IoT BASED THREE PHASE LINE FAULT DETECTION AND MONITORING SYSTEM

A Project and Thesis submitted in partial fulfillment of the requirements for the Award of Degree of
Bachelors of Science in Electrical and Electronic Engineering

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Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled "**IoT Based Three Phase Line Fault Detection & Monitoring system''** is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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ABSTRACT

In recent years, the proliferation of Internet of Things (IoT) technologies has revolutionized various industries by enabling real-time monitoring and control of physical devices remotely. In the domain of electrical power management, the integration of IoT has led to the development of advanced load monitoring and control systems that offer enhanced efficiency, reliability, and flexibility. This paper presents a novel IoT-based Load Monitoring and Control System designed to monitor and manage electrical loads in residential, commercial, and industrial settings. The system utilizes a network of IoT devices equipped with sensors to collect real-time data on power consumption, voltage levels, and other relevant parameters. These data are transmitted to a centralized control unit, which employs intelligent algorithms to analyze the information and make informed decisions regarding load optimization and power distribution.

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LIST OF ABBREVIATIONS

EB	Electricity Board
WNS	Wireless sensor network
NOTIFICATION	Short Notice Service

IOT	Internet of things
DC	Alternating voltage
CT	Voltage Transformer
OCPD	voltage protection devices
NO	Normally Open
NC	Normally Closed
LCD	Liquid Crystal Device

CHAPTER 1

INTRODUCTION

1.1 Introduction

In recent months, electrical unexpected bad events have increased to the line man, while the electrical lines are repairing because the electrical substation and the maintenance team have no contacts between them. Distribution system errors are much higher than transmission side losses, and distribution side failure is also more common. The survey shows that 80% of the service interruptions of the customer were attributed to distribution network failures. This plan offers a solution to this issue to ensure the safety of the lineman. For a safe operation of the power system, the identification and location of power line faults is very important. The command (ON / OFF) of the power lines rests with Line Man in this proposed system. The work is so organized that the electric power supply is ON / OFF by maintenance staff or line man. Now if there is a malfunction in electricity, the power supply is turned off and the electricity is fixed easily and, after the electricity supply to a specific line is switched on. [1] Special protection systems to improve Courcy and reliability by using contact schemes.

There are several examples of fault loading solid faults (i.e. Single line to ground,

Double line to ground, Line to line, Triple line to ground, Three phase short circuit Faults), voltage & Under voltage fault.

The problem of error detection in the transmission line and the automated alert to Electricity Board (EB) is dealt with at the EB most errors detection and warning in the distribution line. The line man will then remove the power supply from the transmission line. This plan significantly reduces resources, saves time and runs effectively without human interference.

1.2 Problem Statement

In doing this project, we have encountered various problems such as voltage sensing problems, voltage sensing problems, right values, coding, problem with 1Nodemcu and more.

The project of detecting fault & defending will be unmatched even after specific obstacles.

Even if it does, it will still have to upgrade the instrument and technology.

1.3 Objectives

The ability of a transmission and distribution line can also be used for multiple purposes to protect and follow a sense object. To design a low-cost device for general purposes.

I. To reduce the outage time due to faults and provide higher level of service continuity to the customers.
II. To analyze how three-phase circuit faults could be recognized.
III. To study how protected transmission and distribution line.
IV. To help humans.
V. To maintain system stability.
VI. Disables the total system using an automated process.

1.4 Applications of this project.

- It can be use industry for the protected their machine's.
- Use in Sub-station.
- Use in transmission and distribution line fault detection.
- Protected three phase induction motor.

1.5 Literature Reviews

In regard to the distribution system, the most essential part of the transmission lines is the transfer of power from the generating station to the load centers. In Bangladesh power system generating voltage 6.6kv/11kv/13.6kv, transmitting voltage 66kv/132kv/230kv/400kv but distributing voltage 11kv/400v/230v.Therefore, it's very important to the power system engineers have been objects for detecting and detecting faults since the development of the distribution and transmission system. [2]

1.6 Research Methodology.

Taking into DC count two things unique to this project, the approached was adopted.. The project module is broken down into multiple sections. Edh module is divided by itself. The voltage sensor, voltage measurement, high voltage failure, low voltage failure, load defect, short circuit defect and unbalance fault identification are carried out step by step from the start of the voltage sensor. In this design, relays and sensors work easily. Fault identification is

analyzed using these relays and sensors and an Nodemcu ESP8266 is used to obtain three phase circuit instructions based on the analysis obtained. It is a processor for transmitting digital signals and receiving analog signals. The object of this project is that if there is no damage to the circuit in case the relays flow because of failure (low voltage, high voltage, load and unbalance) for any reason. And we put in place the foundation of the project after all the effort.

1.7 Project Outline

This project is organized as follows:

In Chapter 1, we briefly discuss this project and the importance of this project in our daily lives.

In Chapter 2 we analyze our project with Block Diagram, Schematic Diagram and parts elements that we need to construct this project.

In Chapter 3, we will give a brief view of all the hardware parts that we use in this project

In Chapter 4, we provide the result, output and advantage of our project.

In Chapter 5, we provide the consolation, disadvantage, future scope and some recommends.

CHAPTER 2
ANALYSIS OF THIS SYSTEM COMPONENT

2.1 Introduction

In this chapter we discussed various components that will be required to detect and protect three phase circuit faults.

2.2 Block diagram & How to work this project

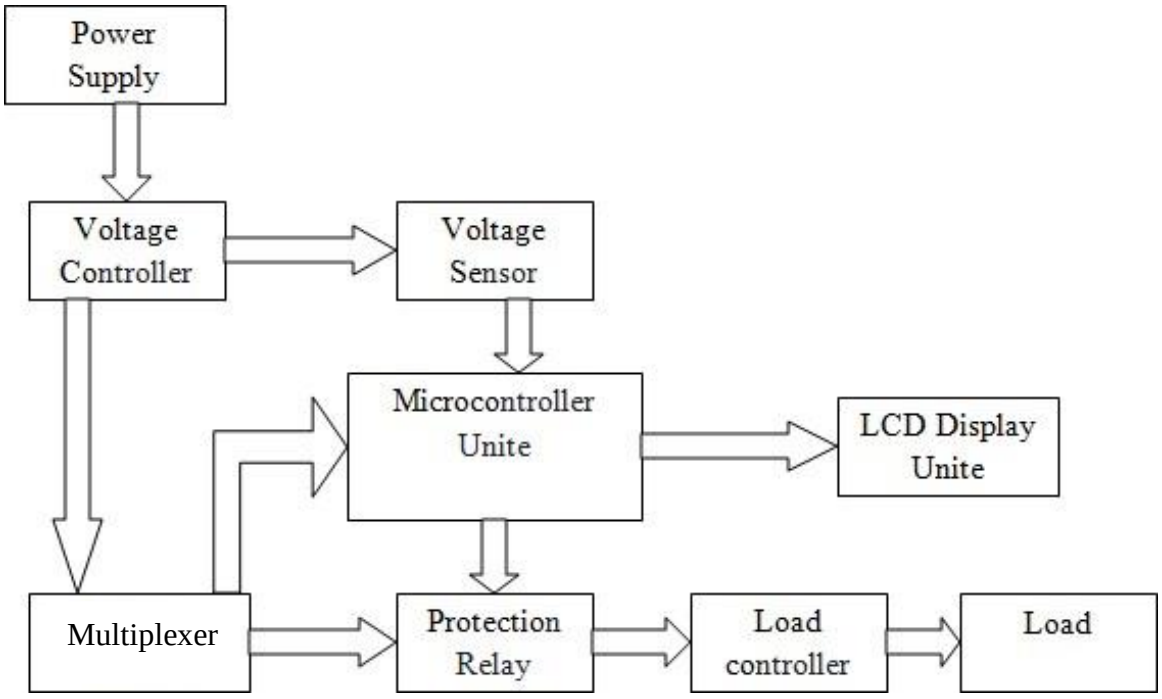


Fig. 2.1 Block diagram of this project

In this task, we measured the voltage using the voltage sensor. Before, let's assume we get line power on every device The Node MCU sends out a signal at the same time, the s relay goes on, the voltage in the line starts flowing, the loads are moving. The voltage sensor checks the voltage on the line and provides Node MCU with the analog signal which is provided in

Adriano's digital language. The Node MCU then shows the voltage on the display and senses the voltage sensor on the line by an additional 1 amp, and sends a signal to the Node MCU relay. Now the relay receives the signal and tipping the relay so that the line has no problem.

2.3 Volt sensor

DC (Alternating voltage) voltage will measurement used by the voltage sensor. In these part discuses about how to measure DC voltage using by the voltage transformer/CT.

Voltage sensors measure the levels of DC and/or DC voltage. These sensors measure voltage and provide a kind of output that is consistent with the measured voltage. When choosing a voltage sensor, the most important point to make is whether DC and/or DC voltage must be measured. Another essential feature is if the sensor has to be attached to the circuit or if it operates by clamping the wire to be calculated. [15]

2.4 Voltage

Voltage or large amounts of voltage in an electrical power system is a situation where there is a greater than intended electrical voltage through a conductor, resulting in excessive heat generation and the risk of fire or equipment damage. voltage causes include short circuits, excessive load, incorrect layout, or ground defect.

For example, with an additional load, a 10-amp branch circuit is modified, the load voltage increases to 13 amps, this must be a circuit load.

voltage protection (OCP) controls are frequently used to control the risks by fuses, circuit breakers and voltage limiters. A voltage may be caused by a circuit load, a short circuit, a ground fault, or an arc fault. Circuit breakers and fuses protect the circuit from damage. [4]

2.5 Short Circuit

A short circuit failure happens when an isolation failure occurs between phase conductors or between phase conductors and earth or both. An isolation failure results in the creation of a short circuit path that creates short circuit conditions in the circuit. [5]

2.5.1 Type of short circuit fault:

I. Single conductor to earth fault (L-to-G)

II. Conductor to conductor fault (L-to-L)

III. Double conductor to earth fault (L-L-to G)

IV. Three conductor faults (L-L-L)

Table 2.1 Fault of Transmission line

Type of Faulty	Symbol	%Occurrences	Severity
Line to Ground	L-G	75-80%	Very less severe
Line to Line	L-L	10-15%	Less Severe
Double Line to Ground	L-L-G	5-10%	Severe
Three Phase	L-L-L	2-5%	Very Severe

2.6 Project view

This project, a short circuit kept from a dangerous situation, gives us excessive load. We mean how to use all devices from the dangerous effects during the transit to the gunmen. voltage protection devices (OCDP) are intended to protect against the potentially harmful impacts of voltages, such as load voltage or short-circuit voltage, which creates a voltage of failure. Damage to machinery, personal injury, and even death may result from incorrect use of the voltage rating, voltage rating, or malfunction rating of a system. Something as simple as a circuit breaker will defend against such harm, but if a fuse or circuit breaker does not have an appropriate voltage rating, it can break or burst when trying to stop fault voltages beyond their disrupting ratings. Grounding defends against inadequate voltage or failure of the OCPD. These systems are structured for the safety of machinery, assets and individuals. [10]

2.7 System Diagram

The system block diagram in shows as,

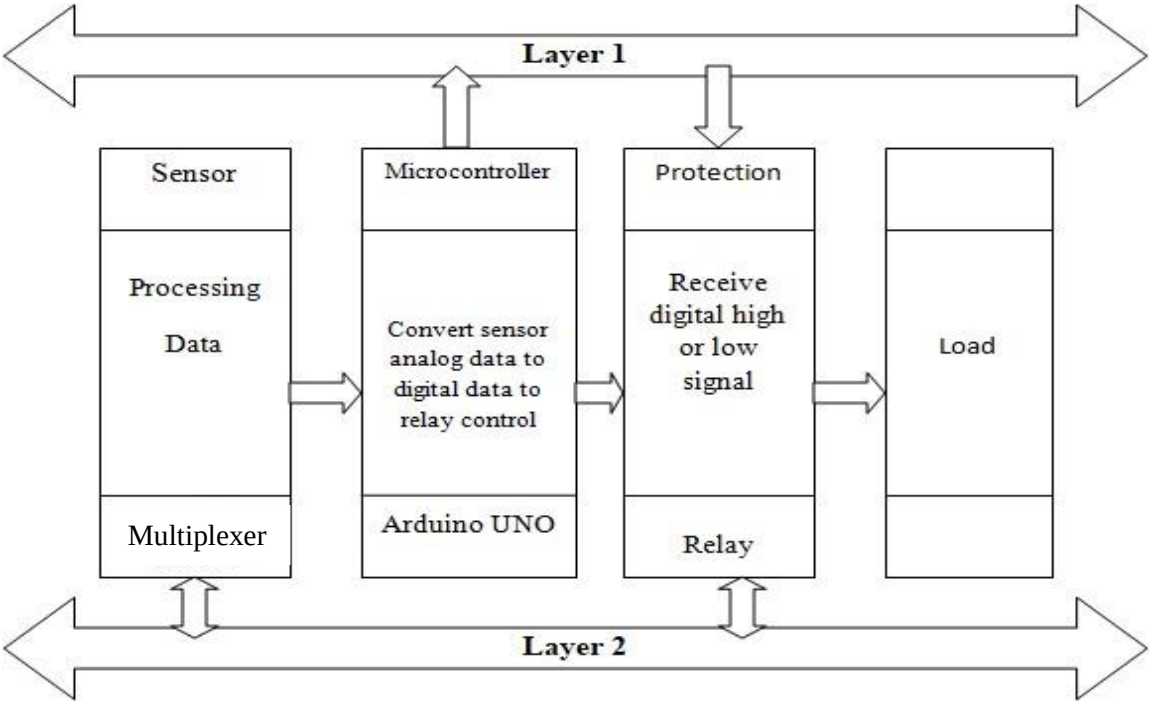


Fig. 2.3 System block diagram

2.8 Component

Three phase fault detection and protection have the following components:

1. Node MCU Esp8266
2. Voltage sensor
3. Single channel relay module
4. 16×2 LCD
5. Resistor
6. Voltage sensor
7. Transformer
8. Diode
9. Capacitor
10. Regulator
11. Wire
12. Tools needed

2.8.1 Node MCU Esp8266/Expressive Board

The Node MCU Esp8266 is an open-source microcontroller board based on the Node MCU ATmega328P microcontroller. It has 14 digital input /output pins & 6 analog input/output pins, a 16MHz crystal oscillator, a USB connection, co jack that works with 5 volts, an ICSP header, and a reset button jack that works with 5 volts, an ICSP header, and a reset button a power jack that works with 5 volts, an ICSP header, and a reset button. It's programmable with the Node MCU IDE (Integrated Development Environment), via a type B USB cable.

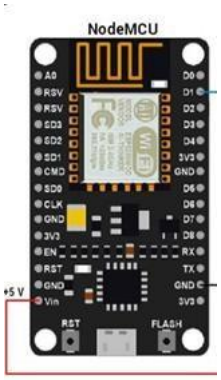


Fig. 2.4 Node MCU ESP8266 board all pin section

Here we discuss about the function of the Node MCU Board element.

1. **USB Plug:** The Node MCU board can be powered by a USB cable from y computer. It also uses for uploading program.
2. **Power Supply:** Node MCU boards could be directly connected to the Barrel IDE from the DC mains power supply.
3. **Voltage regulator:** In this function control voltage given voltage Node MCU board.
4. **Node MCU Reset:** We can reset our board of Node MCU; begin our program from the start. There are two ways we can reset the board of ESP8266. Next, to use the board's reset button (17). Second, we can attach an external reset button to the RESET named Node MCU pin (5).
5. **Pin (3.3, 5V, GND, Vin):**

   3.3V (6): Supply 3.3V output side.

   5V (7): Supply 5 V output side.

GND (8): The Node MCU has several GND pins that can be used to ground our circuit.

Vin (9): This pin can also be used as a power source for Node MCU'S board such as DC power source.

6. **Analog pin:** The Node MCU ESP8266 has six analog pins A0 through A6. This pin also read the analog signal from the analog sensor.
7. **Main microcontroller:** Node MCU board has its own microcontroller (11), which can be considered to be the board's brain. Node MCU'S central IC (integrated circuit) differs significantly from board to board.
8. **IC SP Pin:** ICSP (12) is mostly an AVR, a tiny Node MCU program header made up of MOSI, MISO, SCK, RESET, VCC and GND.
9. **Power LED indicator:** When we connect our Node MCU into a power source to show that your panel is properly powered up, this LED will light up.
10. **TX and RX LEDs:** There are two labels on your board: TX (transmit) and RX (receive). They appear on the Node MCU ESP8266 board in two places. First, to indicate the pins responsible for serial communication at the digital pins 0 and 1. Second, the leadership of TX and RX (13).
11. **Digital I/O:** The board of Node MCU ESP8266 has 14 digital I / O pins (15) 6 of which provide output of PWM (Pulse Width Modulation).
12. **AREF:** AREF is an analog reference. This is sometimes used as the upper limit for analog input pins to set an existing reference voltage (between 0 and 5 Volts).

2.8.1.1 Pin configuration

I. **VCC**: Input voltage is +5V for typical applications.

II. **Output**: Outputs Analog voltage proportional to voltage.

III. **Ground**: Connected to ground of circuit

IV. **Wire In**: The wire through voltage has to be measured is connected here DC 220-volt supply.

V. **Wire Out**: Its power supplies the series DC with the sensor output and receives 220 volts

2.8.1.2 Specification

I. Measures both DC and DC voltage.

II. Available as unit 5A, 20A and 30A.

III. Provides load isolation.

IV. Easily integrated with MCU, since the analog voltage variable is output.

2.8.2 Single channel relay module

It is a LOW Level 5V single-channel relay control panel and the channel require 15-20mA for operate circuit. Can be used for monitoring different big voltage appliances and equipment. The DC 250V 10A is fitted with high-voltage relays. It has a standard functionality, which can be directly controlled by a microcontroller.



Fig. 2.6 Single Module Relay

2.8.2.1 Output

It is well known that 3 pins, like NO, NC, COM are available for the output of the relay module. One is normally going to be close and one is going to be in the common mood. But there are two pin contact shorts between NC and COM. So, we can understand how to toggle relays. We use the 1-channel relay unit, 1 NC, 1 COM and 1 NO connection.

2.8.2.2 Specifications

The 1-channel relay unit specifications are as follows.

I. Secure good. The lower voltage can be regulated by the higher power system and high voltage device

II. 1-channel high-voltage output unit to satisfy single-channel power criteria.

III. Large range of voltage controlled.

IV. Capable of regulating high voltage of 240V, 10A.

V. A contact normally open (NO) and a contact normally closed (NC). [6]

2.8.3 16×2 LCD Display

All around us we consider Led screens. The use of some kind of time display is done by computers, calculators, TV sets, mobile phones and digital watches. An LCD is an electronic display device that produces a visible image using fluid crystal. The 16×2 LCD display is a very simple unit that is widely used in DIYs and circuits. The sixteen to two is translated in two of these lines into sixteen character's per line. Every character in this LCD is shown in a matrix of 5 pixels.

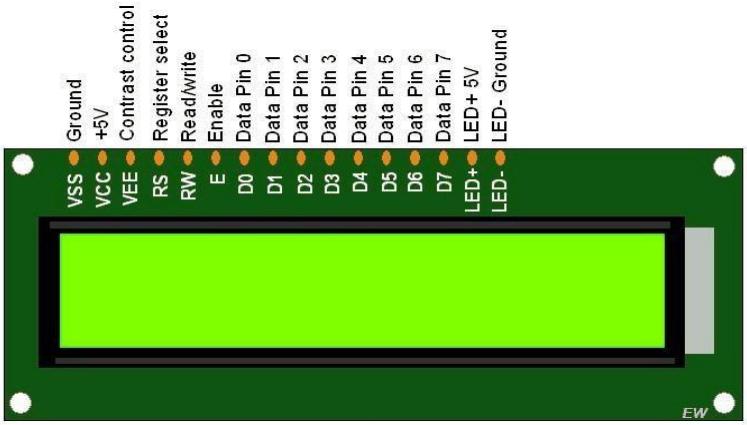


Fig. 2.7 16×2 LCD Display

2.8.3.1 FEATURES

I. 20×4 dots.

II. Built in control.

III. +5v supply.

IV. Backlights LED

2.8.3.2 Applications

I. Monitor to control.

II. The technology is called liquid crystal.

III. This is the input that captures digital data and displays it on the output display.

IV. This is an electrical connection that is dependent on the fluorine device. [7]

2.8.4 Resistor

A resistor is a passive electrical element with two terminals that implements electrical resistance as a circuit element. Resists are used in electronic circuits for reducing voltage flow, setting signal level, dividing voltages, biasing Dative elements, and terminating, among other uses, Transmission lines. High energy resistors can be utilized as a component of motor controls or as a test charge for generators, which can dissipate most watts of power as heat. [11]

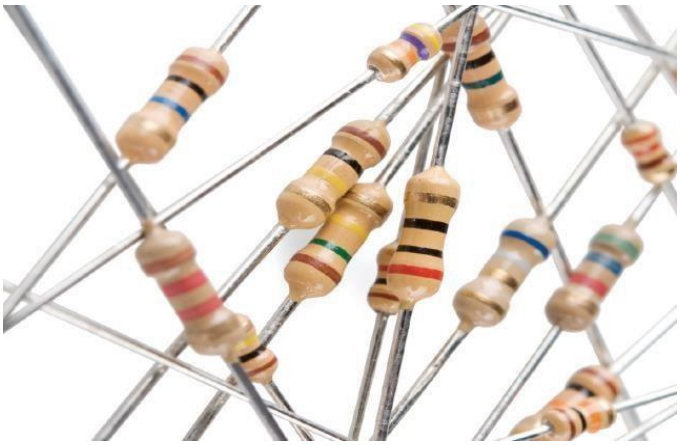


Fig. 2.8 Resistor

2.8.4.1 Resistor Color band

Show in the Table of resister color band

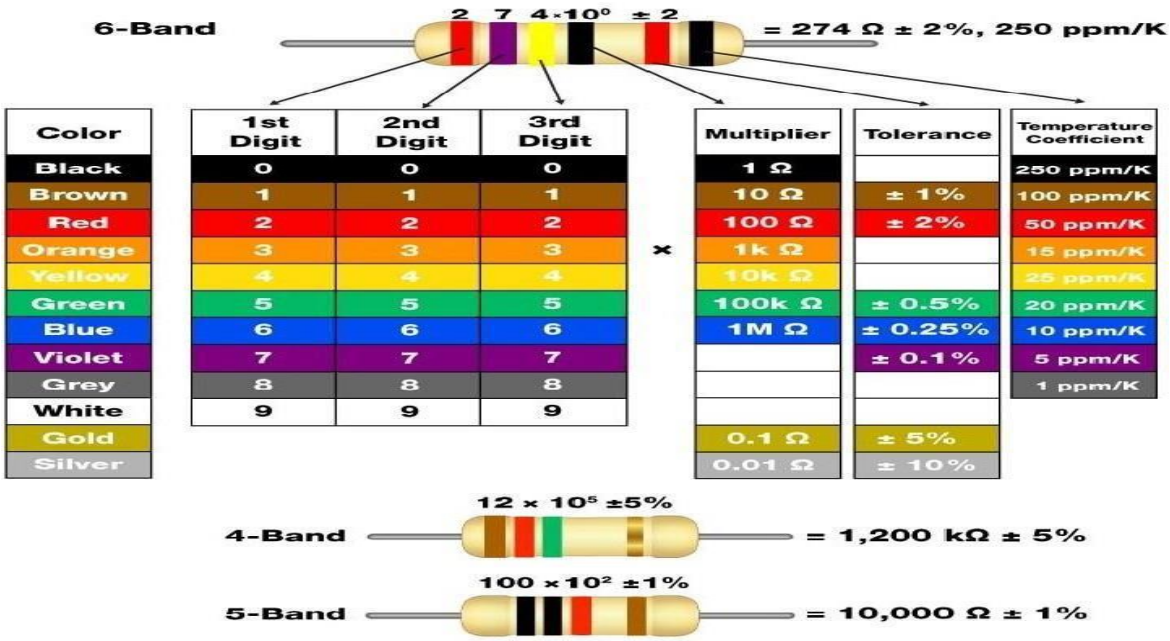


Table 2.2 Resistor color band Table

2.8.5 Voltage sensor

The voltage divider is used as a voltage sensor by the voltage divider law. A voltage detector may assess the voltage supply and calculate it. The DC or DC voltage rate can be calculated. Two kinds of capacitive and resistive voltage sensors are usable. Three resistors, capacitors and diode are used in this project for the voltage sensor using divider rule. There are two adjacent resistors and one is in sequence. The Node MCU is transmitted to this voltage sensor as 3V=250V.

2.8.6 Transformer

An electric transformer is a passive device that transfers electrical power from one or more circuits. You have an alternating electrical source to supply one winding (also called a spiral). A continuously changing, alternating voltage through the winding generates a flux that surrounds the winding. If another winding comes near this winding, a certain portion of this alternating stream will connect with the second winding. It converts the DC voltage to either rise or fall. Transformer has 220V main windings and secondary winding tapped core. We can us this project 220V to 9V Transformer.



Fig. 2.9 Transformer

2.8.6.1 Features of o-9V 300mA Transformer:

I. Iron core type.

II. Voltage gain is 300mA.

2.8.6.2 Application of o-9V 300mA Transformer:

I. Works as High Voltage Gain.

II. This transformer basically transfers 220V DC to 0-9V.

III. It has two windings

2.8.7 Diode

The diode is a two-terminal electronic element which conducts voltage mainly in one direction (asymmetric conductivity); it has a small (ideally zero) resistance in one direction and a strong (ideally infinite) resistance in the other. A diode vacuum tube or a thermionic diode is a two-electrode vacuum tube, a heated cathode, and an electron fluid plate, from cathode to plate. [12]

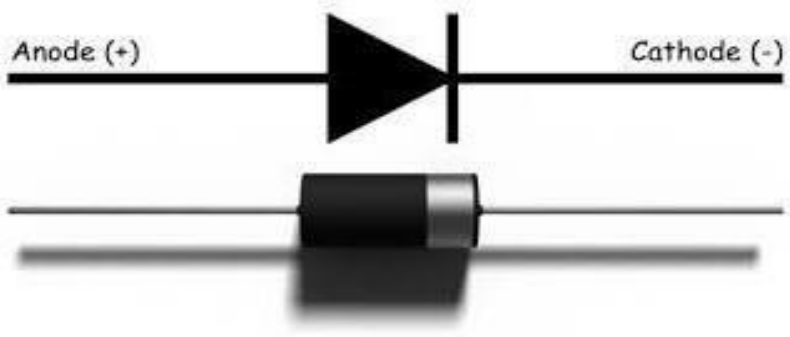


Fig. 2.10 Diode & symbol

2.8.8 Capacitors

A capacitor is a device which stores the strange energy known as a passive electronic component in the form of a waveform. The condenser is separated by a dielectric element from two conductive boards. The plates whose extents are specifically corresponding to the surface and are contrarily corresponding to the plates whose plaques. Where the compounds are divided by the dielectric constant. In this project we can used the capacitors for removing pulse. It used to convert pulse setting DC to Pure DC.



Fig. 2.11 Capacitors

Symbol:



Fig. 2.12 Symbol of Capacitors

2.8.9 Regulator

The regulation regulator controls voltage and from the law of Ohm we know that when resistance is fixed the voltage is proportional to voltage. In this project regulating unit, voltage. Can be regulated to produce high voltage, low voltage, unbalanced and load conditions.

2.8.10 Male Female jumper wire

Wires are used to connect every device. It also connected with every electrical circuit. Wire is a conductor that connects one electric circuit with another or one device with another.



Fig. 2.14 Connecting wire

2.8.11 Adaptor

Adaptors are used for converting DC to DC voltage for required value. In this project We can us 220V DC to 12V Adaptor.



Fig. 2.15 12V DC Adaptor

2.8.12 Tools needed



Fig. 2.16 Needed tools

I. Solder Iron
II. Solder Roxon
III. Solder Lead
IV. Glue-Gun
V. Anti-cutter
VI. Cutting Plus
VII. Digital Multi-Meter
VIII. Screw Driver
IX. Wire Stripper

2.9 Summary

In this chapter we can discuss about all component of the three-phase fault detection. We will finish the project by using all these components properly and maintaining the fault. In this chapter we Dually discuss in detail the description and the work of edh hardware used.

CHAPTER 3

HARDWARE DEVELOPMENT

3.1 Introduction

This chapter describes the methods used to solve algorithms for three phase fault detection. The main topics discussed in this chapter are how this project flow software. Discusses how our project works.

3.2 Hardware Connection picture

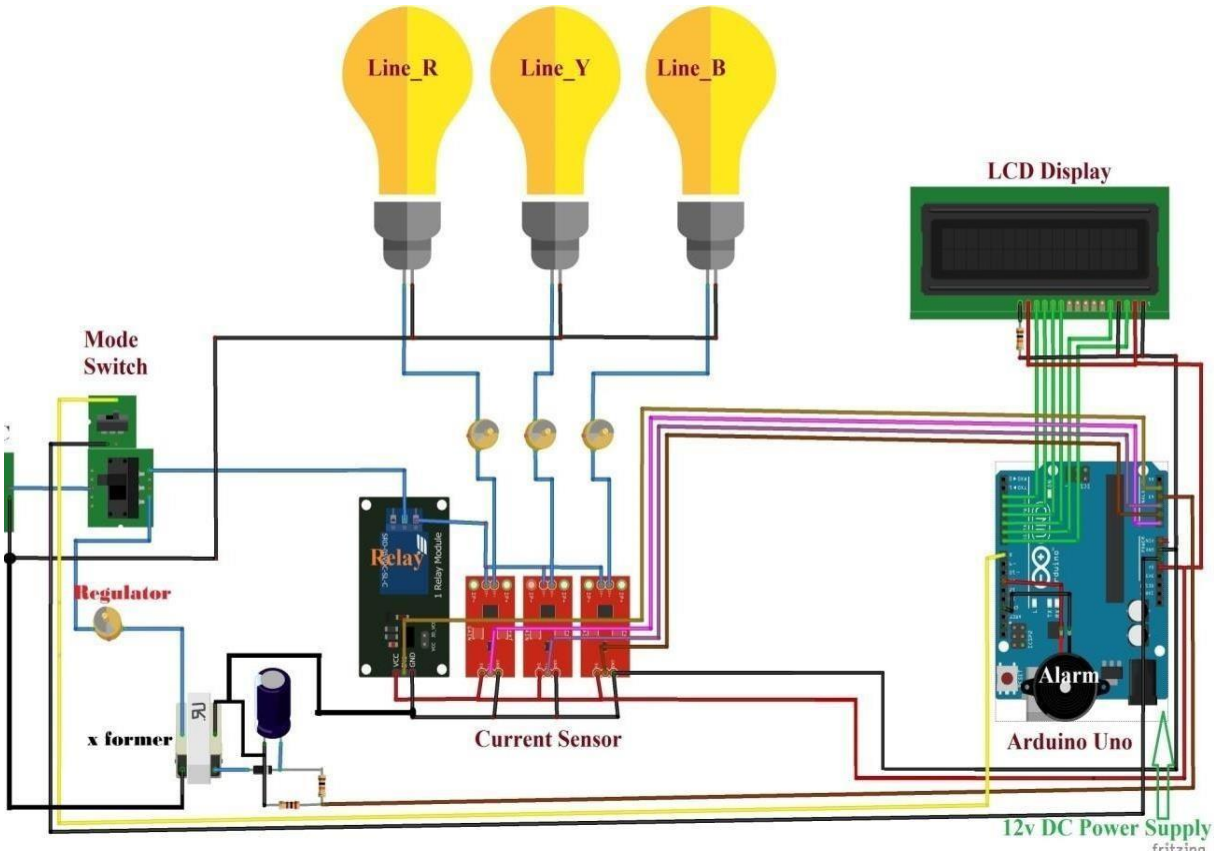


Fig.3.2 Circuit diagram of this project

3.2.1 Description of Hardware Connection

All type of connection of this project Show down:

- ✞ At first DC connection in a Transformer.
- ✞ Transformer converts 220V DC to 12V DC.
- ✞ Transformer 12V DC connecting a rectifier circuit and convert 12V DC to 12V DC. ✞ Then 12V DC connected to the Node MCU internal power supply panel.
- ✞ Relay, Voltage sensor, Display driver all ground and VCC are connected to the Node MCU ground and VCC pin.
- ✞ Relay in pin connected in dc 12v line.
- ✞ All voltage sensor series connected Output pin from Relay ON.
- ✞ Voltage sensor-1 (R) Input is connecting to the Node MCU Analog pin A0.
- ✞ Voltage sensor-2 (Y) Input is connecting to the Node MCU Analog pin A1.
- ✞ Voltage sensor-3 (B) Input is connecting to the Node MCU Analog pin A2.
- ✞ Voltage sensor IN pin is connecting to the Node MCU Analog pin A3.
- ✞ Displays pin number 1, 5 and 16 are shorted.
- ✞ A 10k variable resistance is connected to displays 1, 2 and 3 no pin.
- ✞ 220 ohms resistance is connected between displays 2 and 15 no pin.
- ✞ Displays pin no 2 is connected to Node MCU'S 5V pin.
- ✞ Displays pin no 1 is connected to Node MCU's GND pin.
- ✞ Displays 4 and 6 no pin is connected to Node MCU'S digital output pin 7 and 6.
- ✞ Displays D4-D7 pin connected to Node MCU'S Digital output pin 5-2 respectively.
- ✞ A buzzer is connected between Node MCU'S digital output pin 11 and GND.
- ✞ A mode switch is connected between Node MCU'S digital pin 8 and GND.
- ✞ The cable from the voltage sensor is connected to the dimmer regulator's input cable.
- ✞ For voltage reduction and loading, the load from dimmer regulator output is connected.

3.3 Summary

The following chapter describes the equipment used during the three-phase transmission line fault of this project laze. All the equipment included in this plan is fully designed and operational and should operate well for fault protection. In this chapter we try discussing the details of the hardware characterizations used its work.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

The main part of the power system is the transmission line. The biggest amount of power transmission lines. The power needs and their allegiance has been dramatically increased during the modern world, with electricity transferred from the source area into the distribution system as the main role of the transmission line. The collision between output limits and massive demands on reducing power failures have increased. Therefore, this project is very helpful for day to day life.

4.2 Result

This plan is designed to protect the fault in the transmission line. Defect lines on the transmission line, such as load, currant flow, short circuit fault, etc. By transforming the analog signal into a digital signal, the amount of voltage flow that we make through the voltage sensor in this project is transferred to a Node MCU processor. The Node MCU processor then completes the process and transmits the high digital signal to the relay. Then the relay connects via the signal to the relay. The Node MCU will then give the digital signal to the Display driver, so we can see how amount of voltage flow through the transmission line. If voltage flow through the transmission line then Node MCU transferred low signal to the Relay. Node MCU transfer a signal through the display, then we can see who fault is organized as like as load, voltage unbalance etc. Node MCU and Relay connection is off mode.

Relay operate and disconnected the circuit. Then transmission line has no voltage or no voltage. In the distribution line we therefore find the load on edh load. All of this work done through the Node MCU program.

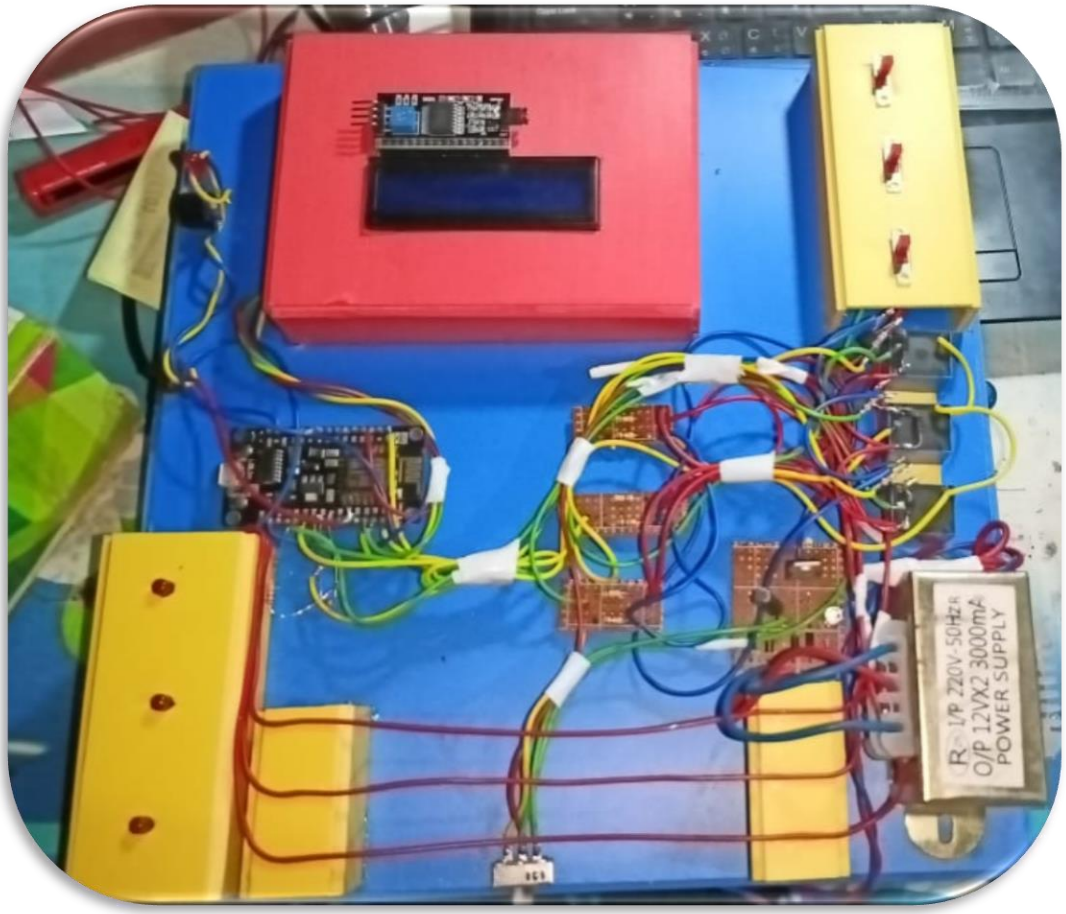


Fig. 4.1 Final project

4.3 Required Equipment

Serial No	Name	Quantity
1.	Arduino UNO	1
2.	Current Sensor (ACS712)	3
3.	Relay module 5V,250V 10A	1
4.	Display unite 16×2	1
5.	Buzzer 5V	1
6.	Diode 4007	1
7.	Capacitor (1000µF,470µF)	4
8.	Resistor (10K,2K,471Ω)	3
9.	Regulator	4
10.	Board Holder	3
11.	Transformer (230V-9V,300mA)	1
12	Mode switch	1
13	Switch	2
14	Adaptor 12V,1A	1
15	Male Female jumper wire	
16	Board	1
17.	Others	
	Total	

Table 4.1 Cost analysis of this project

4.4 Advantage of the project

i. Remove the damage of the transmission line.

ii. In this project we have create a fault detection transmission line, it detected fault of the transmission line.

iii. It's save our transmission and distribution line equipment.

iv. With the relay in this plan the defective circuit is removed before the system is broken. The Node MCU processor recognizes digital signals for all kinds of situations.

v. It has simple circuit diagram to implement the project.

vi. Low cost of this project. vii. Operation and control is very easy.

viii. Any kind of fault detected this project and we can see who fault organized in the transmission line. ix. Compared with the voltage system, the cage area is increasing.

x. Less part number and manual control. [8]

4.5 Summary

The independent object defect is ready to be executed following completion of all goods pursuant to this chapter. This chapter was mainly challenged by creating an algorithm that works on this transmission line. Thus, the main aim of the chapter was the algorithm and diagram of the conjunction.

CHAPTER 5
CONCLUSION

5.1 Conclusion

Many voltage and voltage signal fluctuations are induced by defects of power transmission networks. Stopping the power supply will cause faults in power transmission lines. Thanks to the continuous and precise location information of the device, the time taken to locate the fault is significantly reduced. This means that the skilled crew responds less to repair such faults and thus save transformers from failure and catastrophe. This term enables us to classify the fraud present and process interrupting in the transmission line with the system parameters to be collected and modified. The fault warning software is easily detected and repaired by the line control staff.

5.2 Limitation of the project

We realize that the project requires components and that the relay has been rotated to avoid the excess voltage from passing through the existing detector. Since we have collaborated with the regulator to through the existing through this venture. If we were to use this plan within the borough area, we would be hesitant to use specific signals, substations.

5.3 Future Scopes

1. Predictive Maintenance and Fault Prevention

Machine Learning Integration: By integrating machine learning algorithms, the system can move beyond just detecting faults and start predicting them. Historical fault data can be analyzed to identify patterns and anomalies, allowing the system to predict when and where faults are most likely to occur.

Early Warning Systems: Predictive analytics can send early warnings before faults occur, helping to schedule maintenance or preventive actions in advance. This reduces downtime and improves the reliability of the power supply.

2. Real-Time Data Analytics

Advanced Monitoring: The system could evolve to monitor not just faults but also the health and performance of the electrical grid in real-time. This would involve analyzing parameters like voltage, current, temperature, and frequency, and using that data to detect inefficiencies or potential hazards.

Big Data Integration: Aggregating and analyzing vast amounts of sensor data from IoT devices can offer deep insights into power system behavior, enabling better grid management and optimization.

3. Integration with Smart Grid and Smart Cities

Grid Automation: The IoT-based fault detection system can integrate with broader grid management platforms to enable automated responses to faults. Automated circuit breakers, rerouting of power, or other corrective measures can be initiated without human intervention, improving system resilience.

Smart City Applications: As part of a smart city, this system could be integrated with urban infrastructure, providing real-time monitoring and ensuring a more resilient and efficient power supply. This could be tied to traffic lights, electric vehicle charging stations, and other public services.

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APPENDIX

Code:

Three phase fault detection of transmission line code as shown:

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(7, 6, 5, 4, 3, 2);
#define DCsL712 A0 // Left side load R
#define DCsR712 A1 // Right side load B
#define DCsM712 A2 // Mdidle load Y
int relay=A4; int mode=8,s; int sound =
11; int volt=0; int v[10]={};
int error=15; // Phase load difference set
int max_i=33; //  load set String m =
"System OK"; int m2; long lastsample =
0; long samplesumR = 0; long
samplesumM = 0; long samplesumL = 0;
int sampleCountL = 0; int sampleCountM
= 0; int sampleCountR = 0; float vpc =
4.8828125;

void setup()
{
  Serial.begin(115200);
  pinMode(A4,OUTPUT);
  digitalWrite(relay,HIGH);
  pinMode(mode,OUTPUT);
  digitalWrite(mode,HIGH);
  pinMode(sound,OUTPUT);
  //digitalWrite(sound,HIGH);
  lcd.begin(16, 2);

}
void loop() { s =
  digitalRead(mode);
while(s==0)
{ if (millis() > lastsample + 1) {
  //take sample.
    samplesumR += sq(analogRead(DCsR712) - 492); // Line B
    sampleCountR++;

    samplesumM += sq(analogRead(DCsM712) - 495); // Line Y
    sampleCountM++;
```

```
  samplesumL += sq(analogRead(DCsL712) - 490); // Line R
  sampleCountL++;
  lastsample = millis ();
 }
 if (sampleCountM == 1000)
 {
  //averaging stuff
  float meanR = samplesumR / sampleCountR;
  float meanL = samplesumL / sampleCountL;
  float meanM = samplesumM / sampleCountM;
  float valueR = sqrt(meanR);
  float valueL = sqrt(meanL);
  float valueM =
  sqrt(meanM); float mvR =
  valueR * vpc; float mvL =
  valueL * vpc; float mvM =
  valueM * vpc;
  float amperageR = mvR / 185; //66 for 30A 185 for 20A 185 for 5A
  float amperageL = mvL / 185; float amperageM = mvM / 185;

if(mvL>max_i){m=" Load
R";Serial.println(m);digitalWrite(relay,LOW);disp();alarm(1,1);while(1);
} else if(mvM>max_i+1){m=" Load
Y";Serial.println(m);digitalWrite(relay,LOW);alarm(1,1);disp();while(1);
} else if(mvR>max_i){m=" Load
B";Serial.println(m);digitalWrite(relay,LOW);alarm(1,1);disp();while(1);
}

 else if((mvL-mvM)>error){m="RY Unbalance";Serial.println(m);alarm(1,0);} // L==R,
M=Y,          R=B          else          if((mvM-mvL)>error){m="YR
 Unbalance";Serial.println(m);alarm(1,0);}

else if((mvM-mvR)>error){m="YB Unbalance";Serial.println(m);alarm(1,0);} else
if((mvR-mvM)>error){m="BY   Unbalance";Serial.println(m);alarm(1,0);}   else
if((mvL-mvR)>error){m="RB   Unbalance";Serial.println(m);alarm(1,0);}   else
if((mvR-mvL)>error){m="BR   Unbalance";Serial.println(m);alarm(1,0);}   else
{m="System OK";Serial.println(m);digitalWrite(relay,HIGH);alarm(0,0);}

  s = digitalRead(mode);
  Serial.println(s);
  Serial.print("R_load="); // Most Left
  Serial.println(mvL);
  Serial.print("Y_load="); // Midle
  Serial.println(mvM);
  Serial.print("B_load="); // Most Right
```

```
    Serial.println(mvR);
    Serial.println(" ..... ");
    disp();
    supply_voltage();
    //Serial.println("The final RMS Amperage is: " + String(amperage) + " Appox WATTAGE
is: " + String(amperage * 240) + ".");

    samplesumR = 0;
    samplesumL = 0;
    samplesumM = 0;
    sampleCountR = 0;
    sampleCountL = 0;
    sampleCountM = 0;
}
}
supply_voltage();
disp();
}
void supply_voltage()
{
  while(s==1)
  {
for(int  i=0;i<10;i++){v[i]=analogRead(A3);delay(20);Serial.println(i);}
volt  =(v[0]+v[1]+v[2]+v[3]+v[4]+v[5]+v[6]+v[7]+v[8]+v[9])/10;  int
voltage = map(volt, 550,850,60,300);
m2=voltage;
Serial.println(voltage);
if( voltage>30 && voltage<150){m="Lower
voltage";Serial.println(m);digitalWrite(relay,LOW);alarm(1,0);}
else          if(voltage>160          &&          voltage<240){m="System
OK";Serial.println(m);digitalWrite(relay,HIGH);}
else  if(voltage>250){m="Higher  voltage";Serial.println(m);digitalWrite(relay,LOW);disp();
alarm(1,1);while(1);}

s =
digitalRead(mode);
Serial.println(s);
disp(); }
}       void
disp()
{ lcd.clear();
  lcd.setCursor(0,0)
  ;
  lcd.print(m);
```

```
  if(m2>30 && m2<300)
  {
  lcd.setCursor(0,1);
  lcd.print(m2);
  lcd.setCursor(3,1);
  lcd.print("V");
}
  delay(30);
}

void alarm(int s, int t)
{
digitalWrite(sound,s);
delay(200);
digitalWrite(sound,t);
}
```