



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJIRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

[www.ijirset.com](http://www.ijirset.com)

# IoT-Based Transformer Monitoring System

Anoop K<sup>1</sup>, Kalyani M Hugar<sup>2</sup>, Mukarram S<sup>3</sup>, Syed Khizer Ahmad<sup>4</sup>, Shafreen Parvez S<sup>5</sup>

U.G. Students, Department of Electrical and Electronics Engineering, Ballari Institute of Technology and Management,  
Ballari, Ballari, Karnataka, India<sup>1 2 3 4</sup>

Assistant Professor, Department of Electrical and Electronics Engineering, Ballari Institute of Technology and  
Management, Ballari, Ballari, Karnataka, India<sup>5</sup>

**ABSTRACT:** The increasing demand for reliable power supply necessitates the efficient monitoring and maintenance of transformers in power distribution networks. This abstract presents an overview of an Internet of Things (IoT) based transformer monitoring system designed to enhance the reliability and performance of power distribution systems. The proposed system integrates various IoT technologies such as sensors, communication modules, and data analytics to continuously monitor the operational parameters of transformers in real-time. Through the deployment of sensors, critical parameters including temperature, oil level, moisture content, and load current are monitored, allowing for early detection of potential faults or abnormalities. The collected data is transmitted to a centralized server or cloud platform using wireless communication protocols for further analysis and storage. Advanced analytics algorithms are employed to process the data, enabling predictive maintenance and decision-making based on the transformer's health condition. Additionally, the system facilitates remote monitoring and control, enabling operators to optimize the performance of transformers and minimize downtime. The implementation of an IoT-based transformer monitoring system offers numerous benefits, including improved reliability, reduced maintenance costs, and enhanced operational efficiency of power distribution networks. This abstract provides insights into the architecture, components, and functionalities of the proposed system, highlighting its significance in ensuring the reliability and sustainability of modern power infrastructures.

## I. INTRODUCTION

In the modern era of digitization and interconnectedness, the Internet of Things (IoT) has revolutionized various industries, including the power sector. Among the critical assets in the power grid, transformers play a pivotal role in the transmission and distribution of electricity. Ensuring their efficient operation and timely maintenance is crucial for the reliability and stability of the power system. In this context, IoT-based transformer monitoring systems have emerged as a transformative solution, offering real-time insights and predictive analytics to enhance performance, prevent failures, and optimize maintenance schedules. Overview of IoT-Based Transformer Monitoring System: An IoT-based transformer monitoring system comprises a network of sensors, communication devices, data analytics platforms, and visualization tools. These components work synergistically to collect, transmit, analyze, and visualize various parameters associated with transformer operation. The key components of such a system include: Sensors: These devices are deployed at strategic locations on the transformer to measure essential parameters such as temperature, oil level, pressure, humidity, gas concentration (e.g., dissolved gas analysis), and electrical parameters (voltage, current, power factor). Advanced sensors may also include features like vibration monitoring and partial discharge detection. Communication Infrastructure: IoT-enabled communication protocols such as MQTT (Message Queuing Telemetry Transport), LRWAN (Long Range Wide Area Network), or cellular networks facilitate seamless data transmission from sensors to the central monitoring system. Wireless communication technologies eliminate the need for complex wiring and enable remote monitoring of transformers located in diverse geographical locations. Data Acquisition and Processing: Data from sensors are collected at regular intervals and transmitted to a centralized data acquisition system. Here, the data undergo preprocessing to remove noise and outliers, followed by feature extraction and transformation. Advanced data analytics techniques, including machine learning algorithms, are employed to analyze historical data patterns, identify anomalies, and predict potential failures or maintenance requirements. Cloud-Based Platform: Many IoT-based transformer monitoring systems leverage cloud computing infrastructure for scalable storage, processing, and analysis of vast amounts of data. Cloud platforms offer flexibility, accessibility, and real-time updates, enabling stakeholders to monitor transformer health from anywhere with internet connectivity. Visualization and Reporting: User-friendly dashboards and visualization tools present actionable insights derived from data analysis in an intuitive manner. Key performance indicators (KPIs), trend analysis, alarm notifications, and predictive maintenance recommendations empower operators and maintenance personnel to make informed decisions and prioritize interventions effectively.

## II. LITERATURE SURVEY

Based on a literature survey, it has been observed that transformer-based IoT monitoring projects use transformer models to analyse and make sense of large volumes of data gathered from IoT sensors. These models utilize attention mechanisms to identify crucial features in the data and provide predictions or recommendations based on them. Several studies have been conducted to explore the effectiveness of transformer models in various IoT monitoring tasks such as detecting and classifying anomalies, predicting energy consumption patterns, and monitoring industrial equipment. These projects demonstrate that transformer-based approaches have the potential to handle complex and large datasets while achieving high levels of accuracy, making them a promising solution for IoT monitoring. Supervisory control and data acquisition (SCADA) systems are commonly used by power companies for online monitoring of power transformers. However, extending the SCADA system to monitor power transformers online is often costly. Currently, power transformers are typically monitored manually by personnel who visit transformer sites for maintenance and record-keeping. However, these manual monitoring systems have significant drawbacks, as they cannot provide information about overloads in voltage and current, as well as overheating of transformer oil and windings. As a result, transformer lifespan can be significantly reduced. The use of physical monitoring of distribution transformers is still prevalent, where a person visits the transformer site to analyse its parameters. However, failure to monitor important parameters such as incidental overload and overheating of transformer oil and windings can result in decreased transformer life, which is not feasible in the current operating system. Although some monitoring systems can recognize multiple parameters, the testing pace is slow, and it takes too long for the parameters to be operational.

This design also provides effective solutions for problems faced by India's electricity distribution system, such as power theft, transmission line faults, and other faults. The proposed system uses the internet for real-time monitoring of distribution transformers, which helps to identify various transformer faults and the parameters affecting them. This approach allows for instantaneously keeping the growth of incipient and other faults in check, helping utilities optimally use their transformers and keep them in operation for a longer period. It also enables the identification of problems before any catastrophic failure, resulting in significant cost savings and greater reliability.

## III. PROBLEM STATEMENT

In the realm of power distribution, transformers play a critical role in ensuring the efficient transmission and distribution of electricity. However, the reliable operation of transformers is subject to various internal and external factors, making their monitoring and maintenance a significant challenge for utilities and operators. Traditional methods of transformer monitoring, which rely on periodic inspections and manual data collection, are often insufficient for detecting emerging issues or preventing failures in a timely manner. Therefore, there is a pressing need for advanced monitoring solutions that can provide real-time insights into transformer health and performance.

## IV. PROPOSED SYSTEM

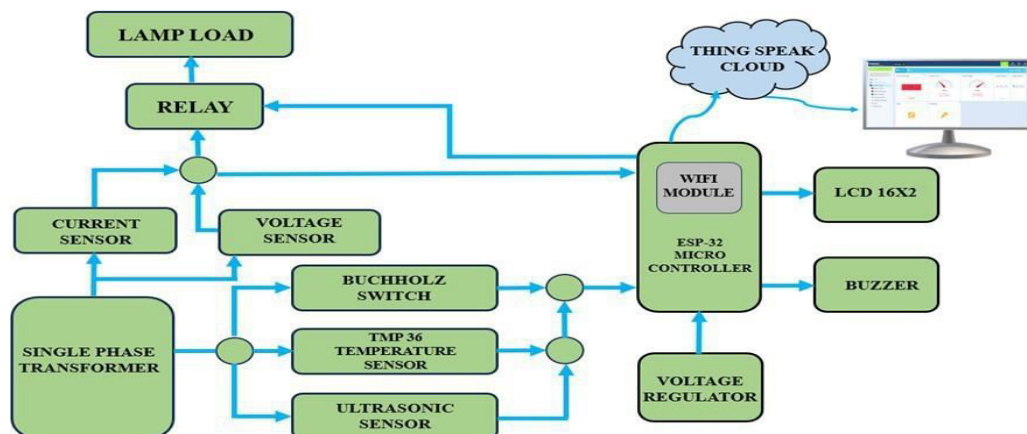


Fig1: Proposed system architecture

The architecture of the proposed IOT based transformer monitoring system using ESP-32, It generally consists of sensor circuit, relay module, ultrasonic sensor, temperature sensor the 1ph transformer used for this purpose the temperature of the transformer is monitored by the TMP36(Temperature sensor) and oil level monitored by the ultrasonic sensor and sensor circuit consists of voltage sensor, current sensor, Buchholz switch. Voltage regulator is



also known as buck converter IC ideally suited for convenient design of a step-down or step-up switching regulator. BUCK convertor is used to step down the DC voltage from 12V/5V and the step downed voltage is fed to all the units .and LCD16x2 is used for displaying the parameters of current, voltage, oil level and temperature of transformer. This DATA is gathered by the Micro controller (ESP-32) which controls and monitored with the preset value and trips if it exceeds or varies above the set limit with the help of relay unit and displays in LCD 16x2.ESP-32 module that combines Wi-Fi and Bluetooth connectivity with powerful processing capabilities. It is based on the Espresso if ESP32system-on-chip(SoC).You can use this module to monitor from any where by anormal cellphone just by sending SMS messages, connecting totheInternetviaGPRS.AndtheoutputofESP-32 is connected to an OLED display. Where we can visualize the current, voltage rating oil level and temperature. By using IoT (Internet of Things), we can visualize the result through the web interface.

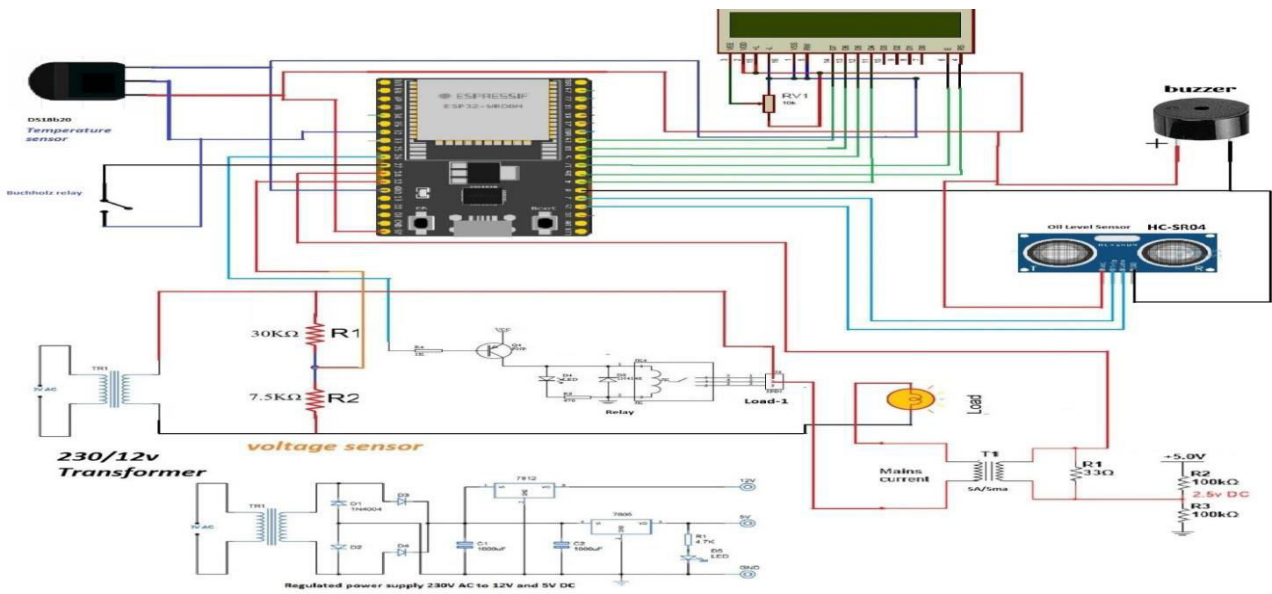


Fig2:Hardware Design of IoT Transformer Monitoring System

V. RESULT & DISCUSSION

A. Result



Fig3: Thing Speak Webinter face using IOT

## B. Discussion

As the title says, the result of IOT BASED TRANSFORMER SYSTEM USING ESP-32 is of extreme use to monitoring the different transformer parameters like: voltage, current, oil level and temperature parameters which benefits in maintaining the healthy operation and inspection of the transformer. These parameters are fetched using ESP-32 with the preset values. By using IoT (Internet of Things), we can visualize the result through the web interface like, how much current its drawing while, and we can check the voltage level. By placing a temperature sensor, we can visualize the temperature level, this is a safety precautions for transformer to prevent by overheating. Implementing an IoT-based transformer monitoring system using ESP-32 can revolutionize how transformers are managed and maintained. Here's a discussion on why such a system is invaluable:

1. **Enhanced Monitoring Capabilities:** Traditional methods of monitoring transformers often involve periodic inspections or manual checks, which may not capture real-time fluctuation or merging issues. By integrating IoT technology with transformers, parameters like voltage, current, oil level, and temperature can be continuously monitored with high accuracy and precision. This real-time monitoring capability enables prompt detection of abnormalities or deviations from optimal operating conditions, allowing for timely intervention to prevent potential failures or damage.
2. **Proactive Maintenance:** One of the key advantages of IoT-based transformer monitoring is the ability to shift from reactive to proactive maintenance strategies. By analyzing the data collected from sensors embedded in the transformer, patterns, trends, and anomalies can be identified, enabling predictive maintenance. Predictive maintenance involves preemptively addressing potential issues before they escalate into costly failures or downtime. This not only improves the reliability and lifespan of the transformers but also minimizes maintenance costs and operational disruptions.
3. **Remote Accessibility and Management:** The integration of IoT technology enables remote accessibility and management of transformer systems. With the use of cloud-based platforms or remote monitoring applications, operators can access real-time data and analytics insights from anywhere with an internet connection. This remote accessibility is particularly beneficial for transformers located in remote or inaccessible areas, as it eliminates the need for physical presence for monitoring and troubleshooting. Furthermore, remote management capabilities facilitate quicker response times to alarms or alerts, as operators can take immediate action regardless of their location.
4. **Data-driven Decision Making:** The wealth of data generated by IoT-based transformer monitoring systems empowers operators and maintenance personnel to make informed, data-driven decisions. By analyzing historical data trends and performance metrics, operators can identify optimization opportunities, assess the effectiveness of maintenance strategies, and allocate resources more efficiently. Additionally, the availability of comprehensive data facilitates regulatory compliance reporting and auditing requirements, ensuring adherence to industry standards and regulations.
5. **Integration with Smart Grid Infrastructure:** IoT-based transformer monitoring systems can seamlessly integrate with broader smart grid infrastructure and energy management systems. This integration enables interoperability between different components of the electrical grid, such as distribution systems, renewable energy sources, and demand-response mechanisms. By leveraging IoT technology, utilities can achieve greater grid resilience, efficiency, and sustainability while accommodating the increasing penetration of renewable energy sources and electric vehicles.
6. In conclusion, the implementation of an IoT-based transformer monitoring system using ESP-32 offers numerous benefits, including enhanced monitoring capabilities, proactive maintenance, remote accessibility, data-driven decision-making, and integration with smart grid infrastructure. By leveraging IoT technology, utilities and operators can optimize the performance, reliability, and efficiency of transformer assets while mitigating risks and ensuring compliance with regulatory requirements.

## VI. CONCLUSIONS&FUTURESCOPE

The advent of IoT-based transformer monitoring systems marks a significant advancement in the realm of power distribution and asset management. These systems have revolutionized the way utilities and operators monitor, manage, and maintain transformers, offering a plethora of benefits ranging from proactive maintenance to enhanced reliability

and operational efficiency.

By leveraging interconnected sensors, real-time data analytics, and predictive algorithms, IoT-based transformer monitoring systems enable utilities to gain unprecedented insights into the health and performance of their transformer assets. The continuous monitoring of critical parameters coupled with advanced analytics empowers operators to detect anomalies, predict potential failures, and prioritize maintenance activities effectively.

One of the primary advantages of IoT-based transformer monitoring systems is their ability to facilitate proactive maintenance strategies. By identifying emerging issues before they escalate into costly failures, these systems help minimize downtime, extend equipment lifespan, and optimize resource allocation. Furthermore, the real-time monitoring capabilities enable utilities to respond promptly to abnormal conditions, ensuring uninterrupted power supply and enhancing grid resilience.

Operational efficiency is another key benefit offered by IoT-based transformer monitoring systems. By harnessing data-driven insights, utilities can optimize maintenance schedules, stream-line workflows, and allocate resources more efficiently. This not only improves asset utilization but also reduces operational costs and enhances overall system performance.

Moreover, IoT-based transformer monitoring systems play a crucial role in ensuring safety and compliance with regulatory standards. The comprehensive monitoring capabilities, coupled with advanced reporting features, enable utilities to maintain a high level of safety and environmental compliance, mitigating risks associated with equipment failures and minimizing the impact on surrounding communities.

#### REFERENCES

1. Sajidur Rahman, Shimanta Kumar Dey, Bikash Kumar Bhawmick, Nipu Kumar Das, "Design and implementation of realtime transformer health monitoring system using GSM technology", International Conference on Electrical, Computer and Communication Engineering (ECCE), IEEE 2017.
2. Rohit R. Pawar, S. B. Deosarkar, "Health condition monitoring system for distribution transformer using Internet of Things (IoT)", International Conference on Computing Methodologies and Communication (ICCMC), IEEE 2017.
3. Majid Ali, Adnan Yousaf, Fuad Usman, "Designing and simulation of load control & monitoring system through Demand Side Management technique", 8th International Renewable Energy Congress (IREC), IEEE 2017.
4. Kazi Ahmed Asif Fuad, Md. Maruf Ibne Hasan, Laila Nawsheen Manzoor, Mohammad Abdul Mannan, "Design and simulation of centralized load controlled automated power system network (CLCAPSN)", IEEE International WIE Conference on Electrical and Computer Engineering (WIECON-ECE), IEEE 2015.
5. Qin Zhou, ZhengCaiFu, "Research and implement of cost-effective remote transformer monitor system", International Conference on High Voltage Engineering and Application, IEEE 2012.



INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details