

OVER AND UNDER VOLTAGE PROTECTION FOR THREE PHASE SYSTEM USING GSM MODULE



Inspiring Excellence

**A Thesis Submitted to the Department of Electrical and Electronic Engineering of
BRAC University**

Authors

Nasif Ahmed

13121138

Supervised by

Avijit Das

Lecturer, Department of Electrical and Electronic Engineering

Co-supervisor

Md . Farhan Tasnim Oshim

Lecturer, Department of Electrical and Electronic Engineering

BRAC University, Bangladesh

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DECLARATION

I declare that my thesis titled “Over and Under Voltage Protection for three phase system using GSM Module” is submitted to the department of Electrical and Electronics Engineering of BRAC University for the partial fulfillment of the degree of Bachelor of Science in Electrical and Electronics Engineering. We hereby affirm that the theoretical research and result was conducted solely by us and has not been presented previously elsewhere for assessment. Materials of the study and work found by other researchers have been properly referred and acknowledged.

Submission Date: December, 2017.

Signature of Supervisor



Signature of Authors

Signature of Co-Supervisor

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Chapter 01

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ABSTRACT

For upgrading system efficiency automation is needed .besides for reliability and quality of electric service depends on automation nowadays .Automation is not only for upgrading the quality of a system it also reduces human effort as well as minimize time of production. We know that for over and under voltage problem many trouble happens in home and outdoor power system. For example insulation and appliance damage. In my report I will describe how over and under voltage problem creates problems to our system and also try to give a solution how to minimize this problem for three phase system by using automation which will be prepared by GSM module which will send sms alert for if fault occurs in system.

Keywords: Systems; Arduino; Microcontroller; Proteus; System-On-Chip (SOC); Relays; MC circuit Breaker; LCD display; Voltage sensor;
Current Controller.

INTRODUCTION

Without electricity we cannot think of our modern life. For continuous electrical supply electrical power distribution system works as an important factor by supplying electricity to the consumers of the system. In this system fault occurs .so for minimizing fault and increase the efficiency of power we need good protection system. this protection system will secure the generation & distribution system from the occurrence which are violating the supply .in order to increase the protection system in three phase I think automation will help a lot as it will find and solve the problem automatically an if not possible then it will find the problem to solve manually . this smart protection device will also helpful for home uses .as we know for home safety circuit breaker is used which is a common protection system our country . When over and under voltage happens circuit breaker burns out to protect the connected appliances to the system like TV, fan, refrigerator etc. For consume power we need to manually fix the circuit breaker and this the main problem of circuit breaker. From this reason the purpose of my project to add automation in the place of circuit breaker .that means when a device exceeds the maximum voltage it can take the system will trip. My device gives an error output if input voltage crosses the range beyond the voltage window as two comparators are used as window comparator. A relay also used to cut off the load for safety issue. In this project we are going to learn about relay and circuit breaker and their response for over and under voltage condition in three phase system.

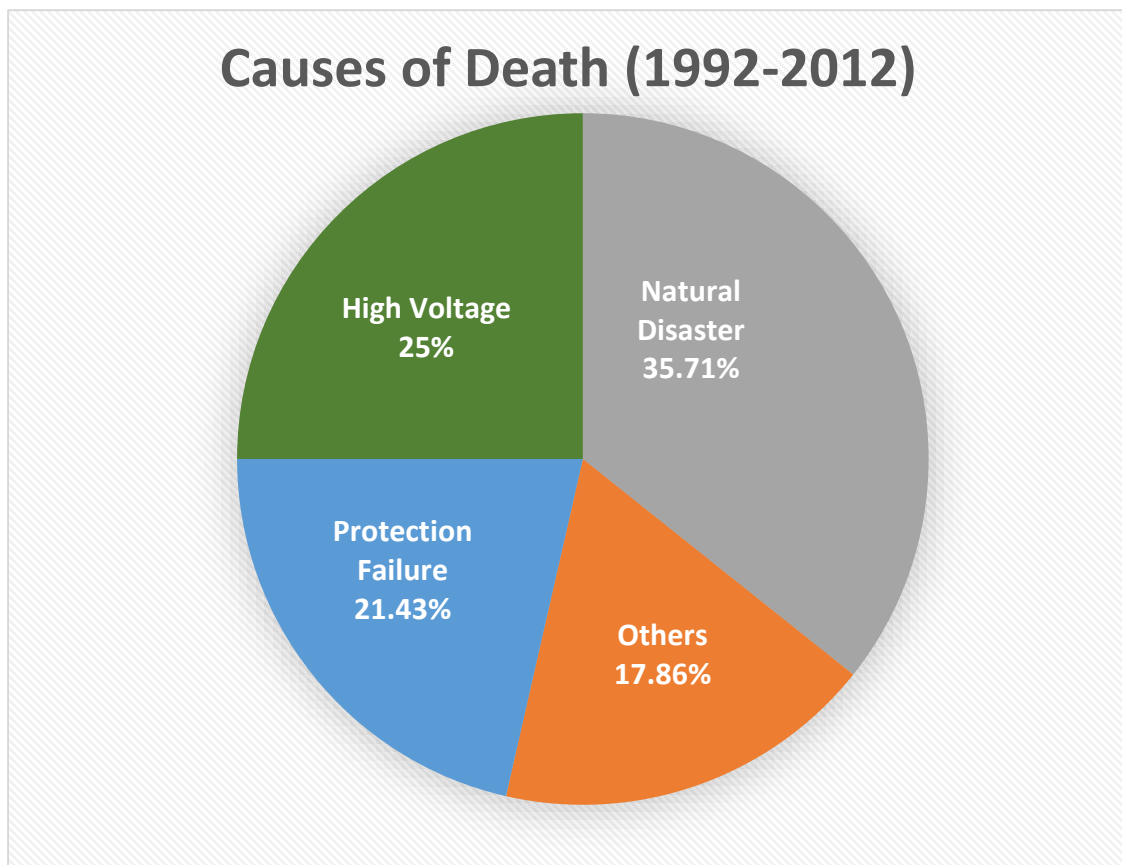
Motivation

In this era of development we are capable of getting mobility, efficiency and flexibility, more over we need protection from the thing we are using to boost up our daily life. this thing motivated me to design a protection system for over and under voltage for three phase system in such way which will give protection to both industrial and home uses .From past we can see that in our developing country accidents because of excess flow of electricity in increasing day by day . I think this project will help to solve the protection problem and also it will help other to study and know about the protection system widely.

CHAPTER 02

Death, Fire and Injuries

Electricity is one of the basic needs of modern society. The chance of accident due to electricity is raising as new equipment's are connecting to the grid every day. Some statics are given below emphasizing the overall injuries, fire and death over years of 1992 to 2012.

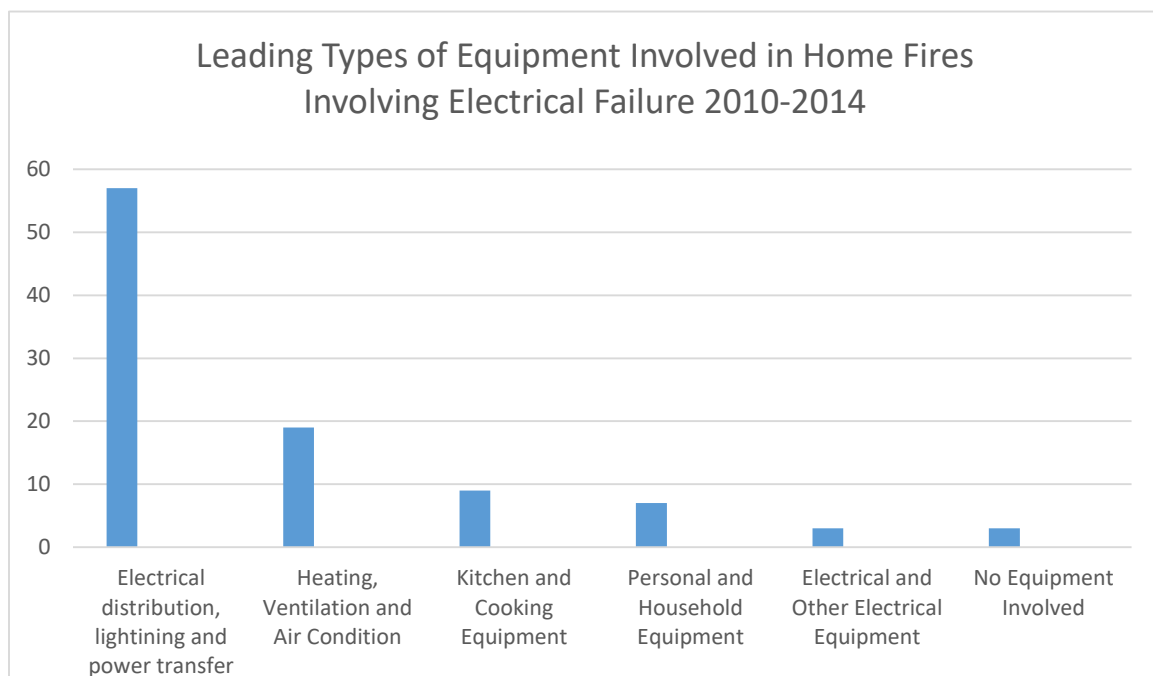


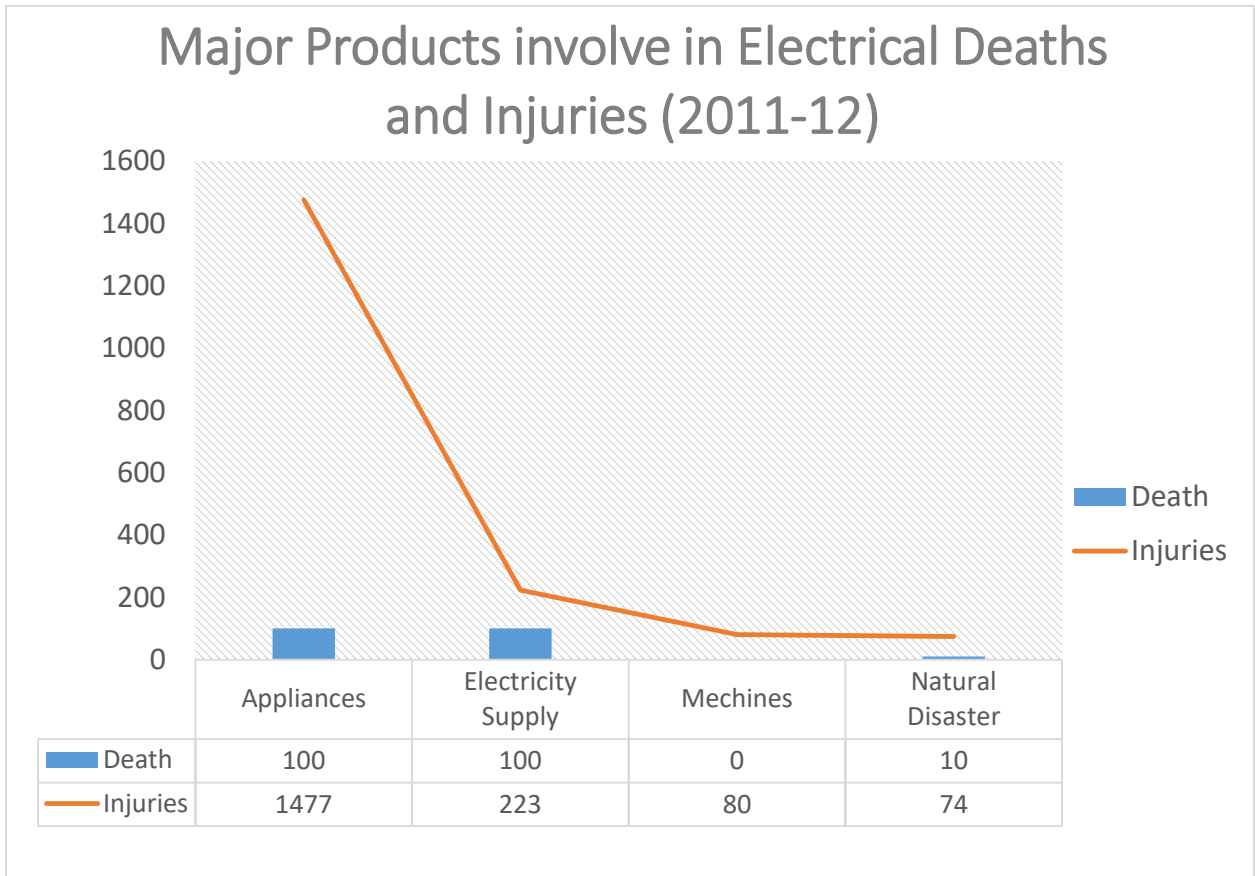
From this statics it is clear that death due to **'High Voltage'** and **'Protection Failure'** is greater than death in natural disaster.

From 1992 to 2012 the overall demand of electricity is increasing. According to the report submitted by the **National Fire Protection Association (NFPA)**

Key findings in the report have to do specifically with home structure fires involving electrical distribution or lighting equipment, including:

- 63 percent involved wiring and related equipment.
- 74 percent cited some type of electrical failure or malfunction.
- Nearly half (44 percent) of civilian deaths were caused by fires that began in the bedroom, living room, family room, or den.
- Wire or cable insulation was the item first ignited in 32 percent of electrical distribution or lighting equipment home structure





From the data we can say that, the damage because to **'Protection Failure'** is causing deaths and injuries around the world.

Switchgear and protection

For turning on or off the electrical circuit a protection system is used which is known as switchgear. The examples of switchgear are

- Switches
- Fuses
- circuit breaker
- Isolator
- relays,
- current and potential transformer
- indicating instrument
- lightning arresters and control panels

The switchgear system is linked with the supply system directly. The high and low voltage side of the power transformer are equipped with switchgear for minimizing damage because of fault. If the system need testing and maintenance switchgear helps to de-energizing the system. It also helps to clear fault from the system by turning off the system. We know that high current flow through the system if fault occurs and for the reason the equipment get damaged and the service is interrupted. This is the reason switchgear and automated protective device is used to protect line and other equipment from receiving damage.

Automatic switchgear consists of relay and circuit breaker which disconnects faulty part of the system by tripping .when it gets a faulty signal in the system it close the trip of the circuit breaker, in this case relay helps to send the signal if there is any fault occurring in a part of the system .circuit breaker can open or close an electrical circuit in both over and under voltage condition.in automated system circuit breaker can break circuit without replacement. This type of circuit breaker are using instead of fuse which were widely used in the system and was costly as it has to be replaced while burnt.

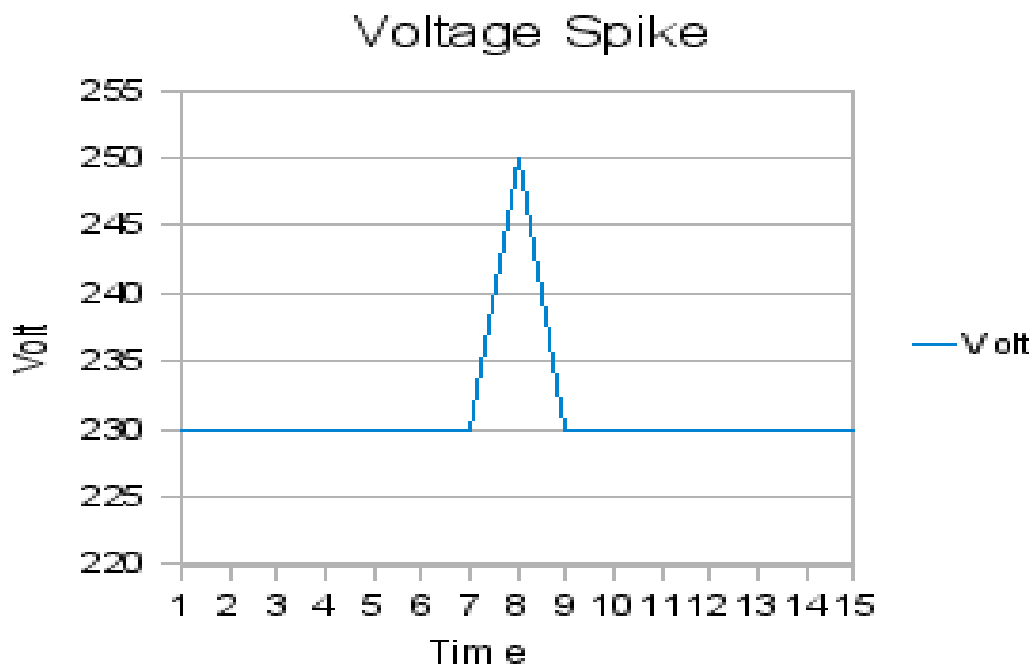
Essential Features of Switchgear

The essential features of switchgear are:

1. **Complete reliability:** switchgear isolates the faulty part of the system and keeps the system safe from damage. It also helps to operate the system by neglecting its faulty part.
2. **Absolutely certain discrimination:** switchgear isolates the faulty section of the system without hampering the section which is perfect, to ensure continuity of supply.
3. **Quick operation:** switchgear operates quickly when fault occurs as faulty creates short circuit current and it can cause damage to the healthy part of the system.
4. **Provision for manual control:** it must have manual control option. If automatic control is damaged then manual control can reduce danger.

Over Voltage Protection

When the system detects voltage beyond its rated voltage, protection system shuts down. This is called over voltage protection.



From over voltage problem circuit can catch fire and it can leads to mass destruction if many components are connected together. For this reason power supply system uses over voltage protection for safety propose.

There are two types of over voltage,

- External Over Voltage &
- Internal over Voltage

External over voltages occurs mainly for lightning. For this condition excess current flow through the line which has no connection with the supplying system. Internal Over voltages happens due to change in the operating condition.

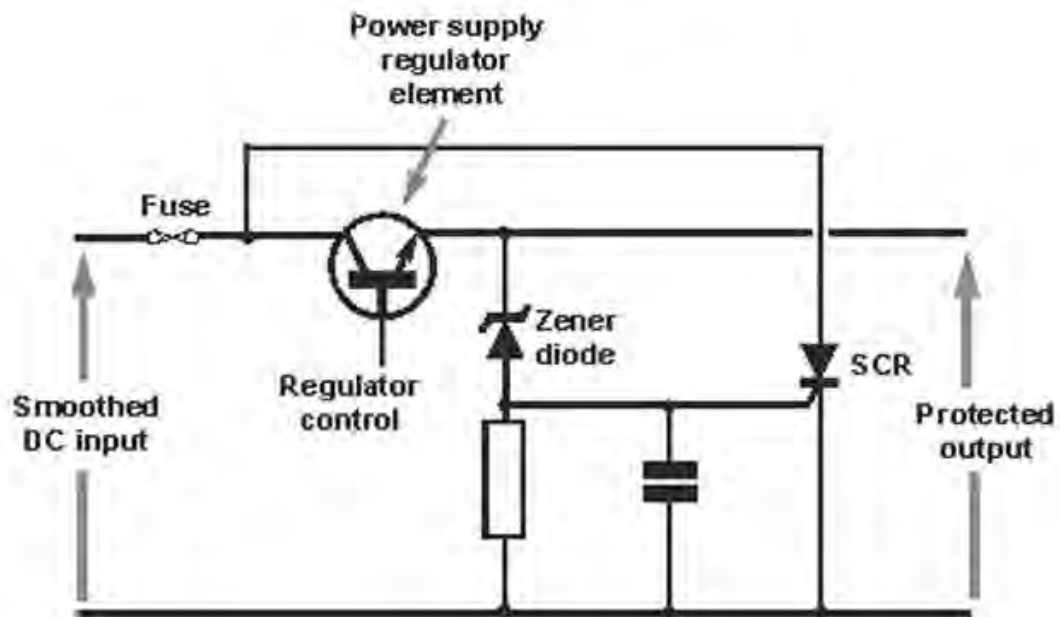
Effects Of Over Voltage

- Damages insulation of the system
- Produces high frequency
- Failure of transformer
- Failure of rotating machines
- Sometimes death because of high magnetic field passes through human body

Ideal characteristics of an over voltage protection circuit

For safety of the system the basic principal of over voltage protection is not to interfere with normal function of the circuit and should work fast to reduce damage

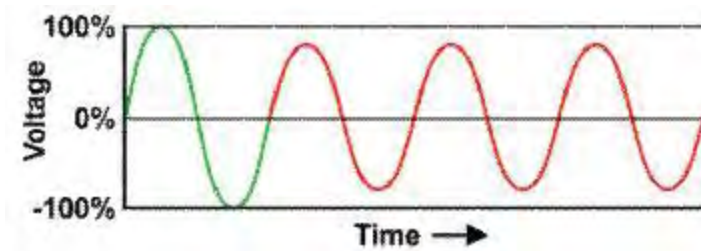
The over voltage protection circuit may be constructed using discrete components, integrated circuits, mechanical devices such as relays, etc. These can either connected internally or externally depending on the circuits involved. For example we can say about crowbar circuit .it is cheap circuit which is used in over voltage protection.



Over-voltage protection crowbar circuit

Under Voltage

Under Voltage is the decrease in AC RMS voltage at power frequency to less than 90% of the network nominal voltage and for duration longer than one minute. According to IEEE 1159/1995, decreased voltage will range from 80% to 90% of the nominal voltage and for duration longer than one minute.



Under voltage causes problems in the system besides sometimes it creates full operation break.

Voltage Sag Impacts:

Problems due to voltage sag are given below

- (1) Elements that microprocessor based control systems gives incorrect information.
- (2) Tripping of contactors and electromagnetic relays.
- (3) Less efficiency of motor and other system that rotates.

Key Features:

Key features to ensure safety are given below -

- 1) Admin can access security control;
- 2) Real time data;
- 3) Total Usage history keeps in memory ;
- 4) Controlled by GSM module;
- 5) SMS facility;
- 6) Auto ON/OFF facility;

1. Admin can access security control:

By a fixed person the system will response that means the data and access is fully password proof.

2. Real time data:

From the module user can see the actual usage data which is consumed.

3. Total Usage history keeps in memory:

User can see the saved data through GSM module any time he wants.there is no possibility of data loss.

4. Remote accessibility:

User can get the usage information from anywhere as he can get the notification by SMS .user can control the usage or on/off system from distant places.

5. SMS facility:

During fault occurs the device sends SMS t to the preset mobile number. The number is pre inserted in the Arduino code. For this function the user is always updated with the device.

6. Automation:

This is a smart device which is controlled by the user and it is smart enough to maintain the users demand. For example it turns off when it sees fault to save the system.

7. Transparency in electrical billing:

In many country we can see that we are paying more bill than usage as electric meter is tempered by the electric board and for extra money they do this type of work. But using this device will stop them to do this because user gets the usage by sms or from their personal access. So they can pay the actual bill they consumed.

Advantages:

Of course we can get enough facilities from an automated device rather than analog. They are as follows-

- 1) Highly efficient and cheap;
- 2) Fast operation;
- 3) Fully automated;
- 4) Consumer can compare between bills they get;
- 5) One admin control;
- 6) Fully password proof;
- 7) Online data storage ;
- 8) Distant control facility;
- 9) Alert user when fault occurs.

Chapter 03

Hardware Components

Circuit Components

- Bridge Rectifier
- Capacitor
- 220-6V Step Down Transformer
- Zener Diode
- Arduino UNO
- Resistors
- 20*4 LCD Display
- Regulator
- Relay
- Voltage Sensor
- Current Sensor
- Diode
- Potentiometer
- BJT 547
- GSM Sim 808
- Opto Coupler
- AC to DC converter

Arduino:

Arduino is an open-source device that made microcontroller based packs for building digitalized gadgets and interactive objects that can be detect and control practical devices. The output depends on microcontroller board plans. These systems give sets of computerized and analog input/output pins that can interface to different extension sheets and different circuits. The sheets highlight serial correspondence interfaces, including Universal Serial Bus (USB) on a few models, for leading programs from PC's. For programming the microcontrollers, the Arduino extend gives an integrated development environment (IDE) in light of programming dialect named processing, which likewise underpins the dialects C and C++.

An Arduino board comprises of an Atmel 8, 16 or 32 bit AVR microcontroller with corresponding parts that encourage programming and joining difference cities. An important part of Arduino is its standard connectors, which let clients associate the CPU board to an assortment of tradable of extra modules named shields. The reason of using Arduino is to control the circuit. In our project, Arduino plays a very important role. The reason behind this is, in our project voltage measurement, perfect tripping time, and give notification to the user on time it is very necessary. To control these things in parallel way, Arduino is important. In this project, we are willing to use Arduino UNO to fulfill our necessity. The Arduino UNO is a microcontroller board based on the ATmega 328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an

ICSP header and a reset button. It contains everything needed to support the microcontroller. We can easily connect it to computer with a USB cable or power it with AC to DC adapter or battery to get started.

We could have used microcontroller. This would fulfill our all demand. But there are some drawbacks using microcontroller. The main superiority of using Arduino is it has a vast amount of library which microcontroller don't have. Besides as we are thinking of making something that does not cost much. Arduino UNO is cheaper than microcontroller so if we think economically Arduino UNO is good for us. Microcontroller will make the device that we are trying to build quite big on the other hand Arduino UNO is small. For these reason we choose to work with Arduino UNO.

Bridge Rectifier:

We used this rectifier as the supply is of AC so we need to convert the AC to DC. We can use full wave also but it has more losses than this rectifier as we don't use center tap in this rectifier as it firms continuous flow of direct current. We will use four diodes in this rectifier and one capacitor parallel to this acts as filtering of the AC currents from DC currents. It requires four diodes instead of two, but avoids the need for a center tapped transformer. During the positive half cycle of the secondary voltage, diodes D1 and D3 are conducting and D2 and D4 are not conducting. Therefore, current flows through the secondary winding, diode D1 and D3, resistor RL. During the negative half cycle of the secondary winding, diode D2 and D4, resistor RL. The diodes D2 & D4 conduct and diodes D1 & D3

do not during the negative half cycle of the secondary voltage. Eventually current through pass the secondary winding \, diode D2, D4 and Resistor RL. In both occasion current went through same direction of the load resistor.

A conventional bridge rectifier, is a combination of rectifiers (12 in a three phase system) wired so that each part of an AC current is passed to respective positive and negative lines of a DC output. It provides full wave rectification of AC to DC. In a sense of making it low cost, highly reliable and small sized silicon bridge rectifiers is now more convenient in the contrary of a center-tap and half wave rectifier. It has a significant number of advantages over a center-tap and a common half wave rectifier. Some advantages are given here. The precise rectification efficiency of full-wave rectifier is two times of that of a half wave rectifier. With the higher frequency and lower ripple voltage in this case full wave rectifier is easy to filtering circuit. We have higher output voltage, higher output power and higher Transformer Utilization Factor (TUF) IN case of a full-wave rectifier. Another perk in a full wave rectifier is, there is no saturation problem due to DC current because of the core where DC current in the two halves of the transformer secondary flow in opposite directions. There is no necessary to use a complex center tap in the transformer secondary winding so in case of a bridge rectifier the transformer required is much simple. We can even omit transformer if step up or step down voltage is not required. The PIV is the other half part of the center-tap rectifier. Hence bridge rectifier is highly computable for higher voltage applications. TUF in case of a bridge rectifier, is higher than that of a canter-tap rectifier. For a given power output, power transformer of smaller size can be used

in case of the bridge rectifier because in both (primary and secondary) windings of the supply transformer flow for the entire AC cycle. It will 0.4\$ globally.

Capacitor:

We all know that capacitors store and release electrical charge. They are used for filtering power supply lines, alternate resonant circuits, and for blocking DC voltages while passing AC signals, among many other uses 470 micro farads: 15 0.1 micro capacitor.

AC capacitors will cost 0.5\$ per piece.

Zener Diode:

The use of diodes in this project near the low voltage and high voltage near low voltage we use 6.0V and near high voltage 6.8V. As this diodes are used as break down voltage contractions: The Zener diode's operation depends on the heavy doping of its p-n junction. The depletion region formed in the diode is very thin (<1 um) and the electric field is consequently very high (about 500kV/m) even for a small reverse bias voltage of about 5 V, allowing electrons to tunnel from the valence band of the p-type material to the conduction band of the n-type material. In the atomic scale, this tunneling corresponds to the transport of valence band electrons into the empty conduction states; as a result of the reduced barrier between these bands and high electric fields that are induced due to the relatively high levels of doping on the both sides. The breakdown voltage can be controlled

quite accurately in the doping process. While tolerance within 0.05% are available, the most widely used tolerances are 5% and 10%. Breakdown voltages for commonly available Zener diodes can be vary from 1.2 V to 200 V.

5-6.8 V Zener diode costs 0.1\$ per piece.

Transformers:

Transformers are also used extensively in electronic devices to step-down the supply voltage to a level suitable for the low voltage circuits they contain. The transformer also electrically isolates the user from contact with the supply voltage.

We used three 220V to 6V step down transformer.

Relay:

When an electric current is passed through the coil it generates a magnetic field that activates the armature consequent movement of the movable contacts either makes or breaks a connection with fixed contact. If the set of contact was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing.

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit. Some automotive relays include a diode inside the relay case. Alternatively, a contact protection network consisting of a capacitor and resistor in series (snubbed circuit) may absorb the surge. If the coil is designed to be energized with alternative current (AC) a small copper shading ring can be crimped to the end of the solenoid, creating a small out-of-phase current which increases the minimum pull on the armature during the AC cycle.

A solid-state relay uses a thermistor or other switching device, activated by the control signal, to switch the controlled load, instead of a solenoid. An opt coupler can be used to isolate control and controlled circuits.

GSM Sim808:

SIM808 module is a total Quad-Band GSM/GPRS module which joins GPS innovation for satellite route. The conservative outline which incorporated GPRS and GPS in a SMT bundle will essentially spare both time and cost for the clients to create GPS empowered applications. Including an industry-standard interface and GPS work, it enables variable advantages for be followed at any area and at whatever time with flag scope.

- Vcc to 5V
- Ground to Ground
- RXD to digital pin 10
- TXD to digital pin 9

This system has a supply voltage range of 3.4-5 V

BJT:

A bipolar intersection transistor is a kind of transistor that utilizes both electron and opening charge transporters. Conversely, unipolar transistors, for example, field-effect transistors, just utilize one sort of charge bearer. For their operation, BJT's utilize two intersections between two semiconductor sorts, n-sort and p-sort.

BJT's are made in two sorts, NPN and PNP and are accessible as individual segments, or created in coordinated circuits, regularly in extensive numbers. The essential capacity of a BJT is to open up current. This enables BJT's to be utilized as intensifiers or switches, giving them wide relevance in electronic gear, including PC's, TV's, cell phones, sound enhancers, mechanical control and radio transmitters. We have used BJT547 in this project.

Potentiometer:

A potentiometer is a three-terminal resistor with a sliding or turning contact that structures a flexible voltage divider. If just two terminals are utilized, one end to and the wiper, it goes about as a variable resistor or rheostat.

The measuring instrument called a potentiometer is basically a voltage divider utilized for measuring electric potential; the segment is a usage of a similar standard, thus its name.

Potentiometers are usually used to control electrical gadgets, for example, volume controls on sound hardware. Potentiometers worked by a system can be utilized as position transducers, for instance, in a joystick. Potentiometers are once in a while used to straight forward control .

Opto Coupler:

In hardware, an opt-isolator, likewise called an opt coupler, photo coupler, or optical isolator, is a part that exchanges electrical flags between two confined circuits by utilizing light. Opt-isolators keep high voltages from influencing the framework getting the signal. Commercially accessible opt-isolators withstand contribution to-yield voltages up to 10 kV.

A typical kind of opto-isolator comprises of a LED and a phototransistor in a similar misty bundle. Different sorts of source-sensor mixes incorporate LED-photodiode, LED-LASCR, and light photo resistor sets. Normally opto-isolators exchange computerized (on-off) signs, however a few methods enable them to be utilized with simple signs.

An opto-isolator contains a source of light, quite often a close infrared light-emanating diode (LED) that believes electrical information motion into light, a shut optical channel and a photo sensor, which distinguishes approaching light and either creates electric vitality straightforwardly, or regulates electric current spilling out of an outside power supply. The sensor can be a photo resistor, a photodiode, a phototransistor, a silicon-controlled rectifier (SCR) or a triac. Since LEDs can detect light notwithstanding producing it, development of symmetrical, bidirectional opto-isolators is conceivable. An

opt coupled strong state hand-off contains a photodiode opto-isolator which drives a power switch, more often than not a reciprocal combine of MOSFETs. An opened optical switch contains a wellspring of light and a sensor, yet its optical channel is open, permitting tweak of light by outer items discouraging the way of light or reflecting light into the sensor.

AC to DC Converter:

An AC to DC converter or widely known as rectifier, is an electrical gadget that rotates current (AC), which intermittently inverts bearing, to direct present (DC), which streams in just a single direction. Rectifiers have many utilizations, yet are regularly discovered filling in as parts of DC power supplies and high-voltage coordinate current power transmission systems. Because of the exchanging way of the info AC sine wave, the procedure of amendment alone creates a DC current that, however unidirectional, comprises of beats of current. Numerous uses of rectifiers, for example, control supplies for radio, TV and PC gear, require a relentless consistent DC current.

The transformer in this experiment was AC, so needed a rectifier to make it DC.

Voltage Sensor:

A voltage sensor will be ready to decide and even screen and measure the voltage supply. It is then ready to take those estimations and transform them into a flag that one will at that point have the capacity to peruse. The flag will regularly go into a specific electronic

gadget for recording, yet once in a while, an eyewitness will be available to physically read the sensor yield.

We have fixed higher voltage to 235V and lower voltage to 200V, otherwise sensor will sense.

Current Controller:

Current controlling is the practice in electrical or electronic circuits of forcing a furthest point of confinement on the present that might be conveyed to a load with the motivation behind securing the circuit producing or transmitting the current from destructive impacts because of a short out or comparative issue in the load.

Diode:

A diode is a two-terminal electronic part that conducts fundamentally in one direction; it has low imperviousness to the current in one heading, and high resistance in the other. A semiconductor diode, the most well-known sort today, is a crystalline bit of semiconductor material with a p–n intersection associated with two electrical terminals. The most regular capacity of a diode is to enable an electric current to go in one heading (called the diode's forward bearing), while at the same time blocking current the other way (the reverse biasing).

LCD Display:

A liquid-crystal display (LCD) is a flat-panel display or optical device that uses the light-modulating properties of liquid crystals. LCD's don't radiate light straightforwardly, rather utilizing a backdrop illumination or reflector to deliver pictures in shading or monochrome. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and indoor and outdoor signage. Small LCD screens

Are common in portable consumer devices such as digital cameras, watches, calculators, and mobile telephones, including smartphones.

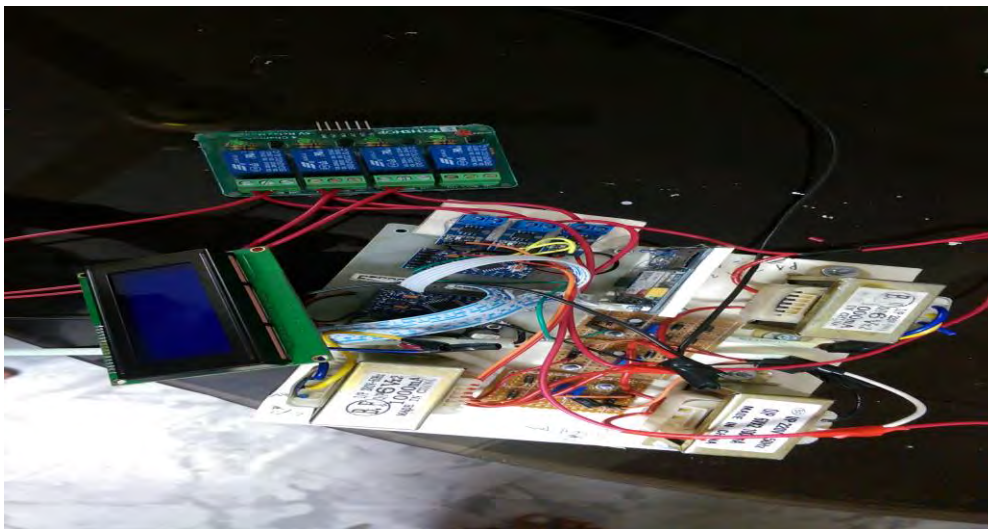
Bread Board:

A present day solder less breadboard attachment comprises of a punctured square of plastic with various tin plated phosphor bronze or nickel silver amalgam spring cuts under the holes. The clasps are regularly called tie focuses or contact focuses. The quantity of tie focuses is regularly given in the determination of the breadboard. The edge of the board has male and female scores so sheets can be cut together to shape an extensive breadboard.

Chapter 04

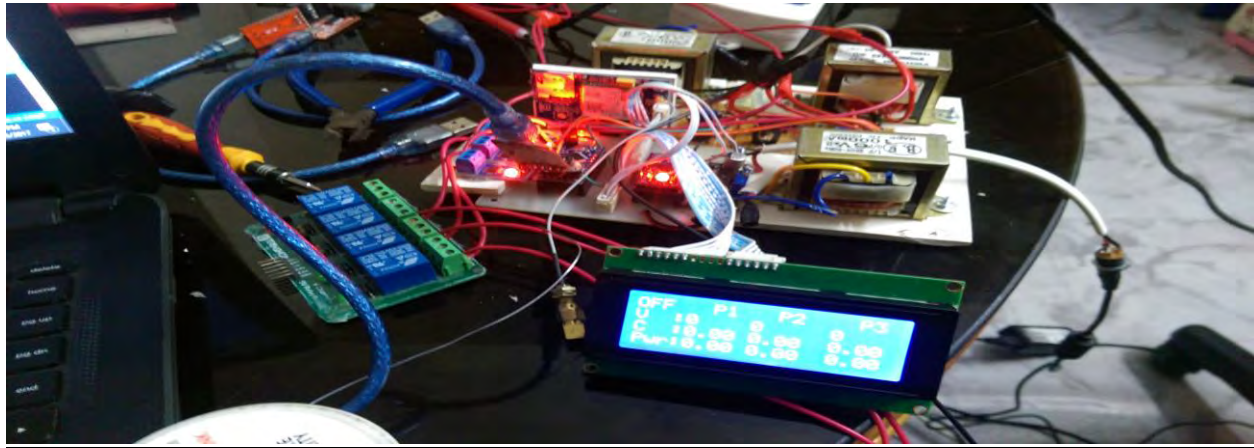
Software Simulation

All electrical devices can bear voltage up to certain limits. For example your home fan normal operating voltage is 220 volt AC. If voltage input to fan become greater than or less than about 20% of normal operating voltage of fan it may burn fan and in case of less voltage fan excessive current may flow which in turn cause short circuit in your home wiring. To avoid all these issues this project is designed which automatically turn on and turn off main power supply in case of issue in AC main power supply and on one need to control it manually. Microcontroller is embedded into this system to make it smart enough to handle all the issues intelligently and to provide control signals to turn on and off AC main



power supply.

Following things are the main components of this project for simulation. Function of each component used in this project will be described briefly with picture.



Voltage Sensor:

Voltage sensor is used to measure voltage of AC main power supply. Voltage sensor is used difference amplifier to step down voltage level from 220 volt AC to 2.8 volt AC or 311 volt peak of AC voltage to 3.96 volt of peak voltage of sine wave. Difference amplifier is used as a signal conditioning circuit to convert high voltage of AC main supply into low voltage which Arduino Uno can easily read. Because analog to digital converter cannot read voltage more than 5 volt and voltage more than 5 volt will eventually damage Arduino. So difference amplifier as a signal conditioning circuit is used to step down voltage by adjusting the gain of difference amplifier.

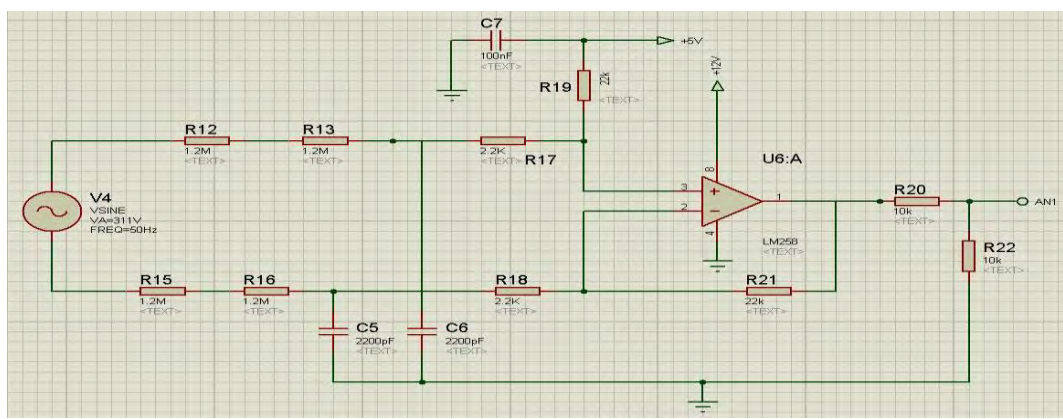
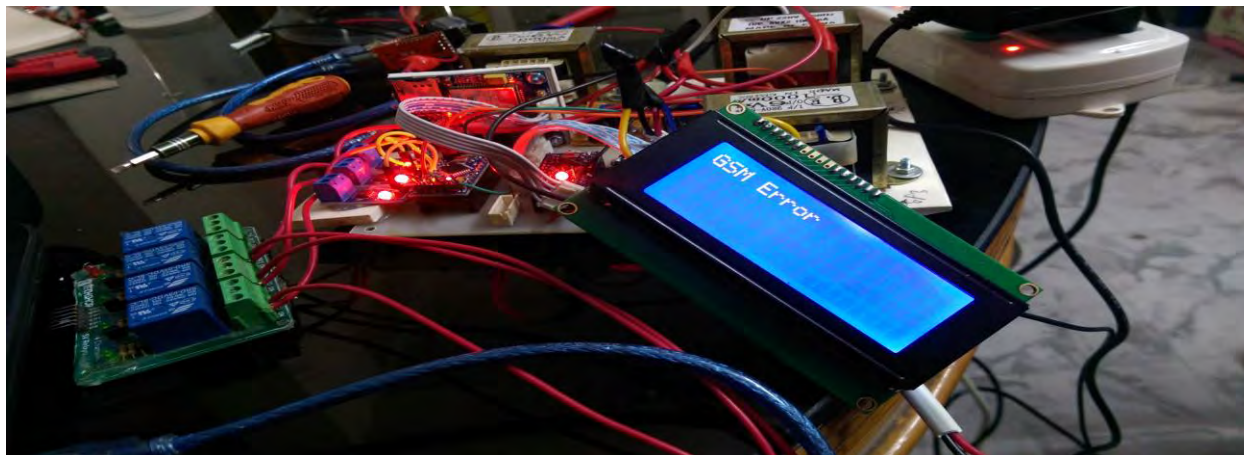
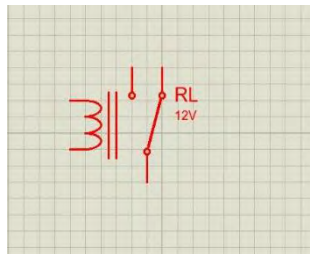


Fig: Difference Amplifier

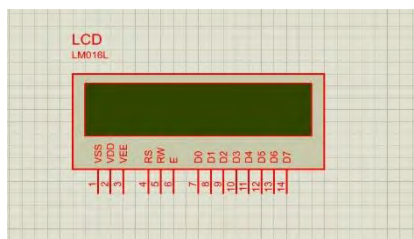
High speed relay:

Relay is used to turn on and turn off main power supply. Relay get control signal from Arduino Uno through a transistor. Diode is use in parallel with coil pin of relay to avoid sparking in case of back EMF (Electromagnetic Force). For relay to turn on, 12 volt DC is needed.



Liquid Crystal Display:

LCD is used to display value of voltage and status of your power supply. If AC voltage of main power supply is greater or less than 20% of normal operating voltage, LCD display “fault occur”. Otherwise LCD display “No fault”. LCD also displays value of AC main voltage supply. For simulation we used 20x4 display.



Arduino Uno:

Arduino Uno is used to make this project intelligent and smart. ADC of Arduino is used to measure analog AC voltage. Control signals are used to turn on or off a transistor which controls the relay. Arduino reads the analog value of voltage and displays it on the LCD. Actually, embedding Arduino Uno makes this project intelligent and smart enough so that it can take control actions automatically in case of under and over voltage. It can also automatically turn on or off the power supply without the need of any person.

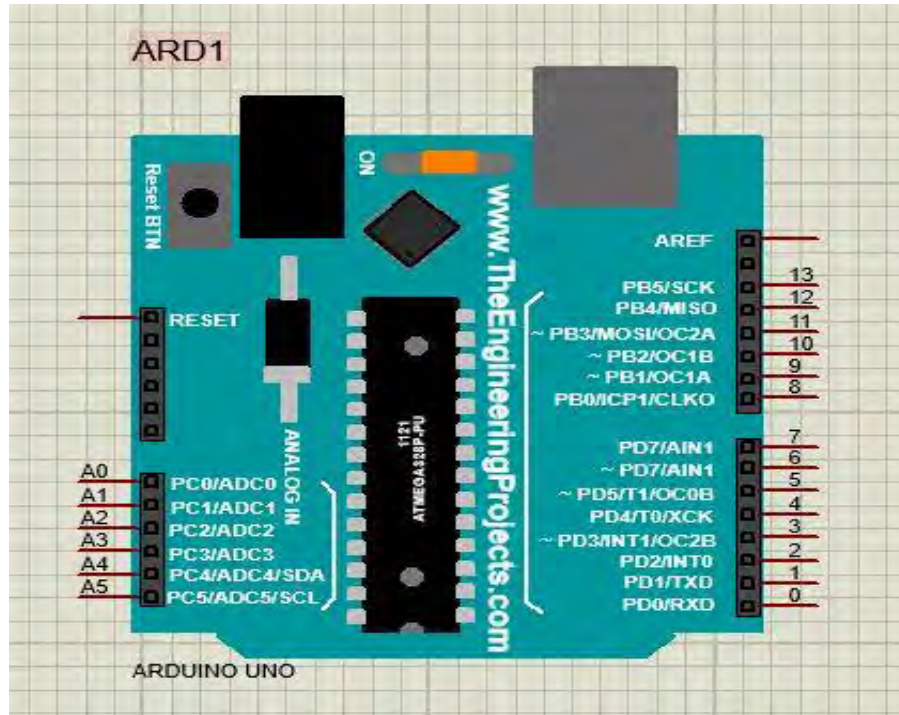
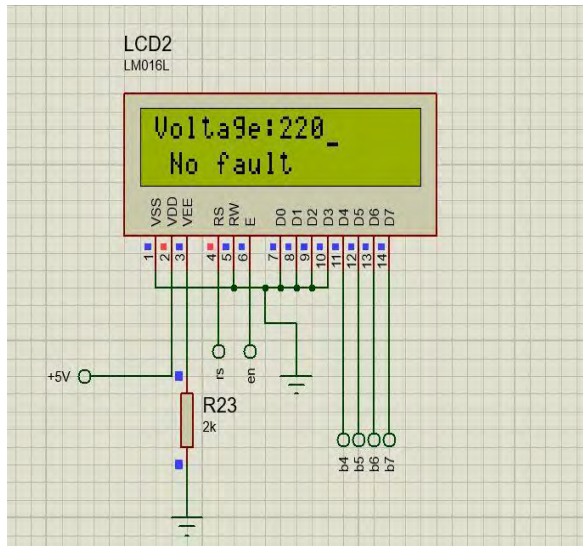


Fig: Arduino Uno

This diagram will show when voltage is 220 volt AC or less than of normal operating voltage, the LED is on and relay is working and the LCD Display will show that there is no fault in the line. Because relay is used as normally closed mode.



Relay is on and RED LED is blinking.

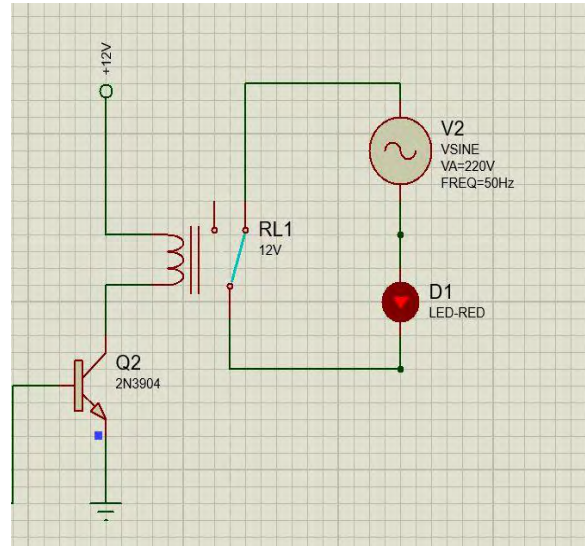


Fig: "NO FAULT" when Normal voltage is passing

Fig:

But when voltage become greater than or less than normal operating voltage it will turn off relay in minimum possible time and relay in return turn off main AC power to ensure safety of devices.

Fig: "FAULT OCCUR" when high voltage is passing

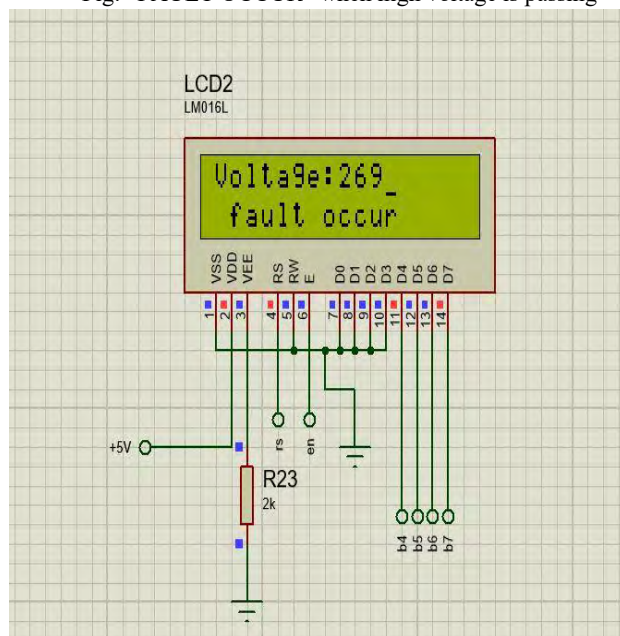
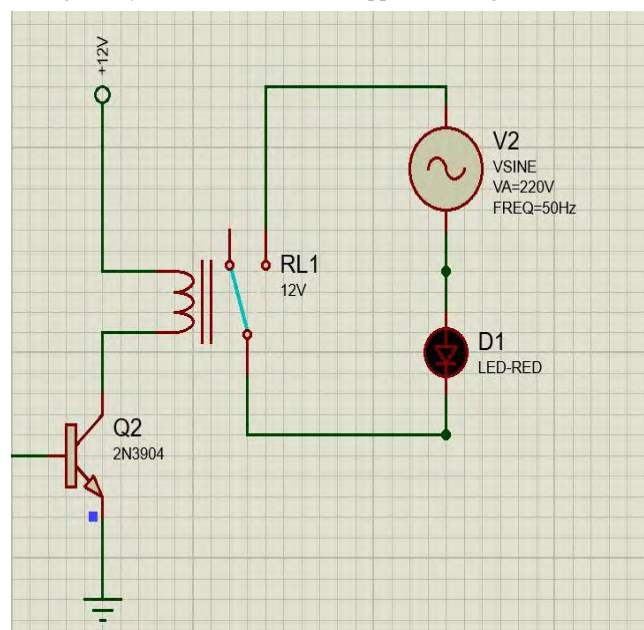
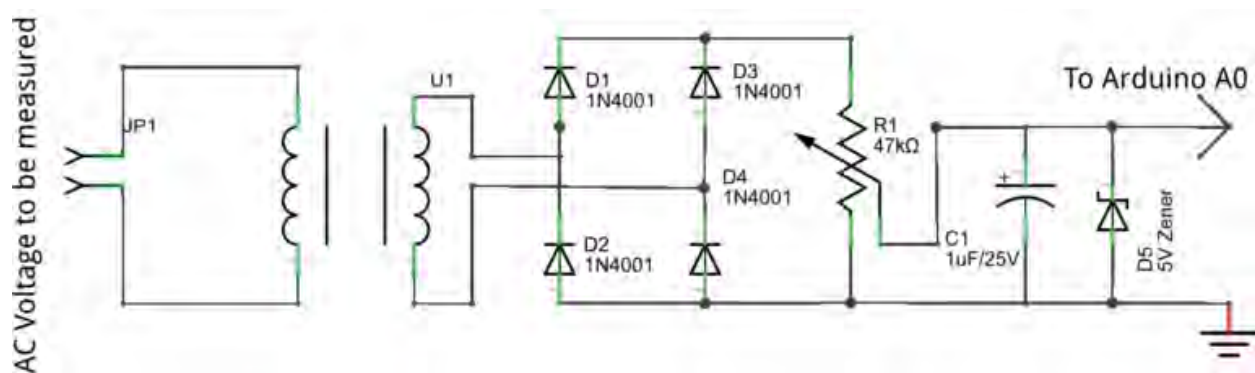


Fig: Relay is Off and LED has stopped blinking



Complete Circuit Diagram along with GSM Module

We have added SIM900 GSM Module along with the rest of the circuit. To this to work we need to practically make this circuit with the GSM. Which we did. In the later part of this paper you will find out the practical implementation of this Schematic diagram.



Protection System:

In a complete electric system there must have safety gauges and protection systems.

Switchgear is such a system that allows electrical circuit to function with safety. Switchgear is a mix of electrical separate switches, wires or circuit breakers used to control, ensure and confine electrical hardware. Changes are sheltered to open under ordinary load current, while defensive gadgets are protected to open under fault current.

Switchgear consists of CT, PT, isolator, busbar etc. The fundamental purposes of switchgear are as follows-

- 1) Switch load currents;
- 2) Make onto a fault;

- 3) Carry fault current without blowing itself up;
- 4) Break normal and fault current.

Relays are widely used safety component around the globe. Relays are the devices, which monitor the conditions of a circuit and give instructions to open a circuit under unhealthy conditions.

Electromechanical and static relays are mostly used relays.

Methodology

This project is designed which automatically turn on and turn off main supply in case of issue in AC main power supply and no one need to control in manually. It is designed to ensure protection of home devices like fan, televisions, refrigerator and all other things we need to protect in case of under and over voltage in main supply. This device has three parts by which it is said to the safeguard given there occurs any irregularities in AC supply. GSM module, Arduino controlling and Networking these are the three parts of this device.

GSM Module

In this device, GSM is mainly used for communication purpose. We made our device in such a way that no extra hand is needed to turn this thing after it first turned on. It can be turned on and off through mobile phone call.

At first when it is introduced with the AC main supply, the device will turn on and a message will be sent to the user's registered sim that the "Device Restarted".

But the status of this device will still remain “off”. As the status is still off the device will not be measuring the current and the power of load even though the load is connected with the device.

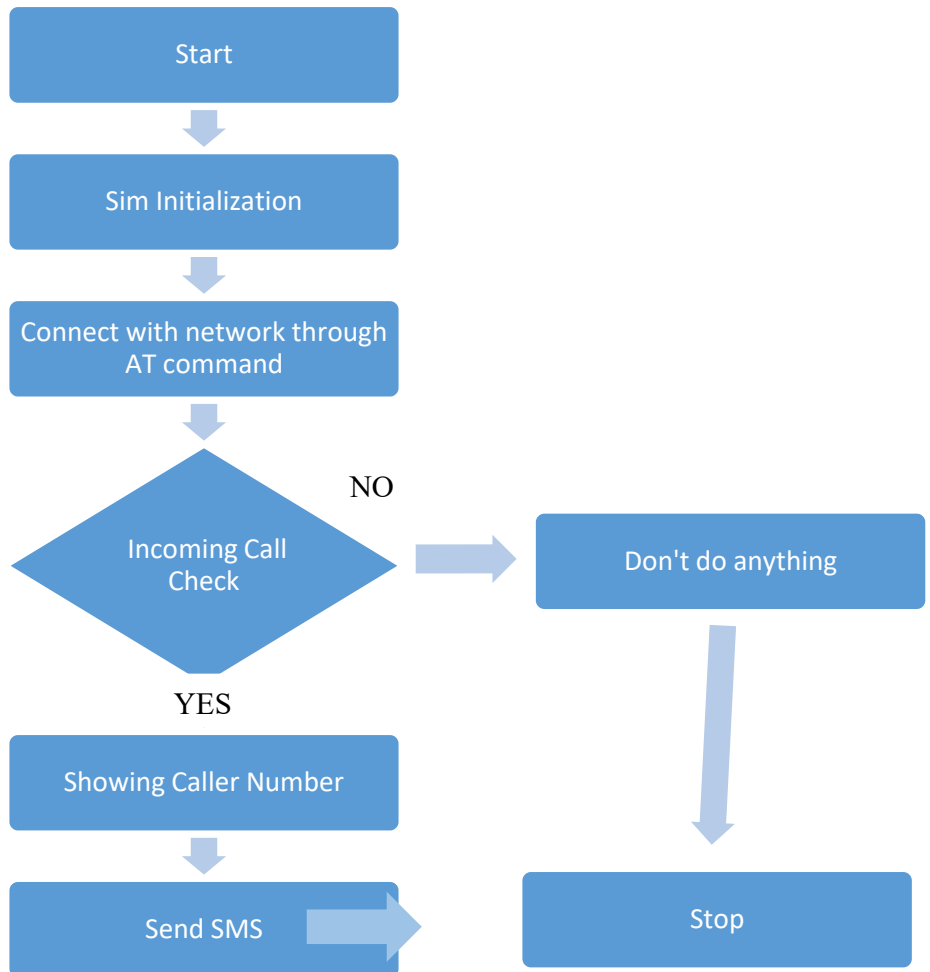
Now the registered user has to call the device to make change the status of the device from “turn off” to “turn on”. After ringing three times the call will automatically end and the status of the device will switch to “Turn on”. A confirmation message will be sent to the user’s cell that “Device Switched On, Volt: Normal”. The message will say “Volt: Normal” if the voltage is normal.

As the device status is now “on”, we can now measure the current and power of the connected load. The device has a display that will show the voltage is currently flowing through the device, current and the power of the connected load. We have connected a multi meter to the AC Supply to see whether the voltage reading is actually right or wrong.

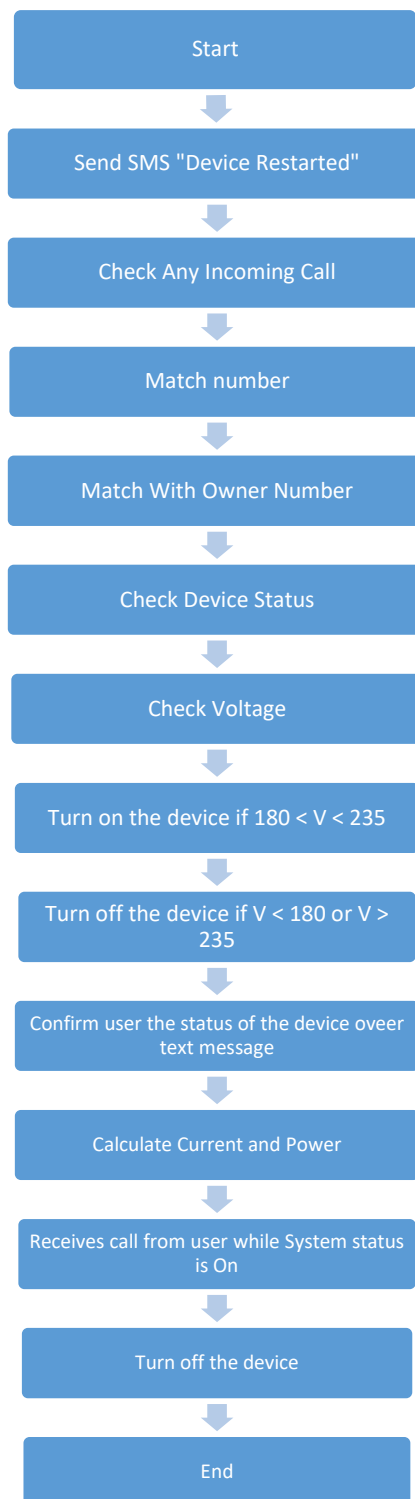
The device will turn off automatically whenever there occurs a under voltage or over voltage in AC supply. If the voltage is below 200 volt, a message will be sent to the user’s cell phone that “Volt limit Lacked, Switched OFF”. If the voltage is over 250 volt, a message will be sent to the user that “Volt limit exceed, Switched OFF” and this is how the user will be notified about the status of the device from anywhere.

If the user wishes to turn off the device without turning it off from the main supply rather from far away from the device, he just need to call the device. After two rings, the device status will switch from “ON” to “OFF” automatically. If someone whose cell phone number is not registered with the device calls the device, the device will not turn on no matter how many times the person calls the device. That means only and only authorized personnel has the authority to turn the device status from “off” to “on”.

GSM Workflow



Arduino Workflow



Chapter 5

Future Work

i want to add more components in future to make my project more efficient in future uses ,such as

- Develop in three phase protection system
- Gas meter
- Security lock for admin access
- AI operating system

Develop Three Phase Protection System:

I will try to make my project more effective by adding more relay and control system . will try to make it even more cheap so that users can easily adopt the system. I will add higher communications modules such as ZigiBee, Wi-Fi, Wireless M-Bus. Both 2.4 GHz and Sub-1 GHz... It will turn on by using three-phase line voltage so extra power will not be needed to turn on the device.

Introducing Gas Meter

A Gas Meter is used to measure the volume of fuel gases .for example natural gas. The seventh largest gas producing country in Asia is Bangladesh. Such as electricity large amount of gas is stolen every year, if consumer pays the bill exactly then everyone can use this natural recourse without any problem. The price of per unit gas will reduce. If I can establish this meter then user will be able to see the usage of gas and pay the bills. Also the government will get to know that how much their consumers are using

and how much new consumers are connecting with the supply and can easily calculate the bills. it will help them to prepare a yearly data .I will try to combine the electric and gas meter together so that government can take both data easily .in this way people will not be able to steal resources and normal people can be able to use the resource without any interruption.

Security Lock for Admin Access

My system can get sms through sms but I want to make android and ios app so that my project becomes smarter and more easy to use. For that reason I am trying to develop a code to work forward in future. I want to publish the software in play store and ios store or other local third party store so that the availability is smooth.

If users do not enable the device admin app then the system will communicate with the user through gsm but if h/she enables the app then the system will use both way function for the safety and easy excess to the user. That means if no software enabled the system smart feature will not on but the system will run generally.

Artificial Intelligence Operating System

The ability of a system to calculate, reason, perceive relationships and analogies, learn from experience, store and retrieve information from memory, solve problems, comprehend complex ideas, use natural language fluently, classify, generalize, and adapt new situations. Goals of AI

- **To Create Expert Systems** – the systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users.

- **To Implement Human Intelligence in Machines** – Creating systems that understand, think, learn, and behave like humans.

There are many types of intelligence system. Among them some of the system we can implement in our device for a better and advance response. Those are,

Linguistic intelligence	The ability to speak, recognize, and use mechanisms of phonology (speech sounds), syntax (grammar) and semantics (meaning).	Narrators, Orators
Logical-mathematical intelligence	The ability of use and understand relationships in the absence of action or objects. Understanding complex and abstract ideas.	Mathematicians, Scientists

These two are the most compatible with our current system. Merging these two with our current system will make the system fully automatic machine with automation. The main objective of this project was to introduce both way communications through internet using this device. This meter will ensure a more secure and transparent billing and monitoring system. Users will get more clear bills and real-time usage availability will rise concern about wasting electricity. This will bring benefit to both consumers and country. This meter designed in a different way from the existing meter. Distributors will be able to have more control over the distribution system and the country will get a more advance and smart power distribution system. Moreover, the electricity stealing will reduce and government will be able to get more

revenue and less loss. In short, to introduce a smart and advance grid to developing countries like Bangladesh, this device will be the first step of a new era in case of Power Management and Distribution.

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APPENDIX

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(8,7,6,5,4,3);

float power_1,power_2,power_3;

int delta=30;

int delta_2=29;

const int sensorIn_1 = A0;

const int sensorIn_2 = A1;

const int sensorIn_3 = A2;

int mVperAmp = 66;

double Voltage_1,Voltage_2,Voltage_3;

double VRMS_1,VRMS_2,VRMS_3;

double AmpsRMS_1,AmpsRMS_2,AmpsRMS_3;

#include <DFRobot_sim808.h>

#define PHONE_NUMBER "+8801672326796"
```

```
#define PHONE_NUMBER "+8801627283739"
//#define PHONE_NUMBER "+8801521200841"
#define MESSAGE_LENGTH 20
#define MESSAGE_1 "Device SWITCHED ON, Volt : Normal"
#define MESSAGE_2 "Device SWITCHED OFF"
#define MESSAGE_3 "Volt Limit Exceeded! Switched off"
#define MESSAGE_4 "Volt Limit Lacked! Switched off"
#define MESSAGE_5 "Device Restarted"
#define MESSAGE_6 "Volt Limit Lacked! Switched off"
char gprsBuffer[64];
char *s = NULL;
int voltage_1,voltage_2,voltage_3;
int c=0;
int i=0;
int z = 0;
int up = 235;
int down = 180;
#define led 9
#define PIN_TX 0
#define PIN_RX 1
//SoftwareSerial mySerial(PIN_TX,PIN_RX);
//DFRobot_SIM808 sim808(&mySerial);//Connect RX,TX,PWR,
DFRobot_SIM808 sim808(&Serial);
bool push = false;
void setup() {

    Serial.begin(9600);
```

```
pinMode(2,OUTPUT);
digitalWrite(2,HIGH);
lcd.begin(20, 4);
lcd.print("Connecting");
delay(200);
lcd.print(".");
delay(200);
lcd.print(".");
delay(200);
lcd.print(".");

Serial.begin(9600);
pinMode(led, OUTPUT);
digitalWrite(led, LOW);

//***** Initialize sim808 module *****

while(!sim808.init()) {
    Serial.print("Sim808 init error\r\n");
    delay(1000);
    lcd.clear();
    lcd.print("GSM Error");
}
delay(1000);

Serial.println("Init Success, please call or send SMS message to me!");
lcd.setCursor(0,3);
lcd.print("Network Connected");
delay(1400);
```

```

sim808.sendSMS(PHONE_NUMBER,MESSAGE_5);
}

void loop() {
  //***** Wait serial data *****
  voltg();
  current();
  lcd.clear();
  lcd.setCursor(6, 0);
  lcd.print("P1");
  lcd.setCursor(13, 0);
  lcd.print("P2");
  lcd.setCursor(19, 0);
  lcd.print("P3");
  ///////////////2nd row/////////////////
  lcd.setCursor(0, 1);
  lcd.print("V:");    lcd.setCursor(4, 1);  lcd.print(voltage_1);lcd.setCursor(11,
1);lcd.print(voltage_2);lcd.setCursor(17, 1);lcd.print(voltage_3);
  lcd.setCursor(0, 2);
  lcd.print("C:");    lcd.setCursor(4, 2);  lcd.print(AmpsRMS_1);lcd.setCursor(11,
2);lcd.print(AmpsRMS_2);lcd.setCursor(17, 2);lcd.print(AmpsRMS_3);
  lcd.setCursor(0, 3);
  lcd.print("Pwr:");  lcd.setCursor(4, 3);  lcd.print(AmpsRMS_1);lcd.setCursor(11,
3);lcd.print(AmpsRMS_2);lcd.setCursor(17, 3);lcd.print(AmpsRMS_3);
  // lcd.setCursor(9, 2);
  // lcd.print(power);lcd.print(" kW");
  status_M();
}

```

```

delay(50);

Serial.println (c);

if((voltage_1>up || voltage_1 <down)&& c%2!=0){
  digitalWrite(led,LOW);
  c++;
  delay(50);
  if(voltage_1>up){
    sim808.sendSMS(PHONE_NUMBER,MESSAGE_3);      // voltage limit exceeds
  }
  else if(voltage_1 <down){
    sim808.sendSMS(PHONE_NUMBER,MESSAGE_4);      // voltage limit lacks
  }
}

if(sim808.readable()){
  sim808_read_buffer(gprsBuffer,32,DEFAULT_TIMEOUT);
  //Serial.print(gprsBuffer);

  /******* Detect the current state of the telephone or SMS
  *****/

  while(NULL != strstr(gprsBuffer,"RING")) {
    Serial.print("AT+CLIP=1\r");
    Serial.println(gprsBuffer);
    // if(NULL != strstr(gprsBuffer,"+CLIP: \"+8801672326796")) {
    if(NULL != strstr(gprsBuffer,"+CLIP: \"+8801627283739")) {
      // if(NULL != strstr(gprsBuffer,"+CLIP: \"+8801521200841")) {
    Serial.println("YOOO");
  }
}

```

```
    i++;  
    if(i>2){  
        Serial.print("ATH");  
        break;  
    }  
  
}  
else {break;}  
delay(2000);  
}  
  
sim808_clean_buffer(gprsBuffer,32);  
}  
if(i>2&&(down<voltage_1&&voltage_1<up)){  
    Serial.print("ATH");  
    //delay(2000);  
    push=true;  
    c++;  
  
}  
i=0;  
if (c % 2 == 0&&(down<voltage_1&&voltage_1<up)) {  
    // delay(5000);  
    digitalWrite(led, LOW);
```

```
} else if(c % 2 != 0&&(down<voltage_1&&voltage_1<up)){  
  // delay(5000);  
  digitalWrite(led, HIGH);  
  
}
```

```
if(push==true && c % 2==0){  
  
  Serial.println("SMS SENDING 2");  
  // delay(5000);  
  while(z<delta){  
  
    voltg();  
    current();  
  lcd.clear();  
    lcd.setCursor(6, 0);  
    lcd.print("P1");  
    lcd.setCursor(13, 0);  
    lcd.print("P2");  
    lcd.setCursor(19, 0);  
    lcd.print("P3");  
  
    //////////////////////////////////2nd row////////////////////////////////////
```



```

    lcd.setCursor(0, 1);

    lcd.print("V:");    lcd.setCursor(4, 1);    lcd.print(voltage_1);lcd.setCursor(11,
1);lcd.print(voltage_2);lcd.setCursor(17, 1);lcd.print(voltage_3);

    lcd.setCursor(0, 2);

    lcd.print("C:");    lcd.setCursor(4, 2);    lcd.print(AmpsRMS_1);lcd.setCursor(11,
2);lcd.print(AmpsRMS_2);lcd.setCursor(17, 2);lcd.print(AmpsRMS_3);

    lcd.setCursor(0, 3);

    lcd.print("Pwr:");    lcd.setCursor(4, 3);    lcd.print(AmpsRMS_1);lcd.setCursor(11,
3);lcd.print(AmpsRMS_2);lcd.setCursor(17, 3);lcd.print(AmpsRMS_3);

    status_M();

delay(50);

    Serial.print("ATH");

    z++;

    Serial.println(z);

    if(z>delta_2){

        Serial.println("SMS SENDING 2 complete");

        z=0;

        sim808.sendSMS(PHONE_NUMBER,MESSAGE_2);

        break;

    }

// voltg();

else if((voltage_1>up || voltage_1 <down)&& c%2!=0){

    digitalWrite(led,LOW);

    c++;

    delay(50);

```



```
    lcd.print("V:");    lcd.setCursor(4, 1);    lcd.print(voltage_1);lcd.setCursor(11, 1);lcd.print(voltage_2);lcd.setCursor(17, 1);lcd.print(voltage_3);
```

```
    lcd.setCursor(0, 2);
```

```
    lcd.print("C:");    lcd.setCursor(4, 2);    lcd.print(AmpsRMS_1);lcd.setCursor(11, 2);lcd.print(AmpsRMS_2);lcd.setCursor(17, 2);lcd.print(AmpsRMS_3);
```

```
    lcd.setCursor(0, 3);
```

```
    lcd.print("Pwr:");    lcd.setCursor(4, 3);    lcd.print(AmpsRMS_1);lcd.setCursor(11, 3);lcd.print(AmpsRMS_2);lcd.setCursor(17, 3);lcd.print(AmpsRMS_3);
```

```
    status_M();
```

```
delay(50);
```

```
Serial.print("ATH");
```

```
z++;
```

```
Serial.println(z);
```

```
if(z>delta_2){
```

```
    Serial.println("SMS SENDING 1 complete");
```

```
    z=0;
```

```
    sim808.sendSMS(PHONE_NUMBER,MESSAGE_1);
```

```
    break;
```

```
}
```

```
else if((voltage_1>up || voltage_1 <down)&& c%2!=0){
```

```
digitalWrite(led,LOW);
```

```
c++;
```

```
delay(50);
```

```
sim808.sendSMS(PHONE_NUMBER,MESSAGE_6);
```

```
break;
```



```
    Serial.print("AC Voltage: ");
// Serial.print(voltage);
    Serial.println(" Volts");

    //delay(500);
}

void status_M(){
    if(c%2==0){

        lcd.setCursor(0,0);
        lcd.print("OFF");
    }
    else{

        lcd.setCursor(0,0);
        lcd.print("ON");
    }
}

float getVPP()
{
    float result_1,result_2,result_3;

    int readValue_1,readValue_2,readValue_3;           //value read from the sensor
```

```
int maxValue_1,maxValue_2,maxValue_3;    // store max value here
int minValue_1 = 1024;    // store min value here
int minValue_2 = 1024;
int minValue_3 = 1024;

uint32_t start_time = millis();
while((millis()-start_time) < 1000) //sample for 1 Sec
{
    readValue_1 = analogRead(sensorIn_1);
    readValue_2 = analogRead(sensorIn_2);
    readValue_3 = analogRead(sensorIn_3);
    // see if you have a new maxValue
    if (readValue_1 > maxValue_1)
    {
        /*record the maximum sensor value*/
        maxValue_1 = readValue_1;
    }

    if (readValue_2 > maxValue_2)
    {
        /*record the maximum sensor value*/
        maxValue_2 = readValue_2;
    }

    if (readValue_3 > maxValue_3)
    {
        /*record the maximum sensor value*/
```

```
    maxValue_3 = readValue_3;
}

if (readValue_1 < minValue_1)
{
    /*record the maximum sensor value*/
    minValue_1 = readValue_1;
}
if (readValue_2 < minValue_2)
{
    /*record the maximum sensor value*/
    minValue_2 = readValue_2;
}
if (readValue_3 < minValue_3)
{
    /*record the maximum sensor value*/
    minValue_3 = readValue_3;
}
}

// Subtract min from max
result_1 = ((maxValue_1 - minValue_1) * 5.0)/1024.0;
result_2 = ((maxValue_2 - minValue_2) * 5.0)/1024.0;
result_3 = ((maxValue_3 - minValue_3) * 5.0)/1024.0;

return result_1,result_2,result_3;
```

```
}
```

```
void current() {  
  
    Voltage_1 = getVPP();  
    Voltage_2 = getVPP();  
    Voltage_3 = getVPP();  
    VRMS_1 = (Voltage_1/2.0) *0.707;  
    VRMS_2 = (Voltage_2/2.0) *0.707;  
    VRMS_3 = (Voltage_3/2.0) *0.707;  
  
    AmpsRMS_1 = (VRMS_1 * 1000)/mVperAmp;  
    AmpsRMS_2 = (VRMS_2 * 1000)/mVperAmp;  
    AmpsRMS_3 = (VRMS_3 * 1000)/mVperAmp;  
    // Serial.print(Voltage);  
    // Serial.println(" V RMS");  
    if(AmpsRMS_1<0.11){  
        AmpsRMS_1=0;  
    }  
    if(AmpsRMS_2<0.11){  
        AmpsRMS_2=0;
```



```
}  
if(AmpsRMS_3<0.11){  
    AmpsRMS_3=0;  
}  
power_1=(voltage_1*AmpsRMS_1)/1000;  
power_2=(voltage_2*AmpsRMS_2)/1000;  
power_3=(voltage_3*AmpsRMS_3)/1000;  
  
}
```