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# Hardware Implementation of an Underground Cable Fault Detection

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***Abstract-Till last decades, cables were made to lay overhead & currently it is lay to underground cable which is superior to earlier method. Because the underground cables are not affected by any adverse weather condition such as storm, snow, heavy rainfall as well as pollution. But when any fault occurs in a cable, then it is difficult to locate the fault. So we will move to find the exact location of fault along with indication of type of fault. Now the world is become digitalized, so the project is intended to detect the location of fault in digital way. 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. Also the type of fault and the position is indicated by using a GPS system. A message and a voice are sent to the dedicated mobile number using a GSM module. Once the fault is cleared, it displays a message on LCD indicating that the fault is cleared.***

***Index Terms—ARDUNIO Microcontroller,Bridge rectifier,Cables,GSM Modem,Liquid crystaldisplay,Transformer.***

## I. INTRODUCTION

Underground cables are the electric power transmission cables. Because of their reliability on transmitting, they used in urban areas and in thick population areas, where overhead transmission is dangerous. Underground cables have low maintenance cost, less chances of faults, smaller voltage drop. In recent improvements in the design and manufacture have led to development of cables suitable for use at high voltage.

The design and construction of underground transmission lines differ from overhead lines. The first underground transmission line was a 132 kV line constructed in 1927. The cable was fluid-filled and paper insulated. The fluid was necessary to dissipate the heat. For decades, reliability problems continued to be associated with constructing longer cables at higher voltages. The most significant issue was maintenance difficulties. Not until mid-1960s did the technology advance sufficiently so that a high-voltage 345 kV line could be constructed underground. The lines though were still fluid filled.

In the 1990s the first solid cable transmission line was constructed more than one mile in length and greater than 230 kV. Cables are generally laid directly in the ground or in ducts in the underground distribution system. For this reason, there are little chances of faults in underground cables. However, if a fault does occur, it is difficult to locate and repair the fault because conductors are not visible. Nevertheless, the following are the faults most likely to occur in underground cables[1].

Underground cables are the electric power transmission cables. Because of their reliability on transmitting, they used in congested urban areas and in thick population areas, where overhead transmission is dangerous. Underground cables have low maintenance cost, less chances of faults, smaller voltage drop. In recent improvements in the design and manufacture have led todevelopment of cables suitable for use at high voltage[2].

## II. SCOPE AND OBJECTIVE OF THE PROJECT

Till last decadess, cables were made to lay overhead & currently it is lay to underground cable which is superior to earlier method. Because the underground cables are not affected by any adverse weather condition such as storm, snow, heavy rainfall as well as pollution. But when any fault occurs in a cable, then it is difficult to locate the fault. So we will move to find the exact location of fault along with indication of type of fault. Now the world is become digitalized, so the project is intended to detect the location of fault in digital way.

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. Also the type of fault and the position is indicated by using a GPS system. A message and a voice are sent to the dedicated mobile number using a GSM module. Once the fault is cleared, it displays a message on LCD indicating that the fault is cleared[3].

The majority of systems rely upon three phase AC electric power is the product of two quantities: current and voltage. These two quantities can vary with respect to time ( AC power) or can be kept at constant levels (DC power). Alternating current generators can produce a variable number of phases of power. A higher number of phases lead to more efficient power system operation but also increases the infrastructure requirements of the system. Power systems deliver energy to loads that perform a function. These loads range from household appliances to industrial machinery. Most loads expect a certain voltage and, for alternating current devices, a certain frequency and number of phases.

Power system operator needs accurate information so that he can deploy men and machinery to the accurate spot immediately and rectify the fault thereby saving lot of time and resources. Soft ware system, communication system such as SCADA and PLCC hardware system can be designed. For fault location data from SCADA such as oscillo graphs, relays and the sequence of events are used for fault location now available latest technology.GPS which can be used to locate a fault on long high voltage transmission lines. Self monitoring hardware can be configured at foundation sites for both conditions. By inserting the information of a fault location (GPS) into Geographical information system computer. Some power system operators have adopted this system.

Most previous studies have focused in determination and detect of the location of fault on current mechanism in the power transmission lines approximated by the calculation of the impedance obtained from voltage and current data. Also Account time attended a signal, Signal is sent to the line that the error occurred when the signal reach to the location of fault back accordingly it is estimated the location of fault by determining time to go and return[4].

Also some previous studies spoke on detect the location of fault by using magnetic field sensing coils which determining the magnetic field due to an unspecified number of conductors and due to a three-conductor system are then examined. The results of this analysis are used in simulating the magnetic field for a variety of conductor configurations under normal operating conditions and for line to ground and line to line fault conditions. This information is used to determine the potential effectiveness of monitoring the magnetic field to detect faults. Therefore this to present a circuit that capable of detecting and locating the fault with less proportion of error .This circuit use the global positioning system (GPS) to locate the position and the global system for mobile (GSM) to send these message to system supervisor[5].

## III. BLOCK DIAGRAM

The input voltage 230V is applied to the transformer initially.Then the transformer (230V/12V) steps down the input voltage to 12V. The output of transformer is fed to rectifier bridge which converts 12V AC to 12V DC. But the output of rectifier is pulsating DC. Hence a capacitor filter (10MF) is used to convert into pure DC. Then 12V DC is applied to a voltage regulator to provide enough voltage i.e. 5V to the ATMEGA microcontroller. Both LCD and controller are interfaced each other

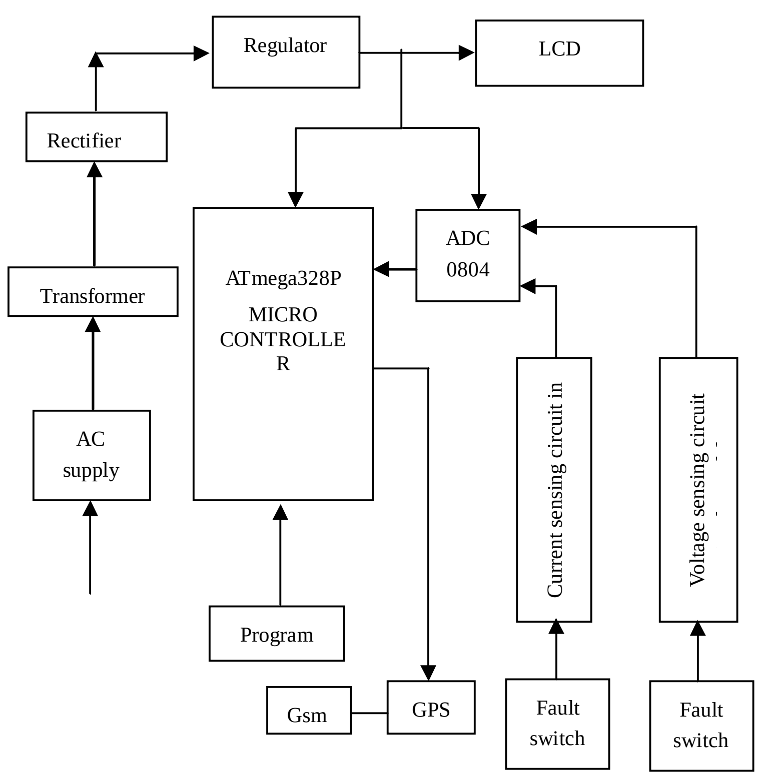


Fig. 3.1:Bock diagram of under ground fault detection

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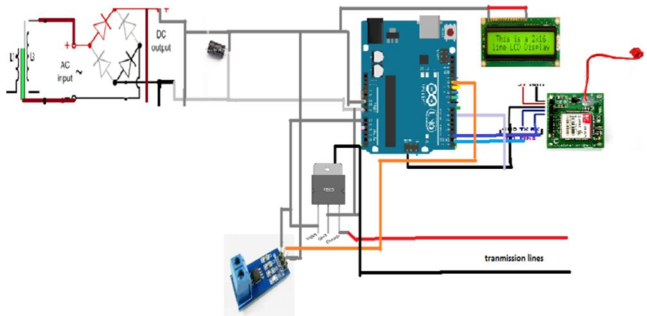
A GSM module is used to send alert messages to the registered mobile number. When there is no fault in the system, it displays a message “Good condition” on the LCD. When a fault occurs(short circuit or open circuit),it displays the type of fault on LCD, along by sending an alert message to the mobile number. The system gives the voltage and current values at normal and abnormal conditions. The location of fault latitude and longitude is shown through GPS system. Also once the fault is cleared, it again sends the message that the fault is cleared[6].

## IV. METHODOLOGY AND OPERATION

The input voltage 230V is applied to the transformer initially. Then the transformer (230V/12V) steps down the input voltage to 12V. The output of transformer is fed to rectifier bridge which converts 12V AC to 12V DC. But the output of rectifier is pulsating DC. Hence a capacitor filter (10MF) is used to convert into pure DC.Then 12V DC is applied to a voltage regulator to provide enough voltage i.e. 5V to the ATMEGA microcontroller.




Fig;4.1 schematic diagram

### A. *Control Unit*

ATMEGA microcontroller and LCD are interfaced each other. When there is no fault in the system, it displays a message “Good condition” on the LCD. When a fault occurs (short circuit or open circuit), it displays the type of fault on LCD, along by sending an alert message to the mobile number. By using the current and voltage sensors how much current and voltage values are present at that condition also displays on LCD and system. The system gives the voltage and current values at normal and abnormal conditions[7].

### B. *System during Good Condition*

When there is no fault in the underground cable, it displays on LCD that the system is in “Good condition” by indicating the voltage and current values

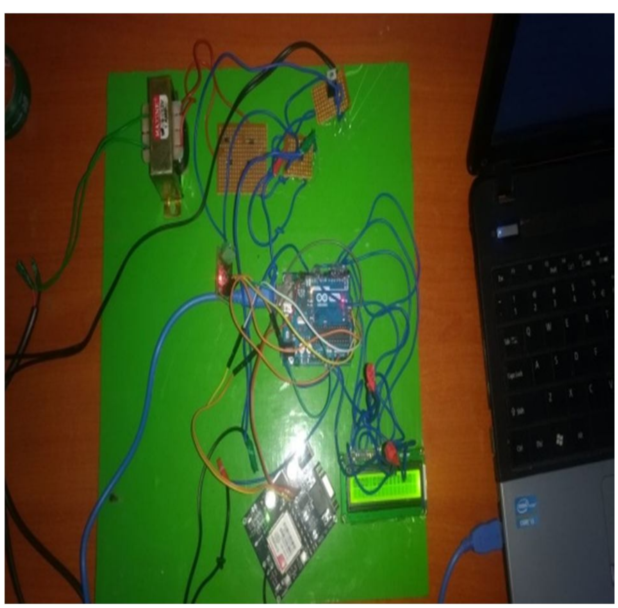


Fig4.2: Circuit during Good condition

### *C. System during Fault Condition (Open Circuit)*

When an open circuit fault is occurred in the system, immediately it displays on the LCD as open circuit has occurred by displaying the open circuit current and voltage

Fig4.3 : Circuit during Open circuit condition

A GSM module is used to send alert messages to the registered mobile number. The location of fault latitude and longitude is shown through GPS system. In registered mobile number displays type of fault and location of fault latitude and longitude. Also once the fault is cleared, it again sends the message that the fault is cleared.

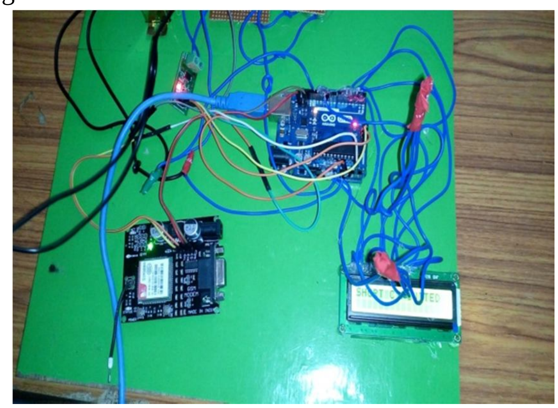


Fig 4.4 Circuit during Short circuit condition

## V. HARDWARE IMPLEMENTATION

An Arduino board consists of an Atmel 8-bit microcontroller with complementary components to facilitate programming and incorporation into other circuits. Official Arduino have used the mega AVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560. Most boards include a 5 volt linear regulator and a 16 MHz crystal oscillator or ceramic resonator in some variants. An Arduino microcontroller is also pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory, compared with other devices that typically need an external programmer[8].

This allows an Arduino to be used by novices and experts alike without having to go through the difficulties first faced by many when using electronics by allowing the use of an ordinary computer as the programmer. At a conceptual level, when using the Arduino software stack, all boards are programmed over an RS-232 serial connection, but the way this is implemented varies by hardware version. Current Arduino boards are programmed via USB, implemented using USB-to-serial adapter chips such as the FTDI FT232[9].

When used with traditional microcontroller tools instead of the Arduino IDE, standard AVR ISP programming is used. Arduino board provides 14 digital I/O pins, six of which can produce pulse-width modulated signals, and other six analog inputs. The output or inputs can be taken from the boards or given to the board using convenient connectors. Both digital and analog inputs and outputs are available in all Arduino boards. The Arduino boards can also communicate with other devices using standard communication ports like USART, IIC, and USB etc[10]

## VI. RESULTS

Whenever there is no fault in the underground cable, it displays on LCD that the system is in “good condition” by indicating the normal voltage and current values. When a fault occurs on the line, it displays the type of fault on the system whether it is open circuit or short circuit fault. Also an SMS is sent by using GSM System to the registered user for alerting purpose. Once the fault is cleared, it displays on LCD again as "good condition" which automatically sends SMS indicating that the fault is cleared.

TableI: NORMAL CIRCUIT CONDITION

| S.no | Condition | Voltage | Current |
|---|---|---|---|
| 1 | Good | 12V | 1A |

When an Open circuit fault is occurred in the system , immediately it displays on the LCD as open circuit has occurred by displaying the open circuit current and voltage.

TableII:OPEN CIRCUIT CONDITION

| S.no | Condition | Voltage | Current |
|---|---|---|---|
| 1 | open | 12V | 0A |

Similarly when a short circuit fault is occurred on the line, it displays on the LCD as short circuit has occurred by indicating the short circuit current and voltage[10].

TableIII: SHORT CIRCIT CONDITION

| S.no | Condition | Voltage | Current |
|---|---|---|---|
| 1 | Short | 0V | 0.85A |

## VII. CONCLUSION AND FUTURE SCOPE

In this project, two types of faults i.e. open circuit & short circuit faults (L-G) are displayed on the LCD along by sending an alert SMS using GSM system to the registered mobile number. The values of voltage and current are displayed during normal and abnormal conditions. Also the fault location is displayed in form of latitude and longitude in mobile.

The project has a extended to the fault location in underground cables can be easily found by using Effective Global Positioning System, Global System for Mobile Communication, which thereby directly indicates the distance of fault from the nearby substation along with sending an SMS or Voice to the registered mobile number. This helps the repairing team to clear the fault within less time. This can be implemented for 3-Phase System also.

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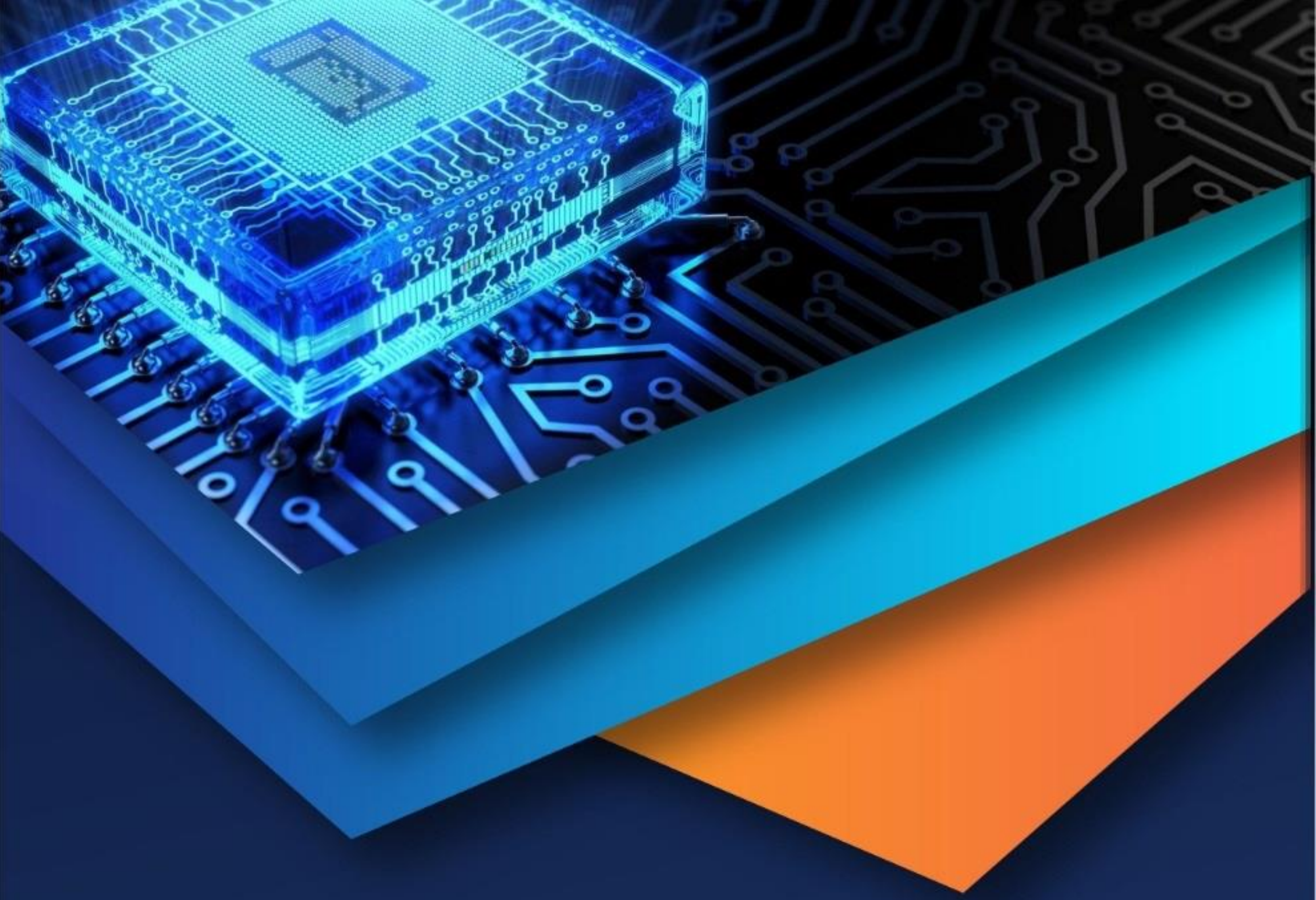


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