

Short Circuit Fault Detection and Automated Reporting System for Power Utility Using Stm32 and Lora in Distribution Line

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Abstract- Short circuit faults in electrical distribution lines result in excessive current flow, equipment damage, safety hazards and prolonged power outages if not detected and reported promptly. This paper presents a short circuit fault detection and automated reporting system for power utilities using an STM32 based control system and LoRa communication technology. Line current is continuously monitored using an ACS712 current sensor and the controller analyzes the sensed data to identify abnormal current conditions indicative of a short circuit fault. Upon fault detection, a solid state relay is activated to isolate the affected section of the distribution line, thereby preventing further damage. Simultaneously, fault information is transmitted wirelessly through a LoRa (SX1278) module to the utility monitoring unit. The received data is processed and the fault status is displayed to enable rapid maintenance action. The proposed system reduces fault detection time, minimizes manual inspection and enhances the reliability and safety of modern power distribution networks.

Keywords: Short circuit fault detection, STM32 controller, ACS712-30A, LORA, Power distribution system, Automated fault reporting.

I. INTRODUCTION

Electrical power distribution systems play a vital role in delivering reliable electricity to consumers however, short circuit faults remain one of the most common and severe disturbances in distribution networks. Such faults result in excessive current flow, leading to equipment damage, safety hazards and prolonged power outages if not detected and isolated promptly. Conventional fault detection methods depend largely on manual inspection and centralized protection schemes, which often cause delayed fault identification and increased system restoration time. With the rapid advancement of embedded systems and wireless communication technologies, intelligent fault monitoring

solutions have gained significant importance in modern power systems. Microcontroller based protection systems provide fast decision making, adaptability and cost effective implementation, while wireless communication enables remote monitoring and automated fault reporting without the need for complex wired infrastructure. In this

context, this work proposes an embedded short circuit fault detection and reporting system using an STM32 controller and LoRa communication technology, where line current is continuously monitored, faulty sections are automatically isolated and fault information is transmitted to the control unit. The proposed approach enhances system reliability, reduces maintenance time and improves the overall safety of power distribution networks.

II. RECENT WORKS

Abhin et al. (2024) proposed an IoT based line breakage detection and alerting system for overhead distribution networks. The approach uses continuous sensor monitoring and embedded processing to automatically identify line breakage faults. Upon detection, alerts are sent wirelessly to a remote monitoring unit, enabling faster maintenance response. The results show improved fault awareness and reduced manual inspection time, highlighting the benefits of automated sensing and communication in power distribution fault management.

Sarwar et al. (2020) developed an intelligent fault detection scheme for high impedance faults in distribution systems. The technique combines current and voltage sensor signals with machine learning algorithms to detect faulted conditions. Results on test systems confirm improved detection accuracy under varying load conditions, demonstrating effectiveness in real time fault classification.

Nguyen et al. (2022) used spatial temporal neural networks for fault diagnostics in distribution networks. By analyzing voltage and current waveforms with graph neural structures, the model accurately detects, classifies and locates faults. The approach improves performance over conventional methods, especially in networks with complex topology. The results demonstrate high detection accuracy under varying load and fault conditions, making the method suitable for modern smart distribution systems.

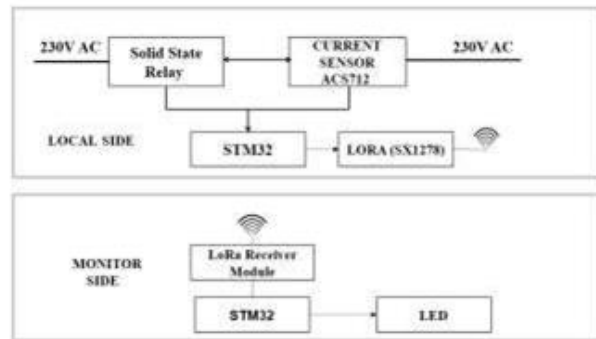
Herrada et al. (2023) applied LSTM recurrent neural networks to detect faults in distribution networks using real time current measurements. The model accurately detects anomalies without synchronization or voltage magnitude integration. Results demonstrate the potential of deep learning in real time protection applications.

Zhang et al. (2023) proposed an embedded sensor network using low cost microcontroller for underground distribution monitoring. Real time current signals were processed to detect and locate faults. Experimental tests showed improved fault identification accuracy and reduced response time.

III. PROPOSED WORK EXPLANATION

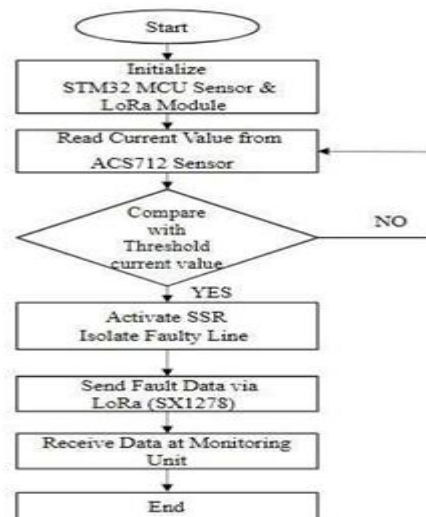
The proposed system implements a short circuit fault detection and automated reporting solution for electrical distribution lines using an STM32 based embedded control system and LoRa wireless communication. Line current is continuously monitored through an ACS712 current sensor connected to the distribution line and the sensed data is processed by the controller by comparing it

with predefined threshold values to identify abnormal conditions. When a short-circuit fault occurs, the controller activates a solid-state relay to isolate the faulty section of the line, thereby preventing equipment damage and ensuring operational safety. Simultaneously, fault information is transmitted wirelessly using a LoRa (SX1278) module to the monitoring unit, where the received data is processed and displayed for quick identification and maintenance action by utility personnel. This integrated approach reduces fault detection time, minimizes manual inspection and enhances the reliability and safety of modern power distribution networks.



Block diagram

Figure 1 block diagram of proposed system



flow chart

Figure 2 flow chart of proposed system

Hardware Implementation

STM32

The hardware implementation of the proposed system is developed using an STM32 microcontroller as the main control unit. All peripheral components are interfaced with the controller to enable real time current monitoring, fault detection, line isolation and remote fault reporting. The complete hardware setup is designed to ensure reliable operation under normal and fault conditions.



Figure 3 STM32

ACS712 current sensor

The ACS712 current sensor is connected in series with the distribution line to continuously sense the line current. The analog output of the sensor is interfaced with the ADC pin of the STM32 microcontroller. The controller continuously monitors the sensed current and compares it with a predefined threshold value of 5 A to detect short circuit faults.



Figure 4 ACS712 sensor
SSR -40DA

Upon detection of a fault, the STM32 generates a control signal to activate the solid state relay. The SSR is connected between the power line and the load to isolate the faulty section immediately, thereby protecting the system from further damage and improving operational safety.



Figure 5 solid state relay

LoRa SX1278

For remote fault reporting, a LoRa SX1278 module is interfaced with the STM32 for wireless transmission of fault information. The transmitted data is received by a LoRa receiver unit at the monitoring side and displayed on a display or alert unit, enabling the lineman to quickly identify the fault location and take corrective action.



Figure 6 LoRa SX1278

power supply

A regulated power supply is used to provide the required operating voltages to the STM32 controller, current sensor, relay and LoRa modules. The integrated hardware implementation ensures fast fault detection, effective line isolation, and reliable long range communication, demonstrating the practical feasibility of the proposed system.



Figure 7 5V Power Supply

LED display

The display unit provides clear visual information about the operating status and fault condition of the distribution line. An LCD display interfaced with the receiver side controller shows real-time system status during normal operation and displays fault details such as current magnitude and fault location or pole identification when a short circuit occurs. By presenting fault information locally, the display unit enables quick understanding by maintenance personnel, reduces response time and improves the reliability and efficiency of the power distribution system.



Figure 8 LED Display

Mathematical Expressions and Symbols

The short circuit fault detection logic is based on a threshold current comparison technique. The line current sensed by the ACS712 sensor is continuously monitored and processed by the controller. A short circuit fault condition is identified when the measured current exceeds a predefined safe operating limit, as expressed by the following relation:

$$I_{Measured} > I_{threshold}$$

where $I_{measured}$ represents the instantaneous line current and $I_{threshold}$ denotes the maximum permissible current under normal operating conditions. When this condition is satisfied, the control unit initiates protective actions by isolating the faulty section of the distribution line and transmitting fault information to the monitoring unit.

IV. RESULTS AND DISCUSSION

The proposed STM32 and LoRa based short circuit fault detection and automated reporting system was successfully implemented and evaluated under various operating conditions. During normal operation, the ACS712 current sensor continuously monitored the line current, which remained below the preset threshold of 5 A, allowing uninterrupted power flow and stable system operation. When a short circuit fault was introduced, a sudden rise in current beyond the threshold was detected in real time by the STM32 microcontroller. The controller immediately activated the solid state relay to isolate the faulty section, effectively preventing further damage to the system. At the same time, detailed fault information, including fault status, current magnitude and pole wise identification with four-pole indication, was transmitted wirelessly using the LoRa SX1278 module. The receiver unit successfully received and displayed the fault alert, enabling rapid identification of the fault location by maintenance personnel. The discussion of results confirms that the proposed system provides fast fault detection, reliable long range communication and effective line isolation, significantly reducing fault response time and manual inspection effort while improving the safety, reliability and operational efficiency of overhead power distribution networks.

Preparation of Figures and Tables

Figures and tables are prepared to clearly present the design, implementation and performance of the proposed Short Circuit Fault Detection and Automated Reporting System for Power Utility Using STM32 and LoRa in Distribution Line. All figures and tables are numbered consecutively in the order of their appearance and are properly referenced within the text. Figure captions are placed below the figures, while table captions are placed above the

tables in accordance with IEEE formatting guidelines. The block diagram, flow chart, and hardware implementation diagrams are prepared with clear labeling, uniform font size and adequate resolution to ensure readability.



Figure 9: Hardware Implementation

Formatting Tables

Tables are used to present component specifications, system parameters, threshold values and experimental results in a concise and structured manner. Each table includes descriptive column headings and appropriate units for numerical data. Consistent formatting is maintained throughout all figures and tables to enhance clarity and ensure a professional presentation of the proposed system.

Table 1: Specifications of components

Component Name	Specification / Rating
STM32	F103C8T6
Solid State Relay (SSR)	24–380 VAC, 40 A
Current Sensor	ACS712
LoRa Module	SX1278, 433 MHz
LED Display	I2C, 16*1
12 DC Adapter	2 V, 2 A

V. CONCLUSION

The proposed Short Circuit Fault Detection and Automated Reporting System for Power Utility Using STM32 and LoRa in Distribution Line has been successfully designed and implemented to enhance the reliability and safety of power distribution networks. The system continuously monitors line current using an ACS712 current sensor and

performs real time fault detection through the STM32 microcontroller. When a short circuit fault occurs, the controller immediately activates the solid-state relay to isolate the faulty section, thereby preventing further damage and improving system protection. Simultaneously, fault information is transmitted wirelessly using LoRa communication to a remote monitoring unit, enabling quick identification of the fault location by maintenance personnel. The experimental results confirm that the proposed system provides fast fault detection, reliable long range communication and effective automated reporting, significantly reducing fault response time and manual inspection efforts. Overall, the system offers a practical and efficient solution for modern power utility applications in distribution lines.

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