Underground Cable Fault Distance Finding using Arduino and GSM

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Abstract— In Power system Generation to distribution has more long cable are used and now we used underground cable. When the underground cable is used to distribution in the urban area, sometime fault occurs is an underground cable that time finding fault in the underground cable is so difficult. Using the microprocessor and GSM modem fault finding method is easily and accurate. Proposes to use fault location model for underground power cable using a microcontroller. The aim of the paper is to determine the distance of underground cable fault from a substation in kilometers.

Key words: Power Cable, Fault, Microprocessor, GSM Modem

I. INTRODUCTION

In electrical utilities, transmission lines form the backbone of power systems. With regard to reliability and maintenance costs of power delivery, accurate fault location for transmission lines is of vital importance in restoring power services and reducing outage time as much as possible. Accurately locating faults on high voltage transmission networks is very important for utilities to allow a quick maintenance action of the repair crew [1]. Cable faults can be categorized into three main types: Open conductor faults, shorted faults, and high impedance faults.

II. TECHNIQUES OF FAULT LOCATION

The faults occurring in the power lines and cables can be classified into four main categories- short circuit to another conductor in the cable, short circuit to earth, high resistance to earth and open circuit. Not all approaches work best for each type of fault. Three methods that are mostly used in detecting fault location are described as follows [2].

- A-frame
- Thumper
- Time Domain Reflect meter (TDR)

A. A - Frame Method

A persistent short circuit to earth fault can be most easily located using A-Frame method. For high resistance to earth faults. A-Frame method is not always sufficient. In this case, thumper method needs to be used to reduce fault resistance. Thumper method alone may be sufficient for fault location but when applied for a longer duration, it may damage the cable insulation [3]. A-Frame is not useful for locating faults which do not have an earth connection. Time Domain Reflectometer (TDR) is suitable for determining the locations of most of the faults.

In a pulsed direct current (DC) is injected into the faulty cable and earth terminal to locate the ground fault. The DC pulse will flow through the conductor and return via earth from the earth fault location back to the ground stake as shown in Figure 1. The flow of pulsed DC through the ground will produce a small DC voltage. A sensitive voltmeter is used to measure the magnitude and direction of the DC voltage in segments of the earth along the cable route.

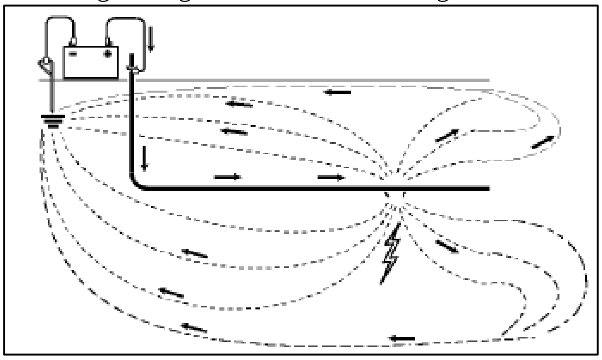

Fig. 1: A-Frame Method

Analyzing the results of the measuring voltage along the route, the location of the fault in the cable can be pinpointed A- Frame is an accurate method but it is not the fastest one since the operator has to walk along the length of the cable from the transmitter to the ground fault [4].This method may face a problem if the return DC finds some easier path back to the earth stake of transmitter instead of returning through the ground. If the ground is sandy, paved which provides high resistance and consequently, less current flows through the ground. In that case, the voltmeter fails to measure the voltage and fault detection becomes complicated.

B. Thumper Method

Thumper is basically a high voltage surge generator which is used to apply a reasonable high voltage to the faulty core of an underground cable to generate a high current arc resulting in a loud noise to hear above the ground. This method requires very high current thump at voltages as high as 25 kV to make an underground noise loud enough to be loud enough to be heard from the ground. In thumper method of finding fault locations Like A- Frame, the thumper method requires an operator needs to walk along the path of the cable and listen for the sound from above the ground. Different ground conditions, nearby traffic, and noises may make this sound hard to listen to make a clear distinction.

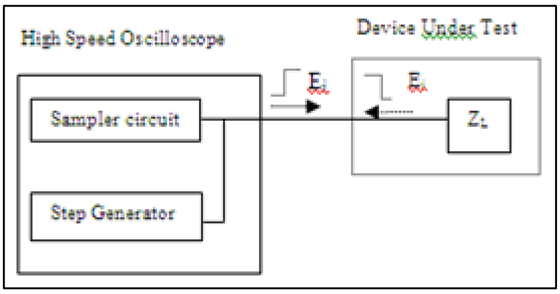

Fig. 2: Functional block diagram of TDR

C. Time Domain Reflectometry (TDR)

In the Time Domain reflectometry (TDR) method, a low energy signal is sent through the cable where the perfect cable with the uniform characteristic impedance returns the signal within a known time and with a known profile. This time and profile of the signal are altered once the cable has impedance variation due to any fault [5]. The impedance variation causes a portion of the signal reflected back to the source. The reflected signal fortifies the original signal when there is an increase in characteristic impedance at the fault location, while it opposes the original signal when there is a decrease in characteristic impedance. Graphical representation on the Time Domain Reflectometry (TDR) screen gives the user the distance to the fault in time units. The actual distance can be calculated by multiplying the time by signal velocity.

The functional block diagram of a TDR is given in Figure. Therefore, the low voltage TDR and the thumper methods can be integrated into a single system where a low voltage TDR pulse is taken off the cable under test and stored in a display memory. Then the thumper can be used to send a high voltage pulse for burning the faulty point. While the arc is burning at the faulty point, the TDR can be used to send the same low voltage pulse and new pulse will be superimposed upon the first trace. The arc is low impedance point that results in TDR pulse to reflect as it would with a short circuit. The dashed cursor represents the launching point and solid cursor shows the faulty point. From these two cursors, the machine can directly calculate the distance of the fault. The integrated thumper and TDR method reduces the major insulation damage of the cable but does not discard the risk. TDR method is useful for open circuit fault detection. Again if it has a low series resistance at the fault the problem will be similar as high resistance earth fault.

III. BLOCK DIAGRAM OF UNDERGROUND CABLE DISTANCE FINDING USING ARDUINO AND GSM

By using the simple concept of OHMs law where a low DC voltage is applied at the feeder en through a series resistor. The current would vary depending upon the length of the fault of the cable in case there is a short circuit of LL or 3L or LG etc. The series resistor voltage drop changes accordingly which are then fed to an ADC to develop precise digital data which the programmed microcontroller would display the same in Kilometers. It is assembled with a set of resistors representing cable length in KMs and fault creation is made by a set of switches at every known KM to cross check the accuracy.

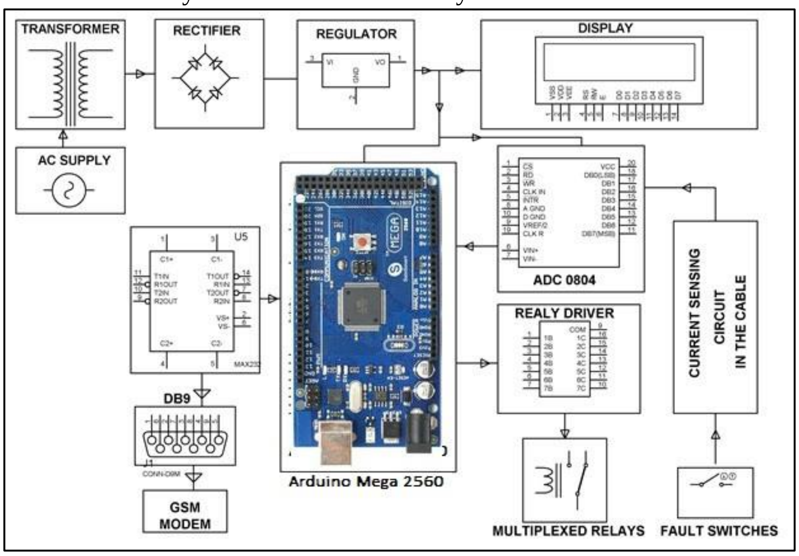

Fig. 3: Block diagram of underground cable fault distance conveyed over GSM

This is proposed a model of underground cable fault distance locator using a microcontroller. It is classified in four parts DC power supply part, cable part, controlling part, display part. DC power supply part consist of a supply of 230v is step-down using a transformer, bridge rectifier converts AC signal to dc & regulator is used to produce a constant dc voltage. The cable part is denoted by a set of resistors along with switches. Current sensing part of cable represented as a set of resistors & switches is used as fault creators to indicate the fault at each location [6]. This part senses the change in current by sensing the voltage drop. Next is controlling part which consists of an analog to digital converter which receives input from the current sensing circuit, converts this voltage into a digital signal and feeds the microcontroller with the signal. The microcontroller also forms part of the controlling unit and makes necessary calculations regarding the distance of the fault. The microcontroller 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 [7]. 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 the case of any fault.

A. Algorithm

1) Step1: Initialize the ports, declare timer, ADC, LCD functions.
2) Step2: Begin an infinite loop; turn on relay 1 by making pin 0.0 high.
3) Step3: Display "R:" at the starting of the first line in LCD.
4) Step4: Call ADC Function, depending upon ADC output, displays the fault position.
5) Step5: Call delay.
6) Step6: Repeat steps 3 to 5 for other two phases. Power Supply

B. Power Supply

The power supply circuit consists of a step-down transformer which is 230v step down to 12v. In this Circuit 4 diodes are used to for M-bridge rectifier which delivers pulsating dc voltage & then fed to capacitor filter the output Voltage from the rectifier is fed to filter to eliminate any AC. components present even after rectification. The filtered DC voltage is given to regulator to produce 12v constant DC voltage [8].

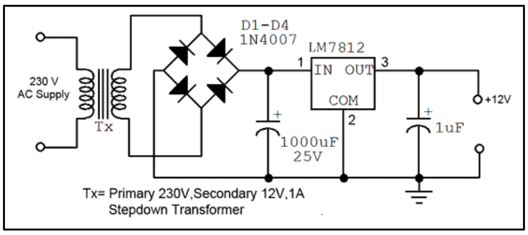

Fig. 4: Power supply of circuit

C. Rectifier

The output from the transformers fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may behalf wave or a full wave rectifier. In this paper, bridge rectifiers used because of its merits like good stability. The circuit has four dies disconnected 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 a rectification. Rectifier shaves many uses but is often funds Erving 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 [9].

D. LCD

Liquid crystal display is interfacing to microcontroller 8051. Most commonly LCD used are 16*2 & 20*2 display. In 16*2 display means 16 represents column & 2 represents rows. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with own 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.

E. Voltage Regulator

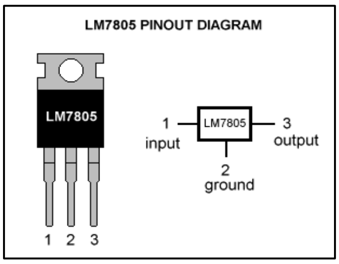

Fig. 5: LM7805 Pin diagram

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage Level. In this paper, the 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 [11].

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric system, voltage regulators may be installed at a substation or long distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

F. Microcontroller

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button [12]. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

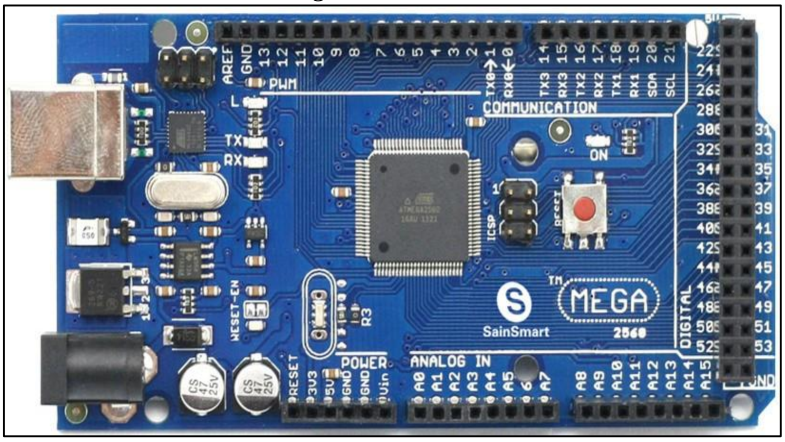

Fig. 6: Arduino Mega 2560

- Microcontroller: ATmega2560
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 54 (of which 14 provide PWM output)
- Analog Input Pins: 16
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 256 KB of which 8 KB used by bootloader
- SRAM: 8 KB
- EEPROM: 4 KB
- Clock Speed: 16 MHz

G. GSM Modem

GSM service is used in mobile in all over the world and it's useful to us now here we use SIM300_V7.03

The physical interface to the mobile application is made through a 60 pins board-to-board connector, which provides all hardware interfaces between the module and customers' boards except the RF antenna interface. SIM300 provide RF antenna interface with two alternatives: antenna connector and antenna pad. The antenna connector is MURATA MM9329-2700. And customer's antenna can be soldered to the antenna pad.

The SIM300 is designed with power saving technique, the current consumption to as low as 2.5mA in SLEEP mode. The SIM300 is integrated with the TCP/IP protocol Extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily, which is very useful for those data transfer applications.

IV. ADVANTAGES

1) Less maintenance
2) It has higher efficiency
3) Less fault occur in underground cable
4) Underground cable fault location model is applicable to all types of cable ranging from 1kv to 500kv&other types of cable fault such as-Short circuit fault, cable cuts, Resistive fault, Sheath faults, Water trees, Partial discharges.

V. CONCLUSION

The objective of this paper is to determine the distance of underground cable fault from the base station in kilometers. When the faults occur in an underground cable, to solve this problem is very time consuming, and costly.

So, we can know about the fault at base Station using the microcontroller and find the distance in kilometers. This paper proposes fault location model for underground power cable using a microcontroller. The aim to determine the distance of underground cable fault from the base station in kilometers. It uses the simple concept of ohm's law. When any fault like short circuit occurs, the voltage drop will vary depending on the length of fault in the cable, since the current varies. A set of resistors are therefore used to represent the cable and a dc voltage is fed at one end and the fault is detected by detecting the change in voltage using an analog to voltage converter and a microcontroller is used to make the necessary calculations so that the fault Distance is displayed on the LCD display and send to mobile through SMS.

VI. FUTURE SCOPE

In this equipment detect only the location of short circuit fault in underground cable line, and also detect the location of open circuit fault, to detect the open circuit fault capacitor is used in AC circuit which measure the change in impedance &calculate the distance of fault.

For future research, proceed with similar neural networks structure for fault section and fault location estimation.

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