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# Microcontroller Based Intelligent Protection Scheme for Heavy Dc & Ac Single and Three Phase Appliances Intelligent Protection Scheme

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**Abstract:- In working with heavy AC and DC appliance problems that arise are common nowadays. Here a new protection method is implemented which is low cost and reliable. The fault that occurs normally in the appliances are over voltage/current fault or under voltage fault or short-circuit problems including system blackout or some other problems regarding frequency disturbances etc. Failure of insulation or occurrence of any of the above-mentioned faults will reduce the life of electrical appliances and can cause enormous economic damages and even sometimes life risk problems. Here we are super excited to implement a protection scheme which is of societal use which will reduce the life and asset damages. This protection scheme is implemented by using ATmega2560 microcontroller.**

***Keywords:-*** *Microcontroller Atmega2560, Protection, Current Sensor, Voltage Measurement, Frequency Measurement, System Blackout Protection.*

## I. INTRODUCTION

This protection scheme mainly deals with live values of voltage, current, and frequency and includes the protection of real-life industrial AC and DC appliances. Whenever if there are any abnormal changes in real live values, protection scheme will automatically isolate the equipment from supply preventing it from damage and raises an alarm with some brief details like in which segment and phase does the fault occurred, type of fault like over voltage, over current and relay trip time etc. This alarm will pass a message to the display which is connected to the control room or security segment of an industry. This scheme will even detect temporary voltage and current spikes and reconnects the isolated equipment after a stable electrical environment is obtained. If electrically stable environment is not obtained after some predefined time, it will consider the fault as a permanent problem, then raises an alarm and intimates the problem to the security section.

## II. SYSTEM ARCHITECTURE

*A. System Architecture*

Overall, this system uses different sensors, modules and some own designed circuits to read live values of voltage, current, and frequency and to detect changes in those values.

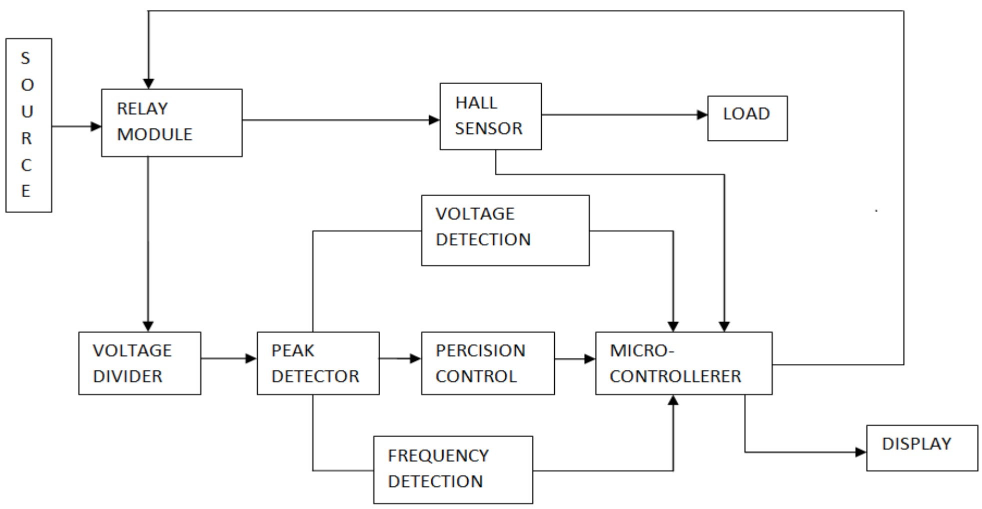


Fig 1:- System Architecture

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*B. Hardware Components Used*

We have used sensors, modules, designed circuits and so many components in order to get maximum reliable protection under optimum cost.

*1. Relay Modules*

Since usually microcontrollers operates at an optimum voltage range of 3V to 6V, it is not so easy to operate and control high rated electrical appliances with a microcontroller. There should be strong isolation between high voltages and the protection equipment for the stable electrical environment. Relay is an electromagnetic switch operated by relatively small current that can closes and opens the external circuit. The heart of a relay is electromagnet a coil of wire that becomes a temporary magnet when electricity flows through it. The main advantage of using relay module is there is a strong isolation between the actual circuit and the microcontroller circuit. Here in this scheme we are using four channel relay modules to control the connections with R, Y, B phases and another relay for neural isolation.


Fig 2:- Four channel relay module

Relay module uses on-board EL817 photoelectric coupler with photoelectric isolating anti-interface ability.

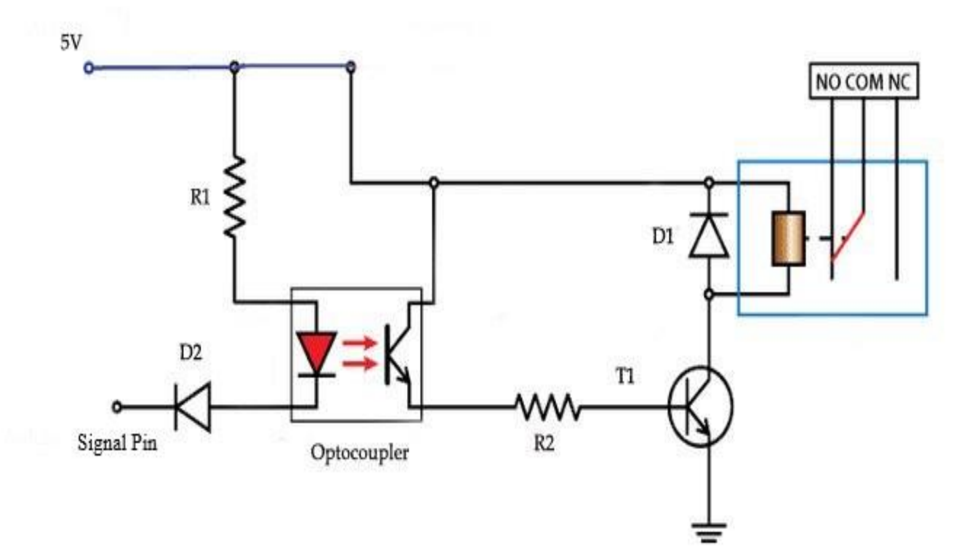


Fig 3:- Schematic Circuit Diagram Of Relay Module

*2. ACS712 Current sensor*

ACS712 current sensor is a sensor that can be used to measure and calculate the amount of current flowing in a circuit without affecting the performance of the system. It is a fully integrated, Hall-effect based linear sensor IC. This IC has a 2.1Kv RMS isolation along with a low resistance current conductor. Usually current sensing can be done in two ways direct sensing and indirect sensing. In direct sensing by considering the voltage drop and by applying Ohm's law current can be measured. In indirect sensing method, magnetic field is measured and by using Faraday's law current will be measured. In ACS712 sensor, indirect sensing technique is used to measure the current flowing in a circuit. The proximity of the magnetic signal to the Hall sensor decides the accuracy of the device. Nearer the magnetic signal higher the accuracy.

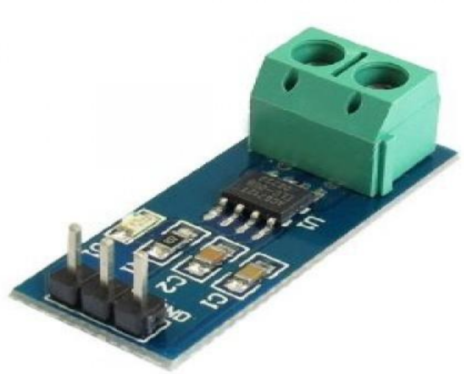

Fig 4:- ACS712 Current Sensor Module

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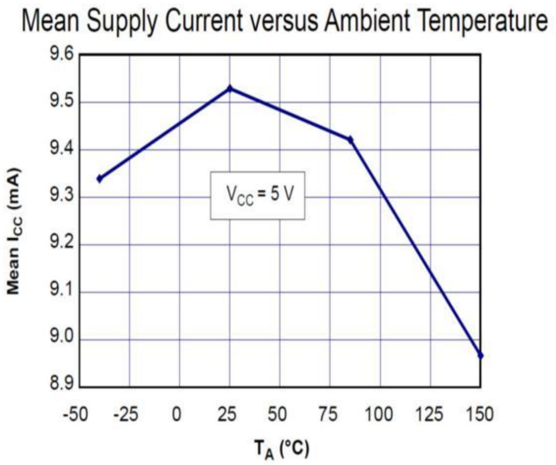
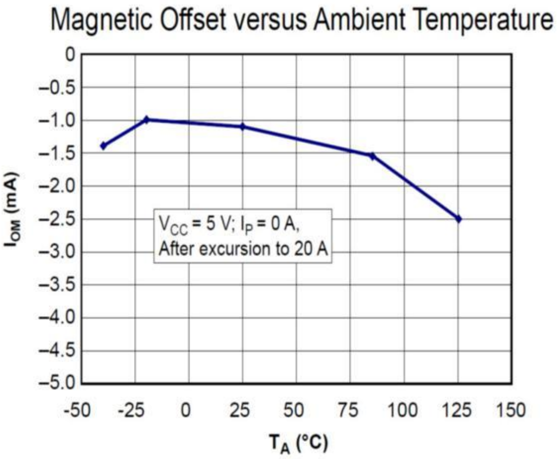
➢ *Characteristics Performances*




*3. Voltage Divider Circuit*

This circuit is typically used for stepping down the AC waveform without changing the shape of the waveform but just the magnitide which is proportional to the original ones. The output from this circuit is feded to the microcontroller for further calculation of voltage and frequency. This circuit will be connected in parllel with the source. The reason why we used lot's of resistors is to dispiate the heat properly.

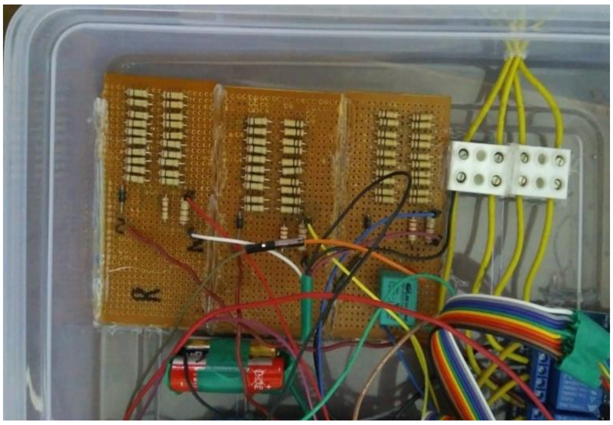


Fig 5:- Voltage Divider Circuit

Three of those circuits works constantly to read live voltages and frequencies from all the phases (in case of AC). Another functionality of this circuit is to rectify the input sinusodial waveform to a half rectified sine wave.

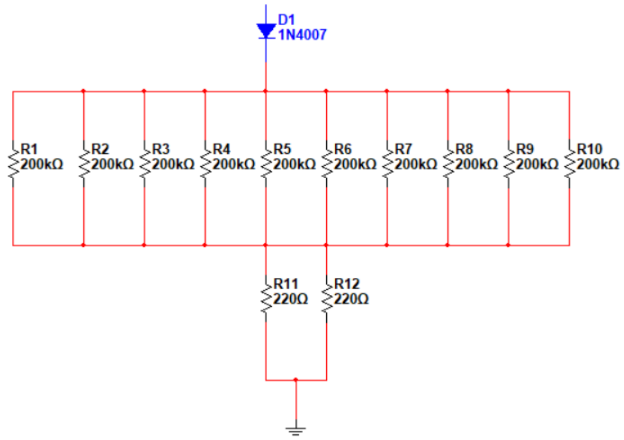



Fig 6:- Schematic Diagram of Voltage Divider Circuit

With a proper input sinusodial waveform, output waveform will be rectified like half wave rectified signal with lower magnitudes. So any changes in the original voltage will cause a change in output of voltage divider circuit which in under supervision of microcontroller. The same circuit is used for measuring frequency as well. The output waveform of the voltage divider circuit is as given below. The Micro controller reads Analog values of the rectified voltage obtained from voltage divider circuit. Micro-controller then based upon the analog values will estimates the proportionate voltage from the real voltage. The peak value of the voltage is detected by the micro-controller and it is processed to get the RMS value of the real voltage.

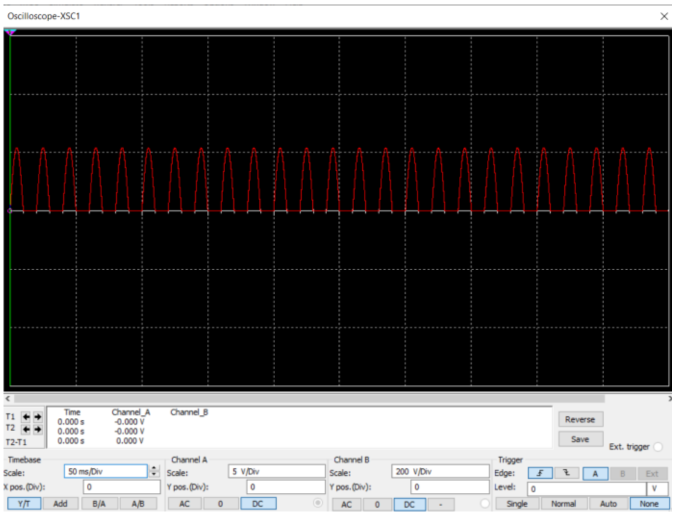



Fig 7:- Output of Voltage Divider Circuit

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By using same rectified waveform, frequency will be calculated by noting down the time instances between two consecutive peaks.

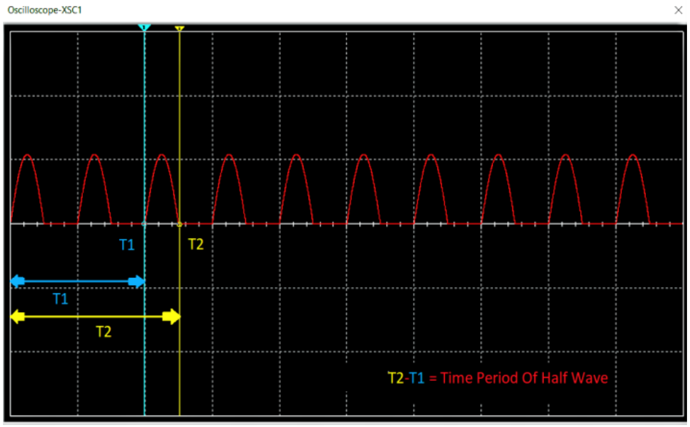


Fig 8:- Frequency Detection

The obtained rectified voltage waveform along with the peak value is further calculated to obtain the frequency. The time taken for the next cycle's peak value is doubled and then inverted to get the frequency of the real waveform.

We have seen how to obtain the live values of voltages, currents and frequencies for all the three phases (in case of AC). Now its time to see how to assemble all these modules in one place and we need to know how to measure all the values simultaneously. Voltage divider circuit is connected in parallel with the source and ACS712 circuit modules were connected in series with the load so that the current flowing into the load will be accessed accurately.

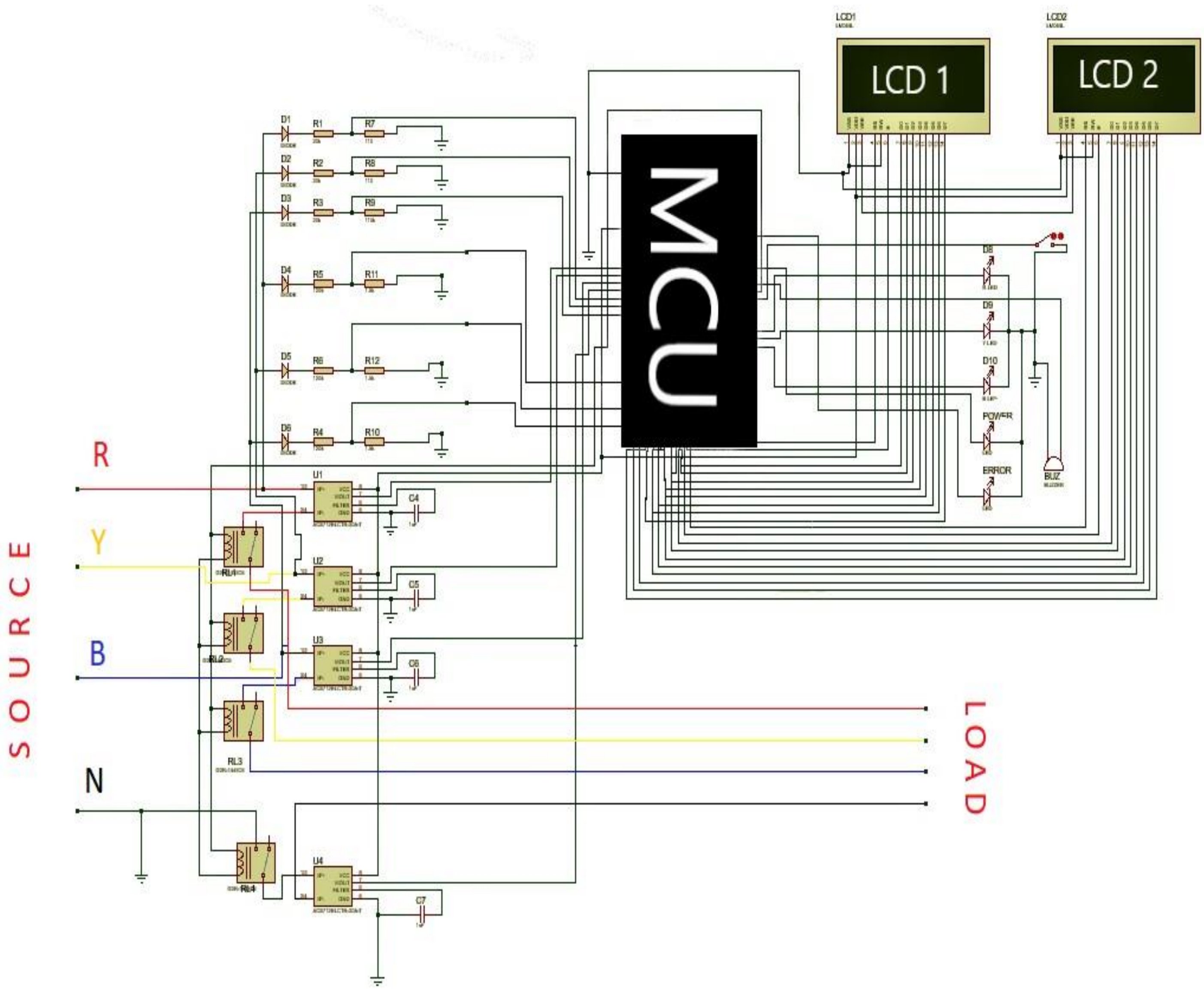


Fig 9:- Overall Circuit Diagram of Protection Scheme

➢ *Microcontroller Used*

In this protection scheme we have used ATmega2560 microcontroller which comes inbuilt with Arduino mega which has 16 analog pins and 54 digital input/output pins of which 14 pins can be used for pulse width modulation. Click here to learn more about Arduino mega.


Fig 10:- ATMEGA2560 Microcontroller

## III. PRACTICAL IMPLEMENTATION

Finally, all modules and circuits were consolidated in a PVC insulating case to form the layout of overall protection system as shown in fig-11. Matrix keyboard and LCD displays were connected to the microcontroller to take input and to display real time values.

Fig 11:- Overall Protection Kit

In this project, a protection system has been designed for safeguarding heavy industrial equipment against all possible faults. Sensors and some specially designed circuits are used to keep tabs on different parameters like voltage, current, frequency etc. The point when an abnormality happens, protection kit will decide whether it is a temporary fault or permanent fault and it will take an appropriate decision and intimates the fault to the alarming system if required.

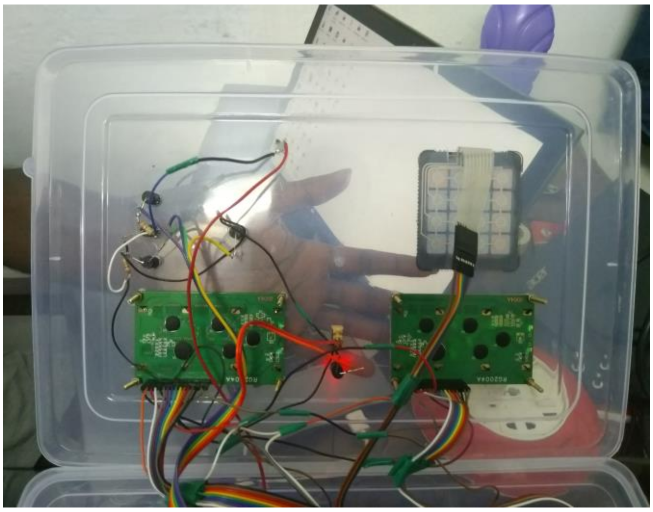

Fig 12:- Internal Connections

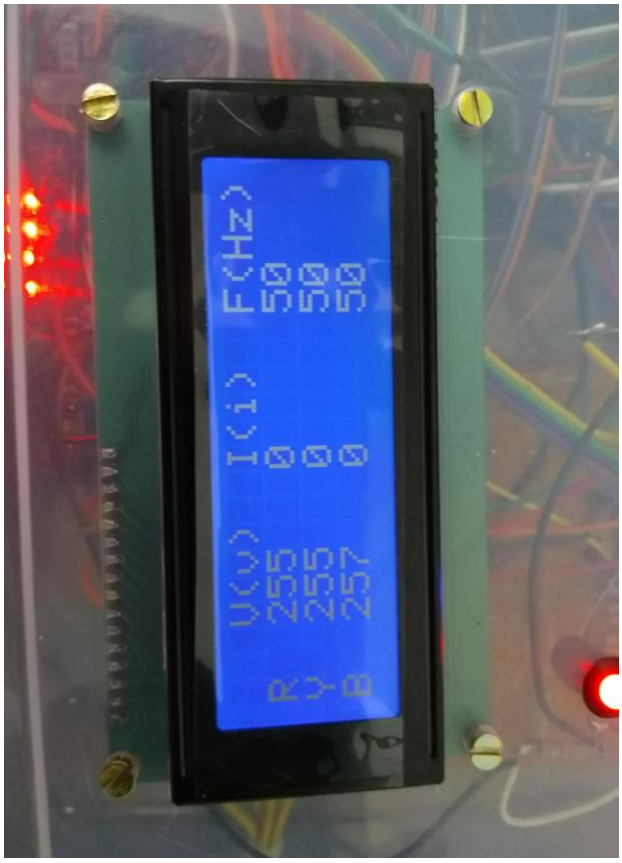

Fig 13:- Measuring runtime values for a 3-phase system without load

Overall the kit was tested on a three-phase inductive and resistive loads. Under faulty condition, the running current and voltage of load is more or less than the rated values. Now the fault that arises is under voltage. In this condition the health of load is bad. Now the microcontroller sends signal to relay, relay trips the signal and load gets disconnected from supply. To learn more about our project, please click here.


Fig 14:- Practical Testing


Fig 15:- Practical Testing

## IV. SOFTWARES WE HAVE USED

- **Proteus** is used for simulation and to draw the circuit layout. Click here to learn more about Proteus software.
- **Integrated development environment (IDE)** by Arduino to code the microcontroller. Click here to learn more about Arduino IDE.
- **Multisim** software is used for simulation and pre output rendering. Click here to learn more about Multisim software.
- **MATLAB** software is used to learn more about serial communication with the microcontroller. Click here to learn more about MATLAB software.
- **Simulink** is used to study about analog to digital and digital to analog conversion techniques. Click here to learn more about Simulink.

## V. CONCLUSION

In conclusion, this scheme is used to protect the costliest industrial equipment with a maximum voltage and current ratings of 900V and 20A.

Voltage sensing accuracy: 1 V
Current sensing accuracy: 1 mA
Frequency sensing accuracy: 1 Hz

Whenever if any of the abnormalities or shortage occurred, protection scheme will automatically isolate the equipment from supply preventing it from damage and raises an alarm with some brief details like in which segment and phase does the fault occurred, type of fault like over voltage, over current, frequency mismatch and relay trip time etc. This alarm will pass a message to the display which is connected to the control room or security segment of an industry.

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