A Mini Project Report

On

"UNDERGROUND WIRE FAULT DETECTOR"

Submitted in partial fulfillment of the requirement of

University of Mumbai for the Degree of

Bachelor of Engineering

In

Mechatronics Engineering

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Academic Year 2020 – 21

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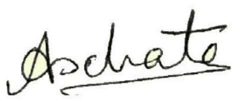

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ABSTRACT

A fault in electrical equipment can be defined as adefect in its electrical circuit due to which the current isdiverted from the intended path. Faults are generally caused by mechanical failure, accidents, excessive internal, externalstresses, and others. When a cable is faulty the resistance of such cable is affected. If left unrectified, it will totally hinder voltage from flowing through the cable. The challenge with the existing methods used for locating faults in underground cables is the inaccuracy in calculating the distance where the fault is located and the low durability of such equipment. To overcome these challenges, this paper presents a novel underground cable fault detector that has the capacity to measure the resistance of the cable, and also accurately compute the location of the fault using cheap materials. Several tests were conducted using the proposed device, and the results indicated that the proposed method produced satisfactory results in detecting both open circuit and short circuit problems in underground cables within a maximum distance of 25km**.**

1. Introduction

1.1 Background

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 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.

Related concepts: Underground Cable, Fault Location, Fault Detection, Arduino Microcontroller, LCD.

1.2 Motivation

It is a very tedious and costly process to assess the faults found in underground cable networks .In the process surrounding infrastructure is damaged,hence the cost increases,
as we need an abundance of manpower and heavy machinery to do so . Hence we thought about making this process accurate ,easy and less expensive.

2. The Problem Definition

2.1Problem Statement

Underground wires are prone to wear and tear . It is very difficult to find the faulty area in an underground wire affected by rodents ,soiletc… It is very costly to find and resolve such problems as it requires heavy machinery ,and a lot of manual labour. So our device detects that problem and displays it ,hence making it easy to find fault at an exact distance.

2.2 Objectives

1) To understand the use of microcontrollers and basic electrical laws
2) To solve the problem of inaccurate methods of fault detection.

2.3 Scope

Programming arduino and creating a basic logic behind finding faults and reporting back. Build circuits containing a power supply and a transformer.Learn to connect devices to an arduino.

3. Literature Survey

3.1 Literature Survey Summary

Table 1.1

Sr. No.	Paper	Advantages and Disadvantages
1.	Xu Sun, Wing Kin Lee1, Yunhe Hou1, and Philip W. T. Pong1" Underground Power Cable Detection and Inspection Technology Based on Magnetic Field Sensing at Ground Surface Level ",IEEE ,2014	Advantages: 1.Accuracy is very high 2.There are virtually no limitations to the length of the network cable that can be measured. Disadvantages:1. The Arduino and other component require 5V DC Supply. 2. Relay requires 12V dc. 3. Sometimes network Problems for rural areas may happen 4. Angular value required time to read so some delay occur. 5.Magnetic field needs to be prespecified. 6.We have to travel with the wire.
2.	Saurabh Kulkarni, Student Member, IEEE, Surya Santoso,"Incipient Fault Location Algorithm for Underground Cables", IEEE,2014	Advantages:1.This enables us to be present at a single location and detect faults remotely. Disadvantages:1.It requires 2 to 3 iterations of the same process to detect fault accurately. 2.It being an algorithm takes time to create that simulation and it outputs data from that simulation hence it takes time to convert that data to real time fault location.

4. Proposed System (1-2 page)

4.1 Overview

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 the inbuilt ADC of the 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 occurs at a particular distance and the respective phase is displayed on a LCD interfaced to the Arduino board. Further this project enhanced by measuring capacitance of cable which can even locate the open circuited cable.

The circuit consists of 4 line display, arduino and resistance measurement circuit. 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 to 50 Ohm, Maximum cable length it can check up to 25000 meters.

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 occurs at a particular distance and the respective phase is displayed on a LCD interfaced to the Arduino board. Further this project is enhanced by measuring capacitance of cable which can even locate the open circuited cable.

- Scope of implementation: 1) Programmingarduino and creating a basic logic behind finding faults and reporting back.
  2)Build circuits containing a power supply and a transformer.
  3)Learn to connect devices to an arduino.
- Advantages : 1. Accuracy of a relay switch based model was very low ,hence we overcame that by using low value resistance measurement.
  2. The cost of the project has been reduced due to use of less components.
  3.easy to use and handle and transport.
  4.we do not need to scout for faults all over the network it can be done from a base location.

- limitations: 1.for closed circuit fault and open circuit fault we need two different setups and different algorithms.
  2.the range is limited to 25km.

4.2 Functional modules

LM041L(lcd display)

16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters . In this LCD each character is displayed in 5x7 pixel matrix.

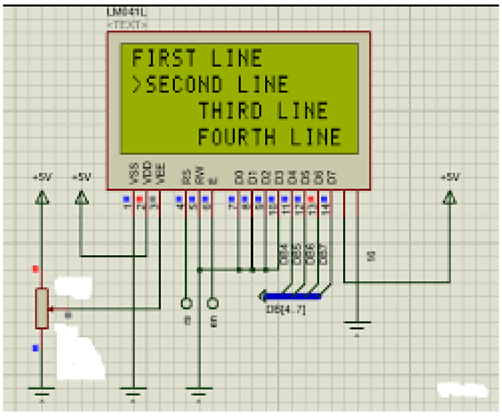


fig (1.1): LM041L(lcd display)

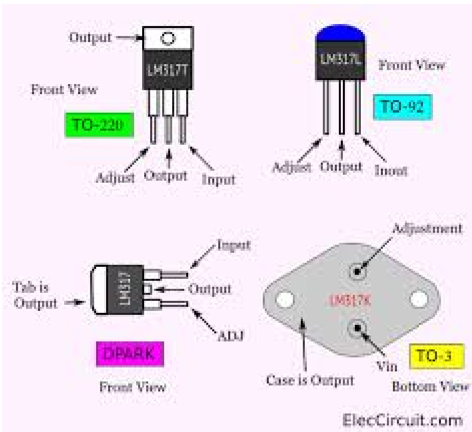
arduinouno R3:

The Arduino Uno R3 is a microcontroller board based on a removable, dual-inline-package ATmega328 AVR microcontroller. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs). The Arduino has an extensive support community, which makes it a very easy way to get started working with embedded electronics. The R3 is the third, and latest, revision of the Arduino Uno.

fig(1.2): Ardinouno R3

LM317T (voltage regulator)

The LM317T is an adjustable 3-terminal positive voltage regulator capable of supplying different DC voltage outputs other than the fixed voltage power supply of +5 or +12 volts, or as a variable output voltage from a few volts up to some maximum value all with currents of about 1.5 amperes.



fig(1.3): LM317T (voltage regulator)

5. Methodology

5.1 System Design

The project detects the distance of a fault in underground cables from the point where the device is connected ,we have characterized and analyzed this project which was provided by “ Manoj Thakur " .We have simulated the available circuit and also constructed a physical circuit to test it. It works on a simple ohms law ,a low dc voltage is applied at the connection point of the device hence the current would vary as the load(resistance) of the cable which is ultimately dependenton the internal resistance of the cable. We have also developed a open circuit fault detector from the available short circuit device .It also uses the basic principle of measuring time taken to charge the "capacitor" which is in this case a open wire ,and based on that it can calculate the capacitance and then based on the conductivity of the material of the cable we can calculate the distance of the fault.

5.2 System Simulation

Describe how you have simulated and conformed the solution to the problem using simulation tools / experiments ?

5.3 System Component Selection   fig(3.1)

LM041L

- 16 character x 4 lines
- Controller LSI HD44780 is built-in (See page 115).
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size .... 87W x 60H x 12T (max.) mm
Effective display area .... 61.8W x 25.2H mm
Character size (5 x 7 dots) .... 2.95W x 4.15H mm
Character pitch .... 3.55 mm
Dot size .... 0.55W x 0.55H mm
Weight .... about 60g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD} - V_{SS}$)	0	6.5 V
Power supply for LCD drive ($V_{DD} - V_O$)	0	6.5 V
Input voltage (V_I)	V_{SS}	V_{DD} V
Operating temperature (Ta)	0	50°C
Storage temperature (Tstg)	−20	70°C

ELECTRICAL CHARACTRISTICS

Ta=25°C, V_{DD}=5.0V±0.25V
Input "high" voltage (V_{IH}) .... 2.2V min.
Input "low" voltage (V_{IL}) .... 0.6V max.
Output "high" voltage (V_{OH}) ($-I_{OH}$=0.2mA) . 2.4V min.
Output "low" voltage (V_{OL}) (I_{OL}=1.2mA) ... 0.4V max.
Power supply current (I_{DD}) (V_{DD}=5.0V) ... 2.0 mA typ.
3.0 mA max.
Power supply for LCD drive (Recommended) ($V_{DD} - V_O$)
Duty = 1/16
Range of $V_{DD} - V_O$ .... 1.5~5.25 V
Ta=0°C .... 4.6 V typ.
Ta=25°C .... 4.4 V typ.
Ta=50°C .... 4.2 V typ.

OPTICAL DATA .... See page 5.

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function	
1	V_{SS}	–	0V	Power supply
2	V_{DD}	–	+5V	
3	V_O	–	–	
4	RS	H/L	L: Instruction code input H: Data input	
5	R/W	H/L	H: Data read (LCD module→MPU) L: Data write (LCD module←MPU)	
6	E	H, H→L	Enable signal	
7	DB0	H/L	Data bus line Note (1), (2)	
8	DB1	H/L		
9	DB2	H/L		
10	DB3	H/L		
11	DB4	H/L		
12	DB5	H/L		
13	DB6	H/L		
14	DB7	H/L		

Notes:
In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.
(1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$ and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$ when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$ when interface data is 8 bits long).
(2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

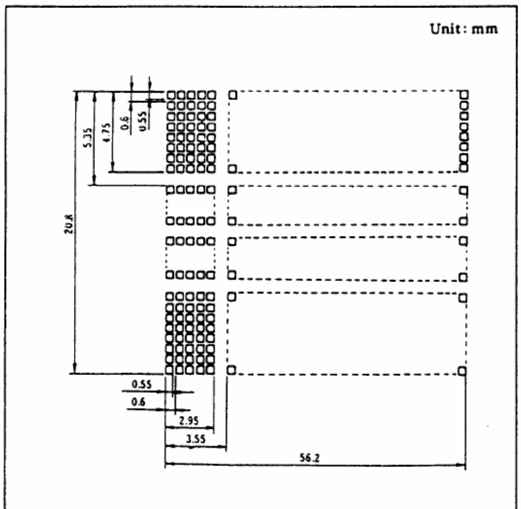


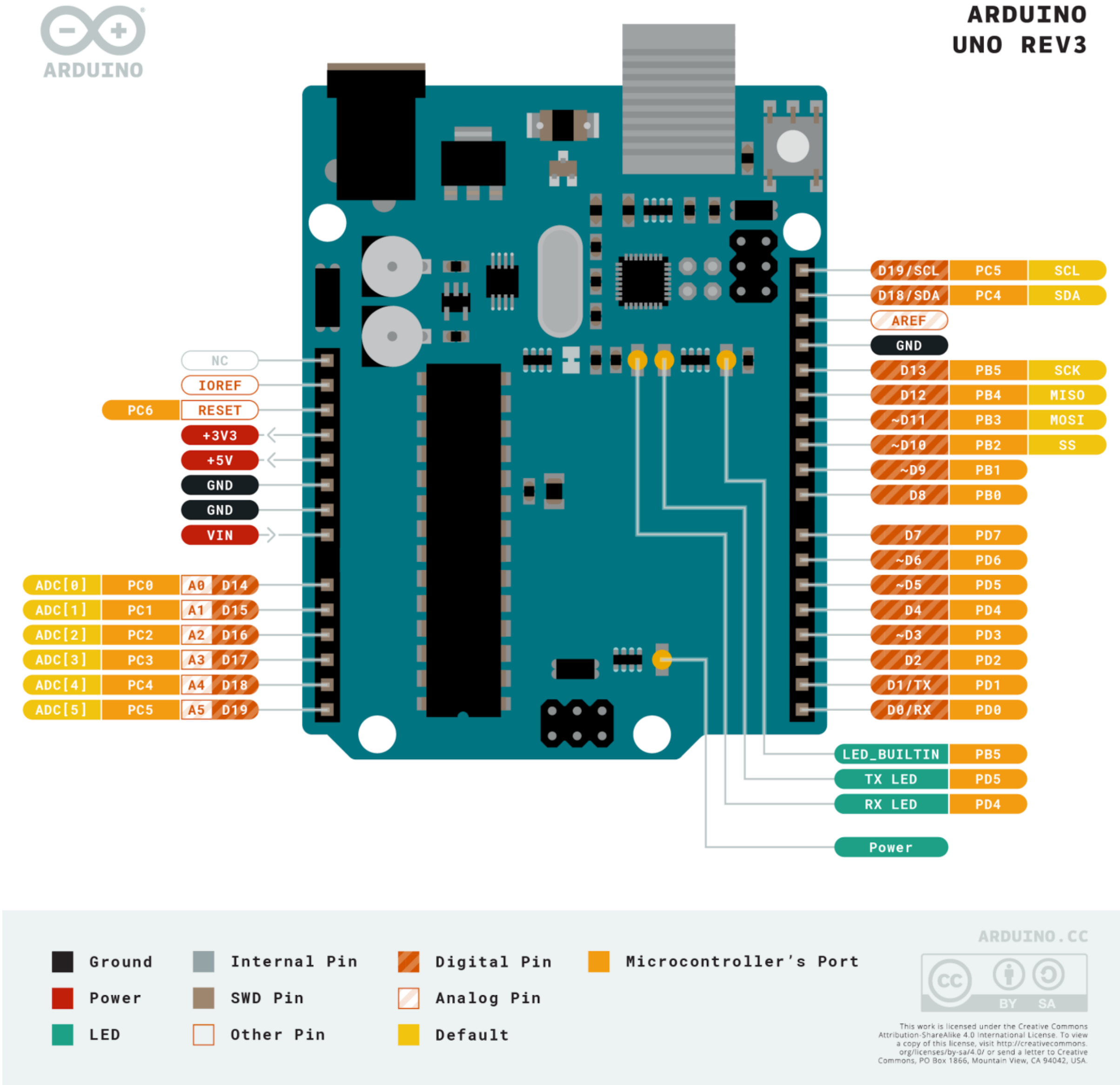
Fig. 1 Display pattern

DISPLAY POSITION AND DD RAM ADDRESS

Character No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1st line	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
2nd line	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
3rd line	90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
4th line	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF

Notes:
(1) 80 ~ DF are described in hexidecimal for DD RAM address.
(2) The set to HD44780 are "N = "1", F = "0" (2 lines 5 x 7 + cursol)."
(3) DD RAM address is no series in line. Address set is necessary to change the lines.
(4) Circuit is equal to 32 characters by 2 lines type.
(5) In case of executing shift, first line and third line are shifted continuously, also second line and fourth line. Therefore it happens that display of third line is transferred to first line.

fig(3.2): specification of lcd



fig(3.3): specification of Arduino

The given hardware was selected due to the following requirements:

1. arduino uno r3: we wanted all of the functionality a microcontroller can offer also it is easy to configure and use with a led .
2. LM041L (LCD display): It is a 8 bit display and has input and output suited to an arduino uno r3. Also being a 8 bit Display it can display sufficient information.
3. LM041L(voltage controller):This is used to make a circuit with capacity to measure very low value of resistance hence to determine the distance of the fault.

6 Implementation

6.1 **Action plan for actual implementation of the project**

The circuit consists of a 2 line display, arduino and resistance measurement circuit. 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 to 50 Ohm, Maximum cable length it can check up to 25000 meters.

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 occurs at a particular distance and the respective phase is displayed on a LCD interfaced to the Arduino board. Further this project is enhanced by measuring capacitance of cable which can even locate the open circuited cable.

6.2 Simulation (proteus)

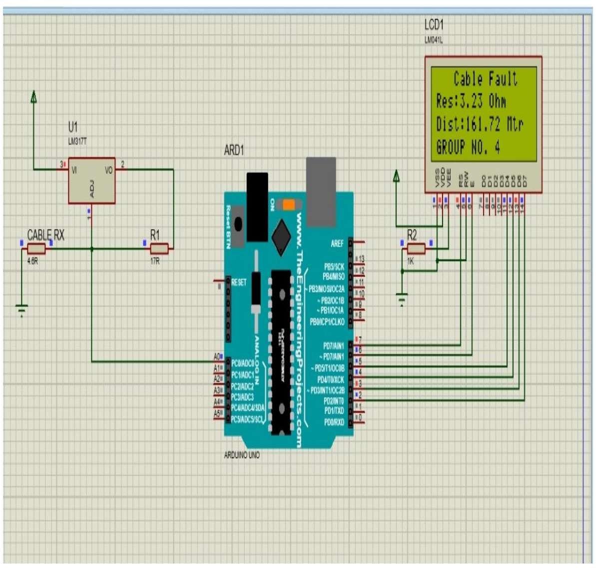
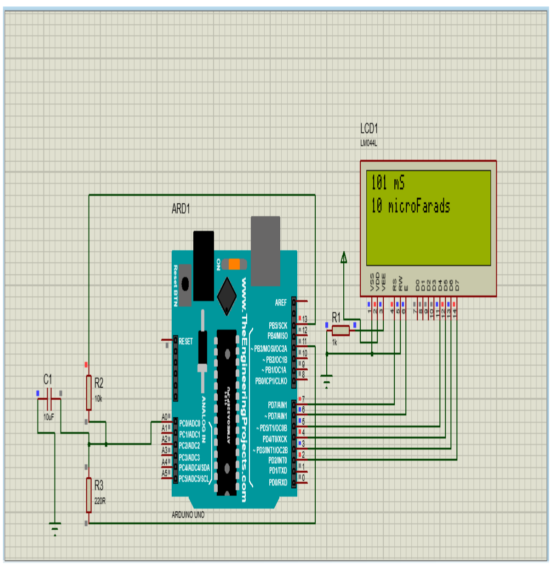
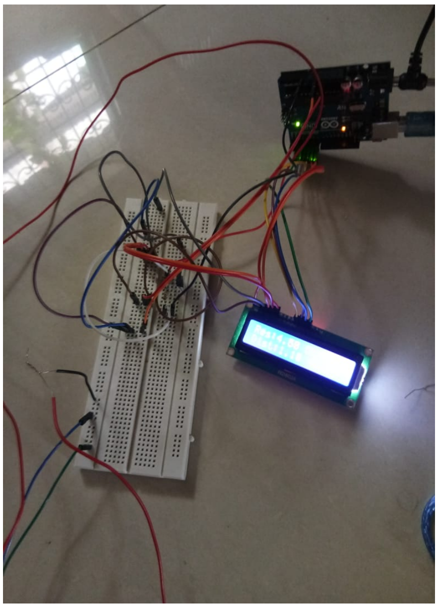


Fig (4.1)Short circuit fault



fig(4.2).open circuit fault

6.3 Physical implementation of project



fig(4.3)

fig(4.4)

Drive link for implementation video :

https://drive.google.com/drive/folders/1MWl2HwKQkMpbmLnLoKBP-CZKwnShFZ7d?usp=sharing

7 Observation and calculation

7.1 Observation and graph

Column1	Column2	Column3	Column4
Cable Rx(Ω)	R2(Ω)	Resistance(Ω)	Distance(mtr)
0	12	0	0
2	12	2	100
4	12	4	200
6	12	6	300
8	12	8	400
10	12	10	500

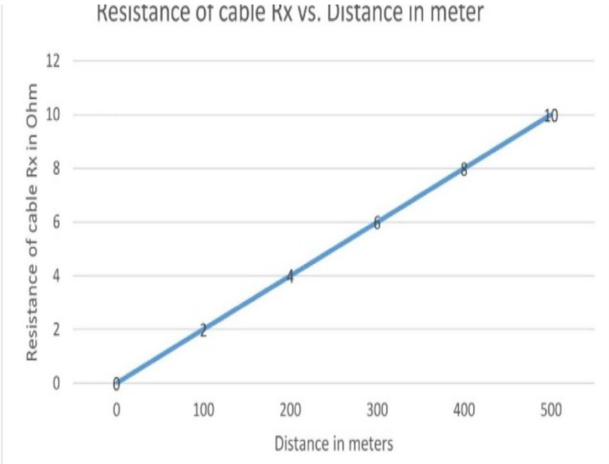


fig (5.1)

7.2 Calculation

- Calculation to find out the fault location of the cable let's consider R_2 is the constant resistance to drop down the voltage, I as current across R_2 , and R_c as constant internal resistance

  Known : R_2 = 12 ohm , I = 1.25 mA , R_c = 0.01 ohm/mtr

  10 bit analog to digital converter = 2^{10} = 1024

  & power suppply = 5v

  A_o = Anolog pin = 42.67

  $V_x = 5/1024 * A_o$ ----------- (1)

  $R_x = V_x/(1.25/12)$ ----------- (2)

  Put V_x value in equation (2)

  $R_x = 5/1024 * 42.67 * 12/1.25$

  R_x = 2 ohm

  Distance = $(R_x/2)/R_c$

  = 1/0.01

  = 100 mtr

  In this way we can find out the distance of fault in the cable .

- Calculation to find out the fault location of the cable let's consider R_2 is the constant resistance to drop down the voltage, I as current across R_2 , and R_c as constant internal resistance

  Known : R_2 = 12 ohm , I = 1.25 mA , R_c = 0.01 ohm/mtr

  10 bit analog to digital converter = 2^{10} = 1024

  & power suppply = 5v

  A_o = Anolog pin = 42.67

  $V_x = 5/1024 * A_o$ ----------- (1)

  $R_x = V_x/(1.25/12)$ ----------- (2)

  Put V_x value in equation (2)

  $R_x = 5/1024 * 85.333 * 12/1.25$

  R_x = 4 ohm

  Distance = $(R_x/2)/R_c$

  = 2/0.01

  = 200 mtr

- Calculation to find out the fault location of the cable let's consider R_2 is the constant resistance to drop down the voltage, I as current across R_2 , and R_c as constant internal resistance

  Known : R_2 = 12 ohm , I = 1.25 mA , R_c = 0.01 ohm/mtr

  10 bit analog to digital converter = 2^{10} = 1024

  & power suppply = 5v

  A_o = Anolog pin = 42.67

  $V_x = 5/1024 * A_o$ ----------- (1)

  $R_x = V_x/(1.25/12)$ ----------- (2)

  Put V_x value in equation (2)

  $R_x = 5/1024 * 128 * 12/1.25$

  R_x = 6 ohm

  Distance = $(R_x/2)/R_c$

  = 3/0.01

  = 300 mtr

- Calculation to find out the fault location of the cable let's consider R_2 is the constant resistance to drop down the voltage, I as current across R_2 , and R_c as constant internal resistance

  Known : R_2 = 12 ohm , I = 1.25 mA , R_c = 0.01 ohm/mtr

  10 bit analog to digital converter = 2^{10} = 1024

  & power suppply = 5v

  A_o = Anolog pin = 42.67

  V_x = 5/1024 * A_o ----------- (1)

  R_x = V_x/(1.25/12) ----------- (2)

  Put V_x value in equation (2)

  R_x = 5/1024 * 170.66 * 12/1.25

  R_x = 8 ohm

  Distance = (R_x/2)/R_c

  = 4/0.01

  = 400 mtr

- Calculation to find out the fault location of the cable let's consider R_2 is the constant resistance to drop down the voltage, I as current across R_2 , and R_c as constant internal resistance

  Known : R_2 = 12 ohm , I = 1.25 mA , R_c = 0.01 ohm/mtr

  10 bit analog to digital converter = 2^{10} = 1024

  & power suppply = 5v

  A_o = Anolog pin = 42.67

  V_x = 5/1024 * A_o ----------- (1)

  R_x = V_x/(1.25/12) ----------- (2)

  Put V_x value in equation (2)

  R_x = 5/1024 * 213.33 * 12/1.25

  R_x = 10 ohm

  Distance = (R_x/2)/R_c

  = 5/0.01

  = 500 mtr

8 Conclusion:

- Resistance of fault cable is directly proportional to distance of fault cable when current and voltage is constant.

- If Resistance of cable Increases then distance will also increase.

9 Future scope:

Its main application is the detection of underground cable fault which is very hard to detect as it is not possible to see faults like
line to line and other such faults which are quite possible in the case of overhead transmission lines.

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.

Applications

1.Monitoring fault in underground cable line

2.Monitoring fault in industrial line

3.Monitoring fault in residential line

4.Monitoring fault in overhead cable line

Summary

The objective of this project is to determine the distance of the failure of the underground cable in the base station using one kilometer of Arduino board. Underground cable system is a common practice in many urban areas. Even if a failure occurs for some reason, at that time the repair process related to this particular cable is difficultbecause of not knowing the exact location of cable failure. The project uses the classic concept of the Ohm's law, when alow voltage at the end of the power supply device is applied across a series resistor the current varies depending on the location of the Fault the cable. In the case of a short circuit (grounded line), the voltage across the series resistors changes accordingly, then input to the ADC constructs the Arduino board to develop accurate digital data for the in kilometer. The project is mounted with a resistance representing the length of the cable in KM and creating defects is executed by a set of switches in each known KM to check the accuracy of it. Failure occurs at a given distance and the the respective phase is displayed on an LCD screen connected to the Arduino board.

References

1) 440_Iot_based_underground_cable_fault_detect or

2) Saurabh Kulkarni, Student Member, IEEE, Surya Santoso,"Incipient Fault Location Algorithm for Underground Cables", IEEE,2014.

3) KunalHasija, Shelly Vadhera, Anurag Kishore" Detection and Location of Faults in Underground Cable using Matlab/Simulink/ANN and OrCad",IEEE,2014