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Three Phase Transmission Line Fault Detection using Arduino

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I. INTRODUCTION

A. *Problem Summary and Introduction*

Fault is an interruption, that can interrupt the by performing its own task. In electrical engineering fault has many types that can cause interruption in many fields of electricity. In power system the major fault occurs in transmission line (approx. 70-80%). This fault can cause Electrical Accident any may cause electric fire, which can also cause livelihood losses.

There are two types of Transmission system:

1) Overhead Transmission System

⇒ In this transmission system the power is transmitted through uninsulated cable using tower.
⇒ It is done for very high voltage and has no limit of high voltage.
⇒ Maximum high voltage should be transmitted through the overhead transmission system is 720KV.

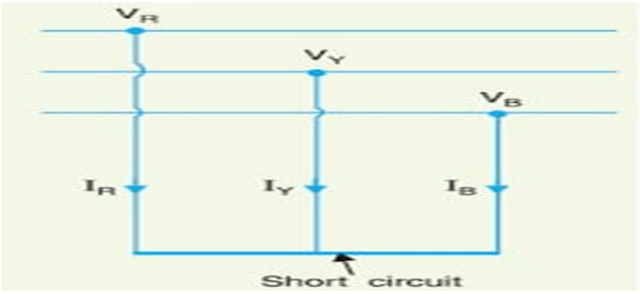
2) Underground Transmission System

⇒ In this transmission system the power is transmitted through insulated cable under the ground.
⇒ It is used in primary distribution which starts from 66KV.
⇒ Maximum voltage that can be transfer through the underground transmission system is 66KV.

In this globe the Alternating power should be transmitted through three phase system. It causes some major power losses during transmission majorly due to the fault. Mainly there are two types of faults happens in transmission which are:

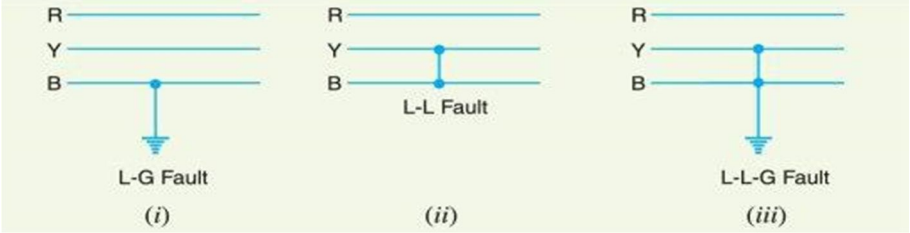
1) Symmetrical Fault

⇒ It is defined as the fault occurs between three phase (Line-to-Line-to-Line fault) or three phase to ground (Line-to-Line-to-Line-to- Ground).
⇒ Power losses in all phase is balanced.



2) Unsymmetrical Fault

⇒ It is defined as the fault occurs between single line to ground(S-L-G), double line (L-L) or double line to ground(L-L-G).
⇒ Power losses in all phase is unbalanced.



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B. Aim and Objective of the Project

Aim of the project is provide high level of service continuously to the customer by reducing the time during the fault.

The main objective is to make the system reliable, fast, less time consuming and rigid. Which can cause very less interruption in the power supply during the temporary fault. For permanent fault it relocates the distance therefore we can resolve the problem physically, mainly on transmission line.

C. Description of the Project

1) *AIM*: To reduce time during the correction of fault in three phase transmission line.

2) *Design*: This project consists of Transformer, Rectifier and Filters, Buck convertor, Arduino, Relay, LCD Display, ULN2003, etc... The input power for this project is not exceed more than 225V, which is the input of transformer that gives 12v output. It works on the very low power, so that the losses are also very less and rating of the circuit breaker, conductor, Insulation is very less. This project is very sensitive.

3) *Costs*: It has high installation cost, maintenance cost and less running cost. It also needs very less worker for controlling and monitoring because it is fully automated.

II. LITERATURE SURVEY

A. Literature Review

1) Prof. Ashwini G. Bhagwat[1], Ganesh S. Pawar[2], Tejas V. Mulane[3], Bhavesh V. Nikam[4], Vaibhav M. Mali[5] 'Three Phase fault Detection System using IOT'.

Vol-9 Issue-3 2023 IJARIIE-ISSN(O)-2395-4396

Conclusion: This paper proposes a model designed to solve consumer problems using Arduino and IoT software. The model can easily detect the type of fault and solve it effectively. The prototype model works quickly and accurately, and helps to avoid future problems in transmission lines. Overall, this model provides an efficient solution for fault detection, which can benefit both consumers and the power industry.

2) Dr. C.S. Hiwarkar, Shimanshu S. Shinde, Akshay J. Landge 'Fault Detection in Three-Phase System using IOT'.

Vol-10 Issue-4 2022 IJRASET-ISSN(O)- 2321-9653

Conclusion: This circuit monitors fault conditions using a step-down transformer, relay coils, fault switches, and a microcontroller. The LCD displays abnormal values when faults occur, helping identify fault locations. The relay disconnects the load to indicate a fault situation.

3) Raunak Kumar 'Three Phase Transmission lines fault Detection, Classification and Location'.

Vol-6 Issue-14 2013 IJSR-ISSN(O)- 2319-7064

Conclusion: The impedance-based fault detection, classification and location methods compares most often pre-known line parameters to the impedance measured in the case of fault. Using this method with pre-known set of values with any soft computing technique detects, classifies and provides probable fault location without any of the bridge methods.

4) Paveena Anjali, Anjum Banu, Abhilasha S, Niveditha P A, Safia Samreen M S 'Three Phase Fault Analysis and Detection in Transmission Line Based on IOT'.

Vol-10 Issue-11 2022 IJERT-ISSN(O)-2278-0181

Conclusion: Maintenance at remote location such as BTS can be handled efficiently and effectively using ATMmega2560 and cutting-edge technology such as IOT communication. This system is very sophisticated in terms of power generator. It is very reliable and effective system. With the help of a specific adjustable variable port, we can monitor and detect fault in this system. As a result, we can adjust the setting to suit our needs. Without requiring human interaction, the system provides effective monitoring and protection of the power generation based on its oil level, oil quality, temperature and operating voltage.

5) Patel Vishal K, Patel Kavyah H, Patel Nikhil D, Panara Sajid M, 'Three phase fault analysis with auto reset on temporary fault and permanent trip otherwise'.

DOI: 10.13140/RG.2.2.34714.80324 Research Gate 2016

Conclusion: Different voltage unbalance such as LL (Line to Line), LG (Line to Ground), and 3L (Three Lines) has been observed. These faults are carried out by closing the fault switch in Simulink model. These faults are taken temporary as well as permanent. X-axis shows Time and Y-axis shows three system Voltage, Current and Fault current between two contacts of Circuit Breaker. From the Figure 3.2, it is shown that fault occurs in one line at a time 0.2 second and it is cleared at 0.4 second. It is a Temporary fault which is cleared by auto reset.

B. Key Activity

Required key activity are: -

1) Initiation
2) Planning
3) Execution
4) Monitoring and Control
5) Closure

III. IMPLEMENTATION

A. Introduction to Fault

Fault is an unplanned event, that can cause interruption in performing specific work. As a study of fault in the Power system the 70-80% of faults are caused in the transmission line and rest other faults are caused in the Generating Stations and Load Centre. These faults should be transient or permanent. Transient fault can be resolve easily but permanent fault cannot be resolve easily so we can clear the fault physically. These are some reasons which causes fault: falling of tree upon the transmission line, Collisions of vehicles to the transmission tower, Aircraft crash to the transmission line or tower, Lightning Stroke, Human failure, wind damage, birds shorting the lines, etc...

B. Fault Analysis

In power system the fault is categories in many ways:

1) Active Fault

The fault which are causes very high current flow in the circuit due to the short circuit of phase to phase or ground. This can also cause the heavy losses or damage the conductor, so this fault is terminated as soon as possible.

2) Passive Fault

The fault which flows current according to their rating of the conductor. This fault is not controlled.
for example-

- Overvoltage: Increase in voltage can cause stress in insulation.
- Overloading: When load is increased then the voltage is increase so, it causes overheating.
- Phase swing: It is cause due to synchronism in the generating station.
- Under Frequency: When frequency goes below its rating then plant behave in correctly.

3) Transient and Permanent Fault

Transient fault is also known as temporary fault that cause disturbance in the transmission line for a short time and it can be resolve easily. The temporary fault is not be resolve easily and it cause disturbance for a long time or permanent.

a) Types of Faults in Three Phase System

There are five types of faults in the three-phase system and total fault happens in the three fault is 11, which is Single Line to Ground (R-G, Y-G, B-G), Line to Line (R-Y, B-Y, R-B), Line to Line to Ground (R-Y-G, B-Y-G, R-B-G), Line to Line to Line (R-Y-B), Line to Line to Line to Ground(R-Y-B-G).

b) Symmetrical and Asymmetrical Fault

The faults which is symmetrical or balanced in nature is known as symmetrical fault, mainly there are two faults happen in the three-phase system is R-Y-B fault and R-Y-B-G fault.
The faults which is unsymmetrical or unbalanced in nature is known as unsymmetrical fault, mainly there are nine possible faults in the three-phase system is R-G, Y-G, B-G, R-Y, Y-B, B-R, R-Y-G, Y-B-G, B-R-G.

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C. Hardware Components

These are the hardware components that are required.

1) Power Supply

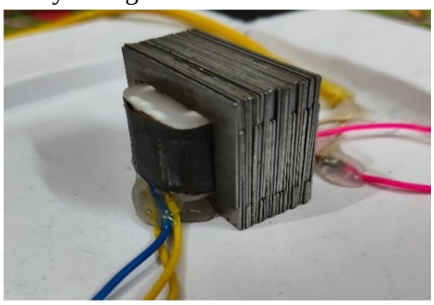
It is the most important part of the component, electrical component required electricity, mechanical component required kinetic energy etc. Due to the power supply the any components perform its task.

In this project we require single-phase AC supply of 230V, 50Hz. We buy the power supply from Jharkhand Bijli Vitran Nigam Limited which is government body.

2) Transformer

Transformer is a static device that can step up or step down the voltage and current with constant power, Its rating in the volt-ampere.

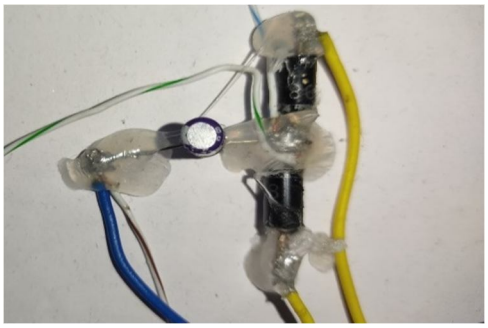
In this project we require 12v maximum to run this project, so we use step down center tapped transformer of 15VA with 9.2 turns ratio with 220v primary voltage and 12-0-12v secondary voltage.



3) Rectifier

Rectifier is an electronics device that is use to convert the AC supply to DC supply, we use center tapped full wave rectifier. we make the rectifier using AC diode.

In this project we use bridge rectifier using 1N5408 diode.



4) Filter

Filter is an electronics device that is use to filter the harmonics of signal, it attenuates the signals of a certain frequencies. we use a capacitor as a filter capacitor stores the stores the potential differences in forms of charges in the two metallics plates which is separated by dielectric material.

In this project we use 100uf 16v Electrolytic Capacitor, use just after the Rectifier.



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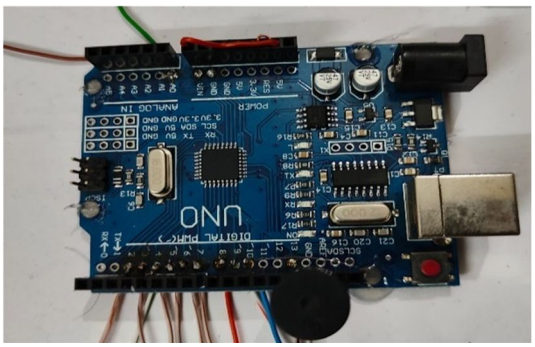
5) Buck Convertor

It is a power electronics device use to stepdown the DC voltage maintaining its high efficiency. We require the two DC voltage source of 5V and 12V. we get the 12v directly by the output of transformer but we also need 5V to power the Arduino UNO and LCD display, so we this buck convertor.



6) Arduino

Arduino is microcontroller that is used to control the different types of signals using different ports of Digital and Analog input. Its input power supply is 5V. There are many types of Arduino board in the market and it is used by what we have to perform. We use Arduino Uno Dev board for this project.



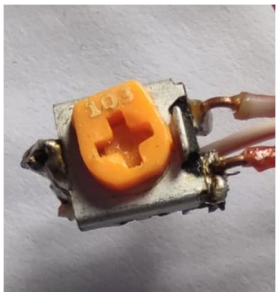
7) Display

It is the most important device with a screen of Arduino to show output in digital form or show the output in the form of pixels. We use 16*2 Arduino Display used to locates fault and display fault is happens or not or happens o where.



8) Rheostat

It is a variable resistor that can resist the voltage or current as per required. we use knob which can is used to vary the resistances as per our use. We use 10k Ohm rheostat to control the brightness of Liquid Crystal Display.



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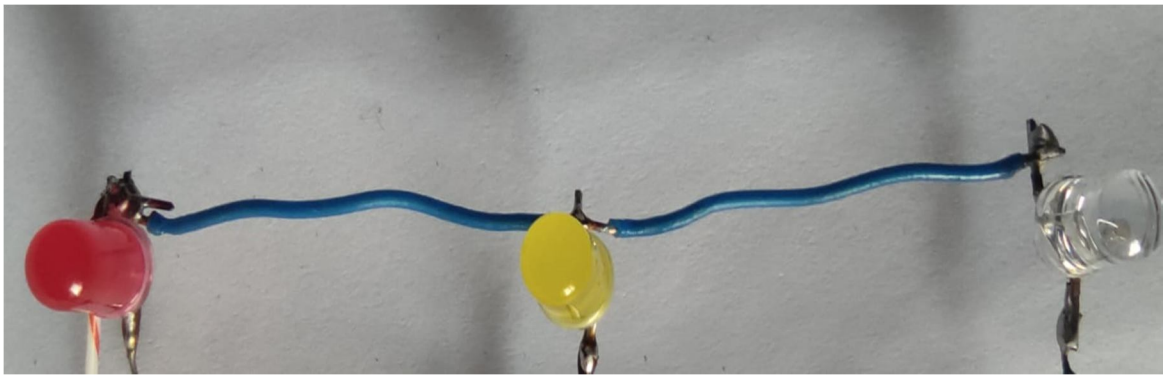
9) Buzzer

Buzzer is an electronic device which beep the sound when supply is pass through it. We use 5v buzzer which is connected to 13no digital pin when the faults is happens then the it beep for 200 milliseconds.



10) LED

Light Emitting Diode is and electronics diode which emits the light when the electric supply is pass through it. We use 2V red, blue and yellow LED when there is no fault then it glows for 200 milliseconds but when the fault is happens then it glows for 500 milliseconds.



11) Motor Driver IC

Motor Driver IC is an integrated circuit that is used to control the motor in the automation, it is made up of combination of NAND Gate. We use ULN2003A to control the relay of 12V.

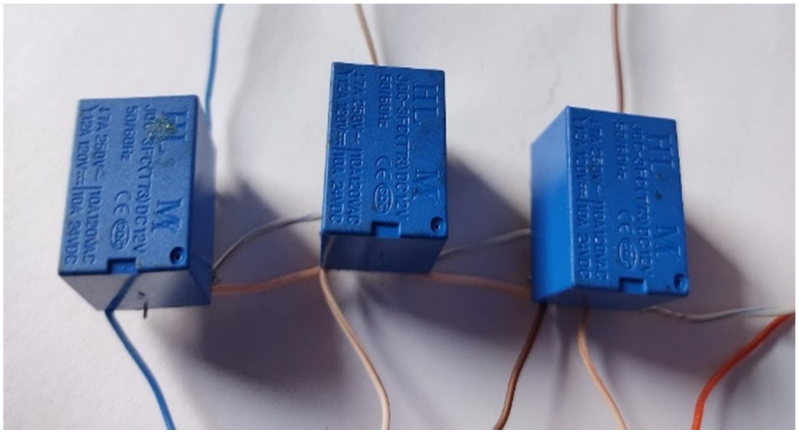


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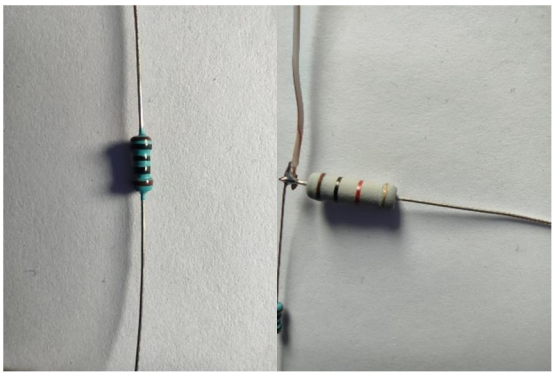
12) Relay

Relay is an electromagnetic switch, which is used to control high voltage operating machine by using low voltage. We use relay of 12V to detect the fault in the transmission cable.



13) Resistor

Resistor is device which is used to resist the flow of electron in circuit. We use 100 & 1K ohm Resistor. we use 1K ohm resistor to replace in this prototype in place of the power transmission cable.



14) Diode

Diode is a semiconductor device that is an uncontrolled unidirectional switch. We use IN4007 diode for making the center-tapped rectifier.



IV. ARDUINO PROGRAMMING

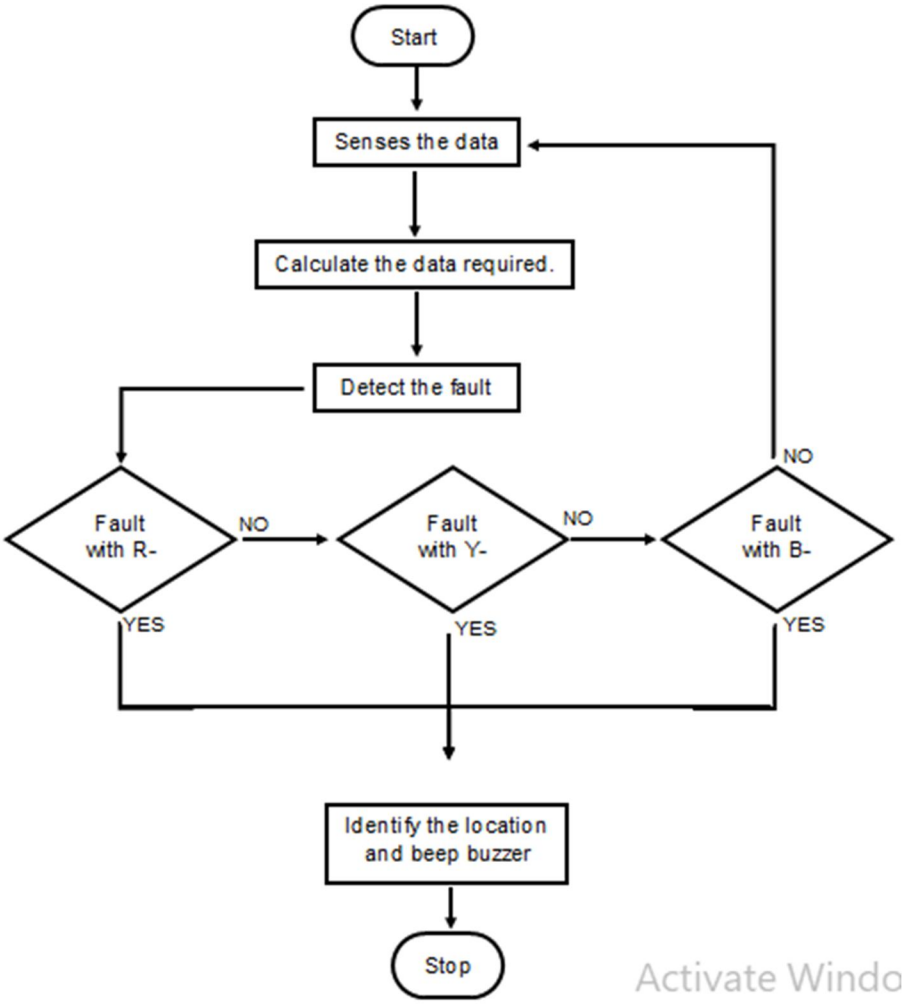
To control the different input and output of Arduino we require a bucket of code to run the different input and output. It is based on the C programming i.e. it is basic programming and easy to understand.

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A. Flow Chart

Before continuing the working we need to understand the flow chart of this project. Using flow chart, we can understand easily the working of the project.



Arduino programming used in this prototype are: -

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(2,3,4,5,6,7);

#define sensor A0

#define relay1 8
#define relay2 9
#define relay3 10

#define buzzer 13

int read_ADC;
int distance;

byte symbol[8] = {
```

```
    B00000,
    B00100,
    B00100,
    B00100,
    B11111,
    B01110,
    B00100,
    B00000};

void setup()
{
pinMode(sensor,INPUT);

pinMode(relay1, OUTPUT);
pinMode(relay2, OUTPUT);
pinMode(relay3, OUTPUT);

pinMode(buzzer, OUTPUT);

lcd.createChar(1, symbol);

lcd.begin(16, 2);
lcd.clear();
lcd.setCursor(0, 0); // set the cursor to column 0, line 2
lcd.print("Welcome to 'The Project made by Harsh and Animesh'");
lcd.setCursor(0, 1); // set the cursor to column 0, line 2
lcd.print("Fault  Detection");
delay(2000);
lcd.clear();
}

void loop()
{
lcd.setCursor(1,0);
lcd.print("R");
lcd.write(1);

lcd.setCursor(7,0);
lcd.print("Y");
lcd.write(1);

lcd.setCursor(13,0);
lcd.print("B");
lcd.write(1);

digitalWrite(relay1,HIGH);
digitalWrite(relay2,LOW);
digitalWrite(relay3,LOW);
delay(500);
```

```
data();
lcd.setCursor(0,1);
if(distance>0){lcd.print(distance); lcd.print("KM");}
else{lcd.print(" NF ");}
digitalWrite(relay1,LOW);
digitalWrite(relay2,HIGH);
digitalWrite(relay3,LOW);
delay(500);
data();

lcd.setCursor(6,1);
if(distance>0){lcd.print(distance); lcd.print("KM");}
else{lcd.print(" NF ");}

digitalWrite(relay1,LOW);
digitalWrite(relay2,LOW);
digitalWrite(relay3,HIGH);
delay(500);
data();

lcd.setCursor(12,1);
if(distance>0){lcd.print(distance); lcd.print("KM  ");}
else{lcd.print(" NF ");}
}

void data()
{
read_ADC = analogRead(sensor);
distance = read_ADC/100;

if(distance>9)distance = 0;
if(distance>0){
digitalWrite(buzzer,HIGH);
delay(200);
digitalWrite(buzzer,LOW);
delay(200);
}
}
```

These programs are divided into many parts, some of them are: -

B. Analog Signals

Analog signals are given or received through the analog pins and used to reading of analog sensor or General-Purpose Input/Output (GPIO) pins. In Arduino the analog pins are represented by A. e.g.- A0, A1, A2, etc...

In analog pins are differs board to board which are: -

In Arduino programming we call these analog pins by directly calling the pins by its name ‘pinmode’.

Syntax

pinmode (name_of_pin, INPUT/OUTPUT)

E.g.

pinmode(A0, OUTPUT)

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C. Digital Signals

Digital signals are obtained by digital pins. In Arduino the digital pins are represented by numbers like 2,6,7,14 etc. Digital pins also contain Pulse With Modulation (PWM) pins which is represented by ~3, ~5, ~12, etc.

In Arduino programming we call the pins by 'digital write' and we control the signal by giving the command ON/OFF.

Syntax

digitalWrite (Pin_Name, INPUT/OUTPUT)

E.g.

digitalWrite(13, INPUT)

D. Looping

Looping is used to repeat the program many times according to use. In Arduino IDE we use 'void loop ()' command for the looping or run the command many times. This looping has different parts for loop, while loop, Do While loop.

But in Arduino only while loop is used, which run the program whenever the given statement until it comes true.

Syntax

void loop ()
{
statement;
}

E.g: -

```
void loop ()
{
lcd.setCursor(1,0);
lcd.print("R");
lcd.write(1);
lcd.setCursor(7,0);
lcd.print("Y");
lcd.write(1);
lcd.setCursor(13,0);
lcd.print("B");
lcd.write(1);
digitalWrite(relay1,HIGH);
digitalWrite(relay2,LOW);
digitalWrite(relay3,LOW);
delay(500);
 }
```

E. Liquid Crystal Display

It is the most important part of the Arduino to show the output in the Arduino in the digital form.

This program needs the unique identification ID. (in bytes) to run the code in the display.

Syntax:-

byte symbol [number of input]=
{
Identification code in bytes.
}

E.g.: -

```
byte symbol[8] = {
      B00000,
      B00100,
      B00100,
      B00100,
```

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B11111,
B01110,
B00100,
B00000};

we also need the to show the output in the display to show the data we use code 'data ()'

Syntax: -

data()
{
statement
}

E.g.: -

```
data();
lcd.setCursor(0,1);
if(distance>0){lcd.print(distance); lcd.print("KM");}
else{lcd.print(" NF ");}
digitalWrite(relay1,LOW);
digitalWrite(relay2,HIGH);
digitalWrite(relay3,LOW);
delay(500);
```

and we need some more programs to connect with Arduino.

V. OPERATION

Operation means how to operates or runs, everything in the universe operates by using the energy in form of wind energy, radiation, heat energy, mechanical energy, electrical energy, etc. In this project we need electrical energy to run these devices. We create three phase fault detection system and its block diagram is below.

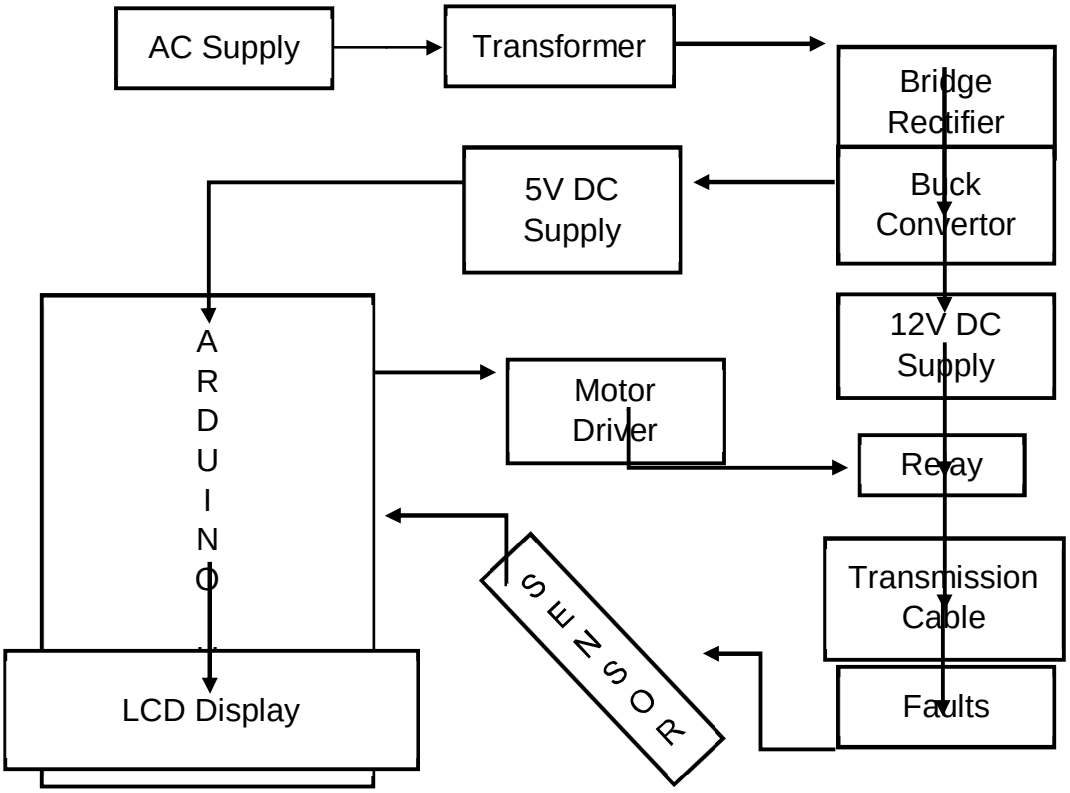
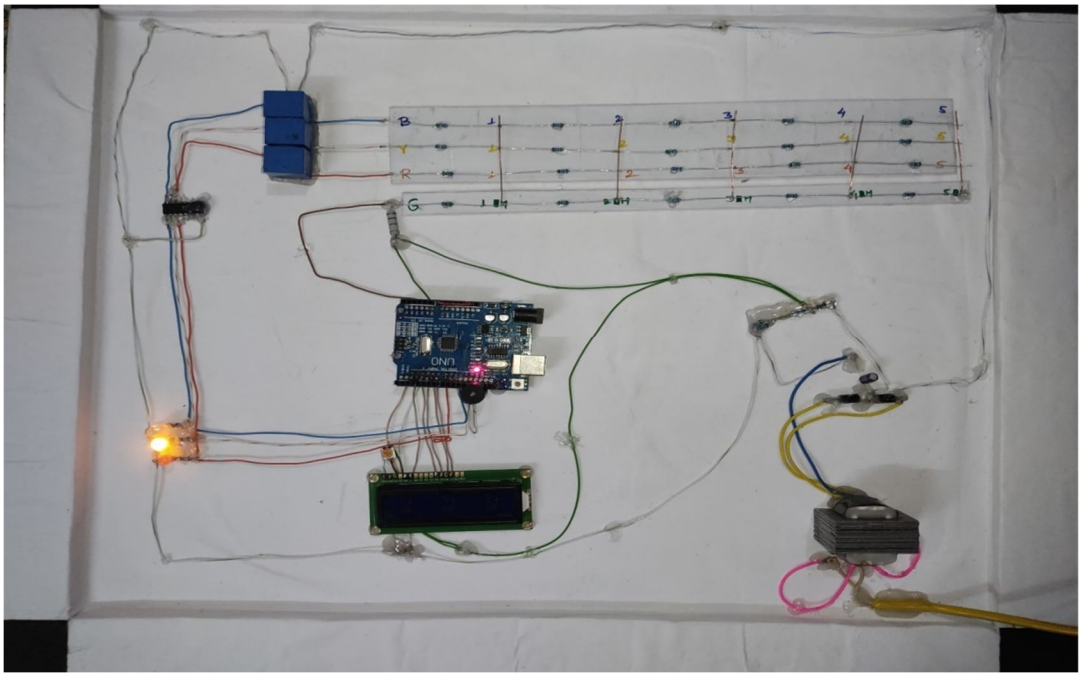


Fig: block diagram of three phase fault detection

A. Working



B. Working Operation

This project is used to protect the circuit and equipment used in the power system, mostly the fault caused in the transmission system is line-to-ground also known as single line to ground fault. This project is coming under the concept of smart grid, we make the prototype by using the Internet of Thing. It works on the principle of flow of fault current. In this project we use Arduino to detect the fault with line to ground in each phase separately. we use resistor instead of power cable which is connected to the relay and relay is connected to the motor driver and motor driver is connected to the Arduino, these all setup is works as a sensor and also deliver the power to the cable, use resistor instead of power cable.

After the analog signals senses by the Arduino by the A0 port, we convert the signals from analog to digital. After converting analog to digital signals, we calculate the required data to identify the fault and locate the fault. this process is repeat consequently for all phases R, Y, B. All the process shown above is happens internally but, externally we see the responses using the Liquid crystal Display and the Light Emitting Diode.

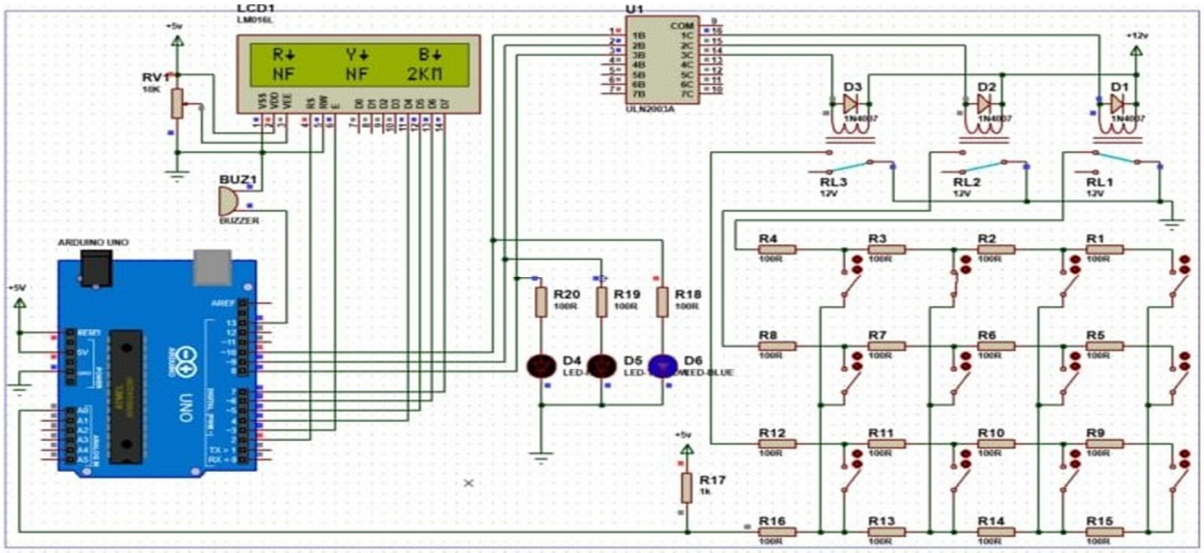


Fig: Circuit diagram of three- phase transmission line fault detection

C. What Happens Externally?

We saw that Liquid Crystal Display show the responses when there is no fault it shows NF with all the phases but when the fault is happens then it locates the fault, and in no fault case the Light emitting diode Blink for 200 milliseconds when fault occurs it glows for 500 milliseconds, during the fault condition buzzer also beep.

VI. ADVANTAGE, DISADVANTAGE AND APPLICATIONS

After getting all working operation, construction, implementation, literature survey at the end comes in the conclusion which is very important to get the advantage, disadvantage and applications.

A. Advantage and Disadvantage

1) Advantage

a) It Operates in low voltage
b) Required less power
c) Having high response time
d) No need an operator to operate this.
e) Locate the fault
f) Easily operated
g) Cost saving
h) Require less time during the recover from the fault
i) Very less equipment damages
j) Very low power losses during the fault
k) It is a concept of Smart Grid
l) No skills require for the operation
m) Operates each and every time
n) Automatically detect the fault
o) Eliminate the Transient Fault
p) Require less maintenance

2) Disadvantage

a) Require large space
b) Installation cost is high
c) Require heavy investment in the starting
d) Require skilled worker for repairing
e) Require DC power
f) Not measures the fault in all phases
g) Fault can pass in another phase when signal in other phase
h) Initial data is sensitive
i) Not show the exact distances
j) Limited inputs to the microcontroller
k) Difficult to capture time-related factors
l) Not store the previous data

B. Applications

1) Used in the three-phase transmission line
2) Used in substations
3) Used in Industries
4) Also used the Apartments

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VII. ACKNOWLEDGEMENT

Every project big or small is successfully largely due to the efforts of a number of wonderful people who have always given their valuable advice or leant a helping hand. I sincerely appreciate the inspiration: support and guidance of all those people who have been instrumental in making this project successful.

I am sincerely grateful to Mr. Pankaj Kumar Mahto for guiding me to make such a project in Three Phase Transmission Line Fault detector using Arduino.

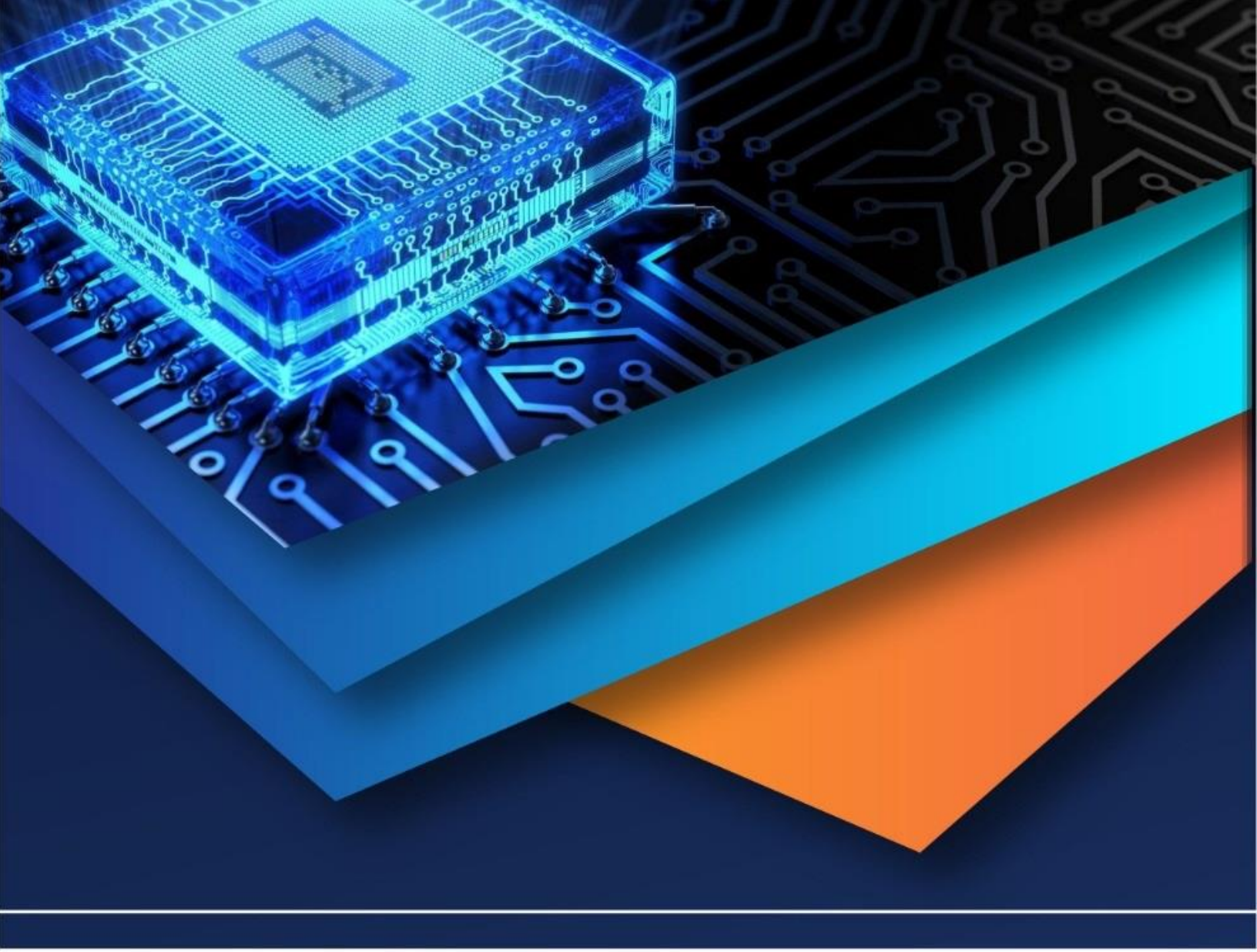
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I Animesh Kumar student of Gola Polytechnic Gola, Branch- Electrical Engineering, Registration No.- 21115080008, Session - 2021-24 am extremely grateful to “Jharkhand University of Technology” for the confidence bestowed in me and entrusting Diploma in Electrical Engineering.

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