shifts Industrial load on Parichha. The local load across Pariccha that is Irrigation Load gets disconnected to avoid overloading. The commercial load starts again because the load has now being shifted on Parichha. The same process repeats for Obra. If Parichha is cut out using NC, the PLC shifts load across Obra and disconnects the Residential load so as to avoid overloading. The Irrigation load comes back again.

The program of PLC has been designed such that if at any time if Panki supply returns the Industrial load will shift automatically on it. The programming has been designed such that first priority is given to Panki, second to Harduaganjganj, third to Parichha and last priority is Obra. In practical approach this can be considered as that Load is connected to source depending upon their cost of power.

1.2 Objective

The main objective of this project is listed as follows-

- To supply the uninterrupted power to the priority loads like Hospitals, Metro etc.
- Prioritize the power plant according to the cost of generation.
- Avoid the Overload on generator by automatically disconnecting the local load.

Figure 1.1 Overview of the project.

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PLC (Programmable Logic Controller)

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2.1 INTRODUCTION

2.1.1 OVERVIEW

The National Electrical Manufacturers Association (NEMA) defines a PLC as a "digitally operating electronic apparatus which uses a programmable memory for the internal storage of instructions by implementing specific functions, such as logic, sequencing, timing, counting, and arithmetic to control through digital or analog I/O modules various types of machines or processes."

Programmable Logic Controller (**PLC**) is a digital computer used for the automation of various electro-mechanical processes in industries. These controllers are specially designed to survive in harsh situations and shielded from heat, cold, dust, and moisture etc. **PLC** consists of a microprocessor which is programmed using the computer language. The program is written on a computer and is downloaded to the PLC via cable. These loaded programs are stored in non – volatile memory of the PLC. During the transition of relay control panels to PLC, the hard wired relay logic was exchanged for the program fed by the user. A visual programming language known as the Ladder Logic was created to program the PLC.

Figure 2.1 Programmable Logic Controller (PLC)

2.1.2 WORKING OF PLC

To know how the PLC works, it is essential that we have an understanding of its central processing units (CPU's) scan sequence. The methodology basically is the same for all PLCs. However, as special hardware modules are added into the system, additional scanning cycles are required.

Here's one simple scanning process that involves every PLC. First, the I/O hardware modules are scanned by the ladder logic software program as follows. Upon power-up, the processor scans the input module and transfers the data contents to the input's image table or register. Data from the output image table is transferred to the output module. Next, the software program is scanned, and each statement is checked to see if the condition has been met. If the conditions are met, the processor writes a digital bit "1" into the output image table, and a peripheral device will be energized. If the conditions are not met, the processor writes a "0" into the output image table, and a peripheral device (using "positive logic") remains deenergized.

A PLC interfaces numerous types of external electrical and electronic signals. These signals can be AC or DC currents or voltages. Typically, they range from 4 to 20 mill amperes (mA) or 0 to 120VAC, and 0 to 48VDC. These signals are referred to as I/O (input/output) points. Their total is called the PLC's I/O capability. From an electronic point-of-view, this number is based on how many points the PLC's CPU is able to look at, or scan, in a specified amount of time. This performance characteristic is called scan time. From the practical perspective of the user, however, the number of I/O modules needed as well as the number of I/O points contained on each I/O module will drive what the system's I/O capability should be.

It's important to have sufficient I/O capability in your PLC system. It's better to have more than less so that, when more I/O points are required at a future time, it's easier to write the existing spare I/O points into the software (since the hardware is already there). There's no harm to the operating system in having spare I/O points; the software can be programmed to ignore them, and these points will have a negligible effect on the PLC's scan time.

2.2 **PLC Hardware**

The hardware components of a PLC system are CPU, Memory, Input/Output, Power supply unit, and programming device. Below is a diagram of the system overview of PLC.

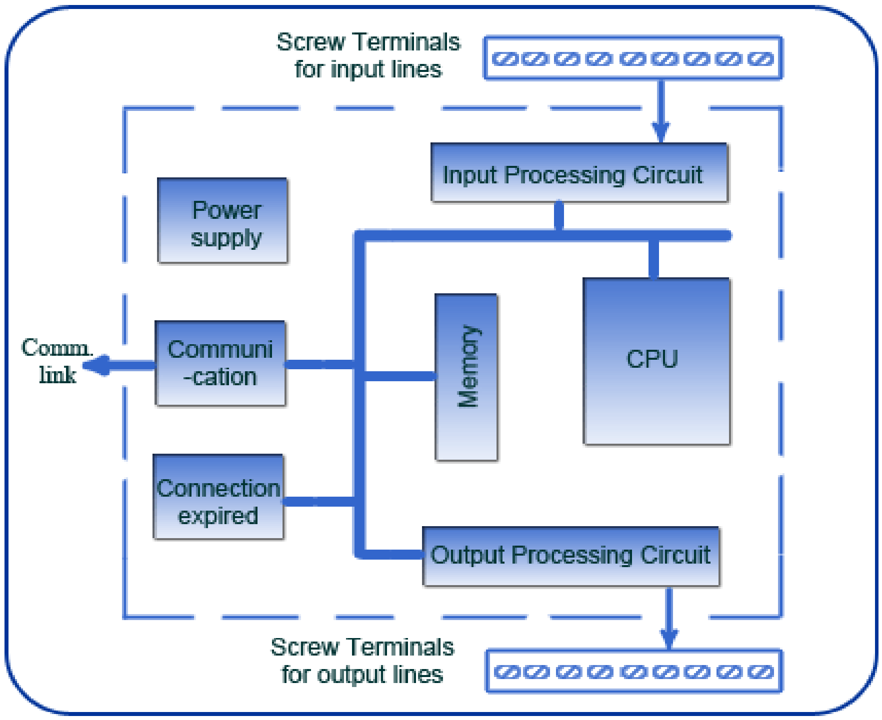

Figure 2.2 Block Diagram of PLC

- **CPU** – Keeps checking the PLC controller to avoid errors. They perform functions including logic operations, arithmetic operations, computer interface and many more.
- **Memory** – Fixed data is used by the CPU. System (ROM) stores the data permanently for the operating system. RAM stores the information of the status of input and output devices, and the values of timers, counters and other internal devices.
- **I/O section** – Input keeps a track on field devices which includes sensors, switches.
- **O/P Section -** Output has a control over the other devices which includes motors, pumps, lights and solenoids. The I/O ports are based on Reduced Instruction Set Computer (RISC).
- **Power supply** – Certain PLCs have an isolated power supply. But, most of the PLCs work at 220VAC or 24VDC.
- **Programming device** – This device is used to feed the program into the memory of the processor. The program is first fed to the programming device and later it is transmitted to the PLC's memory.
- **System Buses** – Buses are the paths through which the digital signal flows internally of

the PLC. The four system buses are:

- Data bus is used by the CPU to transfer data among different elements.
- Control bus transfers signals related to the action that are controlled internally.
- Address bus sends the location's addresses to access the data.
- System bus helps the I/O port and I/O unit to communicate with each other.

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CONTRACTOR

3.1 INTRODUCTION

3.1.1 OVERVIEW

A contactor is an electrically controlled switch used for switching an electrical power circuit, similar to a relay except with higher current ratings and a few other differences. A contactor is controlled by a circuit which has a much lower power level than the switched circuit. Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contractor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24 V DC to many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter on a side. Contactors are used to control electric motors, lighting, heating, capacitor banks, thermal evaporators, and other electrical loads.

Figure 3.1 Contractor used in project

3.1.2 Features of Contactors

- A contactor is a relay that is used for switching power.
- They usually handle very heavy loads like an electric motor, lighting and heating equipments and so on.
- Though their output is used for switching very high loads, they are controlled by a circuit with very less power.
- According to the loads they handle, they vary in sizes from a small device to as huge as a yard.
- Though they are used for switching purposes, they do not interrupt a short-circuit current like a circuit breaker.
- They have ratings ranging from a breaking current of a few amperes and 24 DC volts to thousands of amperes with many kilo volts.

3.2 DESIGN AND CONSTRUCTION

Like a relay, a contactor also has

1. Contact
2. Spring
3. Electromagnet

The contact part of the contactor includes the power contacts as well as the auxiliary contacts. The power contacts gains the power for the contactor and the auxiliary contacts is used to bring a loop with the rest of the rest of the devices it is attached to. These contacts are connected to the contact springs.

The contacts are controlled by the electromagnet. These electromagnets give the initial force to the contacts and make them closed. Both these contacts and electromagnet are enclosed in a frame which is usually made of insulating materials. The usually used insulating materials are Nylon 6, thermosetting plastics and so on. They are useful, as they completely insulate the contacts and help in preventing the touch of contacts. For high-end contactors, an open-frame contactor is commonly used. This will provide a greater protection from oil, dust, weather and also from explosion. The type of frame housing used may also differ according to the voltage rating used. The ones given above are restricted up to a certain voltage. If the contactors are used to manage volts higher than 1000 volts, inert gases and also vacuum is used as frame housing.

Contactors are also used in DC circuits. For their use in DC circuits, magnetic blowouts are also used. The use of blowout coils help in stretching and moving the electric arc. The electric arcs can be AC or DC. An AC arc will have can be easily extinguished as they have low current characteristics. DC arcs of the same current characteristics need more stretching need more current to be blown out. They ratings differ from about 500 Amperes to about 1500 Amperes.

In order to save power in a contactor when it is closed, an economizer circuit is also introduced. This circuit helps in reducing the coil current. There is difference in the amount of power that is required to close the contactor and that from keeping it closed. Greater power is required to close it. This circuit will also help it to stay cooler. Take a look at the diagram given below.

3.3 WORKING OF CONTRACTOR

As contactors are used for high-current load applications they are designed to control and reduce the arc produced when the heavy motor currents are interrupted. Other than the low current contacts, they are also setup with Normally Open contacts. These are devices which handle more than 20 Amperes current and over 100 Kilo Watts power. The contactor has an AC/DC supply driven coil input. This will depend on the requirement. This coil will mostly be controlled by a lower voltage PLC. They can also be controlled by the motor voltage. The motor may have series of coils connected to either control the acceleration or even the resistance.

When current is passed through the contactor, the electromagnet starts to build up, producing a magnetic field. Thus the core of the contactor starts to wind up. This process helps in energizing the moving contact. Thus the moving and fixed contacts make a short circuit. Thus the current is passed through them to the next circuit. The armature coil brings in high current in the initial position. This reduces as soon as the metal core enters the coil. When the current is stopped, the coil gets de-energized and thus the contacts get open circuited.

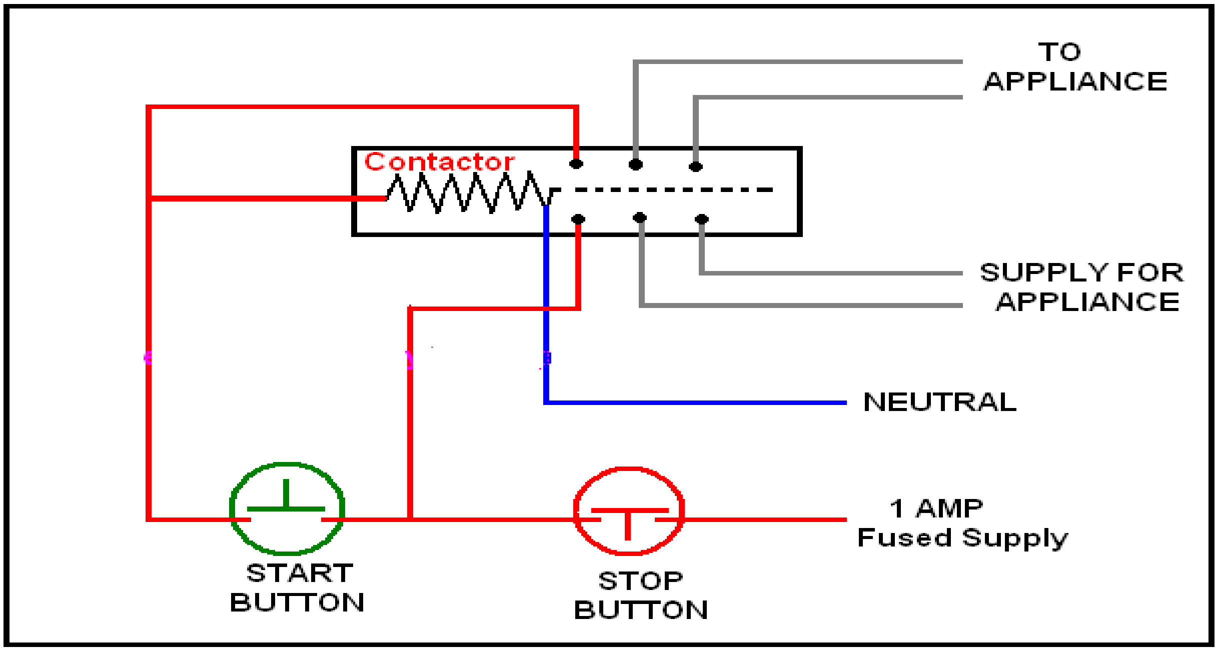

Figure 3.2 Block Diagram of Contractor

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4.1 AC& DC Relays

4.1.1 INTRODUCTION

A relay can be defined as a switch. Switches are generally used to close or open the circuit manually .Relay is also a switch that connects or disconnects two circuits. But instead of manual operation a relay is applied with electrical signal, which in turn connects or disconnects another circuit. Relays can be of different types like electromechanical, solid state. Electromechanical relays are frequently used. Let us see the internal parts of this relay before knowing about it working. Although many different types of relay were present, their working is same.

Every electromechanical relay consists of an-

1. Electromagnet
2. Mechanically movable contact
3. Switching points and
4. Spring

Electromagnet is constructed by wounding a copper coil on a metal core. The two ends of the coil are connected to two pins of the relay as shown. These two are used as DC supply pins. Generally two more contacts will be present, called as switching points to connect high ampere load. Another contact called common contact is present in order to connect the switching points. These contacts are named as normally open(NO), normally closed(NC) and common(COM) contacts. Relay can be operated using either AC or DC.

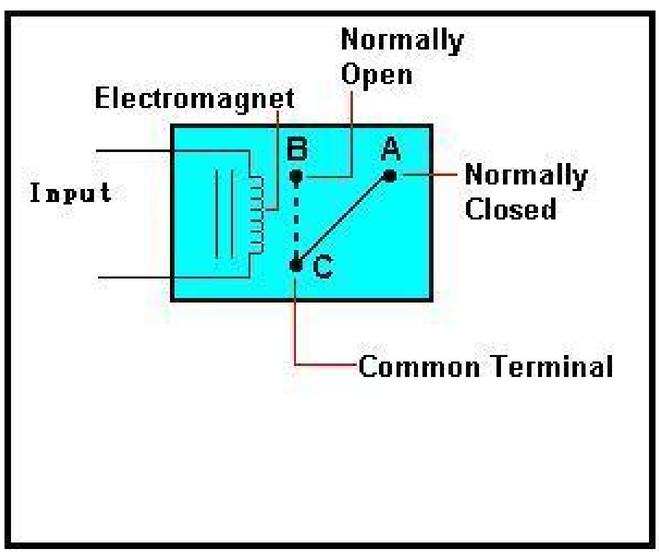

Figure 4.1 Block Diagram of a Relays

4.1.2 WORKING OF RELAYS

The diagram shown below an inner section diagram of a relay. An iron core is surrounded by a control coil. As shown, the power source is given to the electromagnet through a control switch and through contacts to the load. When current starts flowing through the control coil, the electromagnet starts energizing and thus intensifies the magnetic field. Thus the upper contact arm starts to be attracted to the lower fixed arm and thus closes the contacts causing a short circuit for the power to the load. On the other hand, if the relay was already de-energized when the contacts were closed, then the contact move oppositely and make an open circuit.

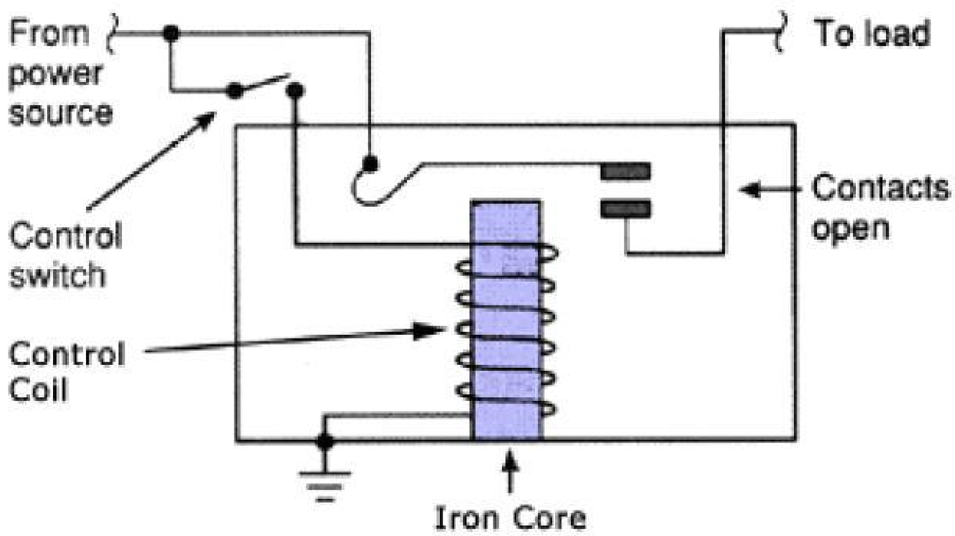

Figure 4.2 Inner Section of a Relay

As soon as the coil current is off, the movable armature will be returned by a force back to its initial position. This force will be almost equal to half the strength of the magnetic force. This force is mainly provided by two factors. They are the spring and also gravity.

Relays are mainly made for two basic operations. One is low voltage application and the other is high voltage. For low voltage applications, more preference will be given to reduce the noise of the whole circuit. For high voltage applications, they are mainly designed to reduce a phenomenon called arcing.

4.2 Difference between AC & DC Relays

AC and DC relays work on the same principle, that of, electromagnetic induction. However, there are some differences in construction. DC relays have something known as the freewheel diode which acts to discharge the emf built in the inductance when the coil is de-energized. AC relays have cores which are laminated to prevent losses due to eddy current heating. Another more conspicuous difference between a DC relay and an AC relay is presence of the Shading Coil. In AC relays, the alternating current supply changes direction about 100 times a second. At each instance, when the sine wave passes through zero, the current flowing through the coil becomes zero. This results in a loss of magnetism for a few milliseconds. When this happens about 100 times a second, the repeated drop and pickup of the coil produces a noise known as chattering. This also leads to the making and breaking of the relay contacts leading to disturbances in the connected electric circuits.

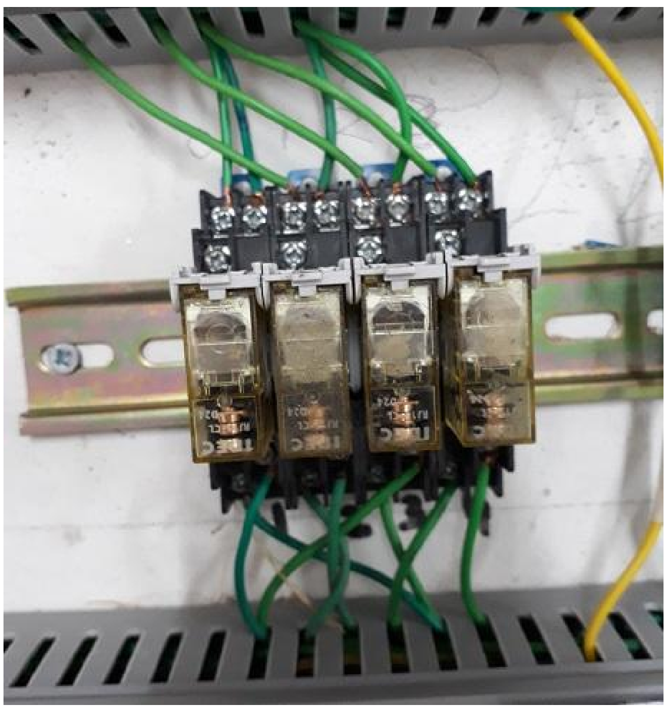

Figure 4.4 DC Relays

A shading coil is a coil with high remanence. Thus when the magnetism of the coil collapses when the current becomes zero. The shading coil still retains the magnetism. Thus, ensuring that the contacts do not drop off.

Figure 4.3 AC Relays

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MCB (Miniature Circuit Breaker)

5.1 Introduction

5.1 Introduction

An MCB or miniature circuit breaker is an electromagnetic device that embodies complete enclosure in a molded insulating material. The main function of an MCB is to switch the circuit, i.e., to open the circuit (which has been connected to it) automatically when the current passing through it (MCB) exceeds the value for which it is set. It can be manually switched ON and OFF as similar to normal switch if necessary. MCBs are of time delay tripping devices, to which the magnitude of overcurrent controls the operating time. This means, these get operated whenever overload exist long enough to create a danger to the circuit being protected. Therefore, MCBs doesn't respond to transient loads such as switches surges and motor starting currents. Generally, these are designed to operate at less than 2.5 milliseconds during short circuit faults and 2 seconds to 2 minutes in case of overloads (depending on the level of current).

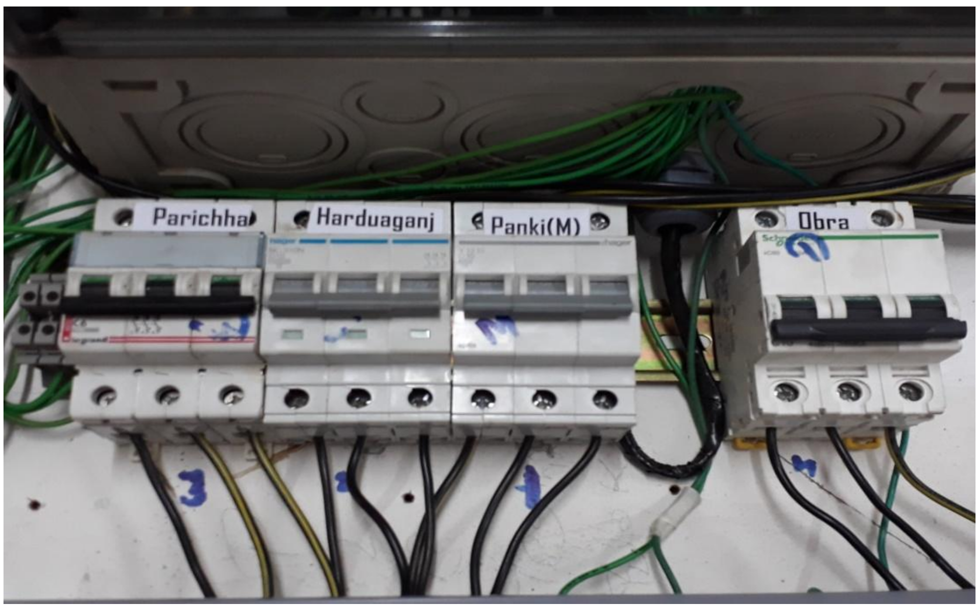

Figure 5.1 MCBs Used in Project

A typical external appearance of an MCB is shown in figure. MCBs are manufactured in different pole versions such as single, double, triple and four pole structures with different fault current levels. Mostly, MCBs are linked to give two and three-pole versions such that a fault in one line will break the complete circuit and hence complete circuit isolation are provided. This feature will be helpful in case of single phasing in three phase motor protection.
These are rated at 220V for DC supply and 240/415 for AC supply (single and three-phase) with different short circuit current capacity. Typically, single phase devices have load current range of up to 100 A. Some MCBs have facility to adjust its tripping current capacity while some devices are fixed for some load current and short circuit rating.

MCBs are used to perform many functions such as local control switches, isolating switches against faults and overload protection devices for installations or specific equipments or appliances.

5.2 Working Of MCB (Miniature Circuit Breaker)

There are two arrangement of operation of miniature circuit breaker. One due to thermal effect of over current and other due to electromagnetic effect of over current. The thermal operation of miniature circuit breaker is achieved with a bimetallic strip whenever continuous over current flows through MCB, the bimetallic strip is heated and deflects by bending. This deflection of bimetallic strip releases mechanical latch. As this mechanical latch is attached with operating mechanism, it causes to open the miniature circuit breaker contacts. But during short circuit condition, sudden rising of current, causes electromechanical displacement of plunger associated with tripping coil or solenoid of MCB. The plunger strikes the trip lever causing immediate release of latch mechanism consequently open the circuit breaker contacts. This was a simple explanation **of** miniature circuit breaker working principle.

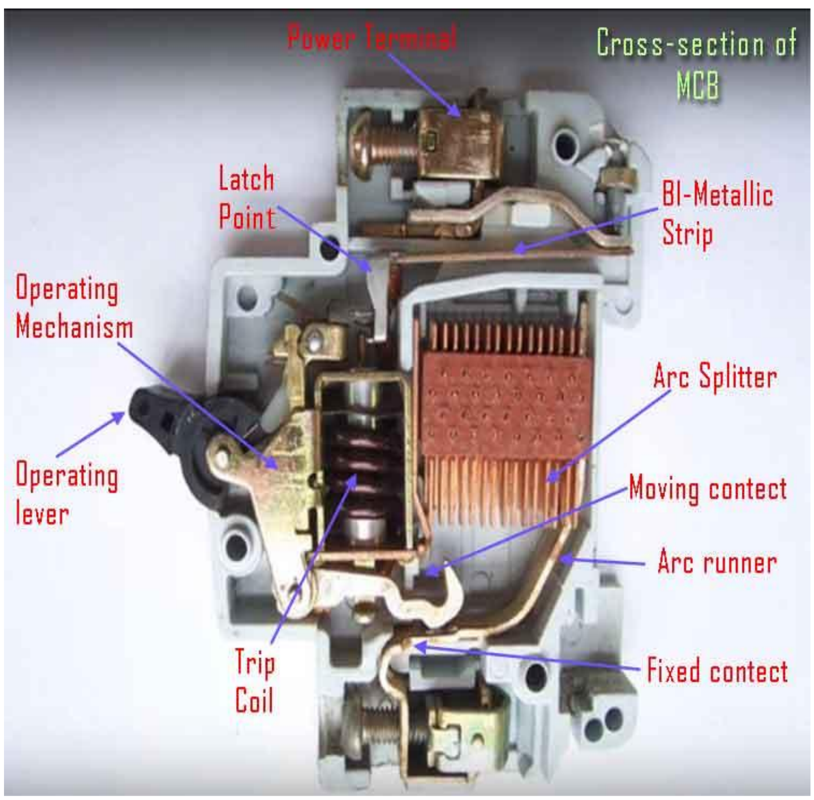

Figure 5.1 Cross Section Of MCB

CHAPTER 6

ALTERNATOR

6.1 Introduction

The machine which produces 3 phase power from mechanical power is called an alternator or synchronous generator. Alternators are the primary source of all the electrical energy we consume. These machines are the largest energy converters found in the world. They convert mechanical energy into AC energy.

For reasons of cost and simplicity, most alternators use a rotating magnetic field with a stationary armature. Occasionally, a linear alternator or a rotating armature with a stationary magnetic field is used. In principle, any AC electrical generator can be called an alternator, but usually the term refers to small rotating machines driven by automotive and other internal combustion engines. An alternator that uses a permanent magnet for its magnetic field is called a magneto. Alternators in power stations driven by steam turbines are called turbo-alternators.

In our project Alternator is driven by DC shunt motor. The Alternator and DC shunt motor is mechanically coupled by a coupler.

Figure 6.1 Motor Generator Set

6.2 Construction of an Alternator

Construction wise, an alternator generally consists of field poles placed on the rotating fixture of the machine i.e. rotor as shown in the figure above. Once the rotor or the field poles are made to rotate in the presence of armature conductors housed on the stator, an alternating 3φ voltage represented by aa' bb' cc' is induced in the armature conductors thus resulting in the generation of 3φ electrical power. All modern day electrical power generating stations use this technology for generation of 3φ power, and as a result the alternator or synchronous generator has become a subject of great importance and interest for power engineers. An alternator is basically a type of AC generator which is also known as synchronous generator, for the simple reason that the field poles are made to rotate at synchronous speed $Ns = 120\ f/P$ for effective power generation. Where f signifies the alternating current frequency and the P represents the number of poles.

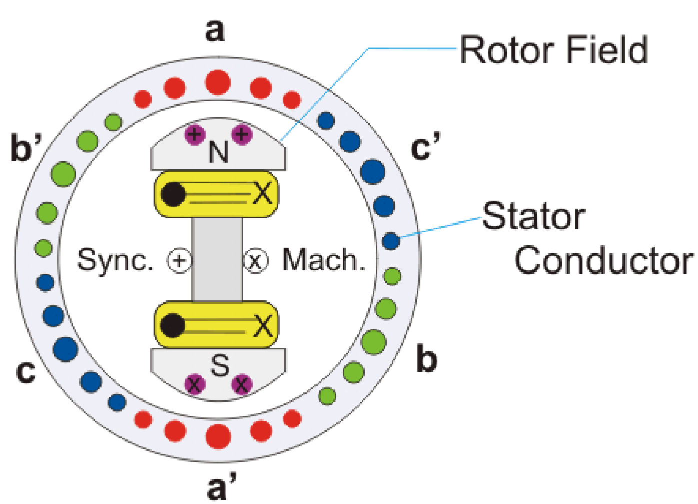

Figure 6.2 Alternator Block Diagram

In most practical construction of alternator, it is installed with a stationary armature winding and a rotating field unlike in the case of DC generator where the arrangement is exactly opposite. This modification is made to cope with the very high power of the order of few 100 Mega watts produced in an AC generator contrary to that of a DC generator. To accommodate such high power the conductor weigh and dimension naturally has to be increased for optimum performance. And for this reason is it beneficial to replace these high power armature windings by low power field windings, which is also consequently of much lighter weight, thus reducing the centrifugal force required to turn the rotor and permitting higher speed limits.

There are mainly two types of rotor used in construction of alternator,

- Salient pole type.

- Cylindrical rotor type.

6.2.1 Salient Pole Type

The term salient means protruding or projecting. The salient pole type of rotor is generally used for slow speed machines having large diameters and relatively small axial lengths. The pole in this case are made of thick laminated steel sections riveted together and attached to a rotor with the help of joint. An alternator as mentioned earlier is mostly responsible for generation of very high electrical power. To enable that, the mechanical input given to the machine in terms of rotating torque must also be very high. This high torque value results in oscillation or hunting effect of the alternator or synchronous generator. To prevent these oscillations from going beyond bounds the damper winding is provided in the pole faces as shown in the figure. The damper windings are basically copper bars short circuited at both ends are placed in the holes made in the pole axis's. When the alternator is driven at a steady speed, the relative velocity of the damping winding with respect to main field will be zero. But as soon as it departs from the synchronous speed there will be relative motion between the damper winding and the main field which is always rotating at synchronous speed. This relative difference will induce current in them which will exert a torque on the field poles in such a way as to bring the alternator back to synchronous speed operation.

The salient features of pole field structure has the following special feature-

- They have a large horizontal diameter compared to a shorter axial length.
- The pole shoes cover only about 2/3rd of pole pitch.
- Poles are laminated to reduce eddy current loss.
- The salient pole type motor is generally used for low speed operations of around 100 to 400 rpm, and they are used in power stations with hydraulic turbines or diesel engines.
- Salient pole alternators driven by water turbines are called hydro-alternators or hydro generators.

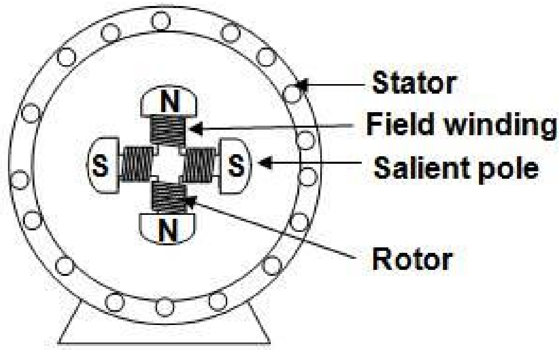

Figure 6.3 Salient Pole Type Alternator

6.2.2 Cylindrical Rotor Type

The cylindrical rotor is generally used for very high speed operation and employed in steam turbine driven alternators like turbo generators. The machines are built in a number of ratings from 10MVA to over 1500 MVA. The cylindrical rotor type machine has uniform length in all directions, giving a cylindrical shape to the rotor thus providing uniform flux cutting in all directions. The rotor in this case consists of a smooth solid steel cylinder, having a number of slots along its outer periphery for hosing the field coils. The cylindrical rotor alternators are generally designed for 2-pole type giving very high speed of $N_s = (120 \times f)/P = (120 \times 50) / 2 = 3000$ rpm. Or 4-pole type running at a speed of $N_s = (120 \times f) / P = (120 \times 50) / 4 = 1500$ rpm. Where, f is the frequency of 50 Hz. The cylindrical rotor synchronous generator does not have any projections coming out from the surface of the rotor, rather central polar area are provided with slots for housing the field windings as we can see from the diagram above. The field coils are so arranged around these poles that flux density is maximum on the polar central line and gradually falls away as we move out towards the periphery. The cylindrical rotor type machine gives better balance and quieter-operation along with lesser windage losses.

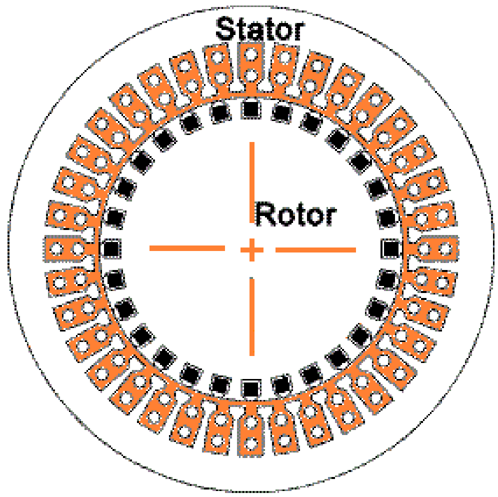

Figure 6.4 Cylindrical Rotor Type Alternator

6.3 Working Principle of an Alternator

The rotor winding is energized from the DC exciter and alternate N and S poles are developed on the rotor. But in our project 1 phase supply is converted into DC using rectifier and then fed to the rotor winding. When the rotor is rotated in anti-clockwise direction by a prime mover, the stator or armature conductors are cut by the magnetic flux of rotor poles. Consequently, e.m.f. is induced in the armature conductors due to electromagnetic induction. The induced e.m.f. is alternating since N and S poles of rotor alternately pass the armature conductors.
The direction of induced e.m.f. can be found by Fleming's right hand rule and frequency is given by;

$f=\frac{PN}{120}$

Where N = speed of rotor in r.p.m.
P = number of rotor poles

The magnitude of the voltage induced in each phase depends upon the rotor flux, the number and position of the conductors in the phase and the speed of the rotor.

When the rotor is rotated, a 3-phase voltage is induced in the armature winding. The magnitude of induced e.m.f. depends upon the speed of rotation and the DC exciting current. The magnitude of e.m.f. in each phase of the armature winding is the same. However, they differ in phase by 120° electrical.

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TRANSMISSION AND LOADS

7.1 Transmission Lines

Transmission line is the long conductor with special design (bundled) to carry bulk amount of generated power at very high voltage from one station to another as per variation of the voltage level. After electricity is produced at power plants it has to get to the customers that use the electricity. Our cities, towns, states and the entire country are criss-crossed with power lines that carry the electricity. The electricity first goes to a transformer at the power plant that boosts the voltage. As the voltage is increased the current will decrease and thus copper loses will be less which will increase the efficiency of the system. The long thick cables of transmission lines are made of copper or aluminum because they have a low resistance.

Then it is stepped down in various substation and the it is further stepped down with the help of distribution transformer and then distributed to the load.

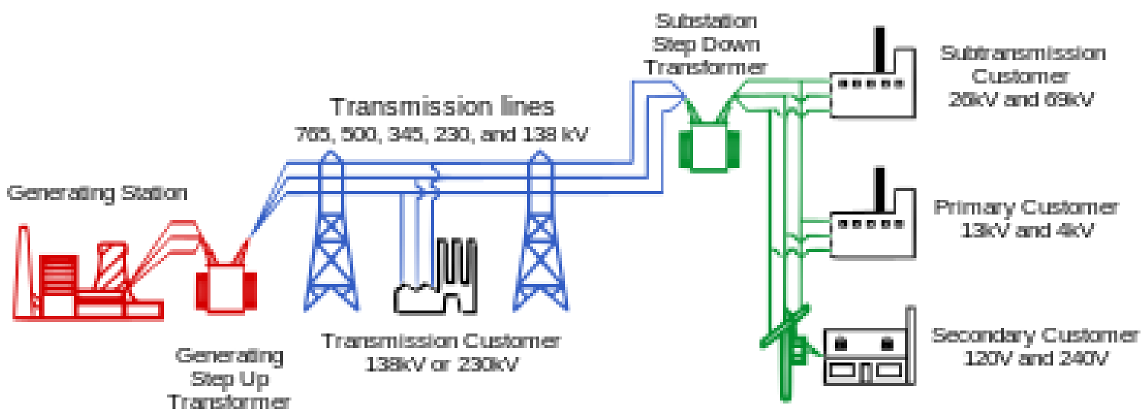


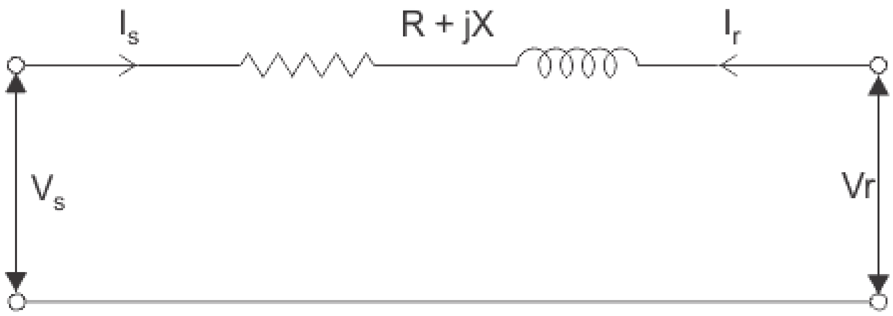
Figure 7.1 Systematic Diagram of Transmission System

In transmission line determination of voltage drop, transmission efficiency, line loss etc. are important things to design. These values are affected by line parameter R, L and C of the transmission line. Length wise transmission lines are three types-

- Short Transmission Line
- Medium Transmission Line
- Long Transmission Line

7.1.1 Short Transmission Line

The transmission lines which have length less than 50 km are generally referred as short transmission lines. For short length, the shunt capacitance of this type of line is neglected and other parameters like electrical resistance and inductor of these short lines are lumped, hence the equivalent circuit is represented in next page (Fig 7.2).



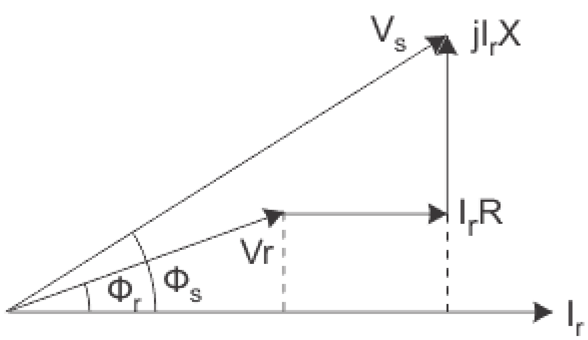


Figure 7.2 Equivalent Circuit Diagram and Vector Diagram

Vector diagram for this equivalent circuit shown above, taking receiving end current Ir as reference. The sending end and receiving end voltages make angle with that reference receiving end current, of φs and φr, respectively.

7.1.2 Medium Transmission Line

The transmission line having its effective length more than 80 km but less than 250 km is generally referred to as a medium transmission line. Due to the line length being considerably high, admittance Y of the network does play a role in calculating the effective circuit parameters, unlike in the case of short transmission lines. For this reason the modeling of a medium length transmission line is done using lumped shunt admittance along with the lumped impedance in series to the circuit.

These lumped parameters of a medium length transmission line can be represented using three different models, namely-

- Nominal Π representation.

- Nominal T representation.

Nominal Π Representation of a Medium Transmission Line

In case of a nominal Π representation, the lumped series impedance is placed at the middle of the circuit where as the shunt admittances are at the ends. The total lumped shunt admittance is divided into 2 equal halves, and each half with value Y / 2 are placed at both the sending and the receiving end while the entire circuit impedance is between the two.

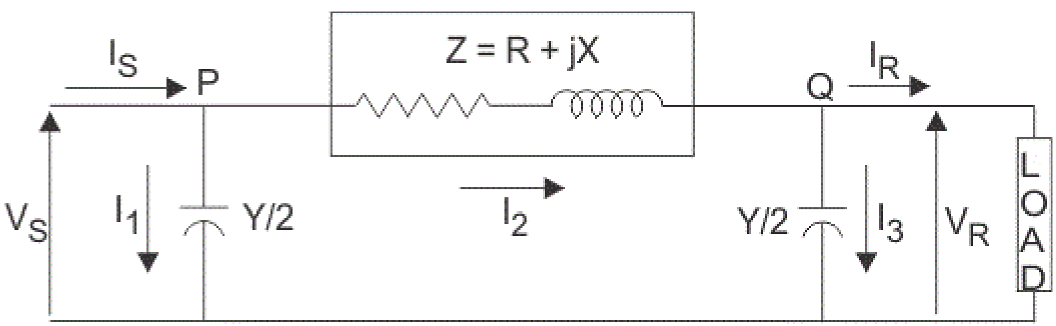


Figure 7.3 Equivalent circuit diagram of Nominal Π Representation.

Nominal T Representation of a Medium Transmission Line

In the nominal T model of a medium transmission line the lumped shunt admittance is placed in the middle, while the net series impedance is divided into two equal halves and placed on either side of the shunt admittance.

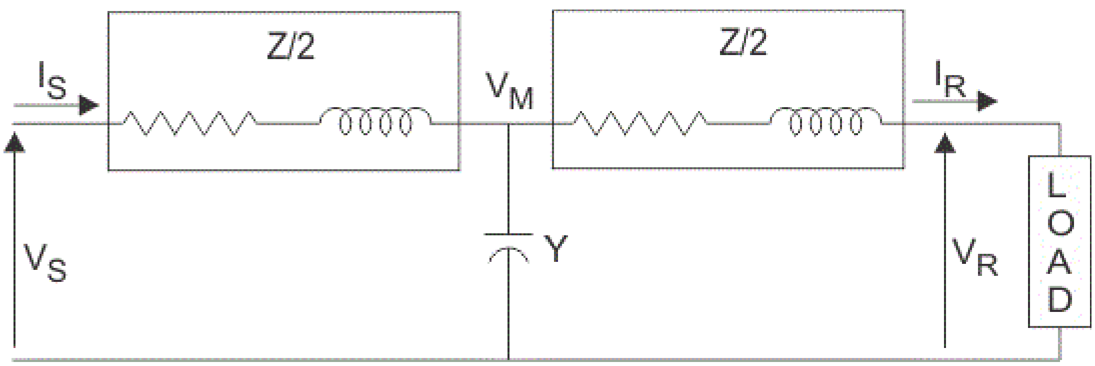


Figure 7.4 Equivalent circuit diagram of Nominal T Representation.

7.2.3 Long Transmission Line

A transmission line having a length more than 240 km is considered as a long transmission line. In a long transmission line, parameters are uniformly distributed along the whole length of the line. For a long transmission line, it is considered that the line may be divided into various sections, and each section consists of an inductance, capacitance, resistance and conductance as shown below.

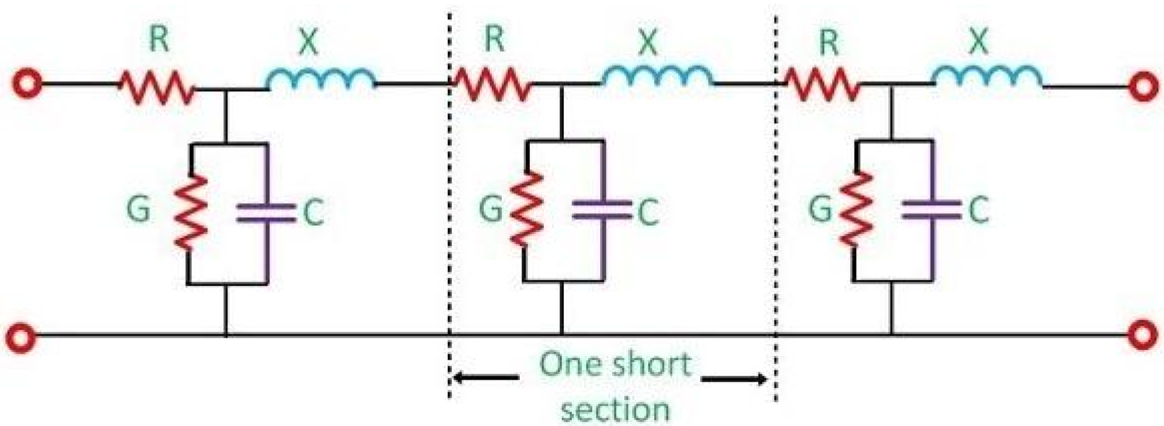


Figure 7.5 Long Transmission Line Showing Distributed Parameter

Let's consider a bit smaller part of a long transmission line having length 'ds' situated at a distance 's' from the receiving end. Series impedance of the line is represented by 'zds' and 'yds' is the shunt impedance of the line. Due to charging current and corona loss the current is not uniform along the line. Voltage is also different in different parts of the line because of inductive reactance.

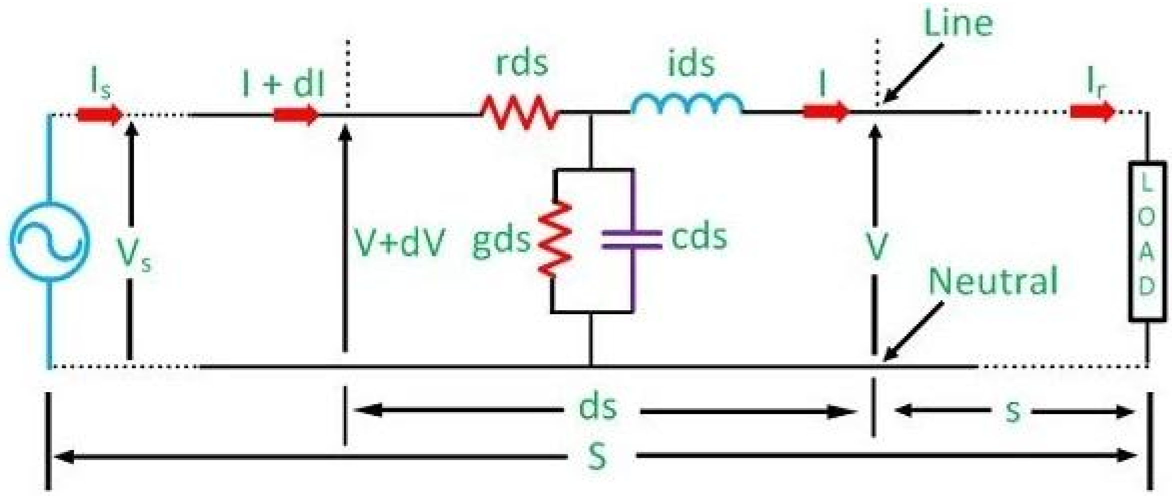


Figure 7.6 Incremental Length of the Transmission Lines

7.2 Towers

7.2.1 Introduction

The main supporting unit of overhead transmission line is transmission tower. Transmission towers have to carry the heavy transmission conductor at a sufficient safe height from ground. In addition to that all towers have to sustain all kinds of natural calamities. So transmission tower designing is an important engineering job where all three basic engineering concepts, civil, mechanical and electrical engineering concepts are equally applicable. They are used in high-voltage AC and DC systems, and come in a wide variety of shapes and sizes. Typical height ranges from 15 to 55 m (49 to 180 ft).

Figure 7.7 Model of Transmission Tower Used in our Project

7.2.2 Insulator

Electrical Insulator must be used in electrical system to prevent unwanted flow of current to the earth from its supporting points. The insulator plays a vital role in electrical system. Electrical Insulator is a very high resistive path through which practically no current can flow. In transmission and distribution system, the overhead conductors are generally supported by supporting towers or poles. The towers and poles both are properly grounded. So there must be insulator between tower or pole body and current carrying conductors to prevent the flow of current from conductor to earth through the grounded supporting towers or poles.

There are mainly three types of insulator used as overhead insulator likewise

- Pin Insulator
- Suspension Insulator
- Strain Insulator

The most common type of insulator used is Suspension Insulator. The model of Transmission tower used in our project also use Suspension Insulator.

Suspension Insulator

In higher voltage, beyond 33KV, it becomes uneconomical to use pin insulator because size, weight of the insulator become more. Handling and replacing bigger size single unit insulator are quite difficult task. For overcoming these difficulties, suspension insulator was developed. In suspension insulator numbers of insulators are connected in series to form a string and the line conductor is carried by the bottom most insulator. Each insulator of a suspension string is called disc insulator because of their disc like shape.

Each suspension disc is designed for normal voltage rating 11KV (Higher voltage rating 15KV), so by using different numbers of discs, a suspension string can be made suitable for any voltage level. If any one of the disc insulators in a suspension string is damaged, it can be replaced much easily. Mechanical stresses on the suspension insulator is less since the line hanged on a flexible suspension string.

Figure 7.9 Suspension Insulator depicted in Model

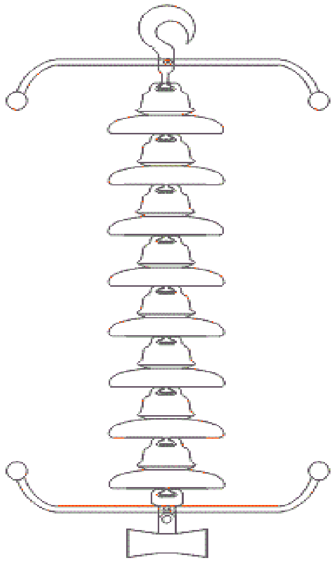


Figure 7.8 Suspension String

7.3 Different Loads

Following are the different loads that are depicted in our project-

- Irrigation Load
- Residential Load
- Commercial Load
- Municipal Load

Figure 7.10 Irrigation depicted in project

Figure 7.11 Residential Load depicted in project

Figure 7.12 Commercial Load depicted in project

Figure 7.13 Municipal Load depicted in project

C

H

A

P

T

E

LADDER LOGIC

8.1 Introduction

The logic in a ladder diagram typically flows from left to right. The diagram can be divided into sections called rungs, which are roughly analogous to the rungs on a ladder. Each rung typically consists of a combination of input instructions. These instructions lead to a single output instruction; however, rungs containing function block instructions may be more complicated.

Each input or output instruction is assigned an indicating the location in the PLC memory where the state of that instruction is stored. Function block instructions may include one or more addresses to store parameters related to the function that they perform. The numerical format of the address depends on the scheme used by the particular manufacturer, and it may be stated in a binary-based numbering system. A name may also be associated with each address to make the ladder diagram easier to interpret.

The structure behind ladder logic is based on the electrical ladder diagrams that were used with relay logic. These diagrams documented how connections between devices were made on relay panels; they are called "ladder" diagrams because they are constructed in a way that resembles a ladder with two vertical rails and rungs between them. The positive power rail (on the left) flows to the negative power rail (on the right) through the physical devices connected on the rung. The example below shows a ladder diagram with pushbuttons (PB), control relays (CR), a motor (M) and a light (L).

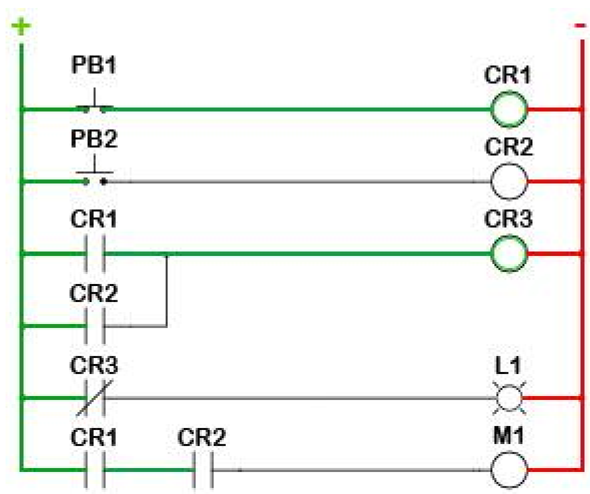


Figure 8.1 Ladder Diagram

8.2 Ladder Logic Diagram

In this situation all the source are present but continues load will be feed by the Panki power plant as shown by the ladder logic below. This is so as Panki power plant is set as the first priority. All the power plants are supplying their respective local loads.

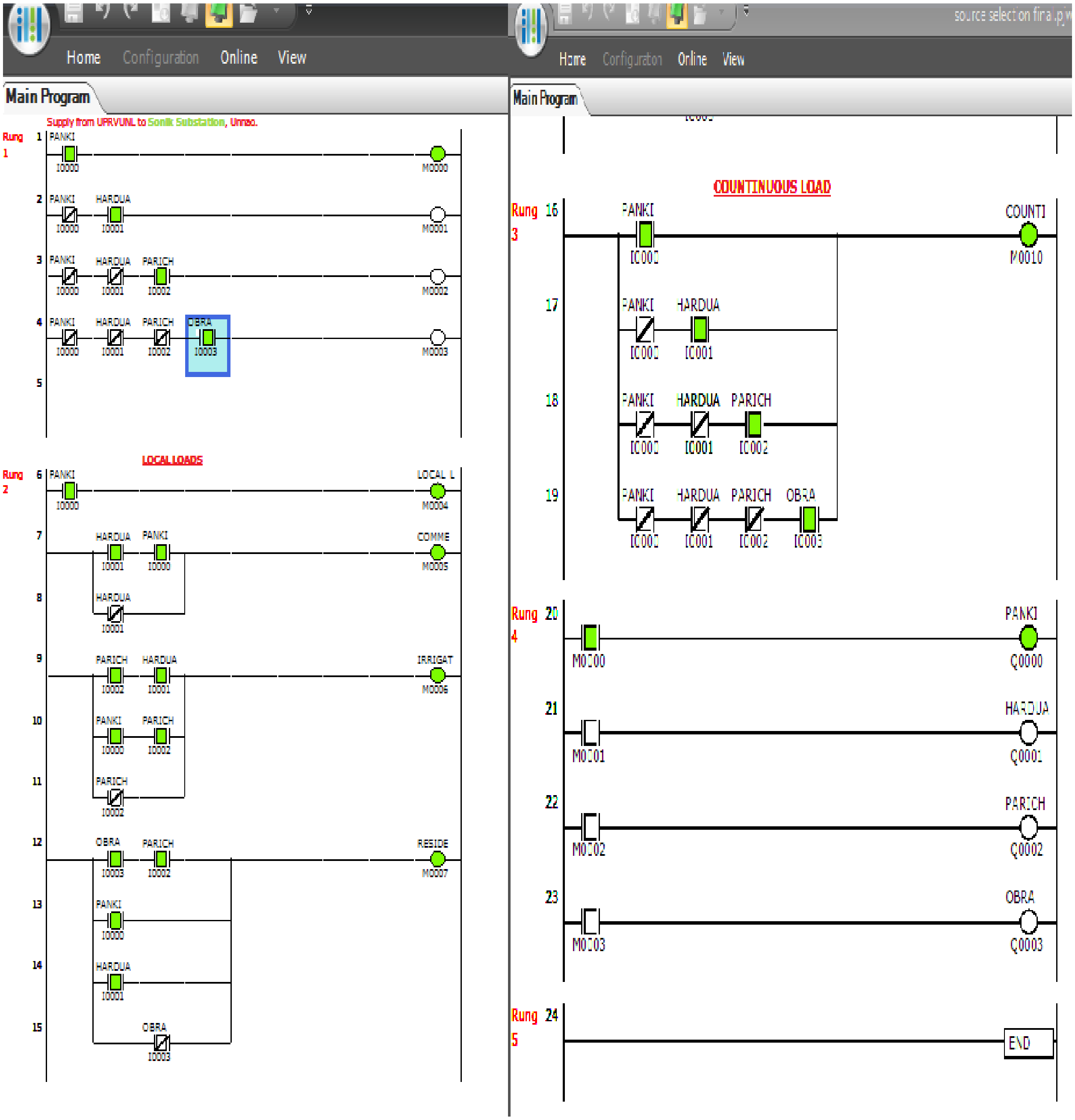


Figure 8.2 Continues load is feed by the Panki power plant

In this, supply from the Panki power plant is cut off. Now according to set priority Harduaganj power plant will now feed the continuous load. Now to avoid over load on Harduaganj power plant, the local load of the Harduaganj power plant is cut of as shown in Ladder Logic diagram below.

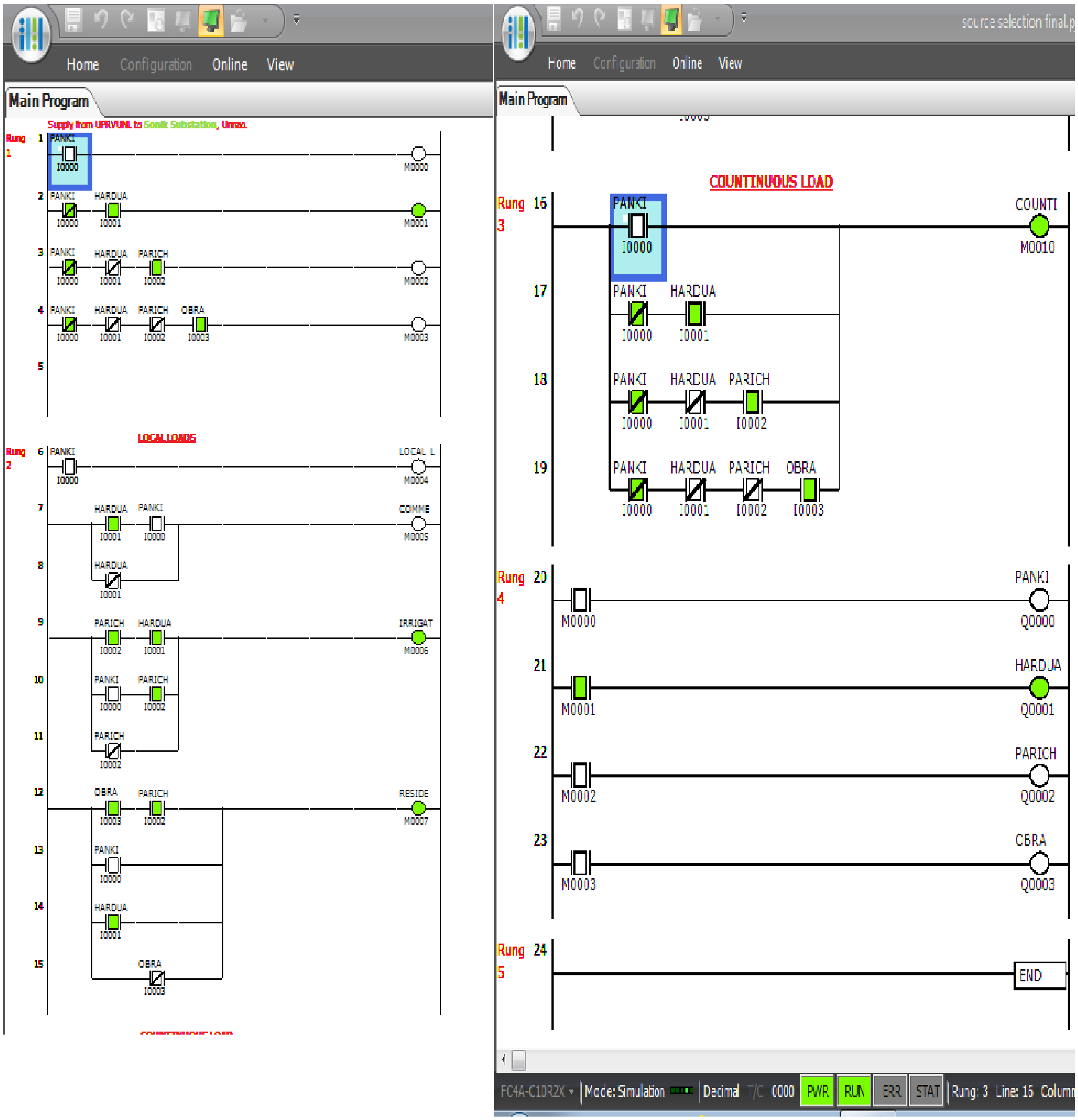


Figure 8.3 Continues load is feed by the Harduaganj power plant.

Now the supply from the Harduaganj power plant is also cut off, so according to the set priority now the Paricha power plant will now feed the continuous load. The local load of Paricha power plant will now cut off to avoid the overload and at same time local load of the Harduaganj power plant will also set on.

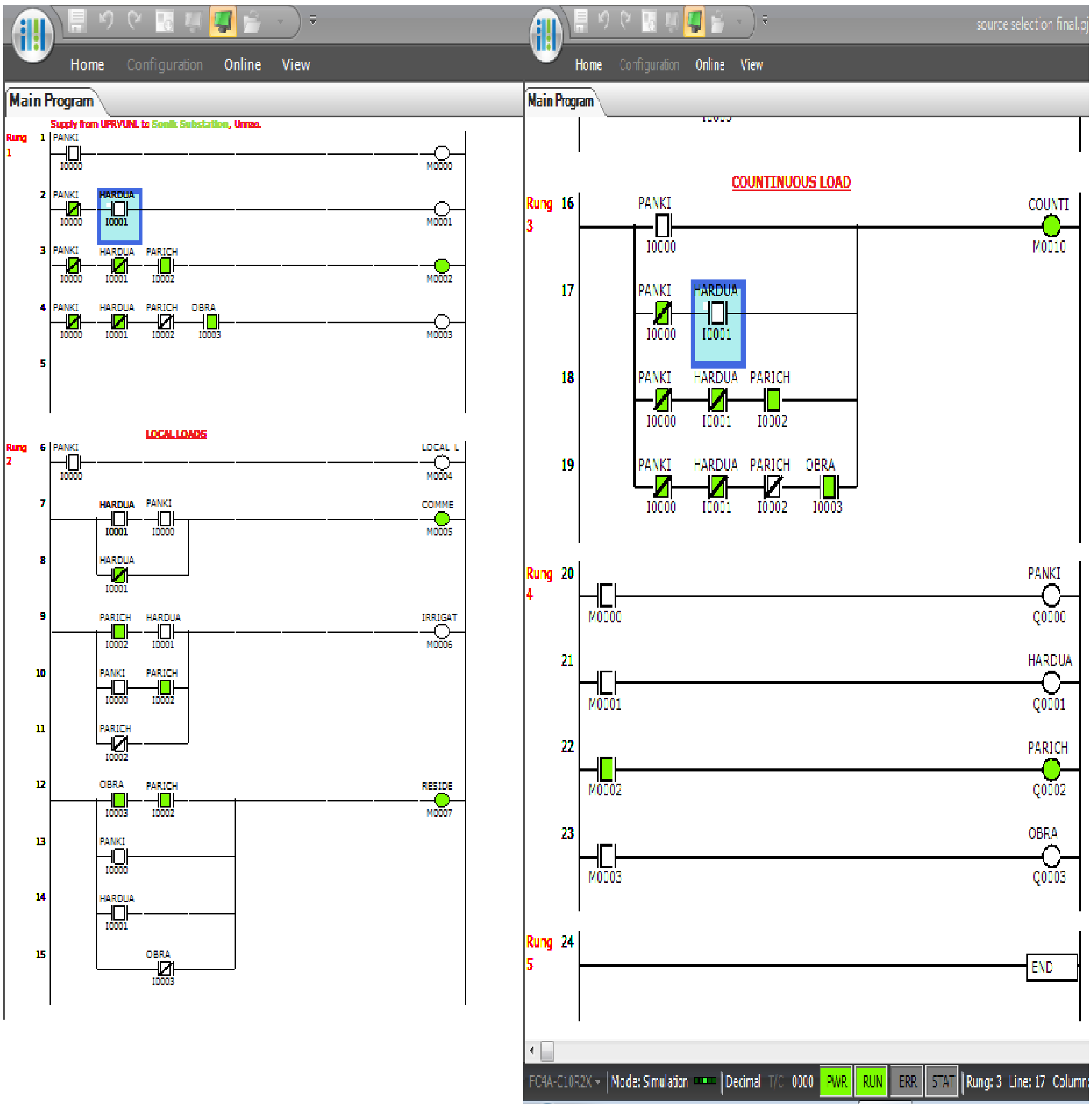


Figure 8.4 Continues load is feed by the Paricha power plant.

Now the supply from the Paricha power plant is also cut off, so according to the set priority now the Obra power plant will now feed the continuous load. The local load of Obra power plant will now cut off to avoid the overload and at same time local load of the Paricha power plant will also set on as shown in below ladder logic diagram.

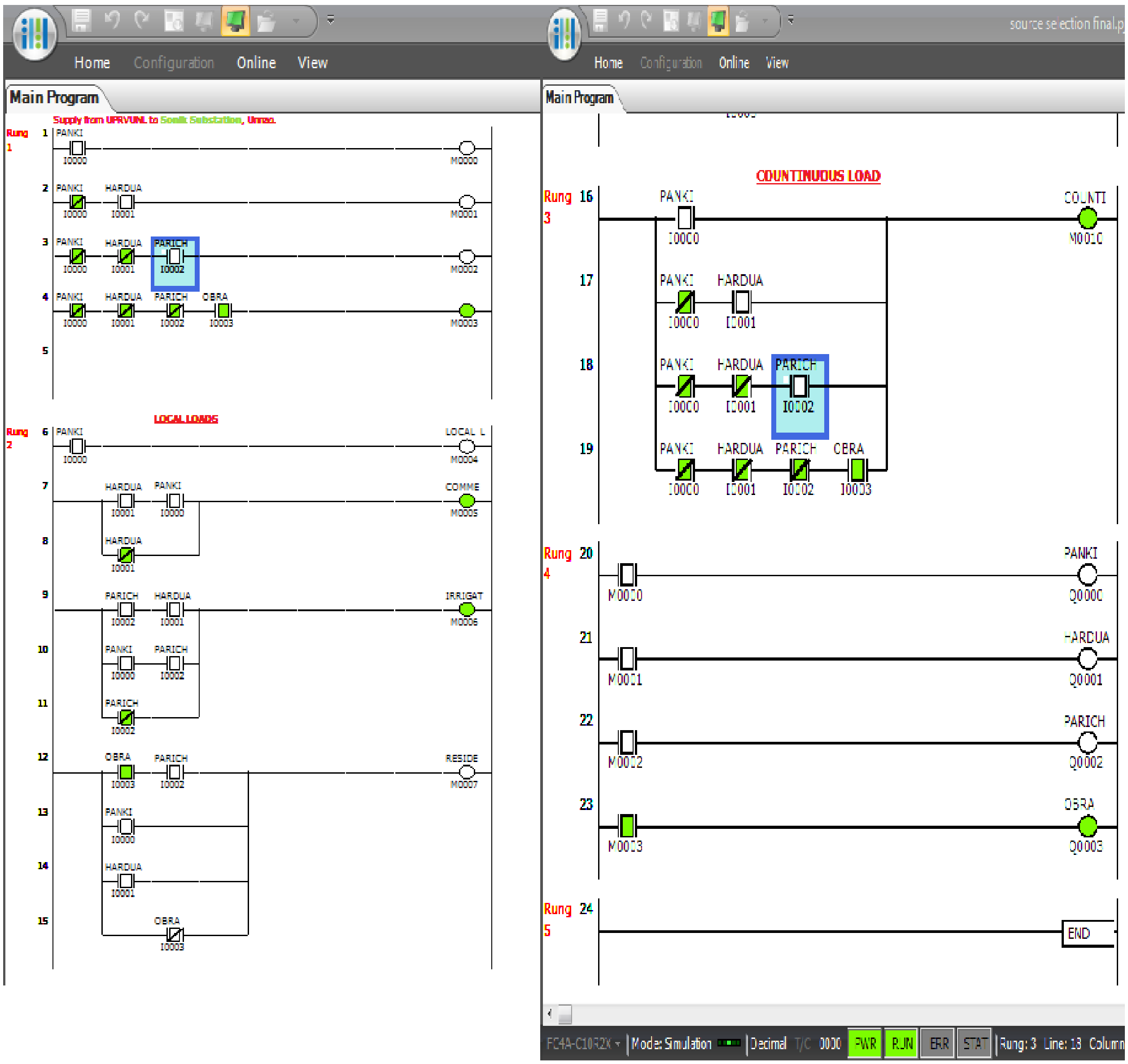


Figure 8.5 Continues load is feed by the Obra power plant.

Now the supply from the Harduaganj is again set on. Now the continuous load will be feed by the Harduaganj power plant once again. This is so because Harduaganj is at second priority and Obra is at last priority.

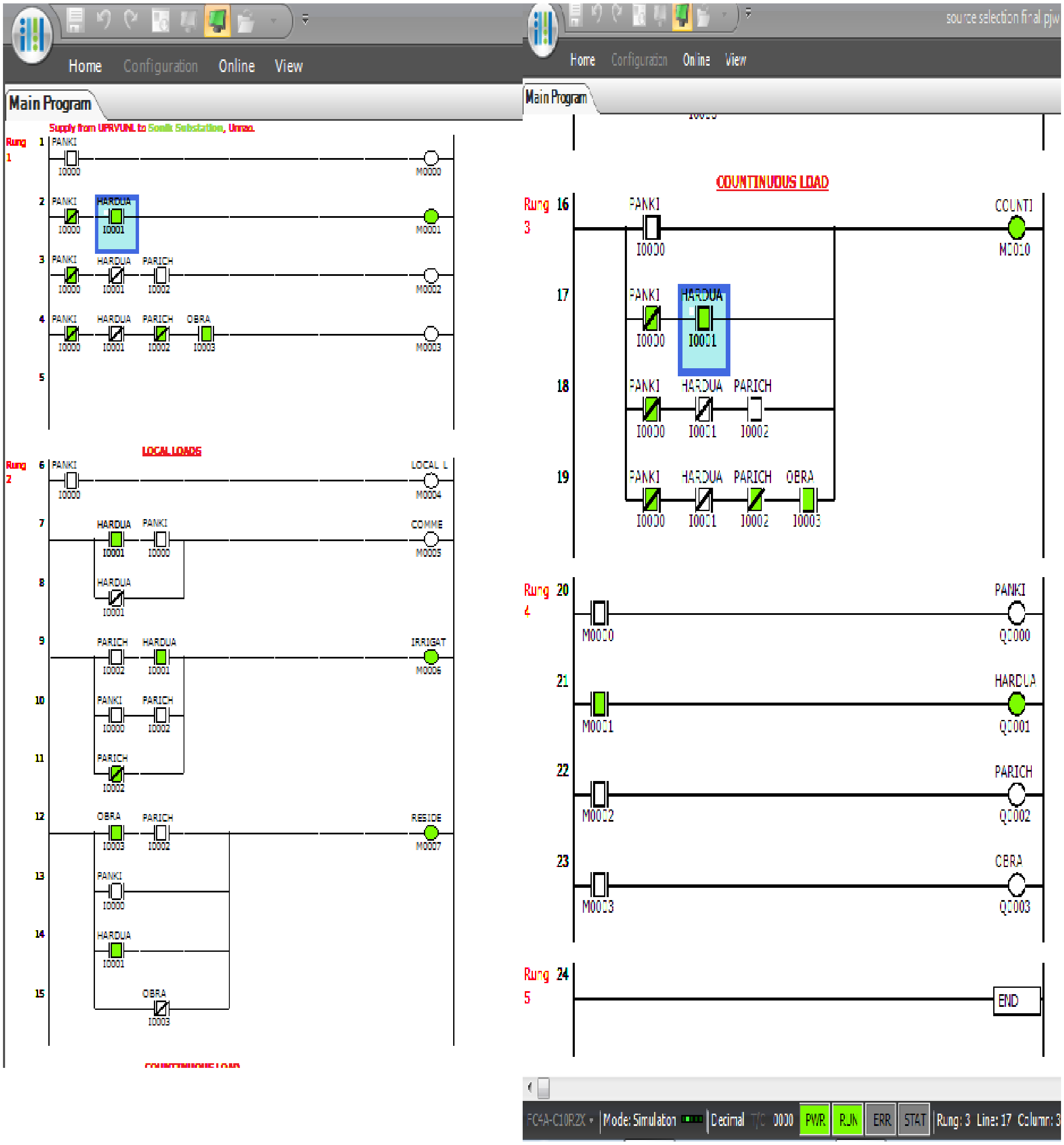


Figure 8.6 Continues load is feed by the Haeduaganj power plant again.

CHAPTER 9

CIRCUIT DIAGRAM

9.1 Circuit Diagram of the Project

CONCLUSION

We have presented the prototype of a smart substation which can automatically switch from one source to another according to the set priority. This priority is set according to the cost of generation of electricity. The power plant having the least generation cost is set as the first priority and the power plant having the maximum generation cost is set as the last priority.

We have selected the ratting of our electrical component such that this project can be easily incorporated to an institution needing continuous power supply like Hospitals, Colleges etc. The safety of this project and the devises is also taken into account and we have place MCB's for the same. . With this project we have learnt a lot of practical as well as technical knowledge of many things which are related to the project work as well as these will help us to get a lot many ideas in future.

Future scope of this project is that we can control the loading and shifting of load from the generator through SCADA.

REFRENCES & BIBLIOGRAPHY

- Modern Power System Analysis - D. P. Kothari, I. J. Nagrath.
- Guarnieri, M. (2013). "The Beginning of Electric Energy Transmission: Part One". IEEE Industrial Electronics Magazine.
- All About Circuits, Tony R. Kuphaldt.
- Electrical power system, Ashfaq hussain.
- Erickson, Kelvin T "Programmable logic controllers". Institute of Electrical and Electronics Engineers.
- Yanik, P. Overview of Programmable Logic Controllers. Cullowhee, NC, United States of America.
- Ian Sinclair, Passive Components for Circuit Design, Newnes.
- Using Transmission Line Equations and Parameters. Star-Hspice Manual.