IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 18, April 2026
Impact Factor: 8.2

Three Phase Fault Analysis With Auto Reset On Temporary Fault And Permanent Trip

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Abstract: *A three-phase fault is one of the most severe types of faults in a power system, causing large currents and significant system disturbances. This project focuses on the analysis of three-phase faults along with an intelligent protection mechanism that differentiates between temporary and permanent faults. The system is designed to automatically reset the supply in case of temporary faults, such as lightning or momentary line disturbances, thereby improving system reliability and reducing downtime. However, in the case of permanent faults, such as equipment failure or line breakage, the system ensures a complete trip to protect electrical components from damage. The proposed model enhances the efficiency, safety, and continuity of power supply by integrating fault detection, classification, and automated control mechanisms. This approach is highly useful in modern power systems where uninterrupted power and quick fault recovery are essential.*

Keywords: *three-phase fault*

I. INTRODUCTION

In modern electrical power systems, maintaining continuous and reliable power supply is very important for industries, commercial buildings, and domestic consumers. Any interruption in the power system due to faults can cause equipment damage, financial loss, and safety risks. Therefore, fault detection and protection are essential parts of every power system.

A fault in an electrical system is an abnormal condition that occurs when the normal flow of current is disturbed. Faults may be caused by insulation failure, lightning strikes, short circuits, equipment malfunction, overloading, or damage to transmission and distribution lines. These faults produce excessive current, which can overheat conductors, damage transformers, motors, generators, and may even lead to fire hazards.

Among all types of electrical faults, the three-phase fault is considered the most severe and dangerous fault. It occurs when all three phases of the system come into contact with each other, either directly or through a grounded path. This type of fault results in a very high fault current because the impedance of the fault path becomes very low. Due to this large current flow, the system voltage drops suddenly, causing major disturbances in the power network..

II. METHODOLOGY

The methodology of the proposed Three Phase Fault Analysis with Auto Reset on Temporary Fault and Permanent Trip is divided into design, modeling, implementation, and testing phases to ensure a systematic and reliable approach .

The system continuously monitors the three-phase supply using current and voltage sensing devices like CTs, relays, and sensors. When a fault occurs, the fault current increases suddenly and the relay detects the abnormal condition. If the current exceeds the preset limit, the circuit breaker trips and disconnects the faulty section. The system then checks whether the fault is temporary or permanent.

DOI: 10.48175/IJARSCT-34399

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If the fault is temporary, such as lightning or momentary short circuit, the breaker automatically resets after a short delay and restores the power supply. If the fault remains after reset, it is treated as a permanent fault and the system performs a complete trip to protect equipment. Manual repair is required before restarting the system. This method improves safety, reliability, and continuity of power supply.

2.1 System Design Approach

The system is designed using a modular approach consisting of—

- Three-phase power supply monitoring unit
- Fault detection and protection unit (CT + Relay + Circuit Breaker)
- Fault analysis unit (Temporary and Permanent Fault Identification)
- Control unit (Microcontroller / PLC)
- Auto reset unit (Automatic Reclosing System)
- Indication and alert unit (LED / Display / Alarm)

2.2 Hardware Implementation

This step involves component selection, hardware installation, and prototype design. The main components used are step-down transformer, bridge rectifier, capacitor, ACS712 current sensor, relay modules, resistors, NodeMCU ESP8266, 16x2 LCD display with I2C, LEDs, 2N4401 NPN transistors, push button, piezo buzzer, and NEO-6M GPS module. These components work together to detect three-phase faults, control relay operation, provide auto reset for temporary faults, and ensure permanent trip for serious faults to protect the power system.

2.2.1 Arduino compiler

Arduino is a tool for making computers that can sense and control more of thephysical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

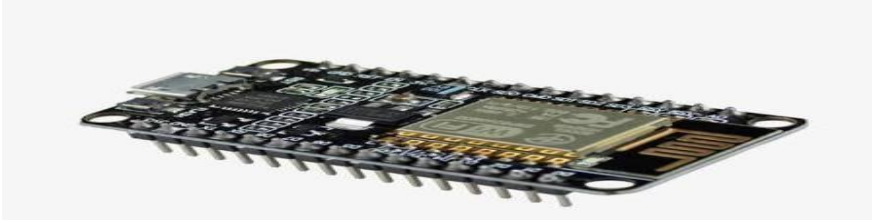

Fig..1 Arduino Compiler

2.2.2 35V 1000µF Capacitor (Electrolytic Capacitor)

A 35V 1000 microfarad (µF) capacitor is an electronic component used to store electrical energy in the form of an electric field. The value 1000µF represents its capacitance, meaning it can store a relatively large amount of charge, while 35V is its maximum voltage rating, indicating the highest voltage it can safely handle without damage. This type of capacitor is commonly used in power supply circuits, filters, amplifiers, and electronic devices to smooth voltage fluctuations and reduce noise.

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Fig..2 35V 1000µF Capacitor

2.2.3 ACS712 5A Current Sensor

The ACS712 5A current sensor is a compact electronic device used to measure both AC and DC current up to ±5 amperes. It is based on the Hall Effect principle, which allows it to sense current without direct electrical contact with the measuring circuit, providing isolation and safety.

This sensor produces an analog voltage output proportional to the current flowing through it, making it easy to interface with microcontrollers like Arduino, PLCs, and other digital systems. Due to its small size, low cost, and simple operation, it is widely used in power monitoring, battery management, and protection

Fig..3 ACS712 5A Current Sensor

2.2.4 Single Channel Relay Module

A Single Channel Relay Module is an important electronic component used in electrical and electronics systems to control a high voltage or high current device using a low voltage signal. It consists of one relay, which acts as an electrically operated switch, and is commonly used with controllers like Arduino Uno, PLCs, and other automation devices. This module provides a safe interface between low-power control circuits and high-power load circuits.

Fig..4 Channel Relay Module

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2.2.5 Buzzer

A −5V Piezo Buzzer is a type of electronic sound-producing component that operates using a negative voltage supply of 5 volts (−5V), meaning the polarity of the supply is reversed compared to the standard +5V supply. It is based on the principle of the Piezoelectric Effect, where certain materials (like piezoelectric crystals) generate mechanical vibrations when an electric voltage is applied, producing sound.

Fig..5 Buzzer

2.2.6 5 Ampere Bridge Rectifier

A 5 Amp bridge rectifier is used to convert AC voltage into DC voltage required for electronic circuits. It receives low AC voltage from the step-down transformer. It converts alternating current into pulsating direct current supply. The bridge rectifier is made using four diodes connected in bridge form. It provides proper DC power for NodeMCU, relays, sensors, and display units. It helps sensitive components work safely and efficiently. The rectified output is sent to the capacitor for filtering and smoothing. It improves voltage stability in the power supply section. It also prevents reverse current flow that may damage the circuit. Therefore, it is an important part of the fault detection and protection system.

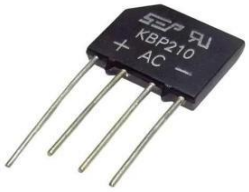

Fig..6 Bridge Rectifier

2.2.7 2 AMPERE STEP DOWN TRANSFORMER

2Ampere step-down transformer is used to reduce high AC mains voltage into low AC voltage for circuit operation.It converts the standard 230V AC supply into a lower voltage such as 12V or 24V AC.This low voltage is suitable for electrical and electronic components used in the project.

It provides a stable and safe power supply for relays, sensors, controllers, and display units.It protects sensitive components from direct high voltage damage.The output of the transformer is connected to the bridge rectifier for DC conversion.It plays an important role in the power supply section of the system.

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Fig..7 2AMPERE STEP DOWN TRANSFORMER

2.3 Research Design

The research design follows an experimental and applied approach to develop and test an IoT-based underground cable fault detection system. It focuses on real-time fault identification, distance estimation, and remote monitoring using NodeMCU, sensors, GSM/GPS, and LCD display for efficient power distribution management.

2.5 Literature Review

The literature review focuses on previous studies related to underground cable fault detection systems, IoT-based monitoring, and fault distance estimation techniques. Various methods such as bridge circuits, TDR (Time Domain Reflectometry), and resistance-based fault detection have been studied. Researchers have also used microcontrollers like Arduino and NodeMCU with GSM/GPS modules for real-time monitoring and fault alerts. These studies help in improving fault detection speed, reducing manual inspection, and increasing the reliability of underground power distribution systems.

2.6 Components Description

- NodeMCU (ESP8266): Controls the entire system and processes fault detection data.
- Resistors: Represent underground cable sections for fault distance calculation.
- Relay Module: Helps in switching operations and fault simulation.
- GSM Module: Sends fault alert messages for remote monitoring.
- GPS Module: Provides the exact location of the cable fault.
- I2C LCD Display: Shows real-time fault status and fault distance.
- LEDs and Buzzer: Give visual and sound indications during fault conditions.

2.7 Working principle

The system continuously monitors the three-phase power supply using current sensors and relays. When a fault such as short circuit or overcurrent occurs, the relay detects the abnormal current and trips the circuit breaker. If the fault is temporary, the system automatically resets and restores the power supply after a short delay. If the fault remains, it is treated as a permanent fault and the system performs a complete trip. LEDs, buzzer, and LCD display provide fault indication and system status.

Advantage

1 . Improves system reliability by auto-resetting after temporary faults.
2. Quickly detects and isolates permanent faults to protect the system.
3. Reduces manual intervention and maintenance work.
4. Ensures continuous and stable power supply with better safety.

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Application

1. Used in power distribution systems for fault detection and protection.
2. Applied in industrial electrical networks to protect machines and equipment.
3. Used in transformers and transmission lines for safe operation.

III. PROJECT DAIGRAM

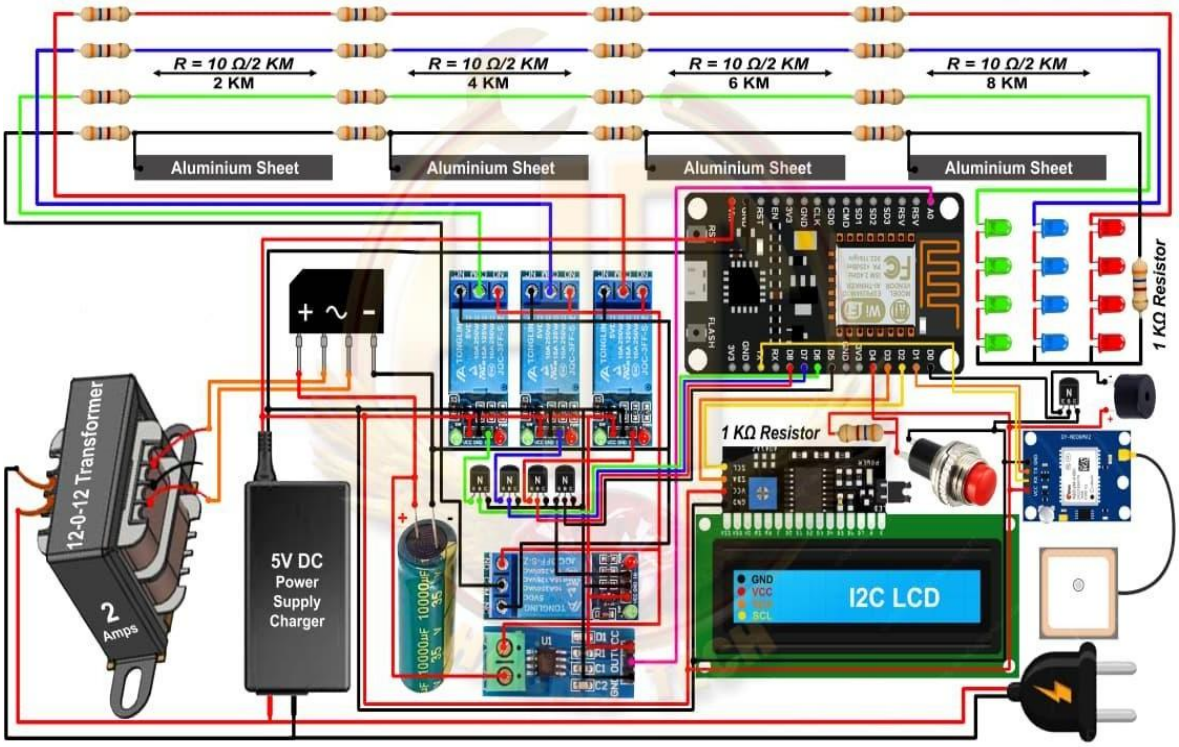

Fig.. Project Model

IV. CONCLUSION & FUTURE SCOPE

4.1 Conclusion

The three-phase fault analysis system with auto reset for temporary faults and permanent trip improves the safety, reliability, and efficiency of power systems. It ensures quick detection of faults and minimizes power interruptions by automatically restoring supply after temporary faults while isolating permanent faults.

4.2 Future Scope

In future, this system can be enhanced by integrating IoT and GSM for real-time remote monitoring and control. It can also be upgraded with AI-based fault prediction to prevent failures before they occur and improve smart grid automation.

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