e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:07/Issue:04/April-2025 Impact Factor- 8.187 www.irjmets.com

INTELLIGENT RE-CLOSURE AUTOMATION FOR AIR BREAK SWITCHES: A PLC AND SCADA APPROACH

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ABSTRACT

By creating an automated re-closure system with Supervisory Control and Data Acquisition (SCADA) and Programmable Logic Controllers (PLC) technologies, this project seeks to improve the efficiency and safety of double-pole transformers. The technology automatically restores power after detecting transformer overloads and initiating a brief disconnection to guard against damage. Real-time defect notifications from SCADA integration allow for quick operator reaction and reduce downtime. This technology lowers maintenance costs, increases power distribution reliability, and guards against transformer failure and overheating.

Keywords :- Automated re-closure, PLC, SCADA, transformer overload, power distribution, fault detection, reliability, real-time monitoring, predictive maintenance.

I. INTRODUCTION

Transformers play a vital role in the power distribution network by scaling down high-voltage electricity to levels that residential, commercial, and industrial users may safely utilise. Despite their significance, transformers are susceptible to a number of failure types that can cause major power supply disruptions, such as overloads, short circuits, and environmental variables.

These malfunctions lead to costly repairs and replacement of damaged infrastructure in addition to prolonged outages. Users may experience extensive inconvenience as a result of such issues, and utility corporations may incur financial losses.

This project suggests creating an Intelligent Re-closure Automation for Air Break Switches in order to overcome these difficulties. By identifying issues such as overloads or short circuits in real time and automating the response with a programmable logic controller, the technology is intended to safeguard transformers. When a fault arises, the system will detect it immediately and take preventative action, such disconnecting the transformer to stop additional damage.

The system uses GSM technology to give real-time fault notifications in addition to fault detection and protection. As soon as a problem is found, a mobile communication alert is sent to the appropriate authorities, allowing for quick action and reducing downtime.

The system is built to run on solar power to increase its dependability and guarantee continuous operation even in the event of a power loss. Because of its solar-powered architecture, the system is ideal for isolated locations where maintenance crews may find it difficult to reach due to power outages.

The system also has integration for SCADA and GPS. Maintenance crews can swiftly identify and fix malfunctioning transformers thanks to the GPS module's ability to pinpoint their precise location. The overall effectiveness of maintenance procedures is increased by SCADA's centralized monitoring and control, which also offers real-time visibility of the system's operational state and fault alarms.

II. PROBLEM STATEMENT

When transformer faults are managed manually, there is a delay, more downtime, and operational dangers. Overloading frequently results in transformer damage; these factors raise maintenance expenses and inefficiency in power distribution networks. An integrated system is absent from current solutions. Operators would also be burdened more by automated re-closure, real-time defect identification, and alerts.

III. LITERATURE SURVEY

The current literature on automated fault detection and isolation systems—especially those that make use of PLC and SCADA technologies—is reviewed in this review. It emphasizes techniques like load control, re-closure systems, and thermal protection that can stop transformer overloading. It is also investigated how well fault location alerting systems work to improve reaction times and decrease downtime.

1. **Conventional Systems and Air Break Switches (ABS):** In power distribution systems, ABS are manually operated, which causes delays in service restoration and fault isolation. This has made automation necessary to cut down on downtime.

2. PLC's Role in Automation: PLC's are essential to automated power systems because they allow for real-time fault processing and quicker protective measures like fault isolation and reclosing.

3. SCADA Systems: SCADA ensures effective fault management and system control by offering centralized monitoring, real-time data, and operator warnings.

4. Automation of Re-closure Systems: With little operator intervention, automated re-closure methods have proven essential in minimizing outage periods caused by transient defects.

5. PLC and SCADA Integration: By combining PLCs with SCADA systems, reliability and operational efficiency are increased through remote control, predictive maintenance, and quick fault identification.

6. Arduino Nano in Automation: The Arduino Nano improves system responsiveness by providing flexible and affordable electrical parameter monitoring.

7. GSM Module for Communication: By providing real-time fault notifications, the GSM module minimizes downtime and enables prompt operator replies.

8. Challenges and Prospects for the Future: Although problems like cost and the integration of legacy equipment still exist, future solutions are promised by developments in protocols like IEC 61850 and the emergence of smart grids.

IV. METHODOLOGY

1. Problem Identification: Determine the difficulties in operating manual transformers, such as overload damage, delayed fault detection, and expensive maintenance.

2. Component Selection: Select the necessary hardware, such as the Arduino Nano, GSM800L module, DC actuator, Delta PLC (DVP14SS), current sensors, and SCADA software (Wonderware InTouch).

3. Hardware Development: Incorporate GSM for remote warnings, relay circuits to regulate actuator operations, and existing sensors to track load conditions. Connect parts to achieve smooth automation.

4. Firmware Development: Set up the PLC for automatic re-closure, actuator control, and fault detection. Send notifications in real time by using an Arduino Nano with GSM connectivity.

5. SCADA Integration: Create a remote monitoring and control interface that lets users alternate between human and automated operations.

6. Data Processing & Analysis: Using PLC logic, assess sensor data to determine normal and overload conditions and initiate the appropriate actions (alarm, disconnection, reclosure).

7. Alert & Display Mechanism: Use GSM SMS alerts, indicator LEDs, and a buzzer to detect faults in real time and notify operators.

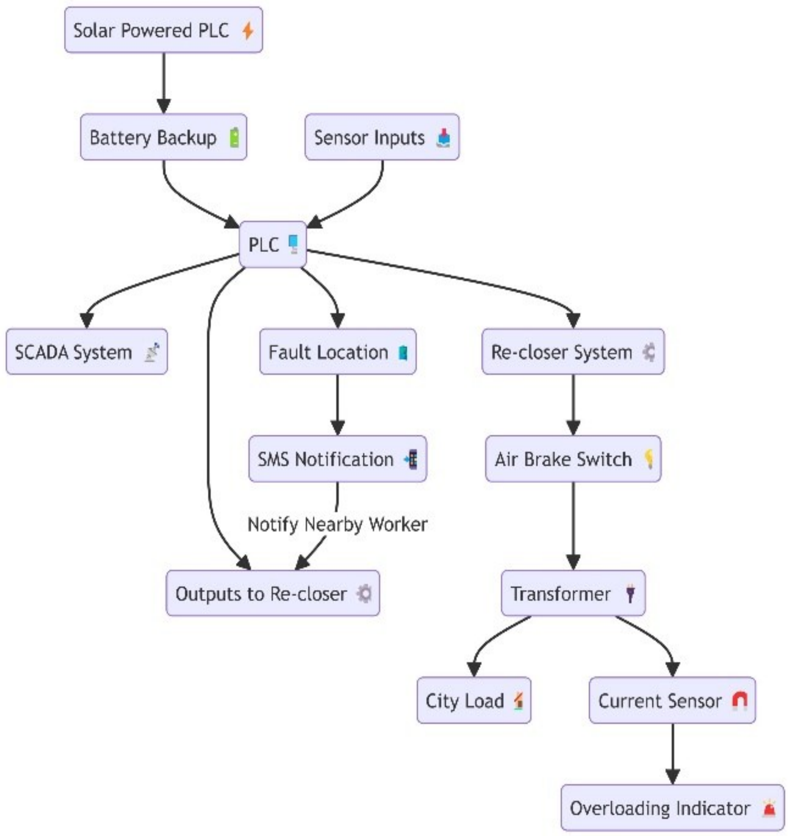
8. Test and Calibration: Verify the accuracy of the current sensor, the PLC program's operation, and the actuator's response time in both normal and overload scenarios.

9. Deployment & Optimization: Set up the system on an actual distribution transformer, adjust the automated re-closure logic, and optimize sensor thresholds.

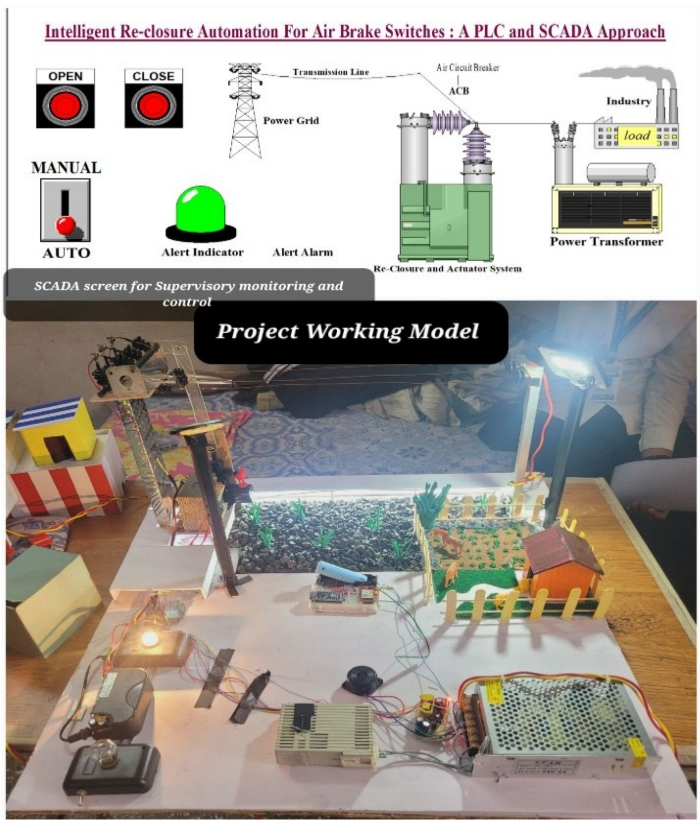
10. Report & Documentation : Prepare a final report detailing system performance, advantages, challenges, and future scalability for grid reliability improvement.

IV. MODELING AND ANALYSIS

1. System Architecture



2. Prototype model and SCADA screen :



The process flow used by the transformer overload prevention system is as follows:

1. Normal Operation: Using current transformers (CT), the system continuously checks the output load of the transformer. The SCADA system shows real-time data for supervisor monitoring.

2. Overload Detection: The current sensors identify the overload state when the load surpasses the transformer's capacity, and the PLC receives a signal to start corrective action.

3. Buzzer Activation: To notify surrounding staff of the overload, the PLC activates a buzzer, which sounds for ten seconds to give an instant warning.

4. SMS Alert: The Arduino Nano receives the overload signal and turns on the GSM module. For quick maintenance response, the operator receives an SMS alert with the location and problem details.

5. Circuit Breaker Operation: The PLC simultaneously activates an electromechanical actuator to open the air break switch (circuit breaker), disconnecting the transformer from the line and preventing damage from the overload.

6. SCADA Update: The SCADA system is updated to reflect the breaker status and the active overload alarm, allowing the supervisor to monitor the situation remotely.

7. Re-Closure Mechanism: After a 10-second delay, the PLC automatically attempts to reclose the air break switch. If the overload persists, the process repeats; if the load normalizes, the system resumes normal operation.

8. Manual Mode (Optional): In manual mode, automatic re-closure is disabled, and the technician manually controls the re-closure via the SCADA system.

Implementation: This technology can be employed in industrial settings or substations that use double-pole transformers. It enhances system reliability by offering a completely automated solution for transformer protection, overload detection, and real-time monitoring. While automated procedures minimize downtime and guard against transformer damage, the manual mode's flexibility guarantees that operators can step in if necessary.

3. Component List :

1. Delta PLC (DVP14SS)
2. 24V 5A SMPS Power Supply
3. 12V 2A Power Supply
4. Current Sensor Circuit
5. Relay Circuit
6. DC Actuator
7. Air Break Switch Mechanism
8. Buzzer and Indicator Lamps
9. Arduino Nano
10. GSM800L Module
11. SCADA Software (Wonderware InTouch)
12. Transformer (12V 5A)
13. Load Components (2A bulb, mist maker, LED strip, 4A bulb)

4. Advantages :

1. Automatic fault detection
2. Enhanced safety & reduced downtime
3. Remote monitoring via GSM & SCADA
4. Cost-effective & scalable for smart grids
5. Prevents overload damage & detects theft

5. Application :

1. Power distribution & rural electrification

2. Smart grids & renewable energy
3. Industrial & infrastructure projects
4. Electricity utilities & high-risk zones

V. FUTURE SCOPE

1. IoT & AI Integration – Smart monitoring with predictive maintenance.
2. Cloud-Based Data Analytics – Real-time performance tracking & historical analysis.
3. Renewable Energy Adaptation – Integration with solar & wind power grids.
4. Enhanced Fault Detection – AI-driven fault classification & quicker response.
5. Scalability for Smart Cities – Widespread automation in urban power distribution.
6. Mobile App Integration – Remote control & monitoring via smartphones.

VI. REFERENCES

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