Transformer Health Monitoring System using GSM

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ABSTRACT

Automation is essential for safeguarding distribution transformers and detecting faults. Additionally, automation lowers human labor, offers superior protection, and is very reliable—all of which are utilized to raise the caliber of electrical services. One of the most expensive parts is the distribution transformer, thus fault and failure protection is essential. The goal of this project is to design and put into place a fault detection and monitoring system for distribution transformers based on GSM. At the transformer site, various types of sensors are mounted, and variables including ambient temperature, oil level, and load current are tracked and recorded. The load current is measured by the current sensor, while the ambient temperature is indirectly measured by the oil level sensor, which also measures the oil level. The engineer will report any abnormal conditions or parameters that are not directly limited by the GSM module, indicating the abnormalities, once this proposed system trips the load. Additionally, the relay will trip the load in the event of an overload or overheating in the distribution transformer, and the engineer will receive an SMS message describing the nature of the malfunction.

Keywords - Distribution transformer, Protection, GSM, Current sensor, Oil level sensor.

1.INTRODUCTION

A distribution transformer is a piece of electrical equipment used in power networks that directly distributes power to low-power, low-voltage customers. The distribution network as a whole depends heavily on the distribution transformer's operational state. Distribution transformers are guaranteed to last a long time if they are operated at rated conditions (as specified on their nameplate).

Overloading, resulting in unforeseen failure and widespread consumer supply loss, significantly diminishes the life span of these systems by impacting their reliability. The two main factors contributing to distribution transformer failure are overloading and inadequate cooling of the transformers. A selection of them are listed below.

1. Power, voltage, current, and phase are examples of the single transformer parameters that are typically detected by an ordinary transformer monitoring system. Even though some detect several parameters, the testing speed is insufficient and the acquisition and operating times are excessively long.

The detection system is unreliable in and of itself. The primary issues include low data measurement precision, weak jamming resistance, and unstable equipment.

3. As monitoring centers cannot determine the three-phase equilibrium of transformers, timely detection data will not be transmitted to them in a timely manner.

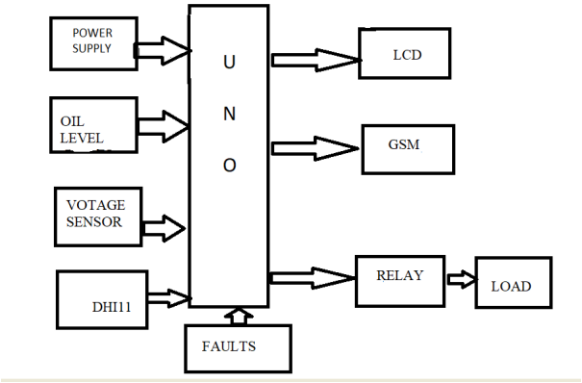
4. In order to save money, a monitoring system can only keep an eye on the operational state of the distribution transformers or prevent power theft. It cannot keep an eye on all relevant data.

5. A lot of monitoring systems transmit data via power carrier communication. However, there are many drawbacks to power carrier communication, such as significant frequency interference, increased signal attenuation at long ranges, and significant load variations that result in significant electrical noise. Therefore, reliability cannot be assured if real-time data transfer via power carrier communication is used.

In light of the aforementioned specifications, a real-time distribution transformer monitoring system is required in order to identify all operational parameters that have an impact on the operation and to promptly transfer the data to the monitoring centre. It results in the online monitoring of the distributing transformer's critical operating characteristics, which can prolong the asset's useful life and provide insightful information about its condition. This will aid in the early detection of issues before they become catastrophic failures, resulting in significant cost savings and increased dependability. The increasing popularity of mobile networks and GSM handsets, together with their falling prices, have made them a desirable choice for a variety of wide

area network applications, including voice media.

BLOCK DIAGRAM



II. LITERATURE SURVEY

In order to increase power reliability for customers, the research proposal titled "Development of a Novel Fault Management in Distribution System Using Distribution Automation System in Conjunction with GSM Communication Development and Implementation of Novel Fault Management at Low Voltage to Improve Power Reliability for Consumers" concentrated on developing and implementing novel fault management at low voltage. Their system consists of a computer acting as a master terminal unit, a microcontroller acting as a remote terminal unit, a current sensor serving as a field data interface device, a GSM communication network, and necessary visual software acting as a human-machine interface (HMI). The WCDMA-based DTMS 12 management technique's fault design development has been developed to successfully find the fault site without requiring human intervention once a problem arises. To make this determination, the results of the stimulation were compared with the laboratory data. "Temperature Coefficient Monitoring System on a Power Transformer Using F.B.G. Sensors," May of 2016. Boda Vamsee, Bajjuri, and Praneeth Kumar Krishna Babu proposed An oil-immersed transformer's longevity and safe operation will be hampered by overheating issues; as a result, the oil and winding temperatures must be kept an eye on while the transformer is operating. The temperature of the windings, cores, and busbars as well as the oil temperature at the top and bottom are all tracked by temperature sensors installed in Fiber Bragg Grating (F.B.G.). An online monitoring system is used to gather and analyze temperature data over time. In a different thesis paper titled Microcontroller Based Substation Monitoring and Control System with GSM Modem, which was published in the IOSR Journal of Electrical and Electronics Engineering, Amit Sachan designed a project to acquire remote electrical parameters like voltage, current,

and frequency and send these real-time values over a GSM network using a GSM Modem/phone along with temperature at a power station. To safeguard the electrical circuits, they also integrated an electromagnetic relay in their design. By using a circuit breaker, the relay can be utilized to cut off the main power supply. The user is able to submit commands via SMS (short message service) to read the remote electrical characteristics. Additionally, real-time electrical parameters can be automatically communicated by their equipment.

III. METHODOLOGY

HARDWARE SPECIFICATIONS

POWER SUPPLY

The section that supplies +5V necessary for the components to function is the power supply section. The IC LM7805 is utilized to supply +5V of steady power. A transformer is used to step down the ac voltage, which is usually 220V, to the level of the desired dc output. After that, a diode rectifier produces a full-wave rectified voltage that is first filtered to create a dc voltage using a straightforward capacitor filter. There is typically some ripple or ac voltage change in the resulting dc voltage. In addition to eliminating ripples, a regulator circuit maintains the same DC value regardless of changes in the input DC voltage or the load linked to the output DC voltage. One of the widely used voltage regulator IC devices is typically used to provide this voltage regulation.

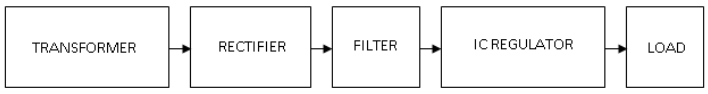


Fig: Block Diagram of Power Supply

3.1.1 TRANSFORMER

Transformers efficiently change the voltage of AC energy without sacrificing much power. One of the reasons mains electricity is AC is because transformers can only run on AC.

Step-down transformers lower voltage, whereas step-up transformers raise it. The majority of power supplies employ a step-down transformer to lower the mains voltage—which is dangerously high in India at 230 volts—to a lower, safer level.

The main refers to the input coil, and the secondary refers to the output coil. The two coils are connected by an alternating magnetic field generated in the soft iron core

of the transformer; there is no electrical connection between them. Power out is (almost) equal to power in since transformers squander relatively little electricity. Keep in mind that current steps up as voltage steps down.

The power supply voltage (0-230V) will be stepped down to a level of 0- 6V by the transformer. Next, the bridge rectifier—which is built with the aid of PN junction diodes—will be connected to the secondary of the potential transformer. Using a bridge rectifier has the benefit of producing a DC peak voltage output.

3.1.2 RECTIFIER

Diodes can be connected in various configurations to create a rectifier that converts AC to DC. The most significant rectifier is the bridge rectifier, which generates full wave fluctuating DC. With a center-tap transformer, it is also possible to create a full-wave rectifier using just two diodes; but, as diodes are becoming more affordable, this technique is not as common. Although a single diode can produce half-wave fluctuating DC, it can only use the positive (+) portions of the AC wave.

3.1.3 BRIDGE RECTIFIER

A circuit is referred to as a bridge rectifier when four diodes are linked as in the figure. The network's two diagonally opposed corners receive the circuit's input, while the other two corners provide the output. Assume for the moment that the transformer is operating correctly and that point A and point B have positive and negative potentials, respectively. Point A's positive potential will cause D3 to forward bias and D4 to reverse bias.

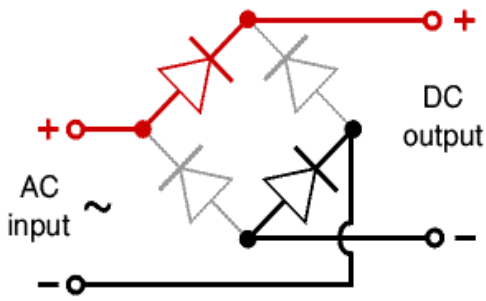


Fig: Bridge Rectifier

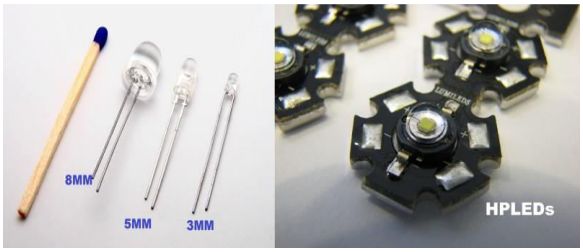
At point B, the negative potential will forward bias D1 and reverse bias D2, allowing current to flow through D3 and D1 while blocking current through D4 and D2.

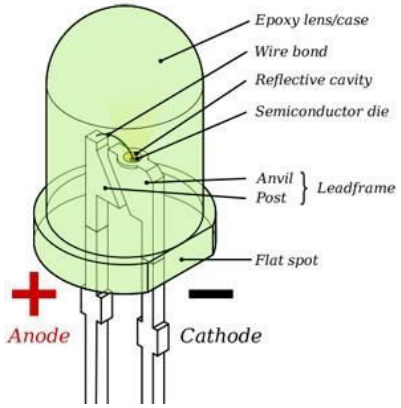
LIGHT EMITTING DIODE(LED)

The term Light Emitting Diode is abbreviated as LED. It’s simply an assembly of semi-conductors that emit light when current passes through them. Light Emitting Devices (LEDs) have been a part of this revolution in semiconductor technology,

which has led to greater advancements over time. As a result, LEDs now provide brighter illumination at lower power consumption.

LED Types: The market is filled with a wide variety of LEDs. As depicted in the image, numerous LEDs are accessible to suit our requirements, with many more options available. Additionally, LEDs are selected based on factors including the amount of area they require, size, color, intensity, etc. The standard sizes of LEDs are 3 mm, 5 mm, and 8 mm. High power LEDs, or HPLEDs, are now available on the market and produce brighter light. To ensure efficient operation, high power LEDs necessitate the utilization of a heat sink, a form of cooling apparatus, due to their significant heat dissipation.





ARDUINO UNO BOARD

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). The device features 14 digital input/output pins, with 6 capable of functioning as PWM outputs, along with 6 analog inputs, a 161 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; to begin, connect it to a computer via a USB cable or power it is using an AC-to-DC adapter or battery. Feel free to experiment with your UNO without excessive concern; in the worst-case scenario, you can replace the chip inexpensively and commence anew.

"UNO," Italian for "one," was selected to coincide with the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of the Arduino software (IDE) served as the standard references for

Arduino, which have since been updated to newer releases. The Uno board is the inaugural USB Arduino board and serves as the benchmark model for the Arduino platform; for a comprehensive list of current, past, or obsolete boards, consult the Arduino index of boards.

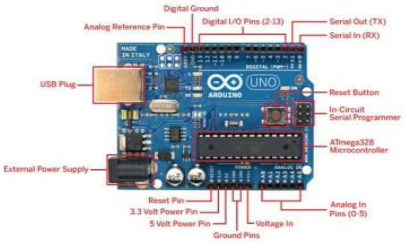


Fig. Arduino Board

BUZZER

A buzzer, often known as a beeper, is an electrical signalling device that is commonly seen in cars, home appliances like microwaves, and game shows.

Usually, it comprises multiple switches or sensors linked to a control unit, which discerns button presses, identifies the pressed button, and determines if a set duration has elapsed. Afterward, it commonly activates a light near the appropriate button or control panel and emits a warning sound, which may be either continuous or intermittent, resembling a beeping or buzzing noise. The initial electromechanical design of this device resembled that of an electric bell, excluding the metal gong responsible for the ringing sound.

Fig. Buzzer

LIQUID CRYSTAL DISPLAY(LCD)

An electrical display module with many uses is the LCD (Liquid Crystal Display) screen. A 16x2 LCD display is a relatively basic module that is frequently seen in many different kinds of circuits and devices. Compared to other multi-segment LEDs particularly those with seven segments, these modules are preferable. The reasons are as follows: LCDs can display special and even custom characters (unlike in seven segments); they are inexpensive; they are easily programmable; and they can display animations and other content.

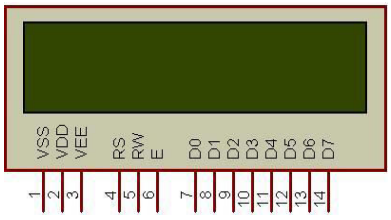


Fig. 16x2 LCD

Fig. GSM Modem

IV. SENSORS

GSM

GSM stands for "global system for mobile communication," which is a type of mobile modem (GSM). At Bell Laboratories, the GSM concept was invented in 1970. It's a mobile communication system that's commonly used worldwide. GSM uses the 850MHz, 900MHz, 1800MHz, and 1900MHz frequency bands to provide mobile voice and data services. It is an open, digital cellular technology.

The time division multiple access (TDMA) technique was employe din crafting the GSM system, a digital communication system. After the data has been reduced and digitalized, a GSM transmits it via a channel carrying two distinct streams of customer data, each scheduled for a certain time slot. Data speeds ranging from 64 kbps to 120 Mbps can be carried by the digital system.

Relays

An electrically powered switch is called a relay. These are electrical switches that can be controlled remotely and are linked to other switches, like horn switches, computer-controlled power train control modules, industrial devices, and home-based applications. Relays provide single or double switches, as well as 4-, 5-, and 6-pin, small current pin configurations. Relays are found all throughout an automobile. Relays are utilized as remote-control switches; they are available in a variety of sizes, ratings, and applications. Twenty or more relays can be found in a standard automobile.

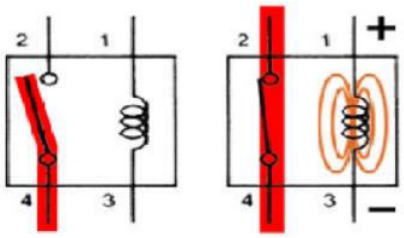


Fig. Relay

DHT 11 Humidity & Temperature Sensor

The complicated temperature and humidity sensor with a calibrated digital signal output is a feature of the DHT11 Temperature and Humidity Sensor. It offers high dependability and outstanding long-term stability by utilizing temperature and humidity monitoring technologies along with an innovative digital signal collecting technique. This sensor, which is connected to a high-performance 8-bit microcontroller and offers great quality, quick response, anti-interference ability, and cost-effectiveness, includes resistive-type humidity measurement component and NTC temperature measuring component.

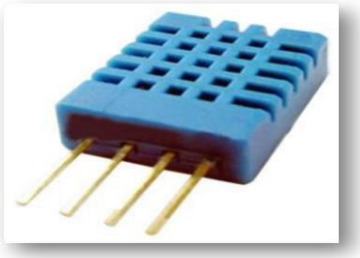


Fig. DHT 11 Sensor

V. Working

An essential component of the transmission and distribution system is the transformer. Transformer faults that are expensive to fix and cause a service interruption can be avoided by keeping an eye out for issues before they arise. Although current systems are either offline or extremely expensive to build, they can provide information on a transformer's condition. Since transformers are a crucial component of power transmission systems, power outages can be costly. Robust GSM networking ensures swift data transfer between networks to facilitate prompt remedial action when needed. To safeguard the complete transmission and distribution, any alteration in the transmission parameters is detected. The effectiveness of the constructed prototype model is evaluated in a lab setting to monitor many parameters, such as transformer over- and under-voltage, over-current and under-current, over-temperature, etc.

VII.RESULTS AND DISCUSSIONS

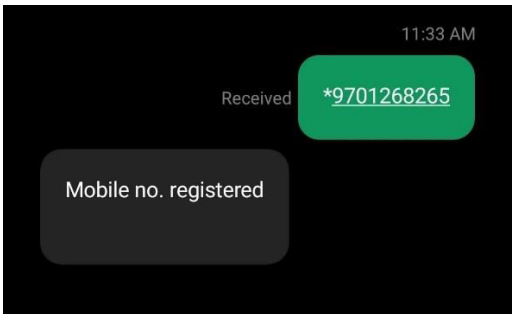


Fig. Registration of mobile number to which the alerts are to be sent.

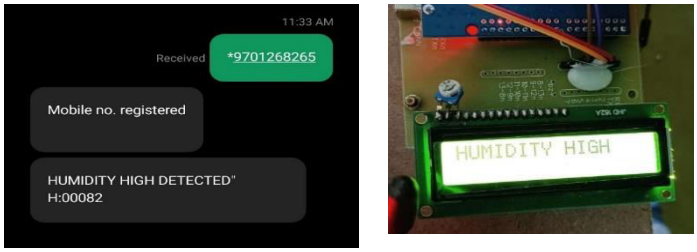


Fig. Detection of high humidity and displaying the alert along with SMS sent to the operator.

Fig. Detection of high oil level in the transformer and displaying the alert along with SMS sent to the operator.

Fig. Detection of fault in the line and displaying the alert along with SMS sent to the operator Display of parameters.

VIII. CONCLUSIONS

This project assists in keeping an eye on distribution transformer malfunctions and problems. Three sensors are being used: a temperature sensor to detect temperature, a voltage sensor to measure voltage, and a current sensor to sense current. When a fault occurs, the microcontroller does a predetermined operation, and the relay trips the load. The engineer receives an SMS message from the GSM module with details on the transformer's various parameters. A voltage of 220 V to 230 V is considered normal; any value above or below this range indicates an abnormal condition that will immediately send out a notification. In addition to saving a great deal of time in preventing failure and loss, this method is superior than manual monitoring. In order to prevent any serious issues, we also need to keep an eye on the parameter.

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