International Journal of Research in Engineering, Science and Management
Volume-2, Issue-7, July-2019
www.ijresm.com | ISSN (Online): 2581-5792


# Fault Detection for Underground Cable

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***Abstract*: The objective of this project is to determine the fault location of underground cable from base station in kilometers. The underground cable system is a common practice followed in many urban areas. While a fault occurs for some reason, the repairing of that particular cable is difficult as the exact location of the cable fault is not known. The proposed system is to find the exact location of the fault. The project uses the Arduino microcontroller kit to detect and locate the open circuit and short circuit fault occurred in underground cable. To find short circuit fault the project is assembled with a set of resistors representing cable length in KM's and fault creation is made by a set of switches at every known KM. The project is enhanced by using capacitor in an AC circuit to measure the impedance that will locate the open circuit fault. The fault occurring at a particular distance and the respective phase is displayed on a LCD interfaced to the Arduino microcontroller kit.**

***Keywords*: Arduino, Cable Fault, Open and Short circuit fault.**

## 1. Introduction

The underground cable system is more common practice followed in many urban areas. While fault occurs for some reason, at that time the repairing process related to that particular cable is difficult due to not knowing the exact location of cable fault. Before attempting to find underground cable faults, it is essential to know where the cable is located and what direction it takes. It is extremely difficult to find a cable fault without knowing where the cable is. Although tracing of the cable can become more complex as more underground plant is installed.

## 2. Guidelines

### *A. Literature survey and basic concepts*

One of the reason for occurrence of fault is when moisture enters the insulation, due to this quality of insulation reduces. Other cause including mechanical injury during transportation, laying process or due to various stresses encountered by the cable during its working life.

The lead sheath is also damaged frequently, usually due to action of atmospheric agents, soil and water or sometimes due to the mechanical damage and crystallization of lead through vibration.

Open circuit fault involves open circuit in conductor. When one or more cable conductors (cores) break, it leads to discontinuity. This discontinuity also occurs when the cable comes out of its joint due to mechanical stress.

A short circuit fault occurs then the individual insulation of the cables is damaged and two or more conductors come in contact with each other. Another reason can be if carbon gets collected on the lux of either end of cable.

### *B. Methods for locating cable fault*

Pulse reflection method

A pulse induced at the starting end of the cable reaches the cable fault with a speed of v/2 and then is reflected back toward the starting end of the cable. The elapsed time multiplied by the diffusion speed v/2 gives the distance to the source of the fault.

### *C. Transient method*

In the transient method, a breakdown is triggered at the cable fault. This effects a low-resistance short circuit for a few milliseconds. This in turn produces two travelling waves diffusing in opposite directions. These waves are reflected at the cable ends so that they then travel toward each other again in the direction of the cable fault. The waves are unable to pass the fault because of the arc produced by the short circuit, so they are therefore reflected back again as with the pulse reflection method, which due to the burning short circuit results in a reversal of polarity. There are various ways to decouple and analyze these transients.

### *D. Route tracing and pinpointing*

Route tracing is used to determine where the faulty cable lies and pinpointing is the process of determining the exact position of cable fault.

### *E. Cable identification*

In cable identification, the faulty cables are identified from the fault free cables at the already determined site.

## 3. Types of faults

### *A. Open circuit fault*

When there is a break in the conductor of the cable, it is called open circuit fault of the cable. The open circuit fault can be checked by megger. For this purpose, the three conductors of the 3-core cable at the far end are shorted and earthed. Then resistance between each conductor and earth is measured by a megger. The megger will indicate zero resistance in the circuit of the conductor that is not broken. However, if the conductor is broken, the megger will indicate infinite resistance in its circuit.

*B. Short Circuit Fault*

When two conductors of a multi-core cable come in electrical contact with each other due to insulation failure, it is called short-circuit fault. The two terminals of the megger are connected to any two conductors. If the megger gives zero reading, it indicates short-circuit fault between these two conductors. The same step can be repeated for other conductors taking two at a time.

## 4. Design

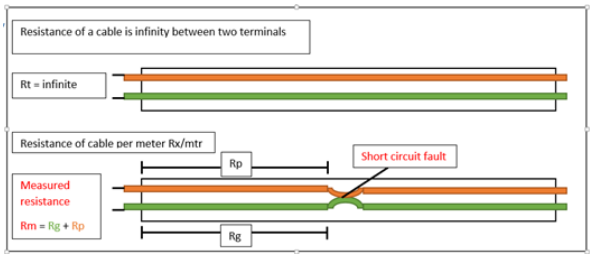


Fig. 1. Cable short circuit fault

Short circuit can be determined by measuring resistance between cables at one end. The value of resistance tells us the exact location of short circuit.

Rm = faulty cable resistance
Rx = cable resistance per meter
Cable fault distance = (Rm / Rx) / 2
Division by 2 is due to upper and lower parts of cable

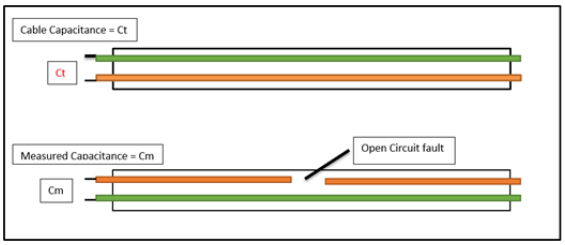


Fig. 2. Cable open circuit fault

Cable open circuit fault can be located by measuring the capacitance of the conductor. Each Arduino capacitance meter relies on the same basic property of capacitors- the time constant. The time constant of a capacitor is defined as the time it takes for the voltage across the capacitor to reach 63.2% of its voltage when fully charged. An Arduino can measure capacitance because the time a capacitor takes to charge is directly related to its capacitance by equation:

TC = R*C
TC is the time constant of the capacitor (in seconds).
R is the resistance of the circuit (in Ohms).
C is capacitance (in Farads).

## 5. Hardware requirement

*A. Arduino uno R3*

Arduino is the advanced version of embedded system. These Arduino has ample types but we selected Arduino UNO. These Arduino UNO helps to develop many advanced version of Arduino UNO creates user friendly environment.it easily to adopt other devices using serial port.

Fig. 3. Arduino

*B. Relay*

Relay is sensing device which senses the fault and sent trip signal to circuit breaker to isolate the faulty section. A relay is automatic device by means of which an electrical circuit is indirectly controlled and is governed by change in the same or another electrical circuit.


Fig. 4. Relay

*C. Liquid crystal display*

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The Command register store command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. the Data register stores the data to be displayed on the screen. The Data is the ASCII value of the character to be displayed on the LCD.

Fig. 5. Liquid crystal display

*D. Transformer*

A transformer is an electrical device used to transfer energy

between two or more circuits. Electrical energy is transferred between the two coils. Transformer is used to increase or decrease the alternating voltage in electrical power appliances.

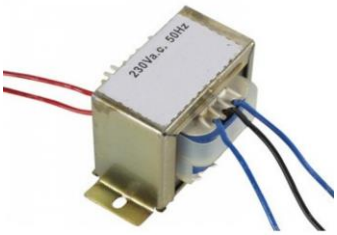


Fig. 6. Transformer

## 6. Results and discussion

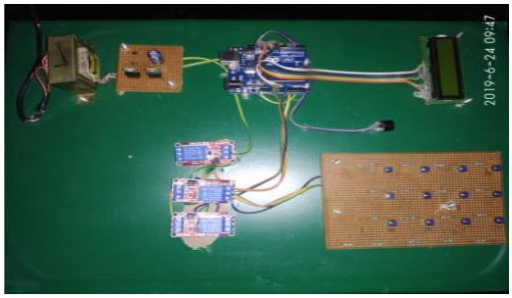


Fig. 7. Hardware setup

The outcome of this project is a prototype for underground cable fault detection. In our project we are able to detect the fault in three phases of underground cable line. Each phase of the system has a massive copper wire. In the prototype we have implement each wire by a set of resistors. So we have represented 1 kΩ resistance at each even Kilometer distance (2km, 4km, 6km, 8km). As the length of the wire increases the resistance also increases. Hence the length of the cable is 8km and total resistance is 4 kΩ. We have created fault at particular distance using switches. In a single cable which has 4 series resistors are connected with 4 switches to create faults at 2km, 4km, 6km, 8km distance. The voltage drop across the series resistor is given as an input to the Arduino to perform required calculations. Also a three phase relay module is also connected to the Arduino which continuously monitors each phase and gives data about each phase one by one back to the Arduino.

## 7. Conclusion

This is a proposed model of underground cable fault distance locator using Arduino. It is classified in four parts -DC power supply part, cable part, controlling part, display part. DC power supply part consist of ac supply of 230V is stepped down using transformer, bridge-rectifier converts ac signal to dc & regulator is used to produce constant dc voltage. The cable part is denoted by set of resistors along with switches. Next is controlling part which consist of analog to digital convertor which receives input from the current sensing circuit, converts this voltage into digital signal and feeds the Arduino microcontroller with the signal. The microcontroller also forms part of the controlling unit and makes necessary calculations regarding the distance of the fault. The Arduino also drives a relay driver which in turn controls the switching of a set of relays for proper connection of the cable at each phase. The display part consists of the LCD display interfaced to the microcontroller which shows the status of the cable of each phase and the distance of the cable at the particular phase, in case of any fault.

## References

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