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ONLINE MONITORING AND DETECTION OF FAULTS IN UNDERGROUND CABLES

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Abstract: In urban areas, electrical cables run underground instead of running over, because it does not affected by any adverse effect of weather such as heavy rainfall, snow, thunder storm. Whenever a fault occurs within the underground cable, it is difficult to detect the exact location of the fault for the repair process of particular cable. The proposed system found the point of the exact location of fault. This project is intended to detect the location of the fault in underground cable lines from the base station to exact location in kilometres using an Arduino micro controller kit. In the urban areas, the electrical cable runs in undergrounds instead of overhead lines. Whenever the fault occurs in underground cable it is difficult to detect the exact location of the fault for process of repairing that particular cable. The proposed system finds the exact location of the fault. This system uses an Arduino microcontroller kit and a rectified power supply. Here the current sensing circuits made with a combination of resistors are interfaced to Arduino microcontroller kit to help of the internal ADC device for providing digital data to the microcontroller representing the cable length in kilometres . The fault creation is made by the set of switches. The relays are controlled by the relay driver. A 16*2 LCD display connected to the microcontroller to display the information. In case of short circuit the voltage across series resistor changes accordingly, which is then fed to an ADC to develop precise digital data to a programmed Arduino microcontroller kit that further displays exact fault location from the base station in kilometres. In this project we used IOT thing speak for monitoring. We can monitor through our android phone the WIFI IOT.

Index Terms - Arduino microcontroller, LCD, ADC, Cable Fault, Relay, IOT.

I. INTRODUCTION

The objective of this project is to determine the distance of underground cable fault from base station in kilometers using an Arduino board. Generally we use overhead lines. We can easily identify the faults but in rushed places or familiar cities we couldn't use overhead lines. So, we are moving to underground cables. Underground cables used largely in urban area instead of overhead lines. We can't easily identify the faults in the underground cables. This project deals with Arduino microcontroller, LCD and IOT. This proposes greatly reduces the time and operates effectively. The underground cabling system is a common practice followed in many urban areas. Many time faults occur due to construction works and other reasons. At that time it is difficult to dig out cable due to not knowing the exact location of the cable fault. Arduino microcontroller, LCD and IOT. This proposes greatly reduces the time and operates effectively. The underground cabling system is a common practice followed in many urban areas. Many time faults occur due to construction works and other reasons. At that time it is difficult to dig out cable due to not knowing the exact location of the cable fault. In this project we proposed a fault localization model for the underground cable lines with Arduino.

The purpose of this paper is to determine the distance from the base station's underground cable fault in kilometres. In this project we used a simple concept of ohm's low. When a fault occurs in the system the distance located on liquid crystal display (LCD). Until the last decade, cables were designed to be placed above the head and, at present, there is no underground cable that is higher than the previous method. Adverse weather conditions such as storms, snow, torrential rains and pollution does not effect on underground lines. But when a fault occurs in underground lines it is difficult to locate the fault in underground cable. We will find the exact location of the fault. Now the world has become digitized so, the project is to detect exact location of the fault in digital form. Underground cabling system is a more common practice in many urban areas. Although the fault occurs for some reason, at that time, the repair process for this particular cable is difficult because of not knowing the exact location of the cable breakdown. Fault in cable can be classified in two groups: Open circuit fault:-In open circuit fault there is no current because there no conducting complete loop for current flowing that is I=0 in this fault supply voltage is equal to the output voltage. Open circuit fault is better than short circuit fault. Short circuit fault:- In this fault output voltage is zero but current is same.

II. Methodology:

Researchers have proposed an innovative methodology for detecting faults in underground power cables using the Internet of Things (IOT) technology. The system employs an Arduino nano and an ESP32 module for communication.

Here's how it works:

- A fault sensing circuit module with interconnected switches is used to simulate faults at regular intervals along the cable's length.
- When a fault occurs, the distance from the base station are determined using Ohm's law principles.
- An Analog to Digital Converter (ADC) generates digital data for the Arduino nano.
- The fault location are displayed on a 16x2 LCD screen.
- Additionally, an IOT module (ESP32) allows users to view fault information through a web application.
- This approach reduces the time and manpower required for fault detection and repair.

III. LITERATURE SURVEY

Analysis of Underground Cable Fault Distance Locator:

Underground cables are prone to a wide variety of faults due to underground conditions, wear and tear, rodents etc. Also detecting fault source is difficult and entire line is to be dug in order to check entire line and fix faults. So here we propose cable fault detection over IOT that detects the exact fault position over IOT that makes repairing work very easy. The repairmen know exactly which part has fault and only that area is to be dug to detect the fault source. This saves a lot of time, money and efforts and also allows to service underground cables faster. We use IOT technology that updates the monitored fault information to internet. The system detects fault with the help of potential divider network laid across the cable. Whenever a fault gets created at a point shorting two lines together, a specific voltage gets generated as per the resistors network combination. This voltage is sensed by the microcontroller and is updated to the user. The information conveyed to the user is the information regarding faults detection. The microcontroller retrieves the fault line data and displays over LCD display, also it transfers this data over internet to display on Gmail server.

Arduino Based Underground Transmission Cable Fault Location System:

The transmission line fault location requires intense human effort and resources. Typically this process is time consuming and while digging the cable there is a risk of damaging the insulation .This paper provides a simple and safe alternative by automating the process of fault detection and location. The project uses the simple concept of OHMs law where a low DC voltage is applied at the feeder end through a series resistor. The current would vary depending upon the length of fault of the cable in case there is a short circuit of LL or 3L or LG etc. The series resistor voltage droop changes accordingly which detects the exact location of the fault for process of repairing that particular cable. The proposed system finds the exact location of the fault. This system uses an Arduino micro controller kit and a rectified power supply. Here the current sensing circuits made with a combination of resistors are interfaced to Arduino micro controller kit to help of the internal ADC device for providing digital data to the microcontroller representing the cable length in kilometres. The fault creation is made by the set of switches. The relays are controlled by the relay driver. A 16x2 LCD display connected to the microcontroller to display the information. In case of short circuit, the voltage across series resistors changes accordingly, which is then fed to an ADC to develop precise digital data to a programmed

Arduino micro controller kit that further displays exact fault location from base station in kilometres. The project in future can be implemented by using capacitor in an AC circuit to measure the impedance which can even locate the open circuited cable.

Underground Cable Fault Detector Using GSM:

The main aim of the project is to detect and locate the fault in underground cable. In the urban areas, the electrical cable runs in undergrounds instead of overhead lines. Whenever the fault occur the repairing process becomes difficult. It is very difficult to identify the exact location of the fault in underground power cable line. This project will ensure a shorter response time for technical crew to rectify these faults. Fault occur due to short circuit fault, low voltage fault, high voltage fault. Previously proposed technique is used to identify short circuit fault only. This project is used to detect not only detect short circuit fault but also detect, low voltage fault, high voltage fault. The system developed here works on the basis of Ohm's law. The proposed technique is used not only for identification but also it is used to send the detail information about the fault to the authority using GSM and also it cut the power supply on that particular location for the security of the people .It also used to display the type of the fault in LCD display. Whenever a fault occurs in a cable the buzzer produces the sound to alert and to take an immediate action.

Underground Cable Fault Detection using Raspberry Pi and Arduino:

This paper proposes fault location model for underground power cable using raspberry pi and the Internet of Things which is based on the internet, which means the information will be transferred through the internet access. The aim of this method is to determine the distance of underground cable fault from base station in kilometres and also find the location of that faulty place. This paper uses the simple concept of Current Transformer Theory (CT Theory). When any fault like short circuit occurs, voltage drop will vary depending on the length of fault in cable; since the current varies Current Transformer is used to calculate the varying current. The signal conditioner manipulates the change in voltage and a microcontroller is used to make the necessary calculations so that the fault distance is displayed by IOT devices. These fault details are after sent to any access point through the internet and displayed.

IV. PROPOSED SYSTEM

Underground fault detection deals with finding the exact fault location from the base station. Cables have some resistance. We are mainly focusing that resistance. Resistance can vary with respect to the length of the cable. If the length of the cable increases, the value of the resistance will also increase. If any deviation occurs in the resistance value, we call that as fault point and that point can be identified with the help of Arduino technology. That fault point represents the standard of distance (kilometre) from the base station and the value is displayed by the display unit.

Underground cables offer an affordable and justifiable solution for critical parts and in some cases the entire length of overhead high voltage power lines. With appropriate technology used in appropriate places, the environmental impact of underground cables can be minimized. Circuit can be tested with different resistor values to simulate various fault conditions. It displays exact location of short circuit and open circuit. Similarly you can find the earth fault in a cable using capacitance measurement technique.

V. BLOCKDIAGRAM

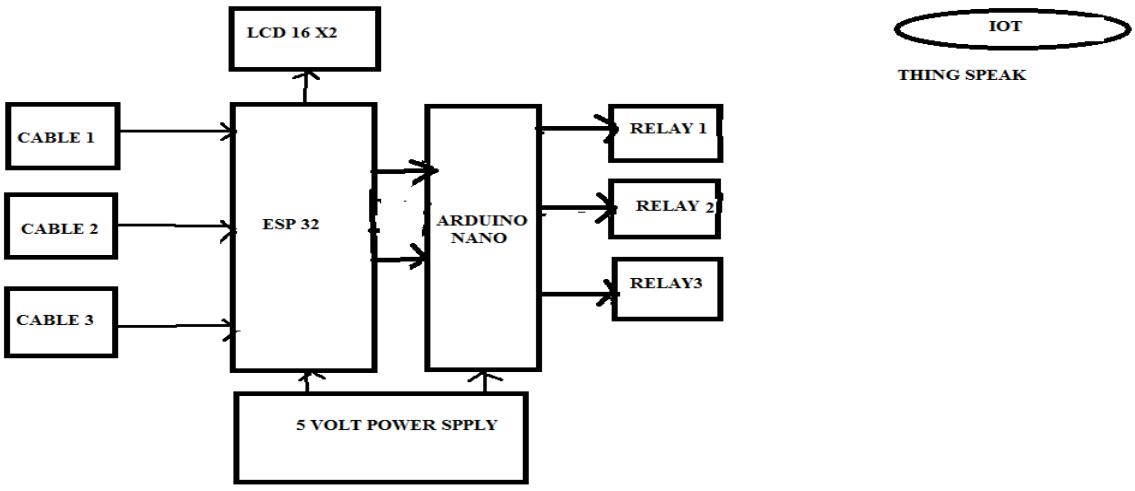

Fig. 1 Block Diagram

This project has been uploaded with in the kit. Program was written and if any fault occurs in the cable, immediately it will open the relay terminal and disconnect that faulty line only. Rest of the other lines operates normally. Arduino is the advanced version of embedded system. These Arduino has ample types but we selected Arduino UNO. It easily adapts to other devices using serial port. Relay is nothing but an electrical device that acts as a switch; if any fault occurs in the line it will disconnect the line using relay. The connector of the relay moves from normally closed conduct to normally open conduct. We can easily find the fault and disconnect the faulty line. Display unit is connected to the Arduino kit which is used to display where the fault occurs. Once faults occur in the cable, the display unit displays the exact fault location and also displays which phase is affected in the cable and how long it's affected.

The main concept of this project is to find the distance of underground cable fault from the base station in kilometers. In many urban areas, cable fault is a common problem. When a fault occurs due to some reason, the process of fault tracking without knowing the location related to that particular cable is very difficult. The proposed system is designed to track the exact location of the fault occurred in the cable.

This project use ohm's law concept, when a low voltage DC is applied to the feeder end through a series resistor, then the current would differ based on the location of fault occurred in the cable. In case is there any short circuit occurred from line to ground, then the voltage across series resistor alters accordingly, then it is fed to an analog to digital converter to develop exact data, which the pre programmed 8051 microcontroller will display in kilometers.

The proposed system is designed with a set of resistors to signifying the length of a cable in kilometers, and the fault creation is designed with a set of switches at every known kilometer (KM) to cross check the exactness of the same. The fault happening at a specific distance and the particular phase is displayed on an LCD interfaced to the 8051 microcontroller. Thus, this is all about underground cable fault distance locator. Programs uploaded in Arduino nano kit to detect faults from the underground cables. When a fault occur in the underground cables, we can find out faults through Arduino controller kit. LCD display which displays the faults in Kilometre. In this project we created faults manually. Cable has many types. Every cable has different resistance which depends upon the material used. The value of the resistance is depends upon the length of the cable. In here resistance is the leading role of the project. If any deviation occurs in the resistance, the value of the voltage will be changed that particular point is called FAULT. We are finding out those faults.

TYPES OF FAULTS : Generally there are different types of faults. Frequently occurring faults are given below:

Short Circuit Fault : A short circuit fault occurs when there is an insulation failure between phase conductors or between phase conductor(s) and earth or both. An insulation failure results into formation of a short circuit path that triggers a short-circuit conditions in the circuit.

Open Circuit Fault : An open-circuit fault occurs if a circuit is interrupted by some failure. If the circuit is not closed that is called open circuit fault.

Earth Fault : An earth fault is an inadvertent contact between an energized conductor and earth or equipment frame. The return path of the fault current is through the grounding system and any personnel or equipment that becomes part of that system.

VI. HARDWARE REQUIREMENT

Arduino nano: The Arduino Nano is an open-source breadboard-friendly microcontroller board based on the Microchip Atmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor. The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers

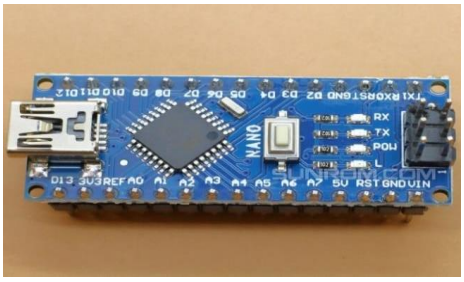

Fig. 2 Arduino nano

ESP 32: The ESP32 is a popular microcontroller and Wi-Fi/Bluetooth module developed by Espressif Systems. It is widely used in IoT (Internet of Things) projects and offers a powerful and versatile platform for embedded systems development. The ESP32 features a dual-core processor, built-in Wi-Fi and Bluetooth connectivity, various GPIO pins, analog-to-digital converters, and other peripherals. It's compatible with the Arduino IDE, making it accessible for a broad community of developers working on diverse projects, from simple DIY electronics to complex IoT applications.

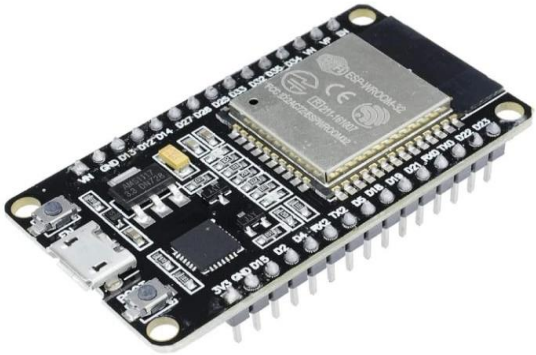

Fig.3 ESP 32

Power supply: A 12V power supply refers to an electrical device or system that provides a constant voltage output of 12 volts. Such power supplies are commonly used to supply electrical energy to various electronic devices, components, or systems that require a 12V input. These power supplies can come in different forms, including wall adapters, desktop power supplies, or integrated modules. They are widely used in applications such as LED lighting, automotive electronics, hobbyist projects, and many other devices that operate on a 12V power source.

Fig. 4 Power supply

LCD 16*2: Liquid Crystal Display (LCD) is a type of flat-panel display technology that uses liquid crystals sandwiched between two layers of glass or plastic. LCDs are widely used in devices such as monitors, TVs, smartphones, and more. They work by applying an electric current to control the alignment of liquid crystals, determining the passage of light and thus creating images. LCDs offer thin, energy-efficient displays with good image quality.

Fig. 5 LCD 16*2

Cables: Cable, in electrical and electronic systems, a conductor or group of conductors for transmitting electric power or telecommunication signals from one place to another. Electric communication cables transmit voice messages, computer data, and visual images via electrical signals to telephones, wired radios, computers, teleprinters, facsimile machines, and televisions. There is no clear distinction between an electric wire and an electric cable.

Fig. 6 Cables

Relays: A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contractor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called “protective relays”.

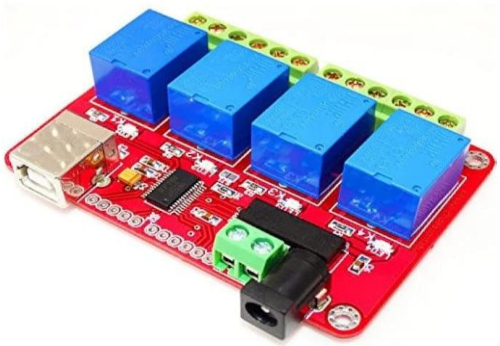

Fig. 7 Relays

DHT11 Sensor: The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

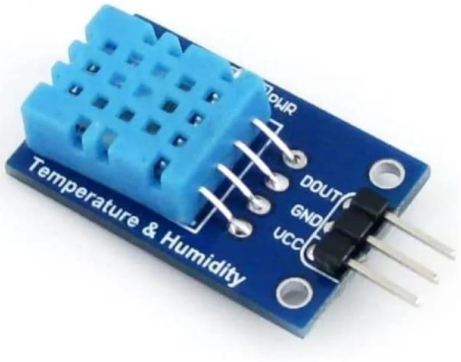

Fig. 8 DHT11 Sensor

VII. SOFTWARE REQUIREMENT

1. Program in c embedded system
2. Software = Arduino IDE

Arduino Software : The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

VIII. Result:

Underground cables offer an affordable and justifiable solution for critical parts and in some cases the entire length of overhead high voltage power lines. With appropriate technology used in appropriate places, the environmental impact of underground cables can be minimized. Circuit can be tested with different resistor values to simulate various fault conditions. It displays exact location of short circuit and open circuit. Similarly you can find the earth fault in a cable using capacitance measurement technique.

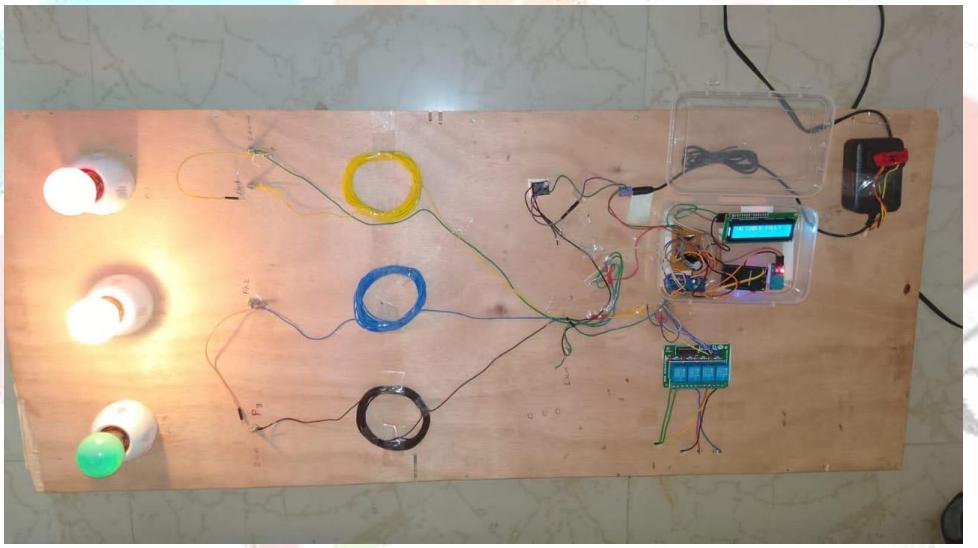

Fig. 9 Project model

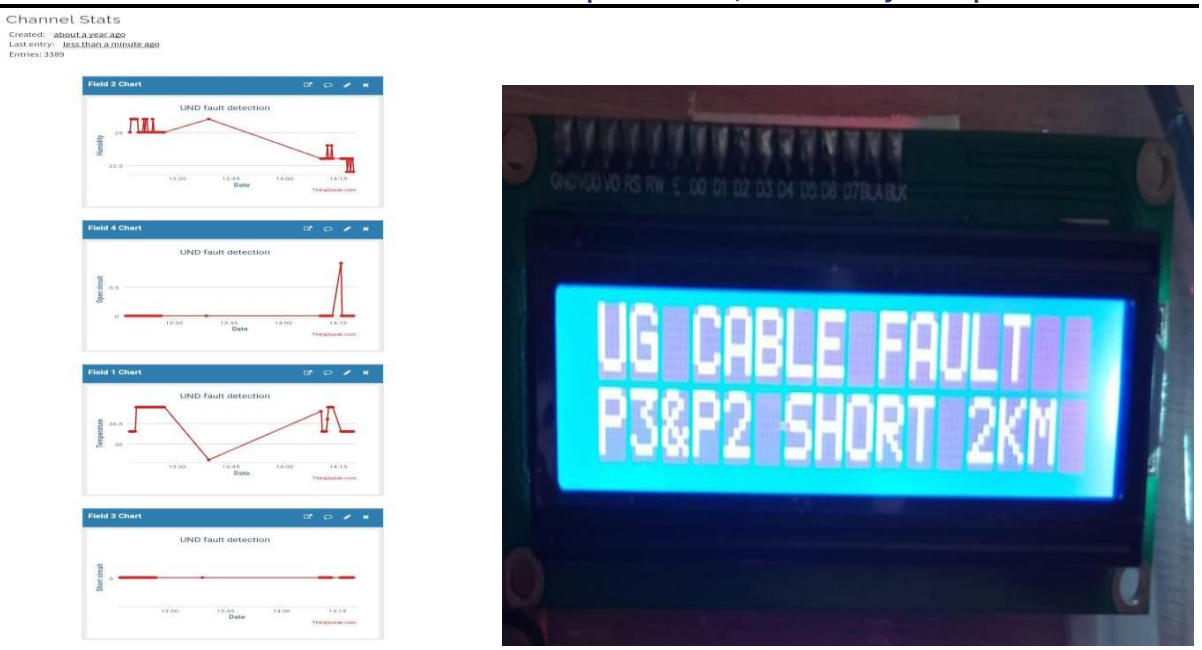

Fig.10 Project outcome

IX. APPLICATIONS:

- Integration with smart grid technologies.
- Fault detection in underground power cable.
- Data analysis for predictive maintenance

X. ADVANTAGES:

- Early Detection
- Less Maintenance
- Less complexity
- It has higher Efficiency
- It can detect other types of cable fault such as Short circuit fault, cable cuts
- Provide precise accuracy in determining the Location of Fault

XI. DISADVANTAGES:

- By Implementation in Real time may occur high cost

XII. CONCLUSION:

This paper designed, implemented a microcontroller based underground cable fault detector. We have successfully designed, implemented and tested a cheap underground cable fault detector. Our proposed method can detect both open and short circuit in underground cables with a maximum distance of 2km. In the future, effort will be concentrated to increase the maximum distance for fault detection to 3km or more, and a graphical display monitor to improve on its information of the underground cable fault could replace the LCD display.

XIII. FUTURE SCOPE:

The project detects only the location of the circuit fault in underground cable line, but it can also be extended to detect the location of an open circuit fault. To detect an open circuit fault, capacitor is used in ac circuits which measures the change in impedance and calculate the distance of the fault.

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