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# Underground Cable Fault Detection Using Arduino

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**ABSTRACT**: The main objective of this project is to detect the faults and abnormalities occurring in underground cables with exact location in kilometres using an arduino. In urban areas, the electrical cable runs in undergrounds instead of overhead lines. If the fault occurs in underground cables it is difficult to detect the proper location of the fault for the repairing process. The proposed system find the exact location of the fault. This system uses an Arduino microcontroller kit and a rectified power supply. The basic idea behind the working of this project is ohm's law. At feeder end, when a DC voltage is applied, based on the location of fault in the cable, the value of current also changes. So in the fault like L-G or L-L fault the change in voltage value measured across the resistor is then fed to the built-in ADC of the arduino. This value is then converted by the arduino and the fault is calculated in terms of distance from the base station. The value is sent to the LCD 16x2 Display interfaced to the arduino board and it displays exact location of the fault from base station in kilometres for all the three phases. This project is made with a set of resistor which represent the length of cable.

**KEYWORDS**: Arduino Board, Ohms Law, Underground fault, Resistance, LCD, ADC(Analogue to digital converter).

## I. INTRODUCTION

An bundle of electrical conductors used for carrying electricity is called as a cable. An underground cable generally has one or more conductors covered with suitable insulation and a protective cover[1].Commonly used materials for insulation are varnished cambric or impregnated paper.Fault in a cable can be any defect or non-homogeneity that diverts the path of current or affects the performance of the cable.So it is necessary to correct the fault.

Power Transmission can be done in both overhead as well as in underground cables. But unlike underground cables the overhead cables have the drawback of being easily prone to the effects of rainfall, snow, thunder, lightning etc. This requires cables with reliability, increased safety, ruggedness and greater service. So underground cables are preferred in many areas specially in urban places. When it is easy to detect and correct the faults in overhead line by mere observation, it is not possible to do so in an underground cable. As they are buried deep in the soil it is not easy to detect the abnormalities in them. Even when a fault is found to be present it is very difficult to detect the exact location of the fault. This leads to dugging of the entire area to detect and correct the fault which in turn causes wastage of money and manpower. So it is necessary to know the exact location of faults in the underground cables.

Whatever the fault is,the voltage of the cable has the tendency to change abruptly whenever a fault occurs[2].We make use of this voltage change across the series resistors to detect the fault.

## II. LITERATURE SURVEY

In AbhishekPandey, Nicolas H. Younan, Presented underground cable fault detection and identification via fourier analysis [3]. The methods of impedance calculation via sending end voltage and differential voltage can be used for differentiating between the different types of cable defects from phase information. It needs study to be conducted to find the best way of visualizing the results, especially the magnitude response.

A.Ngaopitakkul, C. Pothisarn, M. Leelajindakrairerk [4], presented behaviour of simultaneous fault signals in distribution underground cable using DWT. The simulations were performed using ATP/EMTP, and the analysis behaviour of characteristics signals was Performed using DWT. Various case studies have been carried out including the single fault and simultaneous fault.

Yuan Liao, Ning Kang [5] has presented fault location algorithms without utilizing line parameters. By utilizing unsynchronized voltage and current measurements from both ends of line without requiring line parameters based on the distributed parameter line model. The fault location estimatie is not sensitive to measurement errors while line

parameter estimates are sensitive to measurement errors. Thus relatively precise measurements are required to obtain accurate line parameter estimates.

S. Navaneethan, J. J. Soraghan, W. H. Siew, F. McPherson, P. F. Gale [6], presented an automatic fault location method using TDR. This method uses acquired data from an existing TDR instrument. It enables user of TDR equipment to locate ULVDN cable faults without user interpretation.

H. Shateri, S. Jamali Et Al., Proposed An impedance based fault location method for phase to phase and three phase faults [7]. This method utilized the measured impedance by distance relay and the super imposed current factor to discriminate the fault location. This method is sensitive to the measured impedance accuracy and super imposed current factor.

Pooja P.S and Lekshmi.M developed a resilient incipient fault location algorithm in the time-domain, which utilizes data collected by PQ monitors to estimate the fault location in terms of the line impedance by taking into account the arc voltage associated with the incipient cable faults[8].So the algorithm predicts cable fault location between two adjacent manholes.The ANNs are a family of statistical learning algorithm inspired by biological neural networks and are used to appropriate functions that depend on the large number of inputs. The proposed algorithm exactly pin-points the exact fault in the underground cable.

## III.RELATED WORK

Tasks moved in Arduino UNO pack to perceive issues from the underground connections. Right when a fault occur in the underground connections, we can find faults through Arduino controller pack. LCD show which demonstrates the insufficiencies in Kilometre. In this endeavor we made faults physically. Connection has various sorts .Every connections has different deterrent which depends on the material used. The estimation of the hindrance is depends on the length of the connection. In here resistance is the principle occupation of the errand .If any deviation occur in the deterrent, the estimation of the voltage will be changed that particular point is called fault. We find those imperfection

*Types of Faults*

Faults has many types. Frequently Occurring faults are given below,

- Short Circuit Fault
- Open Circuit Fault
- Earth Fault

*Short Circuit Faults*

A short out fault happens when there is an insurance dissatisfaction between stage conductors or between stage conductor(s) and earth or both. A protection disillusionment results into plan of a short out way that triggers a short out conditions in the circuit.

*Open Circuit Faults*

These faults occur due to the failure of one or more conductors. The most common causes of these faults include joint failures of cables and overhead lines, and failure of one or more phase of circuit breaker and also due to melting of a fuse or conductor in one or more phases. Open circuit faults are also called as series faults. These are unsymmetrical or unbalanced type of faults except three phase open fault.

*Earth Faults*

An earth fault is an unplanned contact between an engaged conductor and earth or equipment frame. The entry method for the fault current is through the setting up structure and any work power or rigging that ends up being a bit of that system.

## IV.PROPOSED SYSTEM

The circuit consists of a power supply, 4 line display, arduino and resistance measurement circuit. To induce faults manually in the kit, fault switches are used. About 12 fault switches are used which are arranged in three rows with each row having 4 switches. The 3 rows represent the 3 phases namely R,Y and B. The fault switches: have 2 positions- No fault position(NF) and fault position(F).Main component of the underground cable fault detection circuit is low value resistance measurement.It is constructed using a constant current source of 100mAmps. It can measure very low

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value resistance as the cables have around 0.01 Ohm/meter resistance. For 10meter cable resistance becomes 0.1 Ohm. This circuit can measure resistance up 50 Ohm, Maximum cable length it can check up to 4 kilometres.

So starting from the reference point 4 sets of resistances are placed in series. These 4 sets of resistances represent the three phases and the neutral .Short circuit faults, Symmetrical and unsymmetrical faults can be determined by this method. This project uses three set of resistances in series (ie) R10- R11-R12-R12, R17-R16-R14R21,R20-R19-R18-R25 one for each phase. Each series resistor represents the resistance of the underground cable for a particular distance and so here four resistances in series represent 1-4kms.Value of each resistance is 10kΩ.

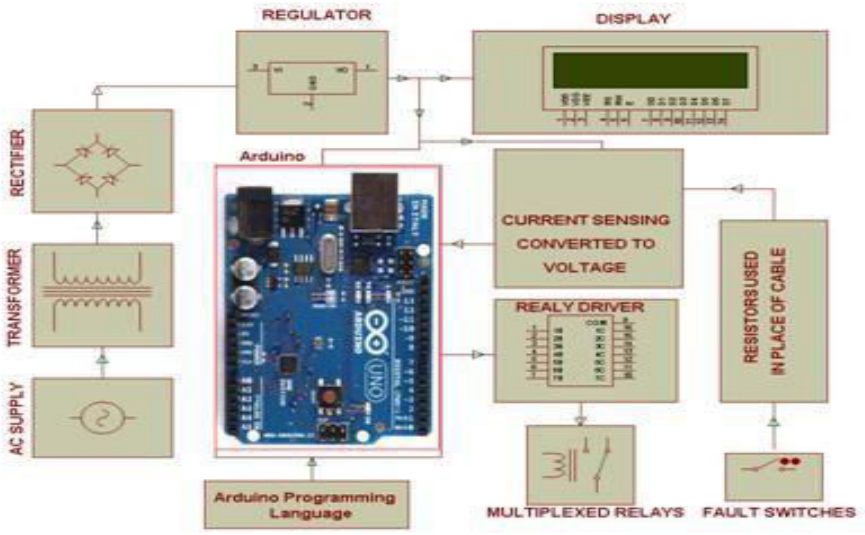


**Fig-1:** Block Diagram

One relay for each phase R, Y and B ao three relays are used and the common points of the relays are grounded and the NO points are connected to the inputs of R17, R21 and R25 and being the three phase cable input. As supply needed for the relays is higher than that of the arduino, Relay driver is used to boost the supply and provide it to the relays. A 230V AC supply is applied to the transformer from where it is stepped down to 12V AC.From the transformer the alternating current gets converted into direct current when it passes through a Bridge wave rectifier. The 12V DC then goes to the voltage regulator where it gets converted from 12V DC to 5V DC. Voltage regulator is used also converts the variable Dc supply into constant DC supply. This 5V DC is used to supply power to the arduino and the LCD. Power supply to the LCD is given from the voltage regulator.

When fault is induced by operating any of the 12 switches (to F position), they impose conditions like LG, LL, LLG fault as per the switch operation. As a result of the fault, there is a change in voltage value. This voltage value measured across the resistance is fed to the ADC of the Arduino. Using this value, the arduino computes the distance. Finally the distance of the fault from the base station is displayed in kilometres.

**POWER SUPPLY**

The power supply circuit consists of step down transformer which is 230v step down to 12v.In this circuit 4diodes are used to form bridge rectifier which delivers pulsating dc voltage and then fed to capacitor filter the output voltage from rectifier is fed to filter to eliminate any a.c. components present even after rectification. The filtered DC voltage is given to regulator to produce 12v constant DC voltage.

**RECTIFIER**

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability .The circuit has four diodes connected to form a bridge. A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification.

Rectifiers have many uses, but are often found serving as components of DC supplies and high-voltage direct current power transmission systems. Rectification may serve in roles other than to generate direct current for use as a source of power.

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**ARDUINO**

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

**RELAY**

Relay is sensing device which senses the fault and sends a trip signal to circuit breaker to isolate the faulty section. A relay is an automatic device by means of which an electrical circuit is indirectly controlled and is governed by change in the same or another electrical circuit. There are various types of relay: Numerical relay, Static relay and electromagnetic relay. Relay are housed in panel in the control room. Here three mini power relay are used each for one of the three phases. The relays periodically scan the three Phases and send the signal to the arduino controller. The rating of each of the relays is about 12V.

## V. ADVANTAGES

- Less Maintenance
- It has higher efficiency
- Less fault occur in underground cable
- This method is applicable to all types of cable ranging 1kv to 500kv
- It can detect other types of cable fault such as short circuit fault, cable cuts, resistive fault, sheath fault.

## VI. CONCLUSION

Finally, we have done this project for location of fault in underground cable in the rural areas where underground transmission system is used. It is difficult to find the fault in the cable. So this project is beneficial to use to detect the fault location. So the fault can easily locate and extinguish. The Arduino has several advantages over the microcontroller so use of arduino is more useful arduino based underground fault detection is more advantageous than microcontroller based underground fault detection.

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