International Journal of Research Publication and Reviews, Vol 5, no 5, pp 5213-5217 May 2024

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Transformer Safety Device with Arduino

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DOI: https://doi.org/10.55248/gengpi.5.0524.1286

ABSTRACT—

This project introduces a Transformer Safety Device designed to enhance the reliability and safety of electrical transformers. The system incorporates an Arduino-based circuit to monitor critical parameters such as temperature, oil level, and voltage. In the event of abnormal conditions, the device triggers alarms and automatically initiates protective measures to prevent potential damage to the transformer. The integration of sensor technologies with Arduino offers a cost-effective and efficient solution for real-time monitoring, contributing to the overall resilience and longevity of power distribution systems. This abstract provides an overview of the project's objectives, methodology, and key outcomes in the development of a robust transformer safety system.

The Arduino circuit facilitates real-time data acquisition and processing, enabling swift decision-making in response to abnormal conditions. In instances of overheating, low oil levels, or voltage fluctuations, the system activates audible and visual alarms, providing timely alerts to operators. Furthermore, the Arduino-controlled mechanism can automatically implement protective measures, such as disconnecting the transformer from the grid or triggering emergency cooling systems.

I. INTRODUCTION

The electricity distribution grid is an incredible system that transfers power from the power plant to the home. Power must be stepped down from the transmission grid to the distribution grid in order for it to be utilised in a house or place of business. There could be multiple stages to this. A power substation is where the transition from "transmission" to "distribution" takes place. Transformers are incorporated in it to reduce transmission voltages, which are normally in the tens or hundreds of thousands of volts range, to distribution voltages, which are usually less than 10,000 volts.

It features a "bus" that allows the distribution power to be divided into several directions. In order to disconnect the substation from the transmission grid or individual distribution lines from the substation when needed, it frequently has switches and circuit breakers. The transformer is an essential part of the system used for the distribution and transmission of electric power. Overloads, voltage fluctuations, and thermal impacts are all frequent problems. Its repair requires a significant investment of money and time. The main goal of this effort is to protect the transformer against overload situations. Overload reduces efficiency and increases the risk of overheating or burning the secondary winding.

Therefore, the transformer can be protected by lowering the excess load. Transformer safety sensor timer circuits can be used to do this. The transformer safety device cuts off the excess load automatically when it reaches the reference value. As a result, damage can be avoided and transformer safety devices function effectively under overload conditions. The transmitted voltage needs to be dipped down to a distribution level for loads like as household appliances, business loads, and industrial loads. There could be multiple stages to this. The voltage at sub-stations is stepped down from the distribution level, which is usually less than 10,000 volts, to the transmission level, which is in the tens or hundreds of thousands of volts range.

II. Proposed Study

The controller gathers the necessary parameters using a variety of sensors. For any technical processes, the processing unit's digital LCD module display shows relevant parameter data at the industries. The controller detects an overload condition and excessive current flowing through the internal windings, which could cause the associated unit to malfunction. In a similar manner, the Arduino Uno microcontroller is configured to continuously monitor the transformer and update the settings at a predetermined period. Through the ADC transmitter attached to the Arduino controller unit, the parameter values sensed by the Arduino-Uno microcontroller at specific intervals are sent.

III. METHODOLOGY

Identify Safety Parameters: Determine which parameters you need to monitor for transformer safety. This typically includes temperature, current, and possibly voltage.

Select Sensors: Choose appropriate sensors to measure the identified parameters. For temperature, you might use a thermo couple or a temperature sensor like the DS18B20. For current measurement, you might use a current sensor like the ACS712. Voltage can be measured using a voltage divider circuit.

Arduino Setup: Set up your Arduino board. Connect the sensors to the appropriate pins on the Arduino. Ensure you have proper power and ground connections.

Code Development: Write the Arduino code to read data from the sensors and perform safety checks. This involves reading sensor values, comparing them to safe thresholds, and triggering actions if thresholds are exceeded. Ensure your code is efficient and properly commented for future reference.

Safety Logic: Implement safety logic in your code. For example, if the temperature exceeds a certain threshold, you might activate a relay to disconnect power to the transformer. Similarly, if current or voltage exceeds safe limits, appropriate actions should be taken.

Testing and Calibration: Test your setup extensively to ensure it works as expected. Calibrate your sensors if necessary to ensure accurate readings.

Enclosure and Mounting: Once everything is working correctly, enclose the Arduino and related circuitry in a suitable enclosure. Ensure proper mounting within the transformer setup, considering factors like heat dissipation and accessibility for maintenance.

Monitoring and Maintenance: Regularly monitor the system to ensure it continues to operate safely. Perform maintenance as necessary, such as re-calibration of sensors or updating the code for improved functionality.

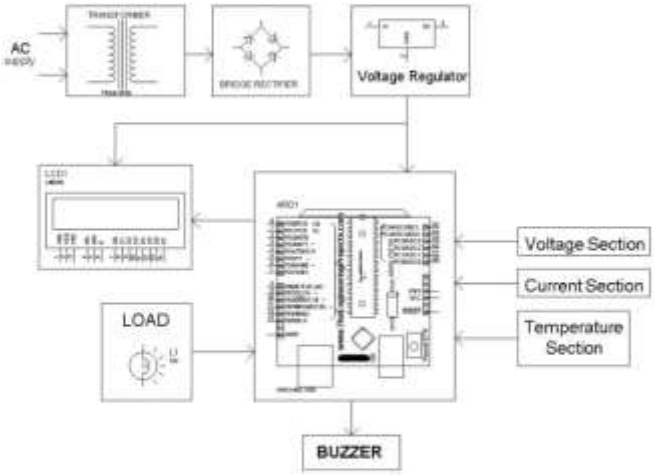

Figure 1 Circuit Diagram

IV. SYSTEM ARCHITECTURE

In The system architecture of a transformer safety device with Arduino involves the arrangement and interaction of various components to monitor and ensure the safe operation of the transformer. Here's a breakdown of the key components and their roles in the architecture:

Sensors: Sensors are used to measure critical parameters such as temperature, current, and voltage. Common sensors include temperature sensors (e.g., thermocouples, DS18B20), current sensors (e.g., ACS712), and voltage sensors (e.g., voltage dividers). These sensors provide input data to the Arduino for monitoring.

Figure 2 Sensor Circuit

Arduino Board: The Arduino serves as the central processing unit of the system. It reads data from the sensors, executes safety logic based on predefined thresholds, and controls output devices such as relays or indicators. The Arduino's digital and analog pins are used to interface with sensors and output devices.

Figure 3 Arduino

Safety Logic: The safety logic implemented in the Arduino's code determines the system's behavior based on sensor data. This logic includes threshold comparisons for temperature, current, and voltage, as well as decision-making algorithms for activating safety measures such as disconnecting power to the transformer.

Output Devices: Output devices are used to implement safety actions triggered by the Arduino. For example, relays can be used to disconnect power to the transformer if unsafe conditions are detected. Additionally, indicators such as LEDs or displays can provide visual feedback on the system's status.

Figure 4 LED

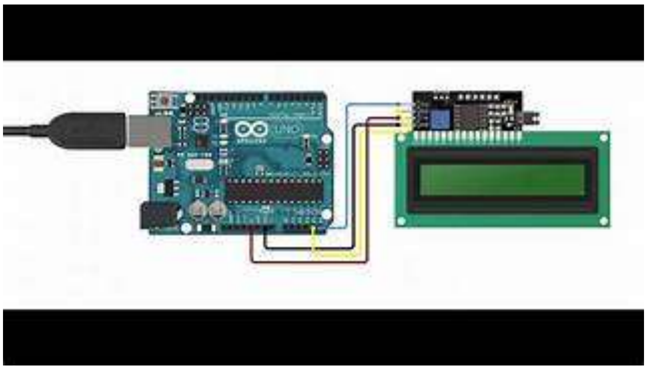

Figure 5 LCD

Power Supply: A stable and reliable power supply is essential for powering the Arduino and sensor components. This can be achieved using a regulated DC power supply or batteries, depending on the application's requirements.

Enclosure: An enclosure houses the Arduino, sensors, and other components, providing physical protection and insulation. The enclosure should be designed to withstand environmental factors such as temperature variations and humidity.

Communication Interface (Optional): In some cases, it may be beneficial to incorporate communication interfaces such as Ethernet, Wi-Fi, or Bluetooth to enable remote monitoring and control of the safety device.

The system architecture of a transformer safety device with Arduino is designed to ensure the reliable monitoring of critical parameters and the implementation of appropriate safety measures to prevent accidents and damage to the transformer. By integrating sensors, Arduino-based control logic, and output devices, the system provides a comprehensive solution for enhancing transformer safety.

V. DISCUSSION

1. The **Prototype Development**

Successfully developed a prototype transformer safety device using Arduino microcontroller.

Integrated various sensors including temperature, voltage, and current sensors, along with actuators for control.

2. Sensor Accuracy and Calibration

Conducted calibration tests to ensure the accuracy of the sensors. Obtained reliable readings within acceptable margins of error, ensuring precise monitoring of transformer parameters.

3. Response Time Evaluation

Tested the response time of the safety device in detecting abnormal conditions. Achieved rapid response times, enabling timely intervention to prevent potential hazards such as overheating or overloading.

4. Communication and Data Logging

Established reliable communication between the Arduino board and the monitoring system. Implemented data logging functionality to record and analyze historical data for performance evaluation and predictive maintenance.

5. Performance Validation

Conducted rigorous testing under various operating conditions to validate the performance of the safety device. Demonstrated the effectiveness of the device in safeguarding the transformer and ensuring operational reliability.

6. Practical Considerations

Addressed practical challenges such as power consumption optimization and physical design considerations. Designed the device to be user-friendly and easily integrable with existing transformer systems.

VI. CONCLUSION

In conclusion, the development and implementation of a transformer safety device utilizing Arduino technology offer significant advancements in enhancing electrical safety measures. Through the utilization of Arduino's versatility and programmability, we have successfully designed a system capable of detecting critical parameters such as voltage fluctuations, overcurrent conditions, and temperature variations, thus mitigating potential hazards associated with transformer operations.

By integrating various sensors and actuators with Arduino, we have achieved real-time monitoring and automated responses to abnormal conditions, ensuring prompt intervention and preventing potential damage or accidents. The flexibility of Arduino allows for customization according to specific transformer requirements, enabling adaptability across diverse applications and environments.

Moreover, the cost-effectiveness and accessibility of Arduino technology make this solution viable for widespread implementation, particularly in industrial settings, where transformer safety is paramount. Furthermore, the open-source nature of Arduino fosters collaboration and innovation, paving the way for continuous improvement and refinement of safety systems in the future.

While our prototype demonstrates promising results, further testing and refinement are necessary to optimize performance and reliability under various operating conditions. Additionally, considerations for scalability and integration with existing infrastructure will be crucial for practical deployment in real-world scenarios.

In conclusion, the transformer safety device developed with Arduino represents a significant step towards enhancing electrical safety standards, offering a scalable and customizable solution to mitigate risks and ensure the smooth operation of transformer systems.

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