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Underground Cable Fault Detection and Location Identification System with GPS

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Abstract: The objective of this project is to determine the distance of underground cable fault from base station in kilometers using an Arduino board. The underground cabling system is a common practice followed in many urban areas. There are many electrical, telephone and other signal cables are laid underground. 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. The purpose of this paper is to determine the distance from the base station's underground cable fault in kilometers. 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). The exact fault location co-ordinates is also displayed in LCD using GPS. 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 affect 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.

Keywords: Underground Cable Fault Detection, Fault Location Identification, GPS Based Fault Detection, Power Cable Monitoring, Electrical Fault Detection System.

I. INTRODUCTION

A 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. 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 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. We make use of this voltage change across the series resistors to detect the fault.

II. PROPOSED SYSTEM

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). And the geographical location is identified and displayed in LCD using GPS module.

Short circuit can be determined by measuring resistance between two cables at one end (base station). The value of

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resistance tells us the exact location of short circuit.

The proposed system is to find the exact location of the fault. The project uses the standard concept of Ohms law i.e., when a low DC voltage is applied at the feeder end through a Cable lines, then current would vary depending upon the location of fault in the cable. In case there is a short circuit (Line to Ground), the voltage across series resistors changes accordingly, which is then fed to inbuilt ADC of Arduino board to develop precise digital data for display in kilometers.

Short Circuit Fault

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

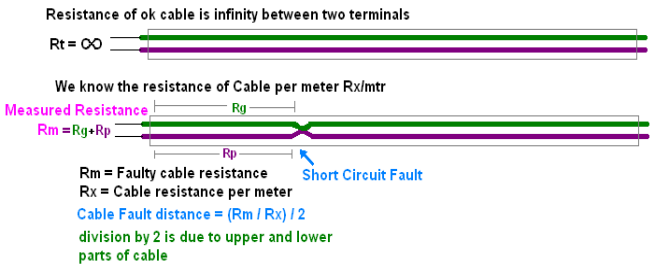

Figure 1: Cable Short Circuit Fault

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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 to cross check the accuracy of the same. The fault occurring at a particular distance and the respective phase is displayed on a LCD interfaced to the Arduino board.

III. FAULT DETECTION METHODOLOGY

The damage position is tracked exactly using the location display based on resistance calculation by measuring the voltage drop through the shorted cable. The wire resistance is calculated based on ohms law principle. The resistance of the shorted cable depends upon the length of the cable where the short circuit occurred. The short circuit forms a loop through which we apply a dc voltage and voltage drop is measured by the microcontroller in arduino. By knowing the resistance we can calculate the location of the fault by comparing the measured resistance value with the known cable resistance. A GPS module is used to detect the exact geographical location of fault occurrence.

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.
- GPS enables the identify exact geographical location.

Block Diagram

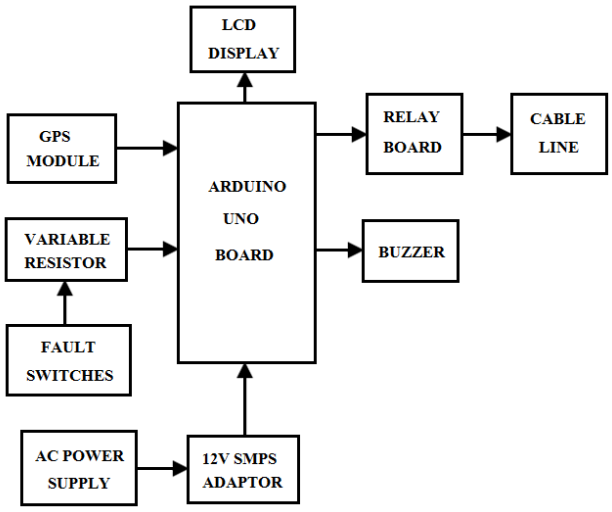

Figure 2: Short circuit Fault Detector Unit

Description

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switches at every known KM to cross check the accuracy of the same. The fault occurring at a particular distance and the respective phase is displayed on a LCD interfaced to the Arduino board.

DC Power Supply part consist supply of 230v then it is step down using SMPS adaptor, which converts AC signal to DC and Voltage Regulator is used to produce constant DC Voltage. The set of Resistors Denote the Cable part along with Switches. The set of Resistors and Switches are used as Fault Creators to indicate the Fault at each location. The circuit consists of a power supply, 4 line display, and 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 kilometres.

So starting from the reference point 3 sets of resistances are placed in series. These 3 sets of resistances be determined by this method. This project uses three set of resistances in series (i.e.) R10R11-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 1-3kms.Value of each resistance is 10kΩ. One relay for each phase R, Y and B as 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 SMPS 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 kilometre.

Circuit Diagram

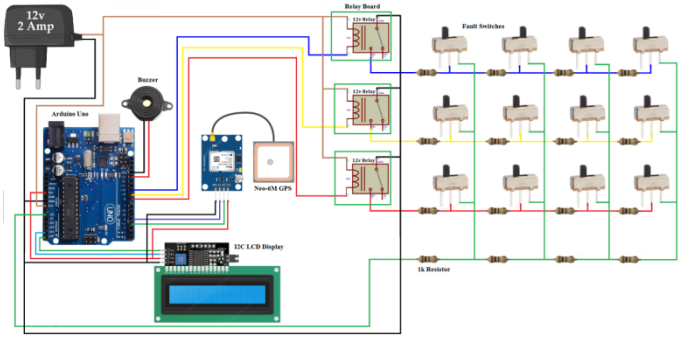

Figure 3: Arduino based Short Circuit Fault Detection Circuit

Circuit Description

This system uses an Arduino microcontroller as the main controller. In this case, the current detection circuit in combination with the resister is connected to the microcontroller with the aid of an ADC device to represent the length of wire in Km. Error creation is performed by a set of switches. The relays are controlled by a relay exciter IC, which is used to check cable line. A Neo-6M GPS Module is connected to the arduino for detecting and displaying the fault location in GPC co-ordinates in the LCD Display. A 16x2 LCD is used to display information. Also one more feature is that using GSM the message of fault detection, location of fault and distance of fault from base station in kilometres this all information is send to base station. As soon as a fault occurs in a cable the buzzer produce the alarm to alert and to take an immediate action by field workers.

IV. SHORT CIRCUIT FAULT LOCATOR

The circuit consists of a power supply, 4 line display, arduino and resistance measurement circuit. Main component of the underground cable fault detection circuit is low value

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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 25000 meters.

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 is 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.

V. CONCLUSION

Finally, we have done this project for location of fault in underground cable in the rural areas where underground transmission system is used. Thus the project on Underground cable fault detection using Arduino was done and the distance of the short circuit fault from the base station in kilometers was displayed for the underground conductor through LCD display. Circuit can be tested with different resistor values to simulate various fault conditions In this project faults up to a distance of 5km 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. Also the GPS data is displayed in the LCD by which the exact geographical location of fault occurrence is identified. So in total both the short circuit conductor fault can be identified in the underground cable using this system economically and efficiently. And also automatic tripping of the circuit is done when fault condition is identified. So this project is beneficial to use to detect the fault location. So the fault can easily locate and extinguish.

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