IOT Based Transformer Health Monitoring System

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ABSTRACT

The key component of the power system that provides power to our electronic and electrical appliances in our homes and factories is distribution transformers. Distribution transformers must be fault-proof and provide consistent, high-quality electricity, i.e., at the rated voltage without interruption. Customers and utility corporations alike are concerned about transformer breakdowns. Poor power supply quality can lead to higher power losses, production losses, and power outages, as well as unfavorable equipment behavior and damage to equipment connected to the transformer's LV side. It has a financial impact on customers by causing damage to appliances that are linked to the power supply. This project creates an in-built system that monitors the zero crossing of current and voltage during low voltage and over voltage, fault protection, fault detection, and fault prevention via an Ethernet LAN on the intended substation. This saves the utility money by preventing unnecessarily long power outages and extending the transformer's life and service period. The solution also allows for remote control of the distribution transformer via the Internet of Things. It also assists customers in avoiding frequent power outages and ensuring that consumers receive stable and high-quality power

Key words: IOT, Control System, Microcontroller.

1. INTRODUCTION:

The implementation of monitoring, protection, and control mechanisms throughout the power system network as part of a smart grid is becoming increasingly important as the need for reliable power grows. Any distribution system would be incomplete without a distribution transformer. From a Libyan perspective, the power system network is only observed and operated to this extent. Transformers have a lifespan of 20 to 25 years. The majority of transformers in use are nearing their end of life. The current monitoring methods are solely concerned with electrical characteristics and provide no insight into the internal state of the distribution transformer. For such a critical component of the power system, routine maintenance is insufficient. Condition-based maintenance will only work if you have an online monitoring system in place, which allows for remote equipment monitoring and real-time maintenance scheduling and control, as illustrated in the diagram. Condition monitoring techniques analyses a transformer's internal and external data to predict its operational status and make appropriate decisions, similar to how a doctor examines a patient's symptoms to diagnose the illness and provide a treatment. Depending on the severity, the decision to perform maintenance or replace with a new one can be taken, which is an important component of asset management. The monitoring device systems that are now used to monitor distribution transformers, however, have some difficulties and shortcomings. A couple of them are listed below. In and of itself, the detecting mechanism is unreliable. Instability, weak jamming capabilities, insufficient data measurement precision, or even another system should not affect the device's performance Typically, a transformer measurement instrument only detects one transformer property, such as power, current, voltage, or phase. While some systems can identify multiple factors, their length and operation settings are excessively long, and their testing speed is inadequate. Because data from timely detection will not be provided to monitoring units in a timely manner, estimating distribution transformer three-phase equilibrium will be difficult. The monitoring 2 system can maintain track of the operation or guard against power theft, but it won't be able to keep track of all transformer user data in order to save money. Although power carrier communication is employed in many monitoring systems, it has a number of limitations, including severe frequency interference, signal attenuation as distance rises, and substantial electrical noise generated by load changes. If we employ carrier communication to convey real-time data, we have no way of knowing how reliable it will be. A real-time monitoring system is required for distribution transformers that can identify all operating parameter changes and report them to the monitoring center in a timely way, based on the criteria set forth previously. It leads to online monitoring of critical distribution transformer operating characteristics, which can provide vital information on transformer health and help utilities to get the most out of their transformers while keeping them in service for longer periods. It will aid in early problem diagnosis, resulting in significant cost savings and greater reliability.

2. BLOCK DIAGRAM:

We can see that the transformer, which is connected to the sensors then sensors, is joined to the microcontroller. Then microcontroller joined to the relay and display sectors (LCD, IOT). The microcontroller is able to take the inputs from all these sensors and perform some operation on the obtained input data according to the program fed in it already. Normally it will measure parameters and send the values to output devices such as LCD, IOT. Relay is connected in case any of the sensor reading exceeds the safe limit.

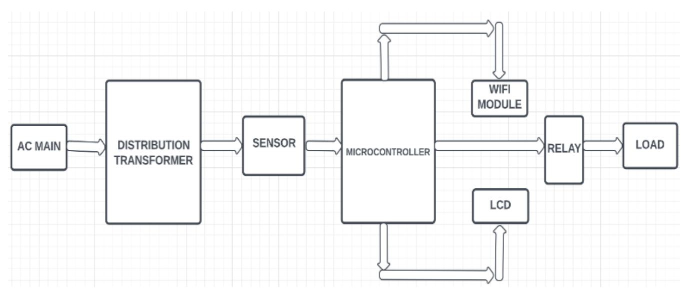


Figure 1.1 :Block Diagram

3. HARDWARE REQUIREMENT:

IOT based power distribution transformer health monitoring system circuitry is based on the following most important & main equipment's:

1. PIC Controller (PIC16F877A)
2. Distribution Transformer (1kva 1:1)
3. IOT Module (ESP8266)
4. Power Supply
5. LCD display (16*4)
6. Temperature Sensor (LM35)
7. Current Transformer
8. Oil level sensor
9. Viberation sensor
10. Potentional Transformer
11. Relay Module

The Controller used in our project is PIC16f877A which is micro controller programmed into C language.

4. RESULTS AND DISCUSSIONS:

As whole project is based on transformer health monitoring and protection so we have to set limits where we need switch on relay to protect our circuit.

ONLINE NORMAL BEHAVIOR

In normal behavior while being online, voltage level, current level and winding temperature will be shown on LCD and mobile application through IOT. Vibration and oil level will be continuously monitored on backhand and only shown on LCD and mobile application while being in abnormal behavior.

OFFLINE NORMAL BEHAVIOR

In normal behavior while offline, data will not be sent to IOT dashboard as WIFI module needs a WIFI connection to send and receive data. So, all the data obtained from monitoring will only be shown on LCD.

ONLINE CASE

The online case through which we can observe and analyze the data obtained on the web page (IOT Module) according to the following data representations consisting both normal and abnormal values of parameters. The main purpose of online results is to keep a record of previous data so that this data can be used in future for further process and analysis regarding any operation such as security purposes. In case of using a monitoring system with parameters of transformer the online data record can be used for protection of transformer health. Dashboard of the account is

On abnormal behavior of different conditions error is showed on LCD and mobile application through IOT and the system is tested continuously until the system returns to normal conditions

ONLINE ABNORMAL BEHAVIOR

In abnormal behavior while being online, the corresponding error will be shown on LCD and mobile application through IOT.

OFFLINE ABNORMAL BEHAVIOR

In abnormal behavior while offline, data will not be sent to IOT dashboard as WIFI module needs a WIFI connection to send and receive data. So, the fault will only be shown on LCD.

VOLTAGE LEVELS

When voltages are high or low “voltage error” will be shown until voltages return to normal conditions after than they can be supplied to load.

CURRENT LEVELS

When current level increases “current error” will be displayed and checked continuously when current will come to normal condition after a time break of 5 seconds the system will automatically start working. LCD showing over current error of our project is shown in figure 6.1.

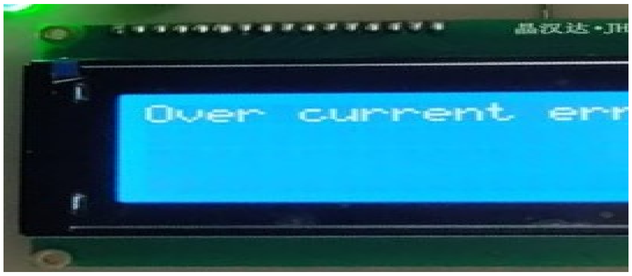


Figure 2.2 Over Current Fault

TEMPERATURE

When temperature of winding reaches 40 degrees' system will, trip and display "temp error" will let the system cool down and will not start again until windings reach the temperature of 35 degrees.

Figure 1.3 Temperature Fault

OIL LEVEL

When the level of oil will drop "oil error" will be shown while turning the system off. System will not start working again unless oil level is restored to its safe level.

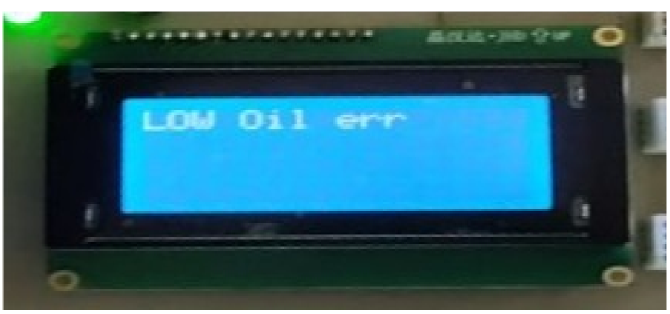


Figure 1.4 Oil Level Error

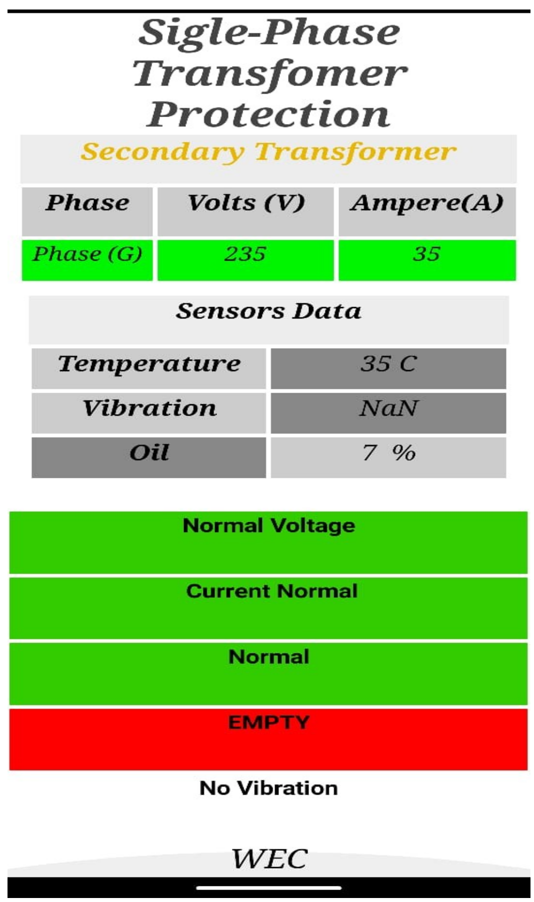
VIBRATION

When abnormal vibration is detected in the system "vibb error" will be displayed and system will turn off and when the system the vibration issue is resolved system will turn on automatically.

Figure 1.5 Vibration Error

DISCUSSION:

IOT Interfacing



5.CONCLUSION:

The main part of the transformer is its winding and it costs a lot to repair it in case of any damage and after constantly observing 5 different parameters (voltage level, current level, oil level, vibration and winding temperature) of the distribution transformer it is concluded that all these 5 parameters are related with each other. We know that voltage and current have inverse relation proved from ohms law. With increase in load current increases which causes rise in temperature of windings and to control temperature raises different oils are used. These oils play an important role in keeping transformer cool, so constant monitoring of level of oil in case of any leakage from body of the transformer is also important. Vibration in a transformer is mainly caused by magnetic effect, which is when dimensions of transformers iron core are changed by the magnetic field created by the current passing through the transformer. The core expands and contracts due to AC, which causes a humming sound. Limit set for temperature tripping is 40 degrees Celsius but the system will not start until the system reaches a safe level of 35 degree Celsius the reason for this is that if resetting temperature is at 40 the system will trip on 40 degrees Celsius and come back to normal on 39 which will take no time and time for system to go off and online will be very low causing repeatedly on off which will cause fault for both loads and transformer itself. Similarly, when current is reset to normal if will take some time to comeback online automatically to avoid any damages.

6. FUTURE SCOPE:

Everything now a day is moving to online activity where less effort and manpower is needed to do our most needed tasks. With increase in population, demand for electricity is increasing so we cannot afford to have power losses and any damage to our distribution system, which will cause inconvenience for both consumers and power management companies.

7. REFRENCES:

[1] Kwarteng, A., Okrah, S, K., Asante, B, & Amanor, P, ‘Design and Construction of an IoT Based Distribution Transformer Condition Monitoring System’, IJES, 2021, vol. 10, no. 5, pp. 20-44.

[2] Waghmare, U, V, Agarwal, A., Rusia, R., Wankar, A., Atkari, P, & Kumare, M, ‘Transform protection using microcontroller-based relay and monitoring using iot and gsm’, Journal of Research in Engineering and Applied Sciences, 2020, vol. 5, no. 02, pp. 65-70.

[3] Soppimath, V, M., Sheeri, P. Kalakaraddi, R, & Kumar, C, S, ‘Monitoring and Control of Operational Parameters of Distribution Transformer using IoT Technology’, IJASE, 2018, vol. 5, no. 1, pp. 871-878.

[4] Sanjeeya, V, Ramyashankari, E, Kannan, M, S, & Vidhya, A, ‘Real Time Transformer Health Monitoring system using IOT technology’, International Journal of Science Technology & Engineering, 2018, vol. 04, no. 9, pp. 87-93.

[5] Venkataswamy, R., Rao, K, U, & Meena, P, “Internet of things based met heuristic reliability centered maintenance of distribution transformers” In IOP Conference Series: Earth and Environmental Science, Mar. 2020, pp. 1755-1763.

[6] Hasan, W, K, Alraddad, A, Ashour, A, Ran, Y, Alkelsh, M, A., & Ajele, R, A, "Design and Implementation Smart Transformer based on IoT" In 2019 International Conference on Computing, Electronics & Communications Engineering, August 2019, pp. 978-994.

[7] Bhavarkar, S, Kore, P, Ambare, V, Dalne, A, Amane, G, & Kapse, S, 'IOT Based Distribution Transformer Monitoring and Controlling System', Journal of Research and Advancement in Electrical Engineering, 2019, vol. 4, no. 2, pp. 37-40.

[8] Tamilselvan, K, S, 'IOT based online transformer maintenance system', IJASE, 2017, vol. 8, no. 1, pp. 88-95.

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