

REAL TIME ALERT SYSTEM FOR TRANSFORMER FAILURE

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering degree in Electronics and Communication Engineering

by

NANDINI R (40130147)

NISHA N (40130156)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

CATEGORY-1 UNIVERSITY BY UGC

Accredited with Grade “A++” by NAAC | 12B Status by UGC | Approved by AICTE

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI-600119

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **NANDINI.R (40130147)** and **NISHA.N (40130156)** who carried out the project entitled "**REAL TIME ALERT SYSTEM FOR TRANSFORMER FAILURE**" under our supervision from November 2023 to April 2024.

INTERNAL GUIDE

Dr.L.MAGTHELIN THERASE,M.E.,Ph.D.,

HEAD OF THE DEPARTMENT

Dr.T.RAVI,M.E.,Ph.D.,

Submitted for Viva voce Examination held on 17/04/2024.

Internal Examiner

External Examiner

DECLARATION

We **NANDINI.R (40130147)** and **NISHA.N(40130156)** hereby declare that the Project Report entitled **"REAL TIME ALERT SYSTEM FOR TRANSFORMER FAILURE"** done by us under the guidance of **Dr.L.MAGTHELIN THERASE,M.E.,Ph.D.**, Associate Professor, Department of Electronics and Communication Engineering, **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY,CHENNAI**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Electronics and Communication Engineering**.

DATE: 17/4/2024

PLACE: Chennai

SIGNATURE OF THE CANDIDATES

1. Nandini.R - Nandini.R
2. Nisha.N - Nisha.N

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ABSTRACT

The proposed system provides effective monitoring and protection of transformer by measuring its fault location of transformer without involving human intervention. Due to this reason transformer failure may occur which leads to unexpected power shutdown. To overcome this shutdown due to transformer failure, a system is proposed for monitoring the transformer. The aim of this project is to monitor and protect the voltage level of transformer without involving human intervention. In case of critical conditions, the system sends SMS alerts to the operator via modem. Additionally, faulty conditions are promptly displayed on the LCD screen as part of this project, and automatically cut off the fault in the transformer. This system excels in fault protection and promptly sends alert messages to users for power generator issues, ensuring reliability and efficiency.

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LIST OF ABBREVIATIONS

ABBREVIATIONS

FULL FORM

SEADA	Supervisory Control and Data Acquisition
LCD	Liquid Crystal Display
GSM	Global System for Mobile Communication
PSU	Power Supply Unit
UART	Universal Asynchronous Receiver Transmitter
IR	Instruction Register
CG	Character Generator
EEPROM	Electrically Erasable Programmable Read Only Memory
USB	Universal Serial Bus
DR	Data Register

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CHAPTER 1

INTRODUCTION:

The electricity is need of day to day life and hence power system plays an important role in supplying uninterrupted power to their consumer. The power system includes number of component includes in line and transformer one of them. It has quiet been said that transformer is the heart of power system. It plays a key role in stepping up and stepping down voltage level. As the time goes the operation of transformer gives some variations and it's been necessary to monitor it with an advance sequential manner. As from present situation the monitoring has been propagated as it has gone through the manual operation. The human has to go to the transformer along with the testing kit to monitor as periodic monitoring. It takes a large time to take relevant tests and upload the data to the utility side. Till now the fault which has been breakdown only that's fault data has been monitored. For furthermost change in the real time fault monitoring gives the benefits to display the operator the real time fault of not one but all faults. It reduces the human intervention and the time span with exact accurate monitoring with new technology the IOT that available globally. The new development of android application can helps in displaying the monitoring action of the process.

The reliability and efficiency of power generation and distribution systems are paramount in ensuring uninterrupted supply to consumers. Transformers play a critical role in this ecosystem, stepping up or down voltage levels to facilitate efficient power transmission. However, transformers are also susceptible to various faults that can lead to costly downtime and disruptions. One of the key features of this real-time alert system is its ability to send instant SMS alerts to operators via modems in the event of critical conditions. This ensures that operators are immediately notified of any anomalies, allowing them to take swift corrective action. Additionally, the system displays fault notifications directly on an LCD screen, providing operators with real-time visibility into the status of transformers.

Furthermore, the system is equipped with automated fault cutoff mechanisms that can isolate the faulty transformer from the grid. This not only prevents further damage but also helps in maintaining the integrity of the power distribution network. By integrating these advanced capabilities, the real-time alert system enhances operational efficiency, minimizes downtime, and ensures reliable and uninterrupted power supply to consumers.

In summary, the real-time alert system for transformer failure is a critical component of modern power infrastructure, offering proactive fault detection, instant alerting, and automated fault isolation capabilities. It represents a significant advancement in ensuring the reliability and efficiency of power generation and distribution systems.

CHAPTER 2

LITERATURE SURVEY:

1. **TITLE:** Forecasting Monthly Electric Energy Consumption Using Feature Extraction.

AUTHOR: Ming Meng, Dongxiao Niu and Wei Sun.

YEAR: 2021

CONTENT: Monthly forecasting of electric energy consumption is important for planning the generation and distribution of power utilities. However, the features of this time series are so complex that directly modeling is difficult. Three kinds of relatively simple series can be derived when a discrete wavelet transform is used to extract the raw features, namely, the rising trend, periodic waves, and stochastic series. After the elimination of the stochastic series, the rising trend and periodic waves were modeled separately by a grey model and radio basis function neural networks. Adding the forecasting values of each model can yield the forecasting results for monthly electricity consumption.

2. **TITLE:** Research and implementation of cost-effective remote transformer monitor system

AUTHOR: Qin Zhou, Zheng Cai Fu

YEAR:2020

CONTENT: This system achieves the distant centralized monitoring function at minimal cost. Its interface is user-friendly, feature-rich, and supports configuration in real-time. As of right now, the system is now only being used for project on site operations; Real-time implementation is not available.

3. **TITLE:** Research on Insulation condition Monitoring System for Transformers.

AUTHOR: Shuangzan Ren, Xu Yang,Wenhu Yang

YEAR: 2021

CONTENT: This system incorporates an online monitoring system that measures the bushings dissipation factor($\tan\delta$),equivalent capacitance, and

contamination of the surface, as well as partial discharge(PD) and gas-in-oil analysis(DGA).

4. **TITLE:** Transformer condition Monitoring

AUTHOR: Rusod, S.Zhivodernikov

YEAR: 2022

CONTENT: A Transformer diagnostics monitoring(TDM) system is a system that evaluates the condition of every part of a transformer in its whole lack a system for interpreting the information gathered.

5. **TITLE:** Transformer Parameter Monitoring System using Proteus Software

AUTHOR: Rashmi Ashok panherker,Prajakta Vaidya

YEAR: 2023

CONTENT: The primary goal of this GSM module Parameter scheming .A temperature detector puts a halt to the transformers scheme.GSM under wirelessly disclose microcontroller.Using a GSM module prohibits changing the transformers voltage,current,or temperature.After that,send an SMS to the far-off place.The system is little more expensive and inefficient when GSM is used.

CHAPTER 3

AIM AND SCOPE:

The aim and scope of a real-time alert system for transformer failure are expansive and intricate, encompassing a spectrum of critical objectives aimed at bolstering the reliability and longevity of transformer infrastructure. At its core, the system is engineered to proactively detect potential failures well in advance, ushering in a new era of preventive maintenance strategies. By continuously monitoring an array of vital parameters including temperature, oil level, vibration, and electrical metrics, the system operates as a vigilant guardian, poised to swiftly identify deviations from normal operating conditions. Through the meticulous collection and sophisticated analysis of real-time and historical data, often employing cutting-edge machine learning algorithms, the system discerns subtle patterns and precursors indicative of impending failures, thus empowering stakeholders with actionable insights. Central to its efficacy is the timely generation of alerts, serving as a clarion call to maintenance personnel and operators, prompting expedited intervention measures to forestall downtime and mitigate potential damage. Seamless integration with existing Supervisory Control and Data Acquisition (SCADA) systems ensures the harmonious convergence of real-time alerts with broader monitoring frameworks, facilitating holistic oversight of transformer health. Moreover, the system is architected with scalability, reliability, and compliance with stringent industry standards in mind, reinforcing its robustness and suitability for diverse operational contexts. By virtue of its cost-effectiveness and intuitive user interface, complete with dynamic visualization tools and comprehensive reporting capabilities, the system catalyzes informed decision-making and enhances operational efficiencies. In sum, the real-time alert system for transformer failure represents a paradigm shift in transformer management, offering a proactive, data-driven approach to safeguarding critical infrastructure and maximizing operational uptime.

At its foundation, the real-time alert system for transformer failure is a sophisticated amalgamation of cutting-edge technology and strategic foresight, with a primary

aim to revolutionize the paradigm of transformer maintenance. Its scope extends far beyond mere detection, encompassing a holistic approach towards ensuring the uninterrupted operation and longevity of transformer assets. Leveraging an intricate network of sensors strategically positioned across transformers, the system orchestrates a symphony of data acquisition, processing, and analysis in real-time. This enables it to not only detect anomalies but also to discern nuanced patterns and trends that could potentially herald impending failures.

Furthermore, the system's ambition transcends reactive measures, aspiring towards a proactive stance in mitigating risks and optimizing performance. Through advanced predictive analytics and machine learning algorithms, it anticipates potential failure scenarios, empowering operators and maintenance personnel with prescient insights to preemptively address issues before they escalate. This proactive stance not only minimizes the impact of downtime but also significantly reduces the overall maintenance expenditure, fostering operational efficiency and cost-effectiveness.

The system's aim also encompasses fostering a culture of continuous improvement and innovation within transformer maintenance practices. By serving as a repository of invaluable operational data and insights, it facilitates informed decision-making and drives iterative enhancements in maintenance strategies. Moreover, its integration with emerging technologies such as Internet of Things (IoT) and cloud computing opens up avenues for the exploration of novel approaches towards transformer health monitoring and management.

In addition to its technical prowess, the system also addresses broader organizational objectives, aligning with regulatory compliance mandates and industry best practices. It provides a robust framework for meeting regulatory requirements related to transformer maintenance, ensuring adherence to safety standards and environmental regulations. Moreover, by promoting transparency

and accountability through comprehensive reporting mechanisms, it fosters trust and confidence among stakeholders, bolstering organizational reputation and credibility.

Ultimately, the aim and scope of the real-time alert system for transformer failure transcend mere technological innovation, embodying a commitment to excellence, reliability, and sustainability in transformer maintenance practices. It represents a cornerstone in the evolution of asset management strategies, heralding a future where transformers operate not merely as passive components but as intelligent, adaptive entities, resilient in the face of challenges and primed for continuous optimization and improvement.

The aim and scope for a real-time alert system for transformer failure would typically encompass several key objectives and considerations:

1. **Preventive Maintenance:** By detecting potential failures early, the system aims to enable preventive maintenance actions to be taken before a failure occurs. This can help minimize downtime, reduce repair costs, and prevent more extensive damage to the transformer and surrounding infrastructure.
2. **Data Collection and Analysis:** The system should collect and analyze data from various sensors installed on the transformer. This includes historical data for trend analysis as well as real-time data for immediate alerts. Data analysis techniques such as machine learning algorithms can be employed to identify patterns indicative of impending failures.
3. **Alert Generation:** Upon detecting anomalies or potential failure conditions, the system should generate alerts in real-time. These alerts can be sent to maintenance personnel, operators, or relevant stakeholders via various communication channels such as email, SMS, or mobile applications.

4. **Integration with SCADA Systems:** The alert system should integrate seamlessly with existing Supervisory Control and Data Acquisition (SCADA) systems or other monitoring platforms commonly used in utility or industrial settings. This integration ensures that alerts are incorporated into the broader monitoring and control infrastructure for efficient response and action.
5. **Scalability and Adaptability:** The system should be designed to scale with the size and complexity of the transformer infrastructure it is monitoring. Additionally, it should be adaptable to different types of transformers, operating conditions, and environments.
6. **Compliance and Regulatory Requirements:** The system should comply with relevant industry standards and regulatory requirements governing transformer monitoring and maintenance. This ensures adherence to safety, environmental, and operational standards.
7. **Cost-effectiveness:** While providing comprehensive monitoring and alerting capabilities, the system should also be cost-effective to implement and maintain. This involves considering factors such as equipment costs, installation expenses, and ongoing operational expenses.
8. **User Interface and Reporting:** The system should provide an intuitive user interface for operators and maintenance personnel to view alerts, access historical data, and generate reports. Visualization tools such as dashboards and analytics tools can facilitate data interpretation and decision-making.

By addressing these aims and scope considerations, a real-time alert system for transformer failure can significantly enhance the reliability, safety, and efficiency of transformer operations in various industrial and utility applications.

CHAPTER 4

4.1 HARDWARE REQUIREMENTS:

- Arduino Uno
- Relay
- LCD Display
- Voltage Sensor
- GSM
- Variable Resistor
- Power Supply Board
- Buzzer

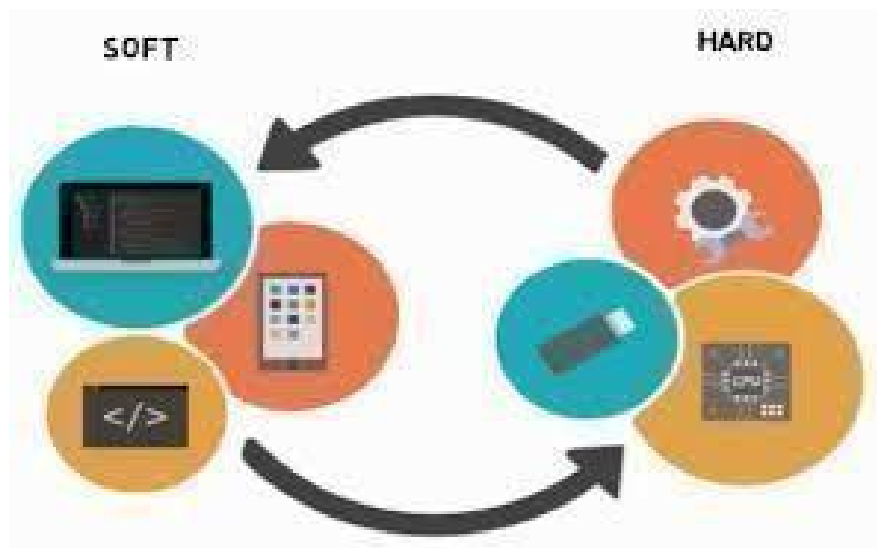


Fig 4.1: Hardware Requirements

4.1.1 ARDUINO UNO:

It is a board based microcontroller on ATmega328P. It has a 16MHz quartz crystal, 14 digital input/output pins, a USB connection, a power jack. It has a reset button. Simply connect it to a computer with a USB cable get started with AC to DC connection. A typical ARDUINO UNO board can be used for many applications based on the coded program. "UNO" was opted to record the release of ARDUINO software. The version 1.0 of the Arduino is the reference and now updated to later versions. The first in a series of USB ARDUINO boards was the UNO board, and the reference model for the Arduino platform. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power, it with a AC to DC adapter or battery to urge started. There are many versions of Arduino boards introduced with in the market like Arduino Uno, Arduino Due, Arduino Leonardo, Arduino Mega, however, commonest versions are Arduino Uno and Arduino Mega. If you're getting to create, a project concerning digital electronics, embedded system, robotics, or IOT, then using Arduino Uno would be the simplest, easy and most economical option.



Fig 4.2: Arduino UNO

4.1.2 ARDUINO UNO AND ITS PROGRAMMING:

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicate with software running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free. The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

4.1.3 RELAY:

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.



Fig 4.3: Relay

4.1.4 LCD DISPLAY:

It can display 16 characters per line and there are 2 lines. In this LCD each character is displayed in 5*7pixel matrix. The 16*2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. The principle of LCD is blocking light rather than emitting light. It requires a backlight as they do not emit light them. We always use devices which are made up of LCD's displays which are replacing the use of cathode ray tube.The 16x2LCD used in this experiment has a total of 16 pins. As shown in the table below, eight of the pins are data lines (pins 7-14), two are for power and ground (pins 1 and 16), three are used to control the operation of LCD(pins4-6),and one is used to adjust the LCD screen brightness(pin3). The remaining two pins (15 and 16) power the backlight.The details of the LCD terminals are as follows:

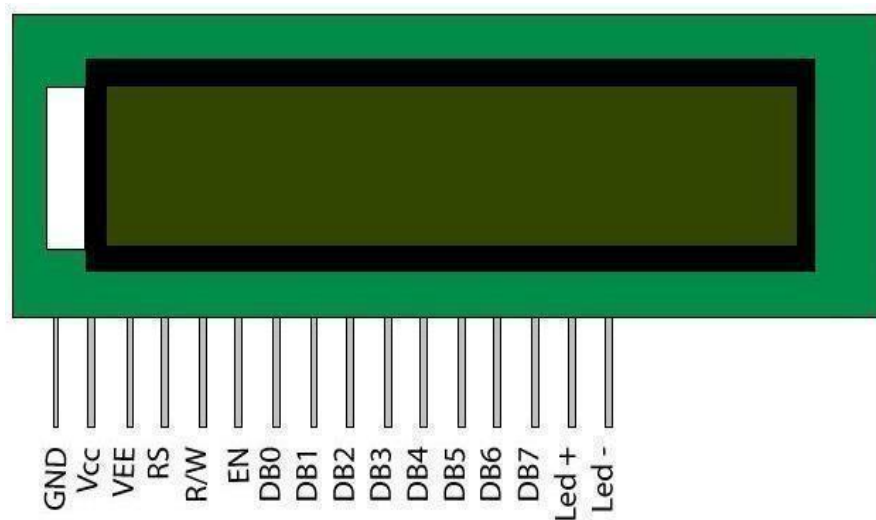


Fig 4.4: LCD Display

4.1.5 VOLTAGE SENSOR:

A voltage sensor is going to be able to determine and even monitor and measure the voltage supply. It is able to take those measurements and turn them into a signal that one will be able to read. The signal will often go into a specialized electronic device for recording, but sometimes, observer will be present manually read the sensor output.



Fig 4.5: Voltage Sensor

4.1.6 GSM:

Global system for mobile communication(GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz. It is a hardware device to provide a data link to a remote network. From the view of the mobile phone network, they are essentially identical to an ordinary mobile phone, including the need for a SIM to identify themselves to the network. Whenever someone sense unsafe, GSM (Global System for Mobile communication module) sends extremity message to chosen contacts and the police control room. The Arduino GSM shield allows an Arduino board to connect to the internet, send and receive SMS, and make voice calls using the GSM library. The shield will work with the Arduino nano out of the box. A customised Global System for Mobile communication (GSM) module is designed for wireless radiation monitoring through Short Messaging Service (SMS). This module is able to receive serial data from radiation monitoring devices such as survey meter or area monitor and transmit the data as text SMS to a host server.

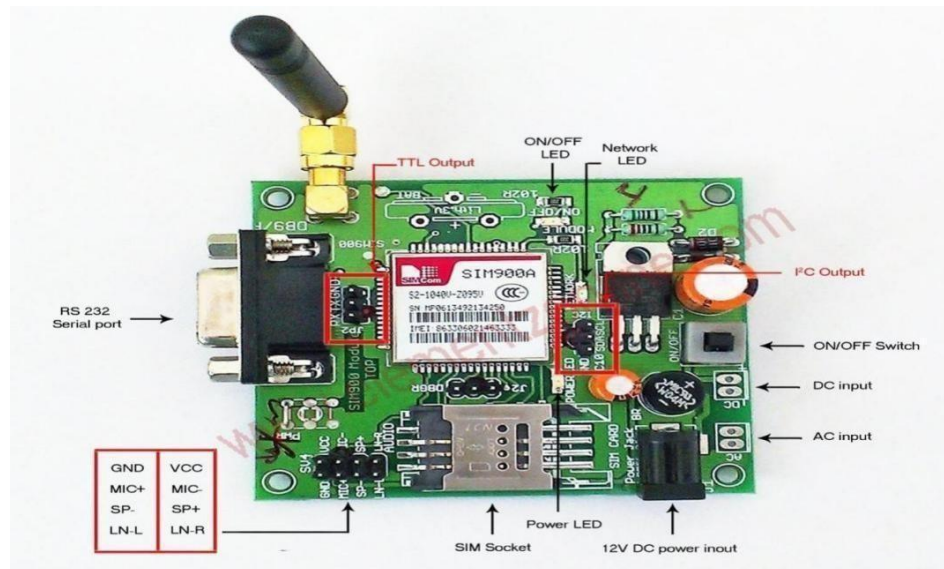


Fig 4.6: GSM

4.1.7 VARIABLE RESISTOR:

A variable resistor is a resistor of which the electric resistance value can be adjusted. A variable resistor is in essence an electro-mechanical transducer and normally works by sliding a contact (wiper) over a resistive element. There are two basic types of variable resistors, one called a potentiometer and the other a rheostat. An example of the potentiometer is the volume control on your radio, and an example of the rheostat is the dimmer control for the dash lights in an automobile. Variable resistors are widely used in electric circuits to adjust the value of current or voltage, since the resistance of variable resistors can be set to a certain value. Variable resistors allow you to adjust the value of voltage by changing the resistance.

10k Ohm Variable Resistor (3386 Package) - Trimpot
Trimmer Potentiometer



Fig 4.7: Variable Resistor

4.1.8 POWER SUPPLY BOARD:

The power supply board is a basic essential interface for regulating and supplying power to the connected components. Despite the name, Power Supply Units (PSU) do not supply systems with power - instead they convert it. Specifically, a power supply converts the alternating high voltage current (AC) into direct current (DC), and they also regulate the DC output voltage to the fine tolerances required for modern computing components.

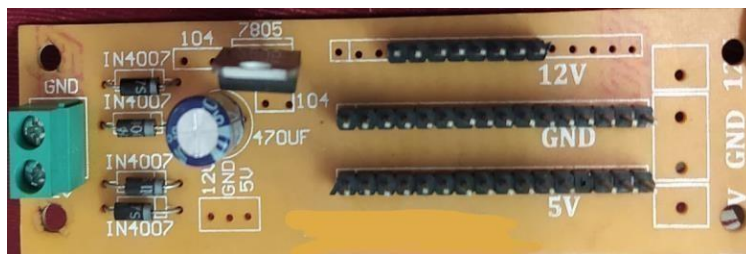


Fig 4.8: Power Supply Board

4.1.9 BUZZER:

Also known as a sounder, audio alarm or audio indicator, a buzzer is a basic audio device that generates a sound from an incoming electrical signal. Buzzers come in two primary forms — piezo buzzers and magnetic buzzers. A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke. A buzzer is an efficient component to include the features of sound in our system or project. It is an extremely small & solid two-pin device thus it can be simply utilized on breadboard or PCB. So in most applications, this component is widely used.



Fig 4.9: Buzzer

4.2 BLOCK DIAGRAM:

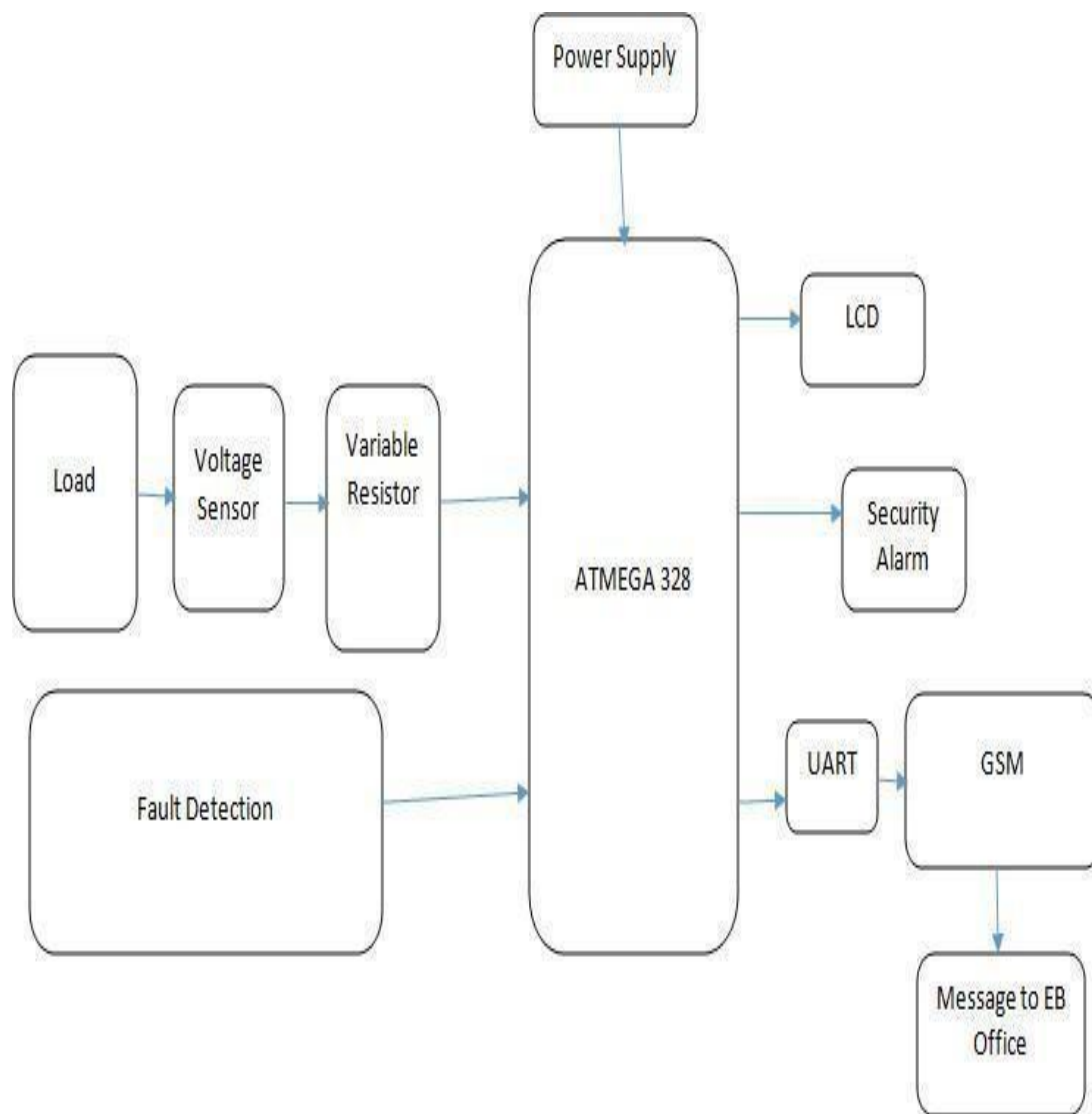


Fig 4.10: Block Diagram-Real Time Alert System for Transformer Failure

4.3 SOFTWARE REQUIREMENT:

- Embedded C
- Proteus software

4.3.1 EMBEDDED SYSTEMS:

OVERVIEW OF EMBEDDED SYSTEMS:

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use. An embedded system is a special-purpose computer system designed to performance or a few dedicated functions, often with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use. Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure. In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Hand held computers share some elements with embedded systems such as the operating systems and microprocessors which power them but are not truly embedded systems, because

they allow different applications to be loaded and peripherals to be connected. Embedded systems provide several functions

- Monitor the environment; embedded systems read data from input sensors. This data is then processed and the results displayed in some format to a user or users
- Control the environment; embedded systems generate and transmit commands for actuators.
- Transform the information; embedded systems transform the data collected in some meaningful way, such as data compression/decompression

Although interaction with the external world via sensors and actuators is an important aspect of embedded systems, these systems also provide functionality specific to their applications. Embedded systems typically execute applications such as control laws, finite state machines, and signal processing algorithms. These systems must also detect and react to faults in both the internal computing environment as well as the surrounding electro mechanical systems.

There are many categories of embedded systems, from communication devices to home appliances to control systems. Examples include;

- Communication devices
- Home Appliances
- Control Systems

CHARACTERISTICS OF EMBEDDED SYSTEMS:

Embedded systems are characterized by a unique set of characteristics. Each of these characteristics imposed a specific set of design constraints on embedded systems designers. The challenge to designing embedded systems is to conform to the specific set of constraints for the application.

APPLICATION SPECIFIC SYSTEMS:

Embedded systems are not general-purpose computers. Embedded system designs are optimized for a specific application. Many of the job characteristics are known before the hardware is designed. This allows the designer to focus on the specific design constraints of a well-defined application. As such, there is limited user reprogram ability. Some embedded systems, however, require the flexibility of reprogram ability. Programmable DSPs are common for such applications.

REACTIVE SYSTEMS:

As mentioned earlier, a typical embedded systems model responds to the environment via sensors and control the environment using actuators. This requires embedded systems to run at the speed of the environment. This characteristic of embedded system is called “reactive”. Reactive computation means that the system (primarily the software component) executes in response to external events. External events can be either periodic or aperiodic. Periodic events make it easier to schedule processing to guarantee performance. Aperiodic events are harder to schedule. The maximum event arrival rate must be estimated in order to accommodate worst case situations. Most embedded systems have a significant reactive component. One of the biggest challenges for embedded system designers is performing an accurate worst case design analysis on systems with statistical performance characteristics (e.g., cache memory on a DSP or other embedded processor). Real time system operation means that the correctness of a computation depends, in part, on the time at which it is delivered. Systems with this requirement must often design to worst case performance. But accurately predicting the worst case may be difficult on complicated architectures. This often leads to overly pessimistic estimates erring on the side of caution. Many embedded systems have a significant requirement for real time operation in order to meet external I/O and control stability requirements. Many real-time systems are also reactive systems.

DISTRIBUTED SYSTEMS:

A common characteristic of an embedded system is one that consists of

communicating processes executing on several CPUs or ASICs which are connected by communication links. The reason for this is economy. Economical 4 8-bit microcontrollers maybe cheaper than a 32-bit processors. Even after adding the cost of the communication links, this approach may be preferable. In this approach, multiple processors are usually required to handle multiple time-critical tasks. Devices under control of embedded systems may also be physically distributed.

SYSTEM SAFETY AND RELIABILITY:

As embedded system complexity and computing power continue to grow ,they are starting to control more and more of the safety aspects of the overall system. These safety measures may be in the form of software as well as hardware control. Mechanical safety backups are normally activated when the computer system loses control in order to safely shut down system operation. Software safety and reliability is a bigger issue. Software doesn't normally "break" in the sense of hardware. However software may be so complex that a set of unexpected circumstances can cause software failures leading to unsafe situations. Discussion of this topic is outside the scope of this book, but the challenges for embedded designers include designing reliable software and building cheap, available systems using unreliable components. The main challenge for embedded system designers is to obtain low-cost reliability with minimal redundancy.

CONTROL OF PHYSICAL SYSTEMS:

One of the main reasons for embedding a computer is to interact with the environment. This is often done by monitoring and controlling external machinery. Embedded computers transform the analog signals from sensors into digital form for processing. Outputs must be transformed back to analog signal levels. When controlling physical equipment, large current loads may need to be switched in order to operate motors and other actuators. To meet these needs, embedded systems may need large computer circuit boards with many non-digital components.

SMALL AND LOW WEIGHT:

Many embedded computers are physically located within some larger system. The form factor for the embedded system may be dictated by aesthetics. For example, the form factor for a missile may have to fit inside the nose of the missile. One of the challenges for embedded systems designers is to develop non-rectangular geometries for certain solutions. Weight can also be a critical constraint. Embedded automobile control systems, for example, must be light weight for fuel economy. Portable CD players must be light weight for portability purposes.

COST SENSITIVITY:

Cost is an issue in most systems, but the sensitivity to cost changes can vary dramatically in embedded systems. This is mainly due to the effect of computer costs have on profitability and is more a function of the proportion of cost changes compared to the total system cost.

POWER MANAGEMENT:

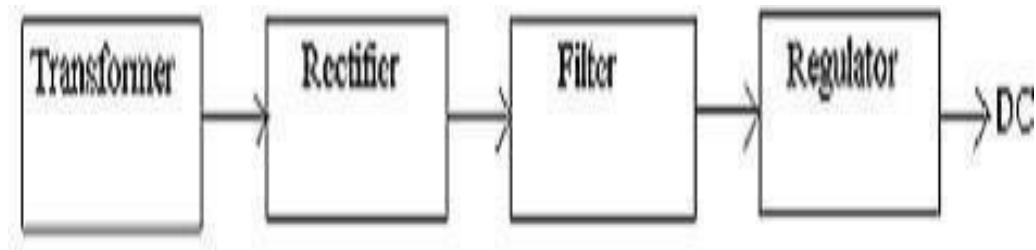
Embedded systems have strict constraints on power. Given the portability requirements of many embedded systems, the need to conserve power is important to maintain battery life as long as possible. Minimization of heat production is another obvious concern for embedded systems.

POWER SUPPLY:

All electronic circuits work only in low DC voltage, so we need a power supply unit to provide the appropriate voltage supply for their proper functioning. This unit consists of transformer, rectifier, filter & regulator. AC voltage of typically 230 volts rms is connected to a transformer voltage down to the level to the desired ac voltage. A diode rectifier that provides the full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit can use this dc input to provide dc voltage that not only has much less ripple voltage but also remains the same dc value even the dc voltage varies somewhat, or the load connected to the output dc

voltages changes.

Table 4.1: Power Supply



TRANSFORMER:

A transformer is a static piece of which electric power in one circuit is transformed into electric power of same frequency in another circuit. It can raise or lower the voltage in the circuit, but with a corresponding decrease or increase in current. It works with the principle of mutual induction. In our project we are using a step down transformer to providing a necessary supply for the electronic circuits. Here we step down a 230volts ac into 12volts ac.

RECTIFIER:

A dc level obtained from a sinusoidal input can be improved 100% using a process called full wave rectification. Here in our project for full wave rectification we use bridge rectifier. From the basic bridge configuration we see that two diodes(say D2 & D3) are conducting while the other two diodes (D1 & D4) are in off state during the period $t = 0$ to $T/2$. Accordingly for the negative cycle of the input the conducting diodes are D1 & D4. Thus the polarity across the load is the same. But here we use 1N4007, because it can withstand up to 1000v.

FILTERS:

In order to obtain a dc voltage of 0 Hz, we have to use a low pass filter. So that a capacitive filter circuit is used where a capacitor is connected at the rectifier output & a dc is obtained across it. The filtered waveform is essentially a dc voltage with negligible ripples & it is ultimately fed to the load.

REGISTERS:

The controller IC has two 8 bit registers, an instruction register (IR) and a data register (DR). The IR stores the instruction codes and address information for display data RAM (DD RAM) and character generator RAM (CG RAM). The IR can be written, but not read by the MPU. The DR temporarily stores data to be written to /read from the DD RAM or CG RAM. The data written to DR by the MPU, is automatically written to the DD RAM or CG RAM as an internal operation. When an address code is written to IR, the data is automatically transferred from the DD RAM or CG RAM to the DR. Data transfer between the MPU is then completed when the MPU reads the DR. Likewise, for the next MPU read of the DR, data in DD RAM or CGRAM at the address is sent to the DR automatically. Similarly, for the MPU write of the DR, the next DD RAM or CG RAM address is selected for the write operation. The dot-matrix liquid crystal display controller and driver LSI displays alphanumeric, Japanese kana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4- or 8-bit microprocessor. Since all the functions such as display RAM, character generator, and liquid crystal driver, required for driving a dot-matrix liquid crystal display are internally provided on one chip, a minimal system can be interfaced with this controller/driver.

REGULATORS:

The output voltage from the capacitor is more filtered & finally regulated. The voltage regulator is a device, which maintains the output voltage constant irrespective of the change in supply variations, load variations & temperature changes. Here we use fixed voltage regulator namely LM7805. The IC LM7805 is a +5V regulator which is used for microcontroller.

FEATURES AND DESCRIPTION OF REGULATORS:

- Output Current upto 1A
- Output Voltages of 5,6,8, 9,10,12,15, 18,24V

- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection.

OVERVIEW:

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources.

This guide covers the Arduino Uno board (Spark fun DEV-09950, \$29.95), a good choice for students and educators. With the Arduino board, you can write programs and create interface circuits to read switches and other sensors, and to control motors and lights with very little effort. Many of the pictures and drawings in this guide were taken from the documentation.

The Duemilanove board features an Atmel ATmega328 microcontroller operating at 5V with 2Kb of RAM, 32Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer. Headers are provided for interfacing to the I/O pins using 22 g solid wire or header connectors.

The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

PIN CONFIGURATION:

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall- wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as

follows:

- VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V. this pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board.
- 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.
- IOREF. This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

MEMORY:

The ATmega328 has 32 KB (with 0.5 KB used for the boot loader). It also has 2KB of SRAM and 1 KB of EEPROM.

INPUT AND OUTPUT:

Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 k ohms. In addition, some pins have specialized functions:

- Serial: 0(RX) and 1(TX). Used to receive (RX) and Transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt () function for details.

- PWM:3,5,6,9,10,and11. Provide 8-bit PWM output with the analog Write() function.

- SPI:10(SS),11(MOSI),12(MISO),13(SCK). These pins support SPI Communication using the SPI library.

- LED:13. There is a built- in LED connected to digital pin13. When the pin is HIGH value,the LED is on, when the pin is LOW, it's off. The Uno has 6 analog inputs,labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values).By default they measure from ground to 5 volts,though is it possible to change the upper end of their range using the AREF pin and the analog Reference() function. Additionally, some pins have specialized functionality.

- TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library. There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with analog Reference().

- RESET. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

COMMUNICATION:

Microcontrollers depend on a host computer for developing and compiling programs. The software used on the host computer is known as an integrated development environment, or IDE. For the Arduino, the development environment is based on the open source Processing platform (www.processing.org) which is described by its creators as a “programming language and environment for people who want to program images, animation, and interactions.” The Arduino programming language leverages an open source project known as Wiring. The Arduino language is based on good old- fashioned C. If you are unfamiliar with this language, don't worry; it's not hard to learn, and the Arduino IDE provides some feedback when you make mistakes in your programs.

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino

software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

As you go through the list of programming statements available in the Arduino IDE (choose Help->Reference), you might think there isn't much power for doing things like running servos, operating stepper motors, reading potentiometers, or displaying text on an LCD. Like most any language based on C, the Arduino supports the notion of "libraries" code repositories that extend core programming functionality. Libraries let you re-use code without having to physically copy and paste it into all your programs. The standard Arduino software installation comes with several libraries you may use, and you can download others from the Arduino support pages and from third-party websites that publish Arduino library code. A good example of a library you'll use with the Robot and likely many other robot projects is Servo. This library allows you to connect one or more hobby R/C servos to the Arduino's digital I/O pins. The Servo library comes with the standard Arduino installation package Library->Servo. This adds the line.

```
#include<Servo.h>
```

Which tells the Arduino IDE that you wish to include the Servo library in your sketch. With the functionality of the library now available to you, you can use its various functions to control one or more servos. For example, you can use the write function to rotate a servo to a specific position, from 0 to 180 degrees. The following code

```
myServo.write(90);
```

Moves a servo to its midpoint, or 90 degree position. Structurally, Arduino sketches are very straight forward and are pretty easy to read and understand. The Arduino program contains two main parts: setup() and loop(). These are programming functions that do what their names suggest: setup () sets up the Arduino hardware, such as specifying which I/O lines you plan to use, and whether they are

inputs or outputs. The `loop()` function is repeated endlessly when the Arduino is operating.

Arduino IDE (Integrated development environment) is used to write the program and dump into the Arduino board.

SKETCHES:

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension `.ino`. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

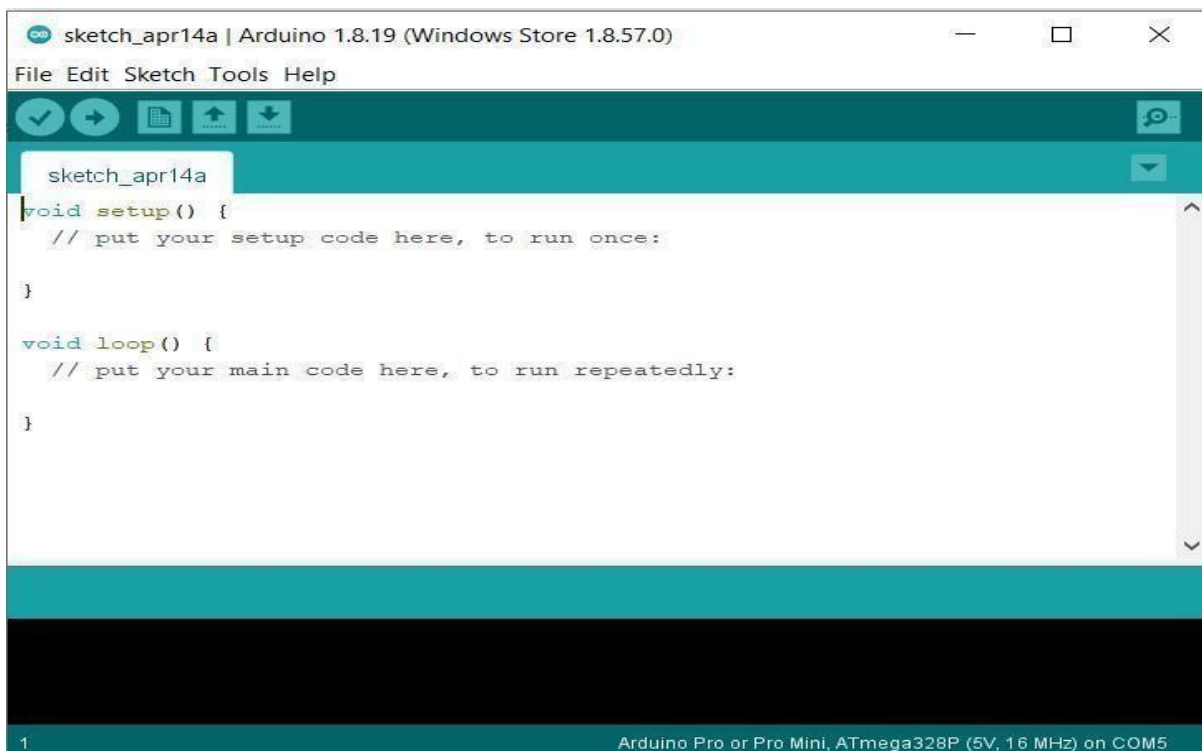


Fig 4.11: Arduino IDE Sketch Window

4.2: 6 Buttons of Menu bar

	<i>Verify</i> Checks your code for errors compiling it.
	<i>Upload</i> Compiles your code and uploads it to the configured board.
	<i>New</i> Creates a new sketch.
	<i>Open</i> Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content.
	<i>Save</i> Saves your sketch.
	<i>Serial Monitor</i> Opens the serialmonitor.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub `main()` into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program `avrdude` to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

UPLOADING:

Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.

LIBRARIES:

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more `#include` statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its `#include` statements from the top of your code.

UPLOADING CODE:

Both the transmitter and receiver codes are uploaded in two different Arduino Pro Mini microcontrollers.



Fig 4.12: Compiling Sketch

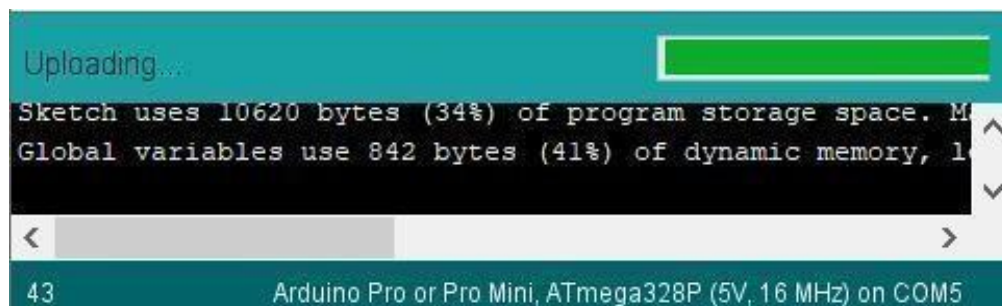


Fig 4.13: Uploading

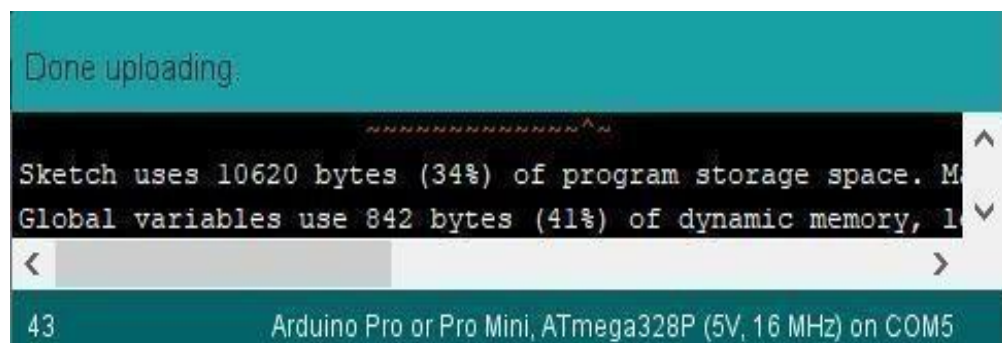


Fig 4.14: Done Uploading

4.3.2 PROTEUS SOFTWARE:

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities.

SCHEMATIC CAPTURE:

Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations.

MICROCONTROLLER SIMULATION:

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co- simulation of:

Microchip Technologies PIC10, PIC12, PIC16, PIC18, PIC24, dsPIC33 microcontrollers.

Atmel AVR(and Arduino),8051 and ARM Cortex-M3 microcontrollers.

NXP8051,ARM7,ARM Cortex-M0 and ARM Cortex-M3 microcontrollers.

Texas Instruments MSP430, PICCOLO DSP and ARM Cortex-M3 microcontrollers.

Parallax Basic Stamp,Free scale HC11,8086 microcontrollers.

PCB DESIGN:

The PCB Layout module is automatically given connectivity information in the form of a net list from the schematic capture module. It applies this information, together with the user-specified design rules and various design automation tools, to assist with error free board design. PCB's of up to 16 copper layers can be produced with design size limited by product configuration.

3D VERIFICATION:

The 3D Viewer module allows the board under development to be viewed in 3D together with a semi-transparent height plane that represents the boards enclosure. STEP output can then be used to transfer to mechanical CAD software such as Solid works or Auto desk for accurate mounting and positioning of the board.

HOW TO USE TRANSFORMER IN PROTEUS SOFTWARE:

- First, open your proteus software.
- After that go to components explorer by clicking on icon P from the left sidebar.
- Now type transformer in the components search bar.
- In the components window, you can see different types of transformers, but we will use only a simple iron core transformer in this proteus tutorial,
- Now double click on the simple transformer, it will be placed in selected components window, as you can see here,
- After that, place the transformer in the simulation window by simply clicking and moving your cursor towards the simulation window.
- Now double click on the transformer to open its properties window.
- In the properties window, you can see a lot of options, such as transformer primary and secondary inductance, coupling factor, primary and secondary resistance.
- These parameters are used to set the transformer to step up or step down the voltage range.
- But before changing these values, let's see the transformer turns ratio calculation formula,
- This is the formula,

$$V_{out} = V_{in} / (L_p / L_s)$$

Here V_{in} and V_{out} is input and output voltages respectively. In other words, V_{in} is a primary side voltage, and V_{out} is a secondary voltage of a transformer.

Here L_p by L_s is the coupling ratio between the primary and secondary coils, and L_p and L_s are the inductances of the primary and secondary coils respectively. This rate is also called the coupling coefficient.

For a ratio of 10 to 1, this transformer works as a step-down transformer, having a coupling ratio of 10. But for this, we are assuming an ideal lossless transformer,

Let's say we want to convert 220 volts AC into 22 volts AC. With these values, the coupling factor will be 10. Now, let's put coupling factor value in the transformer setting.

After that connect an AC voltage source with a transformer. Now connect 220 volts source to the primary side of the transformer, and also connect an AC voltmeter to the secondary side.

Double click on AC voltage source and set frequency to 50 hertz, and voltage to 311 volts which is the peak voltage of 220 volts RMS.

Now click on the simulation play button, as you can see the output voltage is 22 volts, which is reduced by a factor of 10.

CHAPTER 5

5.1 RESULT AND DISCUSSION(SOFTWARE):

5.1.1 LAYOUT OF THE CIRCUIT:

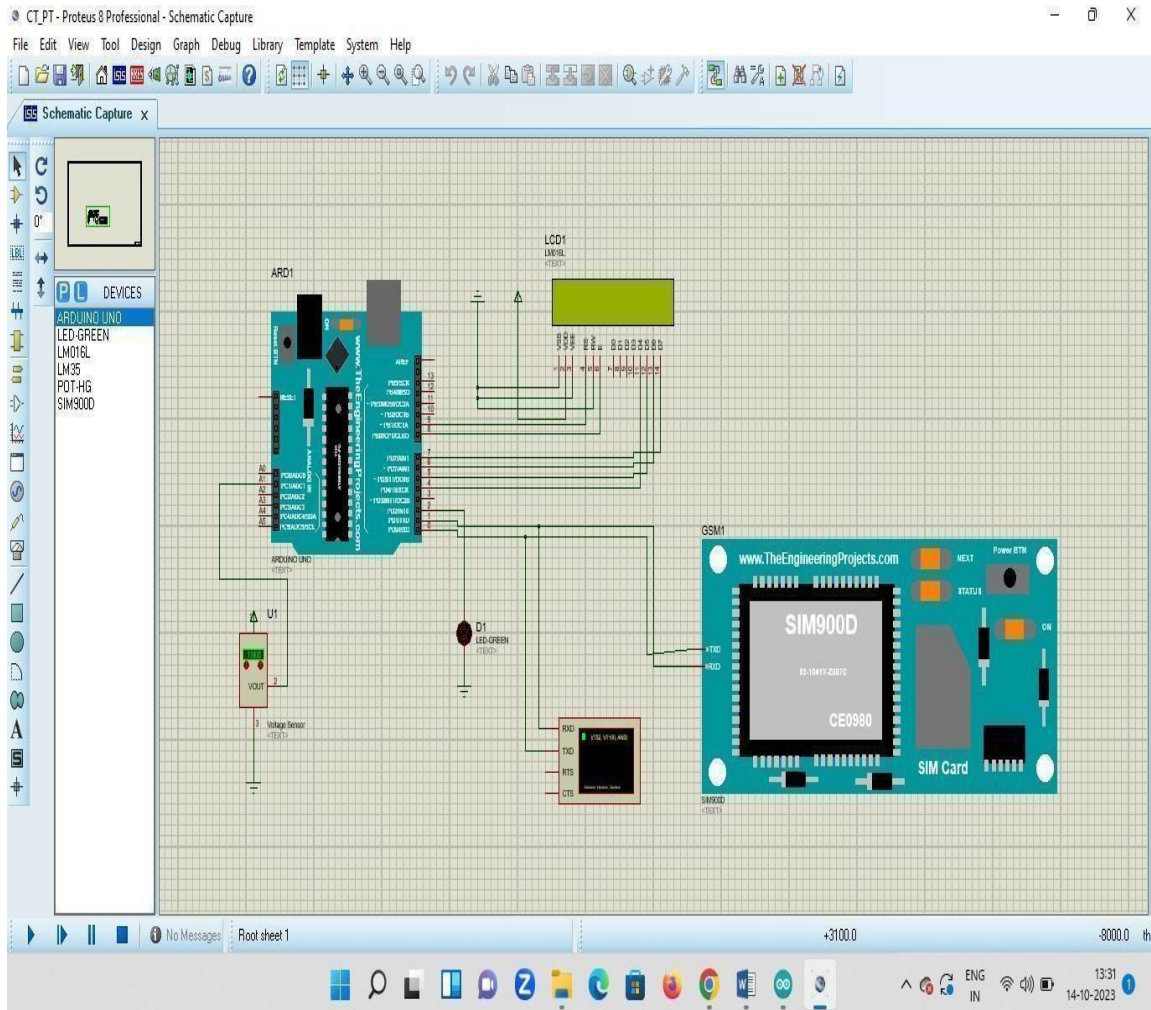


Fig 5.1: Layout Of The Circuit

5.1.2 SIMULATED OUTPUT:

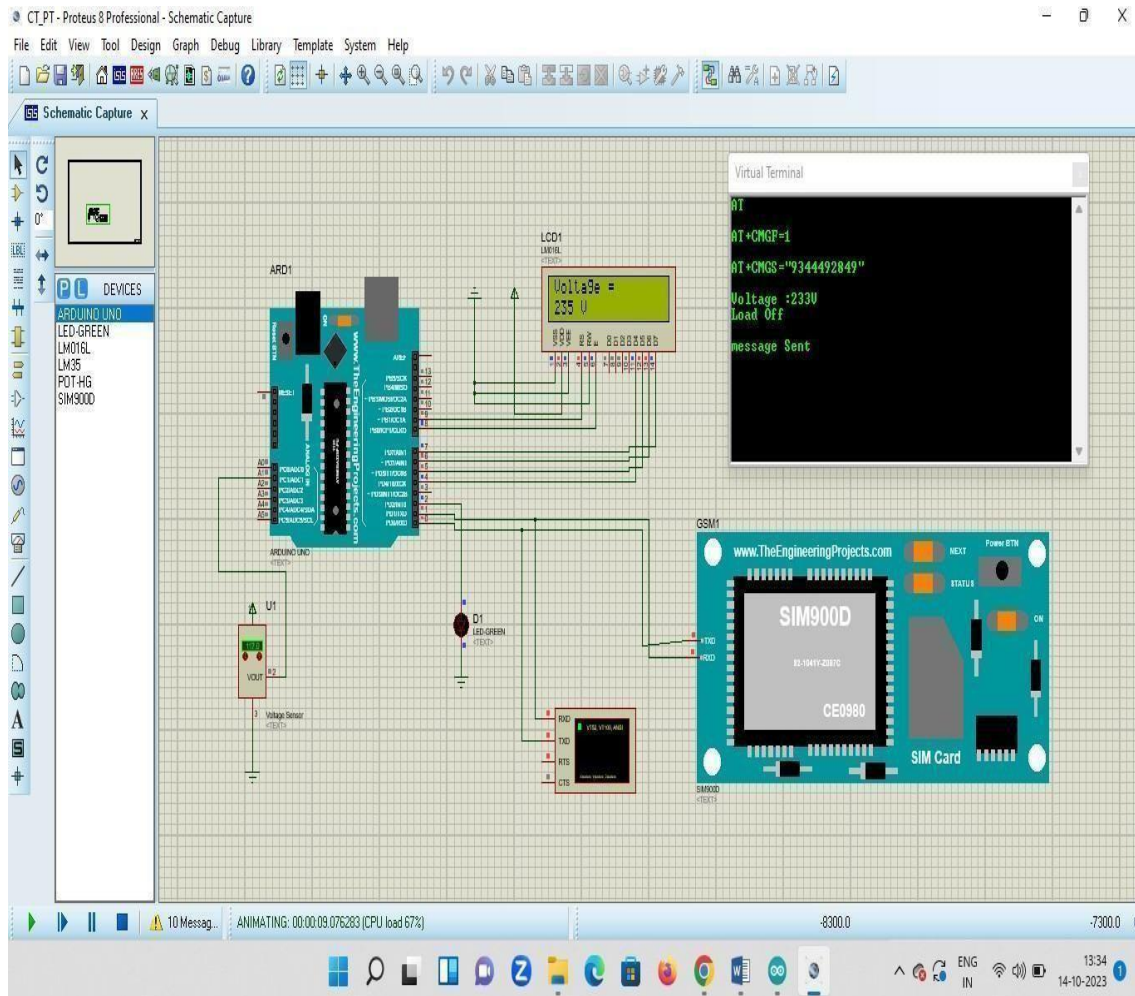


Fig 5.2: Simulated Output

5.1.3 HARDWARE CONNECTION:

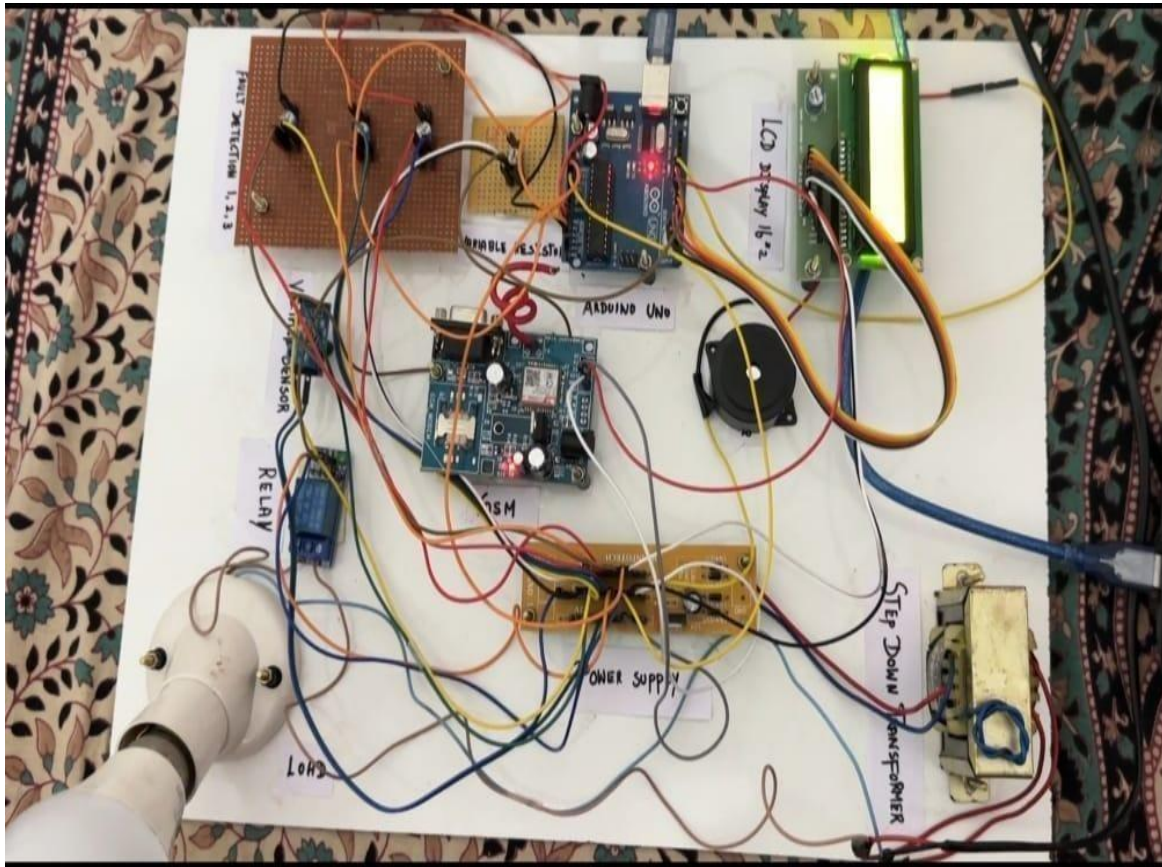


Fig 5.3: Hardware Connection

5.1.4 HARDWARE OUTPUT:

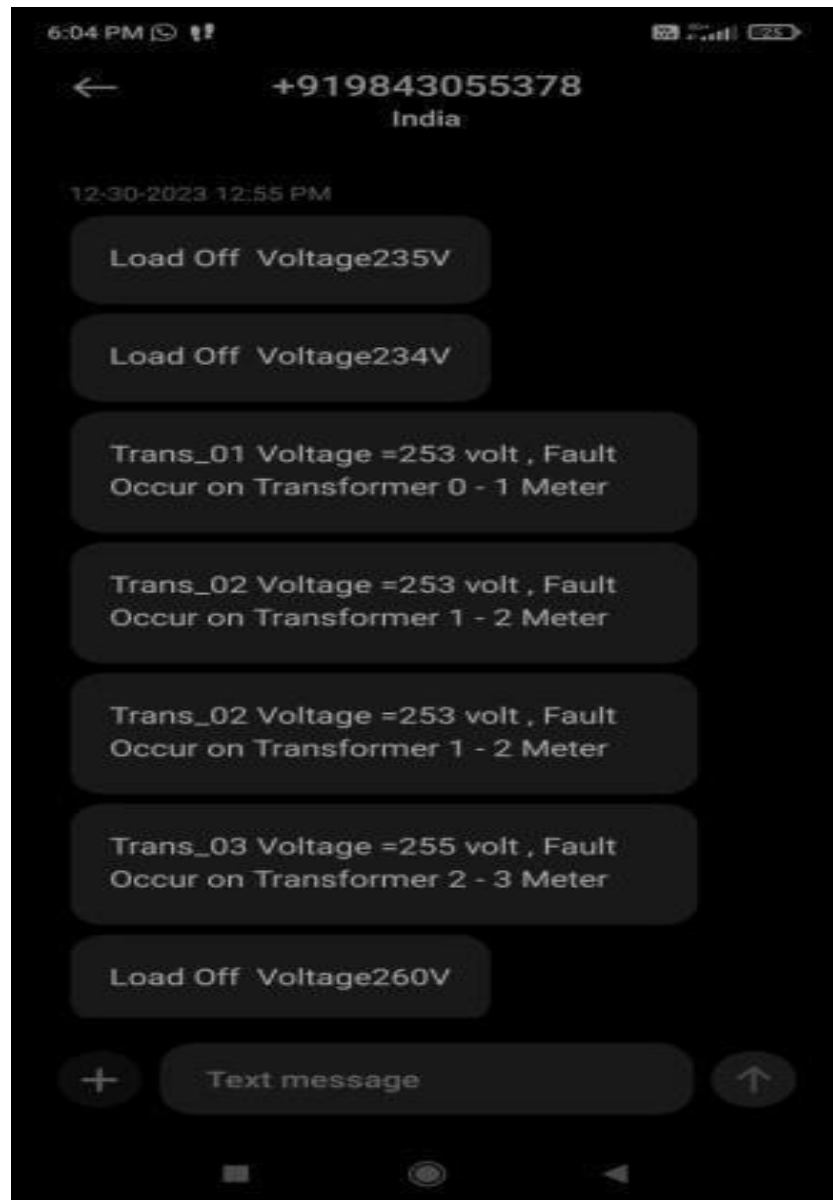


Fig 5.4: Hardware Output

5.2 EXPLANATION:

The AC voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired DC output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. Transformer is connected to the voltage sensor by varying the load. 12V 1Amp Step down transformer is passed to power supply board. In power supply board, bridge rectifier have 12V AC. Bridge rectifier is converted to 12V DC capacitor. Capacitor is converted to 5VDC rectifier, this is the process for power supply board. If the load is above 230v, it will occur fault detection on transformer by using variable resistor. The 1st fault detection occurs on the transformer between the range of 0 to 1 meter. The 2nd fault detection occurs on the transformer between the range of 1 to 2 meter. The 3rd fault detection occurs on the transformer between the range of 2 to 3 meter. The message will be displayed in LCD display. If the load is above 230v, it will automatically send the message by using GSM module to the EB office and automatically get shutdown. So, we can avoid the damages occur home appliances.

5.3 PROPOSED SYSTEM:

- The Microcontroller is programmed to monitor the load such as fans, light and other appliances, with the help of Voltage sensors, the energy is recorded and calculated in the microcontroller, and sent through the GSM module to the user.
- Fault Detection has been implemented.

5.4 EXISTING SYSTEM:

- Meter reading taken manually Errors occurred due to less concentration.
- Their Meter reading not accurate.
- Huge Man power needed Delayed work due to external conditions.
- Power cut manually due to lack of payment.

CHAPTER 6

6.1 SUMMARY:

A real-time alert system for transformer failure is a sophisticated solution designed to enhance the reliability and safety of power distribution networks. It operates by deploying a network of sensors strategically on transformers to continuously monitor key parameters such as temperature, oil level, and vibration. These sensors collect real-time data, which is then transmitted to a central monitoring system.

In this system, advanced algorithms and machine learning models analyze the incoming data to detect any anomalies or deviations from normal operating conditions. These anomalies can indicate potential issues with the transformer, such as overheating, oil leakage, or mechanical stress. When such anomalies are detected, the system generates real-time alerts to notify designated personnel or maintenance teams.

One of the key advantages of a real-time alert system is its ability to facilitate predictive maintenance. By analyzing historical data and identifying patterns, the system can predict potential failure probabilities and recommend proactive maintenance actions. This predictive capability helps in minimizing downtime, reducing maintenance costs, and prolonging the lifespan of transformers.

Furthermore, the integration of the alert system with Supervisory Control and Data Acquisition (SCADA) systems enhances overall monitoring and control capabilities. It enables operators to remotely access real-time data, receive alerts, and take immediate corrective actions if necessary. This integration ensures rapid response to transformer issues, thereby minimizing the risk of equipment failures and ensuring the continuous and efficient operation of power distribution networks.

6.2 APPLICATIONS:

- Multi Family Resident
- Hotels
- Apartments
- Electricity Boards
- Industrial automation
- Smart city development.
- Maintenance Department for troubleshooting fault.
- Fault Analysis of BTS tower.
- Quality Department for improvement.
- Quality and find root cause of fault.

6.3 ADVANTAGES:

- If any faults occur or all fault occur at a time.
- This system can be noticed easily all fault on scrolling LCD display.
- Therefore trouble-shooting is easy.
- Even if there is nobody for monitoring the system the person can get the status on his mobile through SMS.
- Saves money i.e.travelling allowances etc.
- Reduces manpower.
- Easily implementable.

CONCLUSION:

By using Proteus simulation & latest technology like IOT communication, maintenance of remote place like mobile tower can be very well attended in proper way in shortest possible time. This system is very intelligent for protection fault and send alert messages to user for power generator serve as a reliable an efficient system. In this system we can monitor and detect fault with specific adjustable variable pot. So we can change setting as per our requirement. The system provide effective monitoring and protection of power generator by its operating voltage without involving human intervention. This system periodically provides updates and generates immediate alerts in case of the occurrence of the Faults. This SMS containing information about the abnormality regarding voltage level in transformer.

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APPENDIX

A.STANDARDS:

- 1) IEEE Standards: The Institute of Electrical and Electronics Engineers (IEEE) has several standards related to transformer monitoring and protection, such as IEEE C57.104 for transformer monitoring and IEEE C57.12.90 for transformer protection.
- 2) IEC Standards: The International Electrotechnical Commission (IEC) also provides standards like IEC 61850 for communication networks and systems in substations, which can be used for integrating monitoring devices into a real-time alert system.
- 3) ISO 55000 Series: This series of standards provides guidelines for asset management, including transformers. Adhering to ISO 55000 can help ensure that the alert system is part of a broader asset management strategy.
- 4) NFPA 70E: This standard from the National Fire Protection Association (NFPA) focuses on electrical safety in the workplace. It can provide guidelines for implementing safety measures in transformer monitoring and alert systems.
- 5) ANSI/ISA-18.2: This standard deals with the management of alarms in the process industry. While it may not be directly applicable to transformers, it offers valuable insights into alarm management best practices that can be adapted to transformer alert systems.

B.CONSTRAINTS:

When designing a real-time alert system for transformer failure, several constraints need to be considered to ensure the system's effectiveness and reliability:

- 1) **Real-Time Monitoring:** The system must be capable of continuously monitoring key parameters such as temperature, oil level, voltage, and current in real-time to detect any abnormalities or potential failures promptly.
- 2) **Data Acquisition:** It should have the ability to gather data from various sensors and monitoring devices installed on the transformer. This includes both internal sensors within the transformer and external sensors for environmental conditions.
- 3) **Communication Infrastructure:** The system needs a robust communication infrastructure to transmit data from the monitoring points to the central monitoring station. This could involve wired communication (such as Ethernet or Modbus) or wireless communication (such as Wi-Fi, cellular networks, or IoT protocols).
- 4) **Data Processing and Analysis:** The system should be equipped with algorithms and software for processing and analyzing the incoming data. This includes detecting patterns, trends, and anomalies that could indicate potential transformer failures.
- 5) **Scalability:** It should be scalable to accommodate different types and sizes of transformers, from small distribution transformers to large power transformers, without compromising performance or reliability.
- 6) **Integration with SCADA/EMS:** Integration with Supervisory Control and Data

Acquisition (SCADA) or Energy Management Systems (EMS) is crucial for centralized monitoring, control, and decision-making. The alert system should seamlessly integrate with these systems for effective management of transformer assets.

- 7) Alarm Prioritization: The system should prioritize alarms based on the severity and criticality of the detected issues. This ensures that maintenance and corrective actions are prioritized accordingly to prevent major failures.
- 8) Redundancy and Backup: Redundancy measures should be in place to ensure system resilience and continuity of monitoring even in case of communication failures, power outages, or equipment malfunctions.
- 9) Compliance and Standards: The system must comply with relevant industry standards, regulations, and safety guidelines to ensure reliability, safety, and legal compliance.
- 10) User Interface and Reporting: A user-friendly interface with dashboards, reports, and alerts is essential for operators and maintenance personnel to quickly assess the transformer's health status, view historical data, and take appropriate actions.

Considering these constraints will help in designing and implementing a robust real-time alert system for transformer failure that meets operational requirements and ensures the longevity and reliability of the transformer assets.

C. TRADE OFF:

The trade-offs for a real-time alert system for transformer failure can include:

- 1) **Cost:** Implementing a sophisticated real-time alert system can be expensive, involving the cost of hardware, software, installation, and maintenance.
- 2) **Complexity:** A real-time alert system may require integration with existing infrastructure and systems, which can add complexity to the overall setup.
- 3) **False Alarms:** Depending on the sensitivity of the monitoring system, there could be a risk of false alarms, leading to unnecessary maintenance or operational disruptions.
- 4) **Data Processing:** Handling large volumes of data in real-time requires robust data processing capabilities, which can be resource-intensive.
- 5) **Response Time:** While real-time alerts provide immediate notifications, the effectiveness of the system also depends on the speed and efficiency of the response mechanisms in place.
- 6) **Scalability:** Ensuring that the system can scale with increasing demands and changes in the infrastructure is crucial for long-term viability.
- 7) **Maintenance:** Regular maintenance and updates are necessary to keep the real-time alert system functioning optimally and to address any potential issues or vulnerabilities.

Considering these trade-offs can help in designing a real-time alert system that balances cost, complexity, reliability, and performance effectively.