International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

# Industrial Fault Detection System

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**Abstract**

This project presents an industrial fault detection system that monitors important electrical and environmental conditions to improve equipment reliability and safety. Using an ESP32 microcontroller, the system checks for issues like fuse and Miniature Circuit Breaker (MCB) status, as well as under and over-voltage situations with a ZMPT101B sensor. It also tracks temperature and humidity levels using a DHT11 sensor. The system displays real-time information on a 16x2 LCD and can be accessed via a web page, allowing operators to monitor conditions from anywhere. By quickly detecting electrical faults and environmental changes, this system helps reduce downtime and maintenance costs.

**Keywords:** ESP32, 16x2 LCD, DHT11, ZMPT101B sensor

## INTRODUCTION

In modern industry, keeping equipment safe and reliable is very important. With machines becoming more complex, having a good monitoring system helps catch problems early and prevents costly breakdowns.

This project introduces an Industrial Fault Detection System that watches over key electrical and environmental conditions to make sure everything runs smoothly. Using an ESP32 microcontroller, the system checks if fuses and Miniature Circuit Breakers (MCBs) are working properly. It also monitors voltage levels with a ZMPT101B sensor and tracks temperature and humidity using a DHT11 sensor.

The DHT11 sensor is a popular choice for measuring temperature and humidity due to its simplicity and affordability. It provides digital output and can measure temperatures ranging from 0°C to 50°C with an accuracy of ±2°C, while humidity levels are measured from 20% to 90% with an accuracy of ±5%. This sensor is compact and easy to integrate into projects, making it ideal for real-time environmental monitoring in industrial settings.

Real-time information is shown on a 16x2 LCD screen, and operators can also access the system through a web page to keep an eye on things from anywhere. By quickly identifying electrical issues and changes in the environment, this system helps reduce downtime and lower maintenance costs, making it a valuable tool for improving safety and efficiency in industrial settings.

## SYSTEM DESIGN

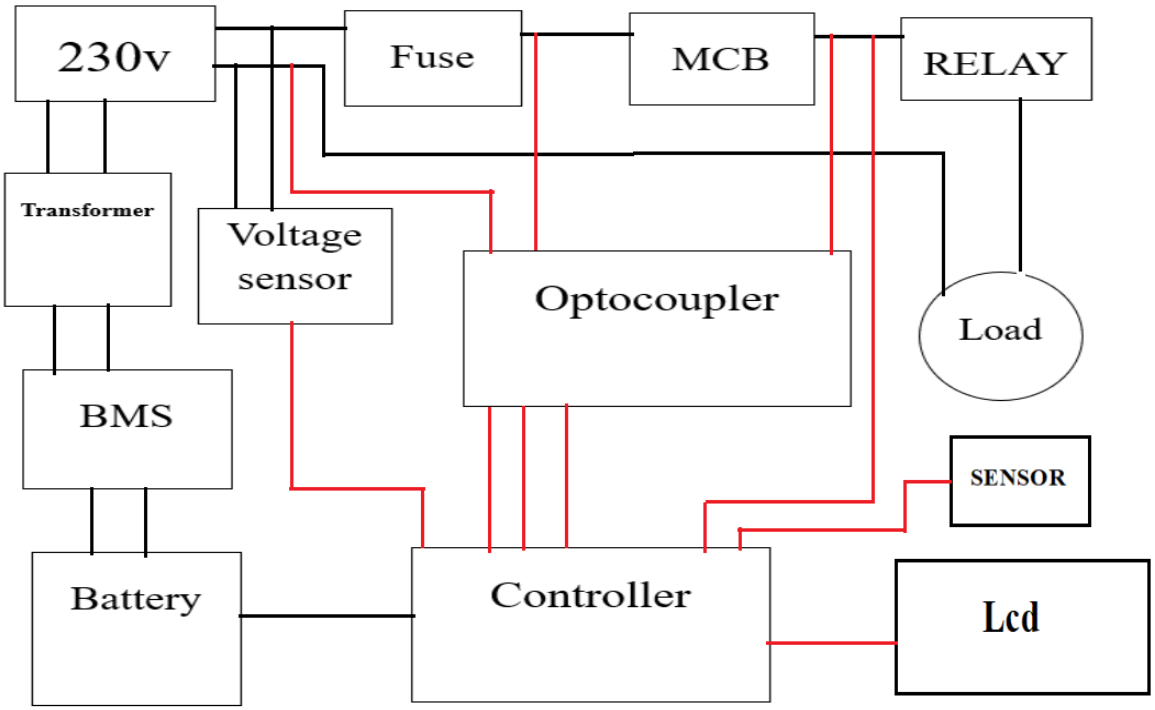



**Fig. Industrial fault detection system block diagram**

This block diagram represents an Industrial Fault Detection System. The purpose of this system is to detect, isolate, and take corrective actions during electrical faults in an industrial environment, ensuring safety and preventing damage to equipment.

1. **230V AC Supply:** The main electrical power source, providing 230V AC to power the industrial system and the fault detection components.
2. **Fuse:** Protects the system by breaking the circuit in the event of an overcurrent, safeguarding against electrical faults.
3. **MCB (Miniature Circuit Breaker):** Automatically disconnects the circuit in the case of overload or short circuits, providing additional protection alongside the fuse.
4. **Relay:** The relay isolates or connects the industrial load to the power supply. It is controlled by the central controller and disconnects the load during fault conditions.
5. **Load (Industrial Equipment):** Represents the industrial equipment or machinery powered by the system. It is protected from electrical faults, temperature, and humidity extremes through the relay and sensors.
6. **Optocoupler:** Provides electrical isolation between high-voltage sections and low-voltage control circuits, protecting the controller from electrical surges and interference.
7. **Transformer:** Steps down the 230V AC to a lower voltage to power the controller and other low-voltage components. It also powers the Battery Management System (BMS) for maintaining battery health.
8. **Battery Management System (BMS):** Manages the battery by ensuring safe charging and discharging. The BMS allows the system to run on battery power during power outages, ensuring continuous fault detection.

**CONSUMABLES REQUIRED**

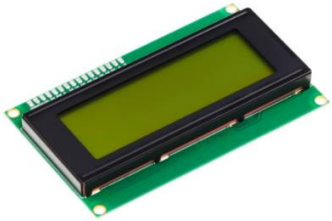
**ESP32:**

The **ESP32** is a powerful microcontroller that is widely used in various electronic projects, especially in IoT (Internet of Things) applications. Here are some key features and benefits of the ESP32, explained in simple language:

**Dual-Core Processor**: The ESP32 has two processing cores, which means it can handle multiple tasks at once. This makes it fast and efficient for running complex applications.

**Built-in Wi-Fi and Bluetooth**: One of the standout features of the ESP32 is that it has both Wi-Fi and Bluetooth built in. This allows it to connect to the internet and communicate with other devices wirelessly, making it ideal for smart home projects and other connected applications.

**16X2 LCD DISPLAY**



The 16x2 LCD display is a popular component used in many electronics projects. Here's a simple overview of what it is and how it works:

**What It Is**: The 16x2 LCD is a screen that can display up to 16 characters per line and has two lines. So, it can show a total of 32 characters at once.

**How It Works**: Each character on the display is made up of a 5x8 grid of tiny dots. When you send data to the LCD, it lights up specific dots to form letters, numbers, and symbols.

**Easy to Use**: It connects easily to microcontrollers like the ESP32 or Arduino. You can control it with just a few lines of code, making it beginner-friendly.

**Backlight Option**: Many 16x2 LCDs come with a backlight, allowing you to see the display clearly in low light.

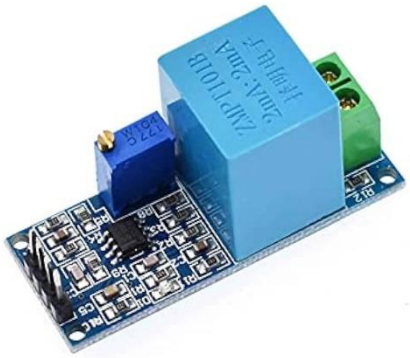
**DHT11 SENSOR**

The DHT11 sensor is a widely used, cost-effective tool for measuring temperature and humidity, making it popular among hobbyists and in various projects related to environmental monitoring. Its ease of use and low power requirements make it ideal for many applications.

**Features:**

Measures temperature (0 to 50°C)
Measures humidity (20% to 80% RH)
Digital output for easy interfacing
Low power consumption

**ZMPT101B VOLTAGE SENSOR**



The ZMPT101B is a voltage sensor module commonly used in various electrical and electronic applications. Here's some key information:

**Features:**

Voltage measurement range: 0-250V AC (50/60Hz)
Output voltage: 0-5V DC (proportional to input voltage)
High accuracy: ±1% FS (full scale)
Low power consumption

## CONCLUSION

In conclusion, this industrial fault detection system using the ESP32 microcontroller is a valuable tool for monitoring key electrical and environmental conditions. By checking the status of fuses, circuit breakers, and voltage levels, as well as tracking temperature and humidity, the system helps keep equipment running smoothly. Operators can easily see real-time information on a 16x2 LCD screen or access it through a web page, allowing them to respond quickly to any issues. This approach not only reduces downtime but also cuts maintenance costs, making operations more efficient and safer. Overall, this project shows how smart technology can improve industrial monitoring and management.

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