Detection of Underground cable fault using Arduino

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Abstract - *The main objective of this project is to detect the faults and abnormalities occurring in underground cables using an arduino.The basic idea behind the working of this project is ohms's law .At the 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 case of a short circuit fault like L-G or L-L fault the change in voltage value measured across the resistor is then fed to the in-built ADC of the arduino.This value is processed by the arduino and the fault is calculated in terms of distance from the base station.This value is sent to the LCD interfaced to the arduino board and it displays exact location of the fault from the base station in kilometers for all the three phases.This project is arranged with a set of resistors which represent the length of the cable.At every known kilometer fault switches are placed to induce faults manually.Finally the fault distance can be determined.*

***Key Words*: Aruduino UNO,Underground Fault,Resistance,LCD**

1.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 insultion 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,lightningetc.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 over head 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.

2.FAULTS IN UNDERGROUND CABLES

2.1 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.

2.2 SHORT CIRCUIT FAULTS

A short circuit can be defined as an abnormal connection of very low impedance between two points of different potential, whether made intentionally or accidentally.These are the most common and severe kind of faults, resulting in the flow of abnormal high currents through the equipment or transmission lines. If these faults are allowed to persist even for a short period, it leads to the extensive damage to the equipment.Short circuit faults are also called as shunt faults[2]. These faults are caused due to the insulation failure between phase conductors or between earth and phase conductors or both.The various possible short circuit fault conditions include three phase to earth, phase to phase, single phase to earth, two phase to earth and phase to phase.In single line to ground fault,fault occurs between any one of the three lines and the ground.In double line to ground fault,fault occurs between any two of the three lnes and the ground.In line to line fault,fault occurs between any two lines.When fault occurs there is an abrupt change change in voltage[6].This change in voltage may cause serious damages to the system if not corrected in time].So immediate step of fault correction is isolation of the faulty part from the rest of the system.

3.FAULT DETECTION METHODS

3.1 ONLINE METHOD

This method utilizes and processes the sampled voltagesand current to determine the fault points[3]. Online method for underground cable are less common than overhead lines.

3.2 OFFLINE METHOD

In this method special instrument is used to test out service of cable in the field.This offline method can be divided into two methods.They are tracer method and terminal method.

3.2.1 TRACER METHOD

In this method fault point is detected by walking on the cable lines. Fault point is indicated from audible signal or electromagnetic signal. It is used to pinpoint fault location very accurately.

3.2.2 TERMINAL METHOD

It is a technique used to detect fault location of cable from one or both ends without tracing. This method use to locate general area of fault, to expedite tracing on buried cable.

4.LITERSTURE SURVEY

In Abhishek Pandey, Nicolas H. Younan, Presented underground cable fault detection and identification via fourier analysis[7]. 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[8],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 [6] 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 [10] , 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[6] . 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[3].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.

5.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 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 kilometers.

So starting from the reference point 4 sets of resistances are placed in series.These 4 sets of resistances represent the three plases 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.

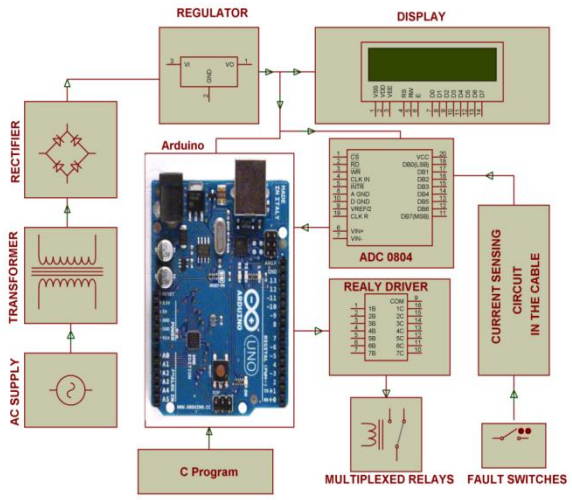

Fig -1: Block Diagram

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 kilometers.

5.1 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.

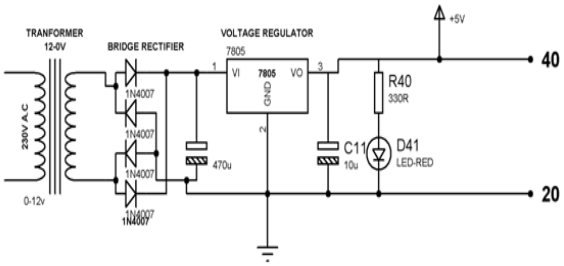

Fig -2:Power Supply Diagram

5.2 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.

5.3 LCD

Liquid crystal display are interfacing to microcontroller 8051.Most commonly LCD used are 16*2 and20*2 display. In 16*2 display means 16 represents column and 2 represents rows. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

5.4VOLTAGE REGULATOR

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels. The L78xx series of three-terminal positive regulators is available.

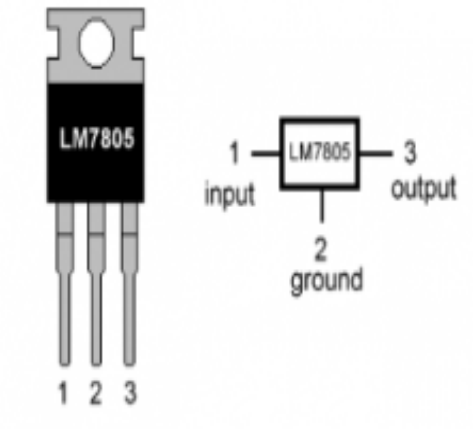

Fig-3 Voltage Regulator IC7805

5.5 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.

5.5 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 relaya are used each for one of the three phases.The relays periodically scan the three ohases and send the signal to the arduino controller. The rating of each of the relays is about 12V.

5.6 RELAY DRIVER IC

Driver Circuit is used to boost or amplify signals from micro-controllers to control power switches in semi-conductor devices. Driver circuits take functions that include isolating the control circuit and the power circuit, detecting malfunctions, storing and reporting failures to the control system, serving as a precaution against failure, analyzing sensor signals and creating auxiliary voltages.In this project,ULN2003 is used as the relay driver circuit.It is an untegrated circuit which functions as the relay driver and boosts up the supply going to the relay.

6.ADVANTAGES

- Less maintenance
- It has higher efficiency
- Less fault occur in underground cable
- This method is applicable to all types of cable ranging from 1kv to 500kv
- It can detect other types of cable fault such as Short circuit fault, cable cuts, Resistive fault, Sheath faults, Water trees, Partial discharges.

7.CONCLUSION

Thus the project on Underground cable fault detection using Arduino was done and the distance of the fault from the base station in kilometers was displayed for the three individual phases R,Y and B. Circuit can be tested with different resistor values to simulate various fault conditions In this project faults upto a distance of 4km can be detected.When the fault switches are operated to fault condition then the phase corresponding to that particular switch is considered as the faulty phase. So the faulty section can easily be located.

8.FUTURE SCOPE

In this paper we detect the exact location of short circuit fault in the underground cable from feeder end in km by using arduino. In future, this project can be implemented to calculate the impedance by using a capacitor in an AC circuit and thus measure the open circuit fault.

REFERENCES

[1] Anurag. D. Borkhade (2014) 'Transmission Line Fault Detection Using Wavelet Transform'-International Journal on Recent and Innovation Trends in Computing and Communication Volume. 2 Issue. 10. [2] Xia Yang, Myeon-Song Choi ,Seung-Jae Lee, Chee-Wooi Ten, and Seong-Il Lim(2008) ' Fault Location of Underground power cable usiNg Distributed parameter approach'-IEEE

Transactions on Power Systems, Vol. 23, No. 4, November 2008.

[3] Pooja P.S and Lekshmi M(2015) 'Fault Detection Technique to pinpoint Incipient Fault for Underground Cables'-International Journal of Engineering Research and General Science Volume 3, Issue 3, May-June, 2015.

[4] Yu Xiang and Joseph F.G. Cobben(2015) 'A Bayesian Approach for Fault Location in Medium Voltage Grids With Underground Cables'-IEEE Power and Energy Technology Systems Journal, Volume 2, No. 4, December 2015.

[5] Abhishek Pandey and Nicolas H. Younan(2010) 'Underground cable fault detection and identification via fourier analysis'- International Conference on High Voltage Engineering and Application, 11-14 Oct. 2010.

[6] H. Shateri, S. Jamali, "Impedance Based Fault Location Method For Phase To Phase And Three Phase Faults InTransmission Systems", IEEE 2010.

[7] Abhishek Pandey, Nicolas H. Younan, "Underground Cable Fault Detection and Identification via Fourier Analysis", 2010 IEEE.

[8] A. Ngaopitakkul, C. Pothisarn, M. Leelajindakrairerk, "Study of Characteristics for Simultaneous Faults in Distribution Underground Cable using DWT", 2011 IEEE.

[9] Yuan Liao, Ning Kang, "Fault-Location Algorithms Without Utilizing Line Parameters Based on the Distributed Parameter Line Model", IEEE
Transactions on Power Delivery, VOL. 24, NO. 2, April 2009.

[10] S. Navaneethan, J. J. Soraghan, W. H. Siew, F. McPherson, P. F. Gale ,"Automatic Fault Location for Underground Low Voltage Distribution Networks" IEEE Transactions on Power Delivery, Vol. 16, no. 2, April 2001.