

Analysis of fault detection and its location using microcontroller for underground cables

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Abstract - Underground cables are prone to a wide variety of faults due to underground conditions, wear and tear, rodents etc. Also detecting fault source is difficult and entire line is to be dug in order to check entire line and fix faults. So here we propose cable fault detection over IOT that detects the exact fault position over IOT that makes repairing work very easy. The repairmen know exactly which part has fault and only that area is to be dug to detect the fault source. This saves a lot of time, money and efforts and also allows to service underground cables faster. We use IOT technology that updates the monitored fault information to internet. The system detects fault with the help of potential divider network laid across the cable. Whenever a fault gets created at a point shorting two lines together, a specific voltage gets generated as per the resistors network combination. This voltage is sensed by the microcontroller and is updated to the user. The information conveyed to the user is the information regarding faults detection. The microcontroller retrieves the fault line data and displays over LCD display, also it transfers this data over internet to display on Gmail server.

Key Words: IOT technology, LCD, microcontroller. Potential divider

1. INTRODUCTION

The paper uses the standard concept of Ohms law i.e., when a low DC voltage is applied at the feeder end through a series resistor (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 an ADC to develop precise digital data which the programmed microcontroller of 8051 family would 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 microcontroller.

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 cable are not affected by any adverse weather condition such as storm, snow, heavy rainfall as well as pollution. But when any fault occur in cable, then it is difficult to locate fault. So we will move to find the exact location 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.

Fault in cable is represented as:

- Any defect,
- Inconsistency,
- Weakness or non-homogeneity that affects performance of cable
- Current is diverted from the intended path,

For most of the worldwide operated low voltage and medium voltage distribution lines underground cables have been used from many decades. To reduce the sensitivity of distribution networks to environmental influences underground high voltage cables are used more and more. Underground cables have been widely used in power distribution networks due to the advantages of underground connection, involving more security than overhead lines in bad weather, less liable to damage by storms or lightning. It is less expensive for shorter distance, eco- friendly and low maintenance.

But if any fault occur in cable, then it is difficult to locate fault. So this project is used to detect the location of fault in digital way. The requirement of locating the faulty point in an underground cable in order is to facilitate quicker repair, improve the system reliability and reduced outage period. The underground cable system is very useful for distribution mainly in metropolitan cities, airport and defense services. More than 3 million miles of electrical cables are strung overhead across the country. Add to that at least 180

million telephone and cable TV lines, and it's no wonder hurricanes, tornadoes, fires and ice storms are wreaking havoc on the electrical systems each year.

This causes the utility outages that last days, weeks and longer. Power outages over extended periods present major health and safety concerns and economic losses.

Concerns about the reliability of overhead lines, increases in their maintenance and operating costs, and issues of public safety and quality-of-life are leading more and more utilities and municipalities to the realization that converting overhead distribution lines to underground is the best way to provide high-quality service to their customers. For utility companies, undergrounding provides potential benefits through reduced operations and maintenance (O&M) costs, reduced tree trimming costs, less storm damage and reduced loss of day-to-day electricity sales when customers lose power after storms.

Creative funding options are often available to make the goal of undergrounding a reality. The underground cable system is very important for distribution especially in metropolitan cities, airports and defense service.

Types of Faults

A fault in a cable can be classified into different types such as

- **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. Temperature. Most environmental sensors were developed from sensors designed for industrial applications such as process control refining, milling, distilling, etc. Therefore many environmental sensors are designed with the same characteristics as industrial sensors such as 4-20 mA output & 12 VDC power supply.

2 LITERATURE SURVEY

[1] Jitendra pal singh, sanjana singh, toshika singh & mohd. Shahrukh. 'underground cable fault distance locator'.

In this paper, a way for sleuthing underground cable fault distance locator is done by using microcontroller. The target of this project is to work out the gap of underground cable fault through base station in kilometers. It uses the straight forward conception of ohm's law, voltage drop can vary counting on the length of fault in cable, since the current varies. A group of resistors are used to represent the length of cable in kilometers and a dc voltage is fed at one end and the fault is detected the change in voltage using analog to voltage converter. The fault occurring at what distance is shown on LCD which is interfaced with the microcontroller that is used to make the necessary calculations.

[2] Priyanka.R and B.Priya. "Underground Cable Fault Detection".

In this paper to detect a fault in an underground cable is still a challenging task in power system. In order to detect an underground cable fault, the standard concept of OHM'S LAW is used. This idea is used to determine resistive variation, short circuit fault, open circuit fault. This project provides accuracy in determining the exact location of fault, when a low DC voltage is applied at the feeder end through a series resistor (Cable lines), then current would vary depending upon the location of fault in the cable from the base station. This project provides detection of fault and also indication of cable's temperature at varying voltage using a developed prototype from a microcontroller family. In the hardware setup we use the ARM 11 MSP430 microcontroller launch pad and a low cost low power 2.4Ghz transceiver and a readable current sensor. We can use X-CTU and MATLAB coding for detecting.

[3] B. Clegg, Underground Cable Fault Location. New York: McGrawHill, 1993.

The author has presented the studies of finding the failure location on a sample cable by using the multiple pulse reflection method and the fault on the results of the measurement. A pulse generator with amplitude of 12 V and pulse width from 20 ns to 2 us has been designed as a multiple pulse reflection meter. The velocity of reflection pulse is calibrated in embedded system. The SOPC system detects the reflection pulse and measures the time of N times reflection pulses, then judge the fault type and compute the fault distance with corrected speed of pulse developed for measurement of pulse reflection by means of pulse velocity correction and have been examined here.

3 BLOCK DIAGRAM

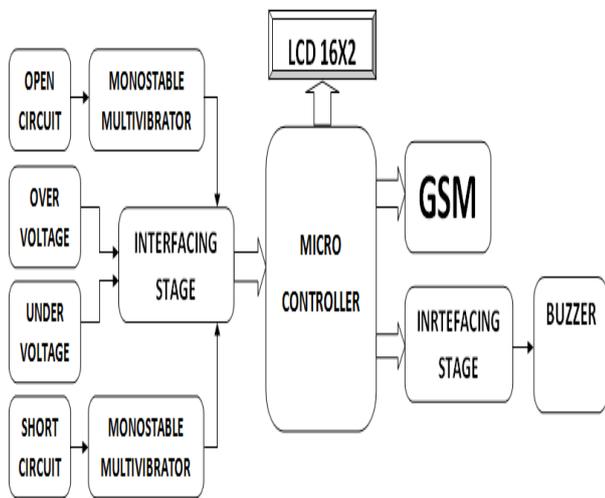


Fig1: Proposed Block Diagram

3.1 Power supply unit

This section needs two voltages viz., +12 V & +5 V, as working voltages. Hence specially designed power supply is constructed to get regulated power supplies.

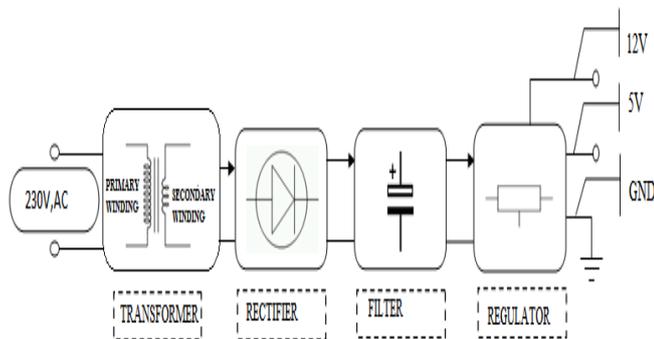


Fig 2: Power Supply circuit diagram

3.2 Over Voltage and Under Voltage

When the voltage in a circuit or part of it is raised above its upper design limit, this is known as over voltage. When the voltage in a circuit or part of it is raised above its lower design limit, this is known as under voltage. This sensor will be used to check whether the over or under voltage occurs to the circuit. If occurs then it will activate the buzzer to indicate over or under voltage has occurred.

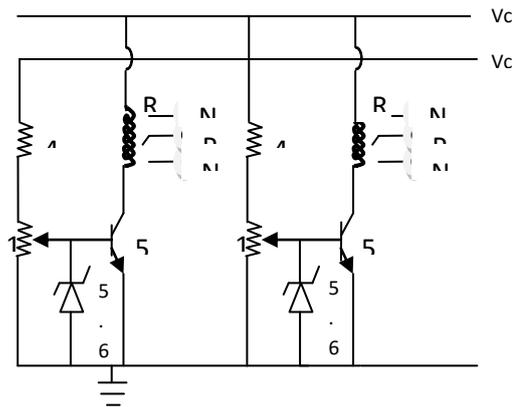


Fig 3: Circuit Diagram of Over Voltage and Under Voltage

3.3 Monostable Multivibrators

Monostable Multivibrators have only one stable state (hence their name: "Mono"), and produce a single output pulse when it is triggered externally. Monostable Multivibrators only return back to their first original and stable state after a period of time determined by the time constant of the RC coupled circuit.

3.4 Microcontroller

Microcontroller is computer processor based RISC architecture. A RISC-based computer design approach means MC processors require significantly fewer transistors than typical processors in average computers. This approach reduces costs, heat and power use. The low power consumption of MC processors has made them very popular. The MC architecture (8-bit) is the most widely used architecture in mobile devices, and most popular 8-bit one in embedded systems.

3.5 GSM

GSM Shield (SIM 900a): The SIM900 which is a complete Quad-band GSM/GPRS solution comes in a SMT module which can be embedded in customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for Data, voice, SMS and Fax in a small form factor and with low power consumption. SIM900 can fit almost all the space requirements in the M2M application with dimensions of 24mm x 24mm x 3 mm. SIM900 is designed with a very powerful single-chip processor integrating AMR926EJ-S core. Quad - band GSM/GPRS module with a size of 24mmx24mmx3mm, SMT type suit for customer application, An embedded Powerful TCP/IP protocol stack Based upon mature and field-proven platform, backed up by our support service, from definition to design and production GSM, which

stands for Global System for Mobile communications, reigns as the world's most widely used cell phone technology. Cell phones use a cell phone service carrier's GSM network by searching for cell phone towers in the nearby area.

4 METHODOLOGY

This paper is designed to achieve monitoring of underground cable and to provide information about detected fault. Over voltage, under voltage, short circuit and open circuit conditions will be monitored by respective sensors.

If any faults occurs that will be detected by respective sensors and sends that signal to controller via Monostable Multivibrators and interfacing stage i.e buffer, driver and relay unit. buffer is used for temporary storage, driver is used to drive the relay and relay for switching. Controller analyses the received signal and activates the GSM modules to send information about monitored parameter to concern person. Controller as well activates the alerting system via interfacing stage i.e buffer, driver and relay unit. In the transmitting section, the corresponding voltage drop is fed into the controller MSP430 launch pad. The launch pad consists of a 12bit Analog to Digital converter. This converter provides precise accuracy for about 3.3V. The 12bit Analog to digital converter converts the voltage into digital signal which is received from the current sensor. The controller MSP430 launch pad makes necessary calculations regarding the fault location. This data is then transmitted to the receiving section. The receiving section consists of a low cost low power wireless controller, transceiver and a display. The data's are fed from the transmitting section to the transceiver. The transceiver is interfaced with the display i.e PC. The display shows the status of the cable at each phase. Also the distance of the cable at particular phase is displayed in case of any fault. The corresponding changes in the voltage and current help us to determine the type of fault in the cable. The data's are displayed using MAT LAB coding. The resistive variation, current reading can be obtained.

5 DESIGN AND DEVELOPMENT OF HARDWARE

The 230V supply is first stepped down to 12V AC using a stepdown transformer. This is then converted to DC using centre tap full wave rectifier. The AC ripples is filtered out by using a capacitor and given to the input pin of this regulator. At output pin of this regulator we get a constant 5v DC which is used for microcontroller and other ICs in this project.



Fig 4: Hardware connection diagram

This project is designed to achieve monitoring of underground cable and to provide information about detected fault. Over voltage, under voltage, short circuit and open circuit conditions will be monitored by respective sensors. If any faults occur that will be detected by respective sensors and sends that signal to controller via Monostable Multivibrators and interfacing stage i.e buffer, driver and relay unit.

Buffer is used for temporary storage and avoids the fluctuations which is present in the input and which is fed to driver. Driver is used to drive the relay where the output is complement of input which is applied to the drive but current will be amplified. Relay is used for switching and also used to drive the load connected across the relay and the output of the relay can be connected to controller or load for further processing. Controller analyses the received signal and activates the GSM modules to send information about monitored parameter to concern person. Controller as well activates the alerting system via interfacing stage i.e buffer, driver and relay unit.

5 ADVANTAGES

- This includes aesthetics, higher public acceptance, and perceived benefits of protection against electromagnetic field radiation (which is still present in underground lines), fewer interruptions, and lower maintenance costs. Failure rates of overhead lines and underground cables vary widely, but typically underground cable outage rates are about half of their equivalent overhead line types. Potentially far fewer momentary interruptions occur from lightning, animals and tree branches falling on wires which de-energize a circuit and then reenergize it a moment later.

- Primary benefits most often cited can be divided into four areas:
- Potentially-Reduced Maintenance and Operating Costs:
- Lower storm restoration cost
- Lower tree-trimming cost
- Improved Reliability: Increased reliability during severe weather wind related storm damage will be greatly reduced for an underground system, and areas not subjected to flooding and storm surges experience minimal damage and interruption of electric service.
- Less damage during severe weather
- Far fewer momentary interruptions
- Improved utility relations regarding tree trimming
- Improved Public Safety:
- Fewer motor vehicle accidents
- Reduced live-wire contact injuries
- Fewer Fires

6 DISADVANTAGES

The main disadvantage is that the underground cables have higher initial cost and insulation problems at high voltages. Another main drawback is that, if a fault does occur, it is difficult to locate and repair the fault because the fault is invisible.

7 APPLICATIONS

Its main application is the detection of underground cable fault which is very hard to detect as it is not possible to see such faults which are quite possible in the case of overhead transmission line. So for such cases our project is very helpful as the distance at which the fault has occurred can be calculated and then further action regarding the fault can be taken to overcome them.

8 CONCLUSION

The hardware model of Underground Cable Fault Locator is implemented and favorable results were brought forward. This hardware model can locate the exact fault location in an underground cable. 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, unlike the short circuited fault only using resistors in DC circuit as followed in the above proposed project. Underground cables are prone to a wide variety of faults due to underground conditions, wear and tear, rodents etc. Also detecting fault source is difficult and entire line is to be dug in order to check entire line and fix faults. So here we propose cable

fault detection over IOT that detects the exact fault position over IOT that makes repairing work very easy. The repairmen know exactly which part has fault and only that area is to be dug to detect the fault source. This saves a lot of time, money and efforts and also allows to service underground cables faster. We use IOT technology that updates the monitored fault information to internet. The system detects fault with the help of potential divider network laid across the cable. Whenever a fault gets created at a point shorting two lines together, a specific voltage gets generated as per the resistors network combination. This voltage is sensed by the microcontroller and is updated to the user. The information conveyed to the user is the information regarding faults detection.

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