Design and Implementation of Under Ground Power Cable Fault Dector Using GSM

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Abstract- *The objective of this project is to determine the underground cable fault from base station in kilometers using Arduino board. The underground cable system is a common practice followed in many urban areas. While a 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 the cable fault.*

The proposed system is to find the exact location of the fault. The project uses the standard concept of hall effect sensor In case there is a short circuit Line to Ground, the voltage across the hall effect sensor changes accordingly, which is then fed to inbuilt Analog to Digital Converter of Arduino board to develop precise digital data for display in kilometers.

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.

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 ohm'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.

Keywords- Fault, Arduino, short-circuit, interface, Line-Line

I. INTRODUCTION

Underground cables are employed for transmission and distribution of electric power where it becomes impracticable to make use of overhead construction. Such locations may be congested areas where right of way cost would be excessive or local ordinances prohibit overhead lines for reason of safety, or around plants and substations or crossings of wide bodies of water which for various reasons would not permit the overhead crossings. The type of cables used will depend upon voltage and service requirement. Recent improvements in design and manufacture have led to the development of cables suitable for use at high voltages. This has made it possible to use underground cables for transmission of electric power for short or moderate distances.

Underground cables consists of one central core or a number of cores (two, three or four) of tinned stranded copper conductors (sometimes use of aluminum conductor is also made) insulation from each other by paper or varnished cambric or vulcanized bitumen or impregnated paper. A metallic sheath of lead or alloy or of aluminum is provided around the insulation to protect it against ingress of moisture. The initial heavy cost is the only factor which discouraged the use of underground cables for the purpose of transmission and distribution of electric power

A.TYPES OF UNDERGROUND CABLES

Cables for underground service may be classified in two ways according to (i) the type of insulating material used in their manufacture (ii) the voltage for which they are manufactured. However, the latter method of classification is generally preferred, according to which cables can be divided into the following groups

(i) Low-tension (LT) cables - up to 1000 V
(ii) High-tension (HT) cables - up to 11,000 V
(iii) Super-tension (ST) cables - from 22 kV to 33 kV
(iv) Extra high-tension (EHT) cables - from 33 kV to 66 kV
(v) Extra super voltage cables - beyond 132 Kv

A cable may have one or more than one core depending upon the type of service for which it is intended. It may be (i) single-core (ii) two-core (iii) three-core (iv)four-core etc. For a 3-phase service, either 3-single-core cables or three-core cable can be used depending upon the operating voltage and load demand. The figure below shows the constructional details of a single-core low tension cable.

B.FAULTS IN UNDER GROUND CABLES

Open Circuit Fault

This type of fault is better than short circuit fault, because when the open circuit fault occurs, then the flow of current through an underground cable becomes zero. This fault can be occurred by disruption in conducting path. Such faults occur when one or more phase conductors break

Short Circuit Fault

Short circuit fault can be divided into two types, namely symmetrical and unsymmetrical faults

- In symmetrical fault, three phases are short circuited in this type of fault. This type of fault is also called as three phase fault due to this reason.
- In unsymmetrical fault, the magnitude of the current is not equal and displaced by 120 degrees

II. PROPOSED SYSTEM

A. INTRODUCTION

The objective of this project is to determine the distance of underground cable fault from base station in kilometers using ANN Arduino board. The underground cable system is a common practice followed in many urban areas. While a 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 the cable fault.

The proposed system is to find the exact location of the fault. The project uses the standard concept of hall effect sensor.In case there is a short circuit (Line to Ground), the voltage across the hall effect sensor changes accordingly, which is then fed to inbuilt ADC of Arduino board to develop precise digital data for display in kilometers.

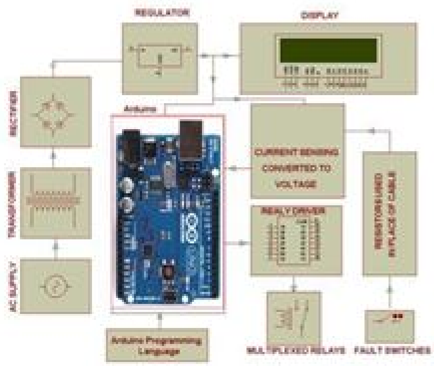


Fig. 1 Block diagram of proposed method

The paper 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. Further this project can be enhanced by using capacitor in an AC circuit to measure the impedance which can even locate the open circuited cable.

The electrical cable runs in undergrounds instead of overhead lines. Whenever the fault occurs in underground cable it is difficult to detect the exact location of the fault for process of repairing that particular cable. The proposed system finds the exact location of the fault.

This system uses an Arduino board and a rectified power supply. Here the current sensing circuits made with combination of resistors are interfaced to Arduino board with help of the internal ADC device for providing digital data to the microcontroller representing the cable length in KM's. The fault creation is made by the set of switches. The relays are controlled by the relay driver IC which is used for switching the power sequentially to all the lines. A 16x2 LCD display connected to the microcontroller to display the information.

B. HALL EFFECT SENSOR

The DRV5023 device is a chopper-stabilized Hall Effect Sensor that offers a magnetic sensing solution with superior sensitivity stability over temperature and integrated protection features

3.4.1 Block diagram for Hall effect sensor

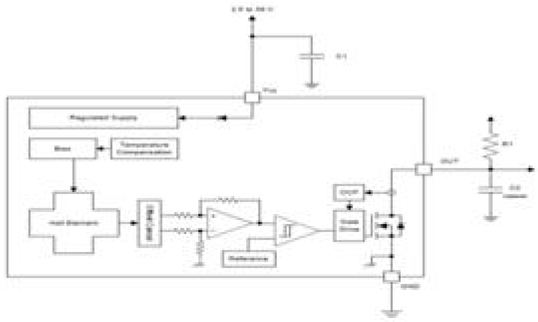


Fig.2 Block diagram for Hall effect sensor

The field polarity is defined as follows: a south pole near the marked side of the package is a positive magnetic field. A north pole near the marked side of the package is a negative magnetic field. The output state is dependent on the magnetic field perpendicular to the package. A strong near the marked side of the package causes the output to pull low (operate point, BOP), and a weak south pole causes the output to release (release point, BRP). Hysteresis is included in between the operate point and the release point therefore magnetic-field noise does not accidentally trip the output.

An external pull-up resistor is required on the OUT pin. The OUT pin can be pulled up to VCC, or to a different voltage supply. This allows for easier interfacing with controller circuits.

C. Pin configuration

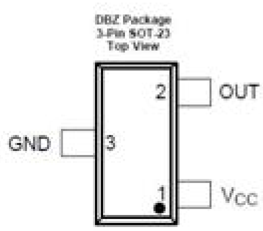


Fig.3 pin diagram of Hall sensor

The DRV5023 device can be powered with a supply voltage between 2.5 and 38 V, and will survive –22 V reverse-battery conditions. The DRV5023 device does not operate when –22 to 2.4 V is applied to the VCC pin (with respect to GND pin). In addition, the device can withstand supply voltages.

D. TRANSFORMER

A transformer is a static device that transfers electrical energy from one circuit to another through inductively coupled conductors—the transformer's coils. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction

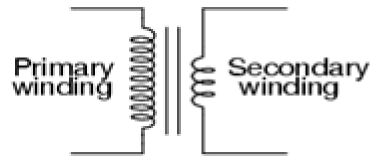
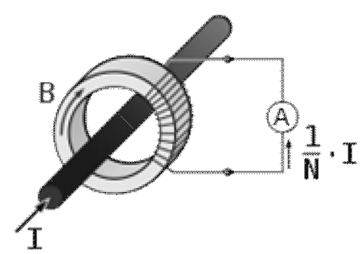


Fig.4 Transformer

E. Current transformer

A **current transformer** (**CT**) is used for measurement of alternating electric currents. Current transformers, together with voltage (or potential) transformers (VT or PT), are known as **instrument transformers**. When current in a circuit is too high to apply directly to measuring instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the electrical power industry



F. POWER SUPPLY

All digital circuits work only with low DC voltage. A power supply unit is required to provide the appropriate voltage supply. This unit consists of transformer, rectifier, filter and a regulator. AC voltage typically of 230Vrms is connected to a transformer which steps that AC voltage down to the desired AC voltage level. A diode rectifier then provides a full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a DC voltage. This resulting DC voltage usually has some ripple or AC voltage variations. Regulator circuit can use this DC input to provide DC voltage that not only has much less ripple voltage but also remains in the same DC value, even when the DC voltage varies, or the load connected to the output DC voltage changes. The required DC supply is obtained from the available AC supply after rectification, filtration and regulation. Block diagram of power supply unit.

G.TRANSFORMER

Transformer is a device used either for stepping-up or stepping-down the AC supply voltage with a corresponding decreases or increases in the current. Here, a transformer is used for stepping-down the voltage so as to get a voltage that can be regulated to get a constant 5V.

E.RECTIFIER

A rectifier is a device like semiconductor, capable of converting sinusoidal input waveform units into a unidirectional waveform, with a nonzero average component.

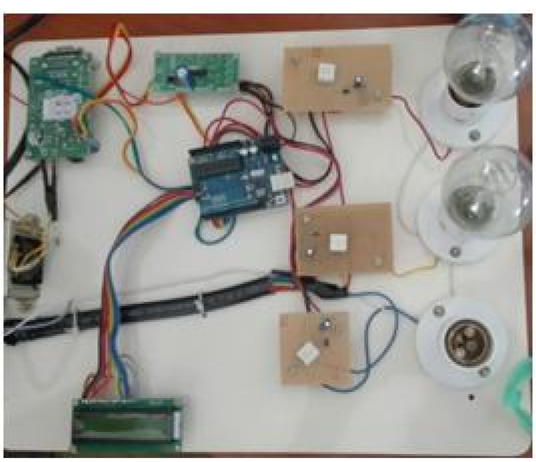
F.FILTERS

Capacitors are used as filters in the power supply unit. The action of the system depends upon the fact, that the capacitors stores energy during the conduction period and delivers this energy to the load during the inverse or non-conducting period. In this way, time during which the current passes through the load is prolonged and ripple is considerably reduced.

G.VOLTAGE REGULATOR

The LM78XX is three terminal regulator available with several fixed output voltages making them useful in a wide range of applications. IC7805 is a fixed voltage regulators used in this circuit.

II.EXPERIMENTAL SETUP



III. TESTING AND EVALUATION

A. A.Line-to-Line Fault

A line to line fault or unsymmetrical fault occurs when two conductors are short circuited. In the figure shown below shows a three phase system with a line-to-line fault phases b and c. The fault impedance is assumed to be Z_f. The LL fault is placed between lines b and c so that the fault be symmetrical with respect to the reference phase a which is un-faulted.

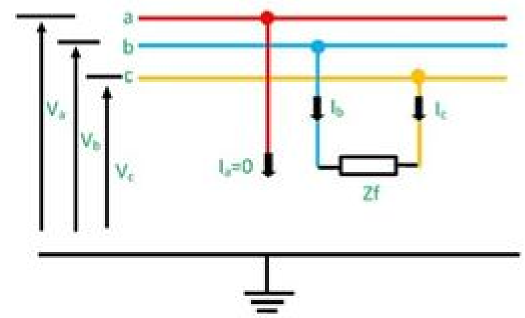


Fig.6 Line-to-Line Fault

B.Single line to ground fault

Single line to ground fault is the most frequently occurring fault (60 to 75% of occurrence). This fault will occur when any one line is in contact with the ground. Double line fault occurs when two lines are short circuited. This type of fault occurrence ranges from 5 to 15%. Double line to ground fault occurs when two lines are short circuited and is in contact with the ground. This type of fault occurrence ranges from 15 to 25% of occurrence.

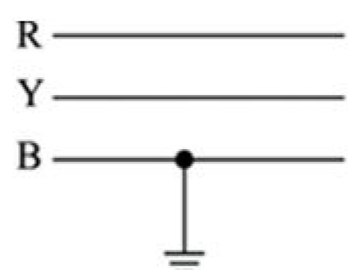


Fig.7 Line-to-Line Fault

C.Three line faults

Three line faults, are more common than three phase faults and have fault currents that are approximately 87% of the three phase bolted fault current. This type of fault is not balanced within the three phases and its fault current is seldom calculated for equipment ratings because it does not provide the maximum fault current magnitude. The line-to-line current can be calculated by multiplying the three phase value by 0.866**,** when the impedance Z1 = Z2**.**

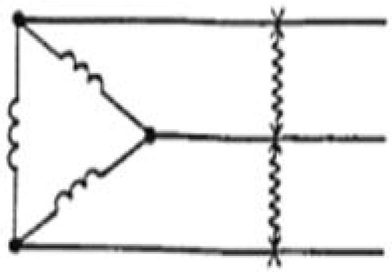
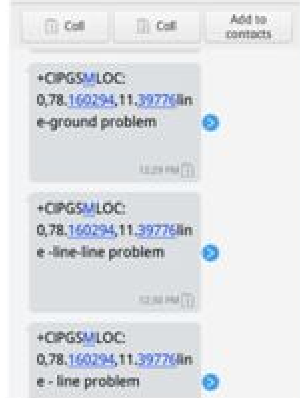


Fig.7 Line-to-Line to line Fault

D.Output verification



D. 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.

IV. CONCLUSION

The Paper underground cable fault detection using GSM and GPS has been successfully designed and tested. Integrating features of all hardware components used have developed it. Presents of every module has been reasoned out and placed carefully thus contributing to the best working of unit. Secondly using high advanced IC's and with help of growing technology the project has been successfully implemented.

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