TRANSFORMER HEALTH MONITORING SYSTEM

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Abstract: *The Internet of Things is a recent, intriguing technology that is expanding quickly and enabling machine-to-machine connectivity (IOT),that describes physical objects with sensors, software, processing abilities and allows the possibility for autonomous devices to exchange data with the help of internet., The design and implementation of real-time monitoring of a distribution transformer's critical operational characteristics, such as load current and voltage level of transformer oil and encompassing temperature and humidity are presented in this study. This project reduces working efforts and improves accuracy, efficiency and stability. a variety of sensors are employed to detect the primary aspects of transformer like over voltage, under voltage, over current, oil level and temperature. This detected data is transferred to a microcontroller, where it is checked against parameter limitations before being uploaded to an IOT web server using the Thingspeak software and a Wi-Fi module. This ensures that the accurate information is sent to the operator and insightful conclusions are made before any catastrophic failure occurs.*

Key Words: Distribution transformer, GSM(global service of mobile), Internet of Things.

1.INTRODUCTION

Electricity plays a major role in our life. Electricity has various components and equipment used to transfer and control the supply in accordance with demand. Transformer is the most crucial equipment of transmission and distribution of electric power. A distribution transformer is a key components of the overall network operation are the power supply for low voltage users and its operating circumstances and constitutes a large portion of capital investment. Distribution transformer have a long life if performed under evaluated circumstances. However, their life is significantly reduced when subjected to heating, overloading, resulting from low or high voltage/current catastrophic failure and loss of supply to a huge number of Customer behavior affects system dependability. There is a transformer anomaly accomplished with variation in different parameters like load current, load voltage, oil level, oil temperature, and ineffective cooling are major cause of failure in distribution transformer. At present the usage of SCADA, for web-based monitoring of, for example, Supervisory Control and Data Acquisition of distribution transformer which is a costly suggestion.

The existing system can be improved by the use of internet of things (IOT) which is all about connecting the unconnected things.

1) Site for support and records the important Currently, distribution transformers can be seen physically where a man occasionally visits a transformer and monitors the parameters. This kind of monitoring cannot provide information concerning overheating of transformer oil and windings and incidental overload. Each of these factors has the potential to reduce transformer life.

2) A monitoring system can only keep an eye on the operation condition and cannot keep track of all relevant data of distribution transformers to reduce costs and stability of the equipment.

3) Normally transformer health measurement system generally discovers a solitary transformer parameter such as current, voltage, etc. While some techniques could identify multi-parameter situations where testing pace is insufficiently swift and operation parameter times are too long.

4) Distribution transformers three phase equilibrium cannot be judged as the data for lucky detection won't be delivered to the operator in time.

To overcome the above deficiencies, this work proposes a real-time monitoring system for distribution transformers with the help of IOT and a widespread use of mobile networks and GSM modems, have made this project an attractive option both for wide area network applications and voice media.

1.1 GSM Module

GSM (Global System for Mobile Communications) is a TDMA based wireless network technology that makes use of a SIM card to identify the account of the user. By simply switching the SIM card, GSM network customers can rapidly shift their phone number from one GSM cellphone to another. Digital air interface is the type of interface used in GSM. Before transmission. The analogue voice signals are converted to digital signals. Up to 8 mobile station subscribers can be handled by the GSM RF carrier at a time. The rate of transmission of GSM network is 270 Kbps.

2. BLOCK DIAGRAM

The system consists of hardware design and software architecture as shown in the fig-1

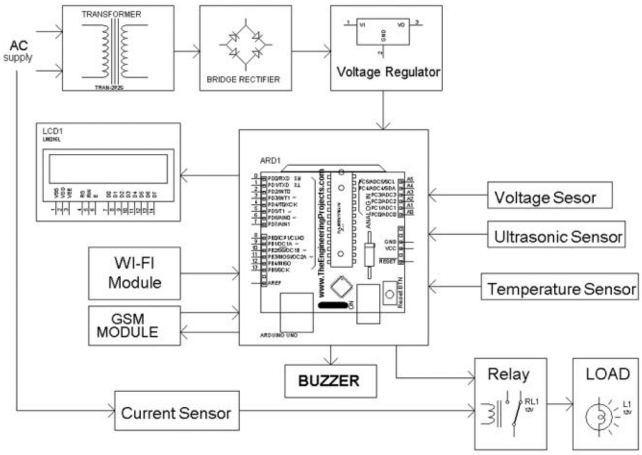

Fig -1

There are two major parts of this project. Firstly, the main parameters of the distribution are monitored continuously using various sensors, in this work over current relay is used to measure the load current, voltage regulator is used to regulate the voltage which helps in identifying over voltage and under voltage, DHT11 sensor that senses both humidity and temperature, ultrasonic sensor used to sense the oil level in the transformer tank. The sensed data is sent to the microcontroller which is processed and further stored in the web server through a Wi-Fi module. Second part is the software part that processed data is displayed on the 16*2 LCD and on the online platform. Thingspeak software is used to monitor and store the data. Short message service (SMS) is sent to mobile phones of the user through Global service of mobile communication network.

A. Current sensing

When the load current exceeds the system's pick-up value, an overcurrent relay, a protection mechanism, activates. The armature is activated when current flows through the relay coil, which creates a magnetic field. The resulting movement of the moveable contacts either makes or breaks a connection with a fixed contact. If the connections are closed after the relay has been de-energized, the contacts will be opened as a result of this movement. The armature returns when the coil's current source is cut off because of a force which is only half as strong as the magnetic force. Most relays are made to operate quickly. Low voltage applications reduce noise, but high-voltage applications increase it reduces arcing.

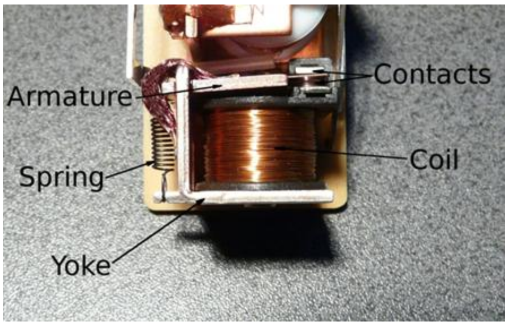

Fig -2: Overcurrent relay

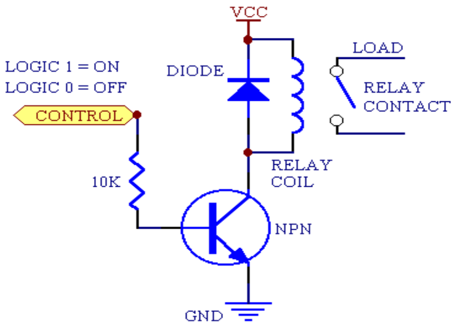

Fig -3: Circuit diagram of overcurrent relay

Although protective relays are available at practically any voltage, 5, 6, 9, 12, 24,and 48 volts direct current are the most popular. The coil's current, which typically runs from 30 to 200 ma, is also influenced by the wire's size and the number of turns.

B. Temperature sensing

Temperature of the distribution transformer should not exceed the rated temperature to ensure its long life and better efficiency. In this work DHT11 temperature sensor is used continuously monitor the temperature of the transformer. Above mentioned sensor is used to sense temperature as well as humidity. Its temperature sensing range lies between 0°C to 50°C and its humidity sensing range lies between 20% to 90%. It is highly accurate and does not raise for 1°C at room temperature.

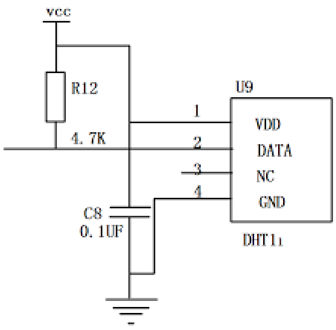

Fig -4: Circuit diagram of DHT11

C. Oil level sensing

Viscosity of the transformer oil is an important factor to be considered to ensure better performance of a distribution transformer. As viscosity of the oil decreases the level of oil also falls resulting in reduction of insulation life and cooling capacity of the transformer. To ensure oil is at level to maintain the health of the transformer an ultrasonic sensor is used which is fitted in the tank. This sensor transmits an ultrasonic wave which returns back after hitting the oil surface and is received by the sensor. When the oil level falls bellow a predefined level the sensor sends an indication to the microcontroller and the buzzer operates. The sensing range of the ultrasonic sensor used in this project lies between 2cm to 400cm.

Fig -5: HC-SR04

D. Voltage sensing

Below figure shows voltage sensor. The atmega16 microcontroller can run at up to or below 5V. 230V/12V step-down transformer is used after 230V AC supply, and it is rectified by a rectifier circuit to provide 12V AC and 12V DC. The data is transmitted to the microcontroller as the voltage varies below/above a preset value (80 volts in our work), where it is processed and the undervoltage/overvoltage is displayed on the LCD. Overvoltage and undervoltage affects the quality of the transformer and may lead to unexpected failures of the distribution transformers due to overheating of the equipment.

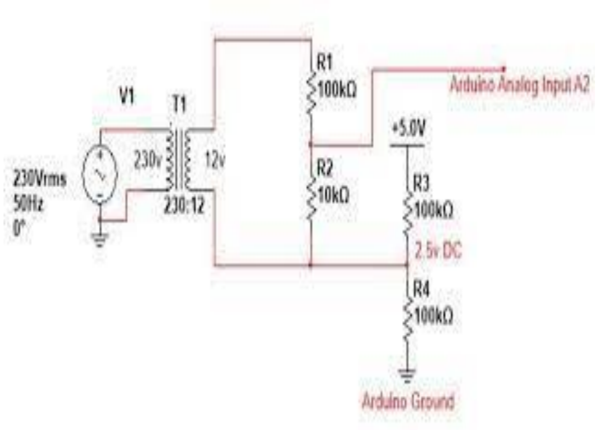

Fig -6: Voltage sensing circuit diagram.

3. HARDWARE DESIGN:

The system hardware consists of three physical components: an ESP8266 module, thingspeak and embedded system built around a microcontroller. It is used to collect, analyze, report, send then retrieve data also on parameters of the power transformer. It serves as a conduit between both the embedded system and thingspeak. The third is thingspeak, an IoT analytic platform service. Two Op Amps are used in each circuit, and a group of resistors is used to change the gain and offset. The current and voltage have tiny transformers and rectifier circuits to scale and convert their values to levels compatible with the Op Amps circuits. The controller block consists of a 16-bit microcontroller, an 8-channel analogue to digital converter (ADC), and a number of input/output digital ports. The embedded software algorithm that handles the parameters acquisition, processing, displaying, transmitting, and receiving is held the built-in EPROM. The parameters were read to use the ADC.The system has 16-LEDs that serve as pilot lights to show the status of each parameter and a 2-line, 16-character LCD. The microcontroller uploads data pertaining to the transformer's characteristics and status using the ESP8266 module as a communication tool.

4. SOFTWARE ARCHITECTURE:

To control the system's operation, a software algorithm was created and put into use. The procedure begins by setting the ADC channels, the input/output ports' data direction flow, and any relevant memory locations that will be used during the process. The system is then given the following commands in order as it continues: Give all variable values a 1000 rest. Read the voltages, temperatures, and currents. Verify for anomalies. Send the information to the Adafruit server if there are any anomalies so that any authorized personnel, such as technicians or operation engineers, can view it. Stored values, display readings, and then repeat the procedure. The information is acquired, processed, transmitted, and received by the software algorithm in the ESP module attached to the microcontroller in around 500 milliseconds. additionally updating and displaying the LCD / LED pilot indicators. The amount of time needed to send or receive data from the utility staff based on the speed of the server to/from the esp8266.The range is 2-1 seconds. The gain of the signal conditioning circuit, offset, current and voltage transformers, and ADC resolutions all have an impact on the results of the reading. Microcontroller ADC resolution is + percent least significant bit (LSB).On a scale of 5000 mV, it is around 10 mV. The resolution of the microcontroller ADC is + percent least significant bit (LSB). On a scale of 5000 mV, it is around 10 mV. The software algorithm can be changed to correct this mistake. Voltage transformer, current sensor, and temperature sensor errors are not taken into account. The system is being expanded in the future to use a server and database system. All of the transformer's parameters will be periodically stored in this database system, and later on, this information can be used for helpful research.

Additionally, gain adjustment, offset, and error correction to reduce error and increase accuracy, more circuits can be added to the signal conditioning circuit.

5.SIMULATION RESULT

The sensed data is continuously recorded on the Thingspeak platform.

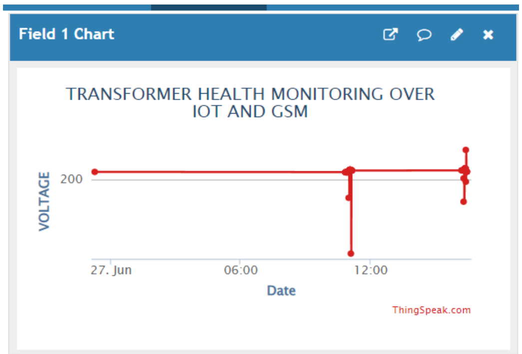

Fig-7: Voltage variation of Transformer

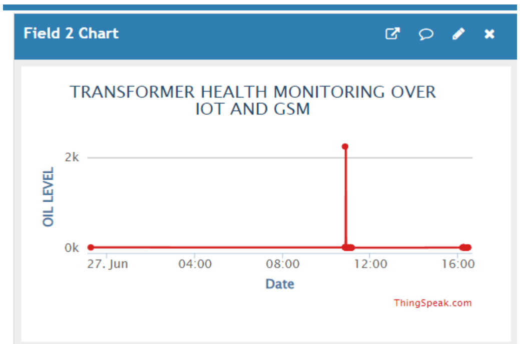

Fig-8:Oil level changes occurring in the transformer

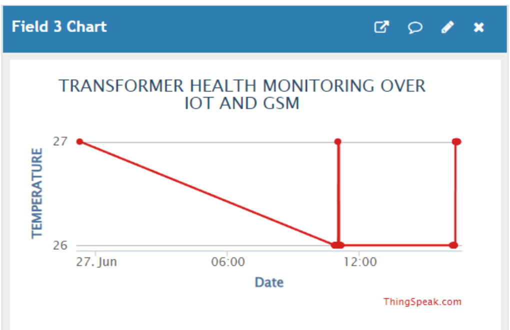

Fig-9: Temperature variations of Transformer

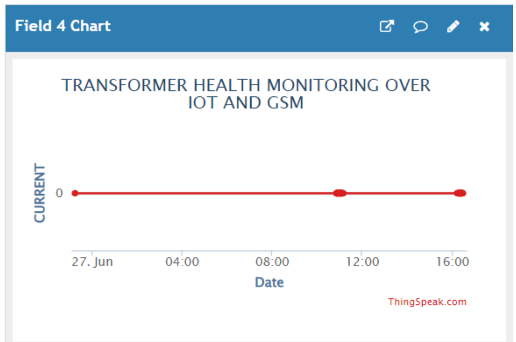

Fig-10:Variations in current of Transformer

3. CONCLUSIONS

The designed Transformer monitoring system is successfully records and sends abnormal operating parameters information to a registered user using GSM and this information is also periodically uploaded on the online database using ESP8266 wi-fi module. The collected data can be analysed to help the user to monitor the varying behavior of the transformer and recognize the faults before any major failure occurs.

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