

# Smart monitoring Smart Monitoring & Fault Detection System for Power Transmission Lines using digital sensors

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## ABSTRACT

Now a days transmission line protection is a key problem in power transmission lines because (85-87) Percentage of power system disturbances are occurring in transmission lines. Identification of fault source is tedious task; fast fault detection can help to protect the equipment before any significant damage of the equipment. The exact fault location can help service man to remove persistent of the faults and locate the areas where the faults occur regularly, thus reducing the occurrence of Fault and minimize the time of power outages. This project proposes an advanced method for detecting and locating faults using real-time data acquisition via sensors interfaced with a ESP32 (microcontroller) and signal analysis. The system continuously monitors voltage levels, identifies abnormal conditions during a fault, calculates the fault location and ensures accurate fault classification (L-G, L-L, L-L-G, L-L-L) displays it on a 16x2 LCD., and an LCD display will Indicate the status of the transmission lines and buzzer will sound when fault is detected. This solution offers a cost-Effective and efficient method to improving response time, reducing downtime and improve the reliability of power transmission networks.

**Keyword :** - ESP32 Microcontroller, Transmission Line Fault Detection, Three-Phase System, Real-time Monitoring, Fault Classification, Wireless Sensor Network (WSN).

## 1. INTRODUCTION

Electrical power systems rely on transmission lines to deliver electricity over long distances, but these lines are prone to faults such as open circuits, short circuits, and earth faults. While underground cables offer protection from environmental damage, finding faults in them is difficult and often costly. This project introduces a smart Fault detection system using IoT technology and an ESP32 Microcontroller. It continuously monitors voltage levels, detects irregularities during faults, and displays the distance of fault Location with ESP32 on an LCD. This method enables faster Fault identification, reduces maintenance time, and Improves the reliability of power distribution systems.

## 1.1 OBJECTIVES

1. To design and simulate a fault detection system using a Programmable controller for overhead lines.
2. To monitor line conditions with ESP32 and ensure quick fault response.
3. To locate faults using ESP32 and send alerts to users.
4. To test system accuracy by introducing faults at different locations.

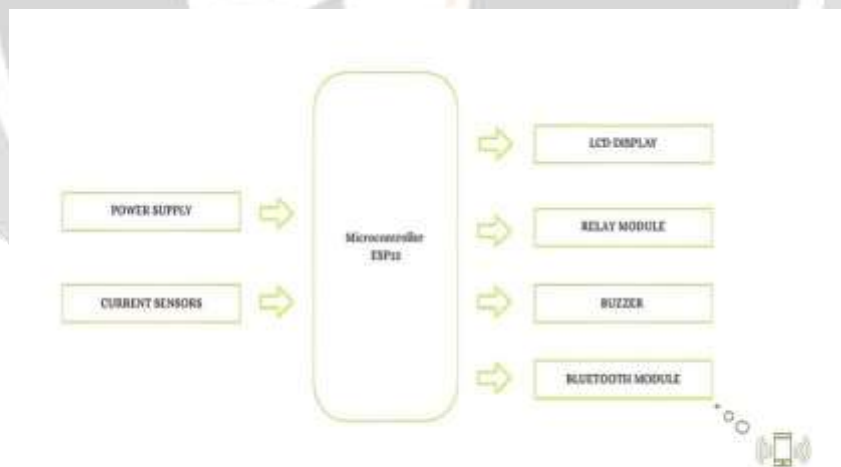
## 1.2 LITERATURE REVIEW

Transmission line fault detection is an important part of power systems to ensure safe and reliable electricity supply. Many researchers have developed different methods to detect faults such as line-to-ground, line-to-line, and three-phase faults. Advanced techniques like Wavelet Transform and Fourier Transform are used to analyze electrical signals, but they are complex and costly. Recent studies focus on low-cost systems using microcontrollers like Arduino IDE, where voltage and current signals are analyzed using simple methods like threshold comparison. These systems can detect and classify faults effectively and provide real-time results. Therefore, Arduino-based fault detection is a simple, cost-effective, and efficient solution.

## 2. SYSTEM DEVELOPMENT

The proposed system is designed to efficiently detect and locate faults in overhead transmission lines and provide realtime fault information using IoT technology. It consists of the following major components:

### 2.1 BLOCK DIAGRAM



**Fig -1:** Block Diagram

## 2.2 HARDWARE DESIGN

The hardware design of the system is divided into the following three major subsystems:

### 2.2.1 POWER SUPPLY SYSTEM

The power supply system plays a crucial role in ensuring the reliable and efficient operation of the entire hardware setup. In this work, a 9v,DC power supply serves as the primary source of power for all connected components. The power distribution in the system is as follows:

1. Relay Modules: Powered directly by the 3.3v or 5v supply for switching operations.
2. Microcontroller (ESP32): Operates at 3.3V.
3. INA 219 Current Sensors: Requires 3.3 - 5V, supplied from battery.
4. Liquid Crystal Display: Requires 4.7-5.3v, supplied from ESP32.

### 2.2.2 FAULT ISOLATION SYSTEM

The fault isolation system is designed to detect and manage faults by isolating faulty sections and ensuring the safe operation of the system. The components and processes involved are as follows:

- Relay: Automatically cuts the power when fault occurs → Provides protection and isolation.
- Buzzer: Makes beeping sound when fault occurs → Provides immediate audio alert.

### 2.2.3 LOCATION TRACKING AND DISPLAY SYSTEM

The Location Tracking and Display System facilitates real-time fault reporting and communication. The ESP32 module transmits messages to the user, providing details about the fault type and its location, ensuring constant monitoring of the system's status and allowing for quick intervention.

Locally, a 16x2 LED display is used to show critical information such as fault status, operational details, and location information directly to the user. This enables effective on-site monitoring and helps in managing the system efficiently.

### 3. CIRCUIT DIAGRAM

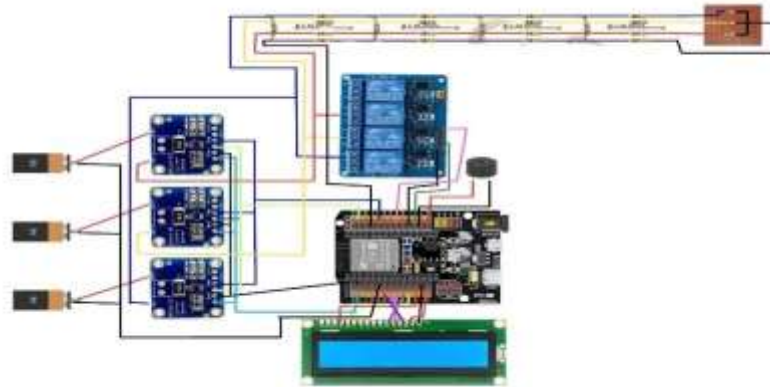


Fig -2: Circuit Diagram

### 4. FLOW CHART

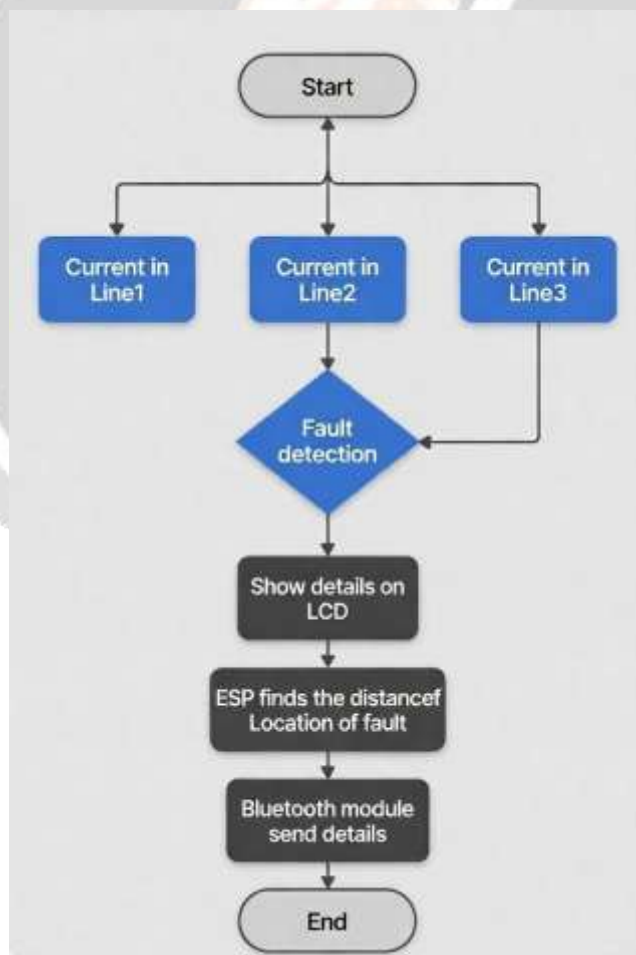


Fig -3: Flow Chart

### 5. PERFORMANCE ANALYSIS

This system provides an efficient solution for real-time fault detection and isolation in power transmission lines. Fault conditions are identified through manual switching, with immediate isolation achieved via controlled relay activation. Upon fault detection, an automated message is sent to the user, detailing the type and location of the issue, ensuring rapid response and enhanced system safety. Local status and fault information are displayed instantly, enabling on-site monitoring without the need for external tools.

The system offers significant improvements over traditional fault detection methods by integrating automated isolation, instant remote fault alerts, and on-site status indication. This approach minimizes downtime, enhances operational reliability, and reduces the risks associated with prolonged faults in transmission networks. Its modular, energy-efficient, and scalable design makes it suitable for both urban and remote applications, ensuring reliable performance and effective fault management.

### 6. RESULTS



Fig -4: L-G Fault



Fig -5: L-L Fault



Fig -6: LL-G Fault



Fig -7: LLL-G Fault

## 7. APPLICATIONS

1. Fault Detection and Isolation: Detects and isolates faults instantly.
2. Remote Monitoring and Control: Monitors and controls faults via Bluetooth or wifi.
3. Rural and Remote Area Monitoring: Enables fault alerts in remote areas.
4. Emergency Response and Disaster Management: Assists in quick fault handling during disasters.
5. Smart Grid technology, power transmission line protection, and industrial power monitoring.

## 8. CONCLUSION

Conventional transmission line protection systems often struggle with delayed fault identification and limited communication capabilities, especially in distributed or remote networks. This work addresses these challenges by developing a real-time fault monitoring and isolation system utilizing microcontroller-based control, automatic relay operation, and wireless communication.

The proposed system effectively detects and isolates faults with relay modules ensuring safe disconnection of faulty sections. Fault details, including type and specific location, are promptly transmitted to the user via wifi Or bluetooth messaging, providing immediate remote awareness. Additionally, operational status and fault notifications are displayed locally using a 16×2 character display, improving on-site responsiveness.

By integrating real-time communication, local indication, And automated isolation, this system enhances reliability, reduces downtime, and offers a cost-effective, scalable solution for improving safety in power transmission networks.

## 9. REFERENCES

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