

Underground Cable Fault Location and Identification using Arduino Based System

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DOI: 10.5281/zenodo.19306756

ABSTRACT

Underground cable systems are widely used in electrical power distribution networks due to their improved safety, reliability, and reduced exposure to environmental conditions. Although underground cables offer several advantages over overhead lines, fault detection and fault location remain challenging because the cables are not physically visible. Locating the exact position of a fault often requires extensive manual inspection and excavation, which increases repair time and cost.

This paper presents an Arduino-based underground cable fault location and phase identification system. The proposed system operates on the principle of voltage drop along the cable length. A resistive network is used to simulate the underground cable, and various fault conditions are created using switches. The Arduino Uno microcontroller processes voltage variations using its inbuilt analog-to-digital converter and determines the faulty phase along with the distance of the fault from the source end. The fault information is displayed on a 16×2 LCD. The system provides a simple, economical, and effective solution for underground cable fault detection in low-voltage distribution systems.

Keywords: - Underground cable fault, Arduino Uno, fault detection, fault location, power distribution system

1. INTRODUCTION

Electrical power distribution systems are increasingly adopting underground cables, especially in urban and industrial areas, due to their enhanced safety, reduced maintenance, and improved reliability. Underground cables are less affected by weather conditions and external disturbances compared to overhead transmission lines. However, fault detection in underground cables is a difficult task because the cable is buried beneath the ground and cannot be visually inspected.

Faults in underground cables may occur due to insulation failure, moisture ingress, overheating, aging, or accidental mechanical damage during excavation work. Conventional fault detection methods are time-consuming and often require skilled manpower and specialized equipment. In many cases, the exact fault location is unknown, resulting in unnecessary digging and prolonged power outages. Therefore, an efficient and reliable fault location system is essential.

2. PROBLEM STATEMENT

When a fault occurs in an underground cable, locating the exact position of the fault becomes a major challenge. Traditional methods involve testing and digging along the cable route, which increases repair time and cost. Lack of accurate fault location information leads to extended power outages and inconvenience to consumers. Hence, there is a need for a low-cost and automated system that can identify the faulty phase and estimate the distance of the fault from the source end.

3. OBJECTIVES

The main objectives of the proposed system are as follows:

- To detect faults occurring in underground cable distribution lines
- To identify the faulty phase among R, Y, and B phases
- To estimate the distance of the fault from the source station
- To display fault information clearly on an LCD
- To reduce fault detection time and maintenance cost

4. SYSTEM OVERVIEW

The proposed underground cable fault detection system is based on an Arduino Uno microcontroller using the ATmega328P processor. The system includes a fault sensing circuit, a resistive network representing

underground cable length, fault simulation switches, a relay driver circuit, a 16×2 LCD display, and a regulated power supply.

The resistive network simulates the underground cable, where resistance increases proportionally with cable length. Faults such as phase-to-ground and phase-to-phase faults are created using switches. The Arduino continuously monitors voltage variations across the resistive network and processes the data to determine fault location and faulty phase.

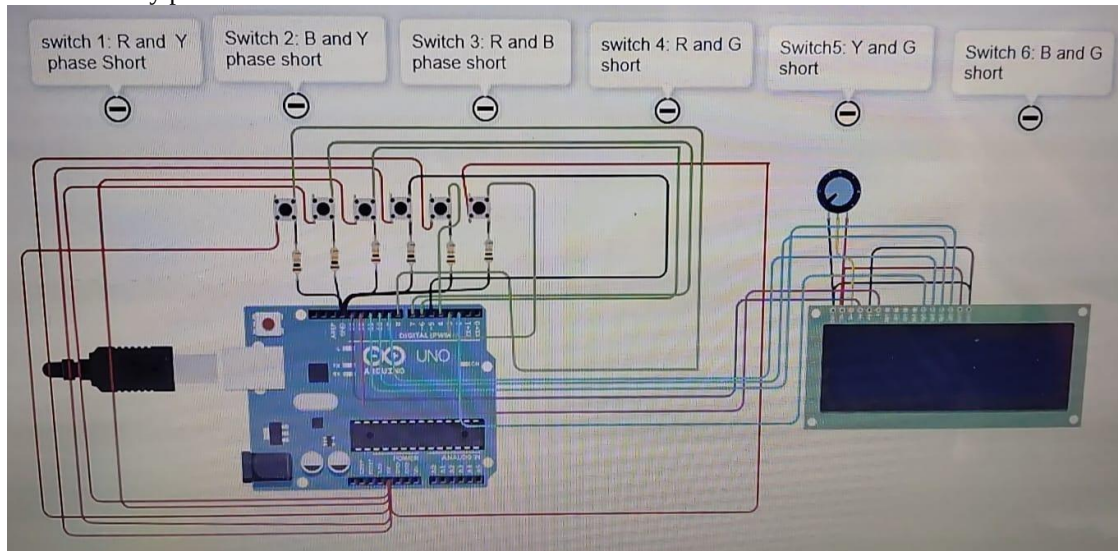


Fig. 1. Circuit diagram of Arduino-based underground cable fault location system

5. WORKING PRINCIPLE

The system operates on the principle that the resistance of a conductor increases with its length. Under normal operating conditions, voltage distribution across the cable remains uniform. When a fault occurs, the voltage at the fault point drops depending on the location of the fault.

The Arduino continuously monitors voltage levels for each phase through its analog input pins. When a voltage deviation is detected, the microcontroller calculates the approximate distance of the fault based on calibrated reference values. The faulty phase and distance are then displayed on the LCD.

6. TYPES OF FAULTS CONSIDERED

The system is designed to detect the following fault conditions:

Single line to ground fault Double line to ground fault Three-phase fault

These faults are commonly observed in underground cable distribution systems due to insulation breakdown or external damage.

7. RESULTS AND DISCUSSION

The system was tested under various simulated fault conditions by activating the corresponding switches. The Arduino successfully detected the faulty phase and displayed the fault distance on the LCD. The measured fault distance closely matched the actual fault position introduced in the resistive network.

Minor variations in readings were observed due to resistor tolerances, which can be minimized by using precision resistors and proper calibration. Overall, the system demonstrated reliable performance for laboratory-scale testing.

8. FUTURE SCOPE

Future enhancements may include extending the system for longer cable lengths, improving accuracy using advanced sensing techniques, and implementing automatic fault isolation mechanisms.

9. REFERENCES

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