ARDUINO BASED UNDERGROUND CABLE FAULT DETECTION

A Major Project Report

Submitted in partial fulfillment of the

Requirement for the award of the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRICAL ENGINEERING

BY

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2023

DECLARATION

We certify that

a) **The work contained in the major project report is original and has been done by ourselves under the general supervision of my supervisor.**

b) **The work has not been submitted to any other Institute for any degree or diploma.**

c) **We have followed the guidelines provided by the Institute in writing the report.**

d) **We have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.**

e) **Whenever we have used materials (data, theoretical analysis, and text) from other sources, we have given due credit to them by citing them in the text of the report and giving their details in the references.**

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APPROVAL OF THE SUPERVISOR(S)

Recommended that the major project report entitled "ARDUINO BASED UNDERGROUND CABLE FAULT DETECTION" prepared by Amisha Raj, Kumar Tanmay Anand, Nishikant Kumar, Sneha Deep, Gaurav Kumar under our supervision and guidance be accepted as fulfilling this part of the requirements for the award of degree for Bachelor of Technology in Electrical Engineering.

To the best of our knowledge, the contents of this report did not form a basis for the award of any previous degree to anyone else.

Date:

(Signature)

Prof. Atul Kumar Choudhary

Supervisor

Asst. Professor

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Government Engineering College, Banka

CERTIFICATE OF APPROVAL

This is to certify that major project work embodied in this report entitled "ARDUINO BASED UNDERGROUND CABLE FAULT DETECTION "is carried out by Kumar Tanmay Anand (18318) is approved for the degree of Bachelor of Technology (8th Semester) in Electrical Engineering of Government Engineering College, Banka.

Date: **Place:**

Internal Examiner	Head of the Department	External Examiners
Name & Signature	(Electrical engineering)	Name & Signature

ACKNOWLEDGEMENT

We would like to express our gratitude towards all the people who have contributed their precious time and efforts to help us in completing this Major Project without whom it would not been possible for us to complete this work.

I would like to thanks my project Supervisor Prof. Atul Kumar Choudhary, Asst. Professor and Head of the Department of Electrical Engineering for his guidance, support, motivation, and encouragement during the project period. His readiness for consultation always, his educative comments, his concern and assistance have been invaluable.

I like to thanks my Parents and friends for their constant motivation, help and moral support throughout the length of this project report.

ABSTRACT

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 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 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 inbuilt ADC 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.

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.

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CHAPTER 1

INTRODUCTION

We suggested a fault localization model for the in this study. Arduino-powered underground cable lines. This paper's goal is to calculate the distance to the base station’s kilometers of subterranean cable fault. This project utilized basic understanding of ohm's low. When a problem with the system the LCD's (liquid crystal display) distance. Up until the past ten years, wires were made to be installed currently, there is no subterranean cable above the head that is superior to the previous approach. negative weather storms, snow, torrential rains, and pollution are examples of environmental factors is unaffected by underground lines but when a problem arises Finding the problem with underground wires might be challenging. We'll locate the fault's precise position. Since the entire world has gone digital, the project's goal is to locate the defect precisely in a digital format. In many urban locations, underground cabling systems are more prevalent. Even when the defect arises for some reason at that time, it is difficult to repair this specific cable because it is unclear where the cable broke down.

Cable faults can be divided into two categories: Open circuit error-Because there is no conducting complete loop for current to pass in an open circuit defect, I=0, there is no current. Supply voltage and output voltage are equal in this malfunction. Short circuit fault is preferable to open circuit fault. Short circuit error: This defect results in a zero-output voltage but constant current. Two forms of short circuit faults can also be distinguished: Equal lead current and phase shift are present in a symmetrical fault. Unsymmetrical fault: In this fault, phase shifting and current magnitude are off by 120 degrees. Terminal method: This technique uses no effort to find the fault location in underground lines. The voltage drop fluctuates with the cable's default length as the current varies in this technique for determining the type of circuit. The cable is represented by a number of resistors, a DC voltage is applied at one end, and the defect is detected by identifying the area of voltage change in the defect.

OBJECTIVE OF THE PROJECT

The objective of this project is to determine the distance of underground cable fault from base station in kilometers. While a fault occurs for some reason, at that time the repairing process related to that 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 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 inbuilt ADC of Arduino board to develop precise digital data for display in kilometers.

CHAPTER 2

LITERATURE SURVEY

For the real worldwide operated voltage distribution lines underground cables have been used from many years. In order to reduce the sensitivity of distribution networks to environmental influences underground voltage cables are highly used. Underground cables have been widely used in power distribution networks due to the advantages of underground connection, more enhanced security than overhead lines in adverse weather condition, less liable to damage by storms or lightning. It is less costly for larger distance, eco- friendly and low maintenance cost. But if any fault occurs in cable, then it is difficult to its type. So, this system is use to detect the location and type 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, 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 11 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. 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 to development of cables suitable for use at high voltage

CHAPTER 3

COMPONENTS USED

Software Requirements
Arduino program

VOLTAGE TRANSFORMER:

One of the main reasons that we use alternating AC voltages and currents in our homes and workplace's is that AC supplies can be easily generated at a convenient voltage, transformed (hence the name transformer) into much higher voltages and then distributed

The reason for transforming the voltage to a much higher level is that higher distribution voltages imply lower currents for the same power and therefore lower I^2R losses along the networked grid of cables. These higher AC transmission voltages and currents can then be reduced to a much lower, safer and usable voltage level where it can be used to supply electrical equipment in our homes and workplaces, and all this is possible thanks to the basic **Voltage Transformer**.

FIG **3.1** Voltage Transformer

Single Phase Voltage Transformer

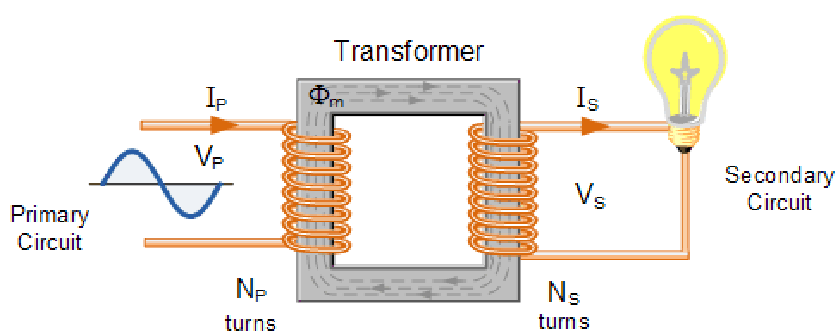


Fig 3.2 Circuit diagram of transformer

In other words, for a transformer there is no direct electrical connection between the two coil windings, thereby giving it the name also of an Isolation Transformer. Generally, the primary winding of a transformer is connected to the input voltage supply and converts or transforms the electrical power into a magnetic field. While the job of the secondary winding is to convert this alternating magnetic field into electrical power producing the required output voltage as shown.

Where:

V_P - is the Primary Voltage

V_S - is the Secondary Voltage

N_P - is the Number of Primary Windings

N_S - is the Number of Secondary Windings

Φ (phi) - is the Flux Linkage

Notice that the two coil windings are not electrically connected but are only linked magnetically. A single-phase transformer can operate to either increase or decrease the voltage applied to the primary winding. When a transformer is used to "increase" the voltage on its secondary winding with respect to the primary, it is called a **Step-up transformer**. When it is used to "decrease" the voltage on the secondary winding with respect to the primary it is called a **Step-down transformer**.

A Transformers Turns Ratio

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} = n = \text{Turns Ratio}$$

Assuming an ideal transformer and the phase angles: $\Phi_P \equiv \Phi_S$

As the magnetic flux varies sinusoidally, $\Phi = \Phi_{max} \sin\omega t$, then the basic relationship between induced emf, (E) in a coil winding of N turns is given by:

emf = turns x rate of change

$$E = N\frac{d\Phi}{dt}$$

$$E = N \times \omega \times \Phi_{max} \times \cos(\omega t)$$

$$E_{max} = N\omega\Phi_{max}$$

$$E_{rms} = \frac{N\omega}{\sqrt{2}} \times \Phi_{max} = \frac{2\pi}{\sqrt{2}} \times f \times N \times \Phi_{max}$$

$$\therefore E_{rms} = 4.44 f N \Phi_{max}$$

Where:

f - is the flux frequency in Hertz, $= \omega/2\pi$

N - is the number of coil windings.

Φ - is the flux density in Weber's

This is known as the **Transformer EMF Equation**. For the primary winding emf, N will be the number of primary turns, (N_P) and for the secondary winding emf, N will be the number of secondary turns, (N_S).

Bridge rectifier

Bridge rectifier circuit is a common part of the electronic power supplies. Many electronic circuits require rectified DC power supply for powering the various components from available AC mains supply. We can find this rectifier in a wide variety of electronic AC power devices like home appliances, motor controllers, modulation process, welding applications, etc.

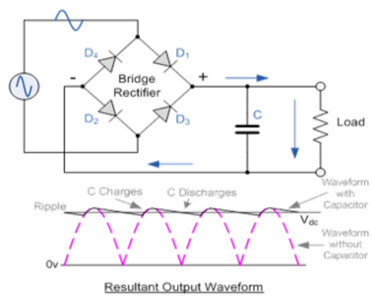


Fig:3.3 Bridge rectifier

This bridge rectifier uses diodes for rectifying the input as shown in the figure. Since the diode is a unidirectional device that allows the current flow in one direction only. With this configuration of diodes in the rectifier, it doesn't allow the power to vary depending on the load requirement. So this type of rectifier is used in constant or fixed power supplies.

VOLTAGE REGULATORS:

The most used regulating modes will be covered. The linear regulator is the basic building block of nearly every power supply used in electronics. The IC linear regulator is so easy to use that it is virtually foolproof, and so inexpensive that it is usually one of the cheapest components in an electronic assembly. This project will present information that gives the user greater understanding of how a linear regulator works, and will help to de-mystify regulator specifications and applications specifications and applications.

Every electronic circuit is designed to operate off of some supply voltage, which is usually assumed to be constant. A voltage regulator provides this constant DC output voltage and contains circuitry that continuously holds the output voltage at the design value regardless of changes in load current or input voltage

Voltage Regulator IC 7805:

7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output.

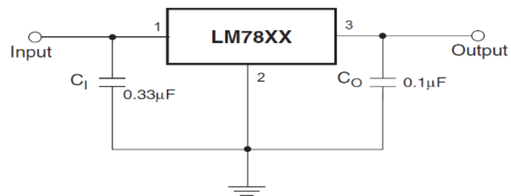


Fig 3.4 Voltage Regulator IC 7805:
The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

Voltage Regulator IC 7812:

7812 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output.

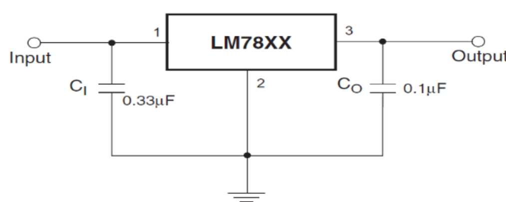


FIG : 3.5 Voltage Regulator Ic 7812:

The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7812 provides +12V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

Arduino

Introduction

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible pack

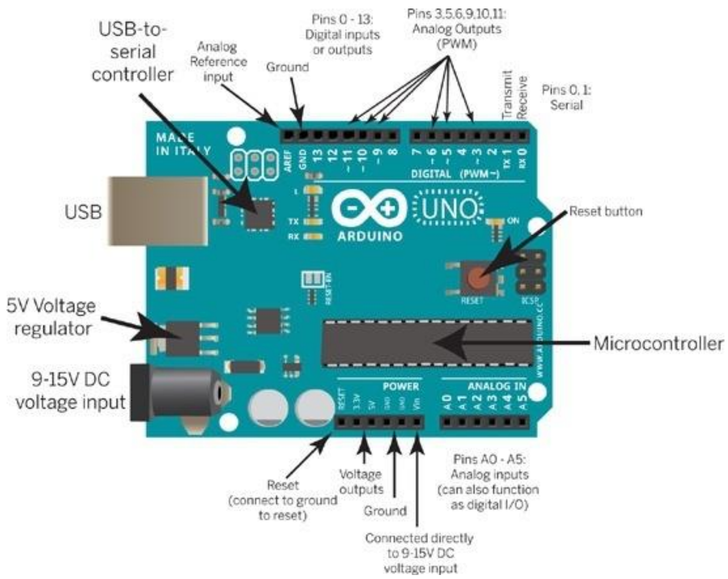


Fig:3.6 Arduino

This is an Arduino

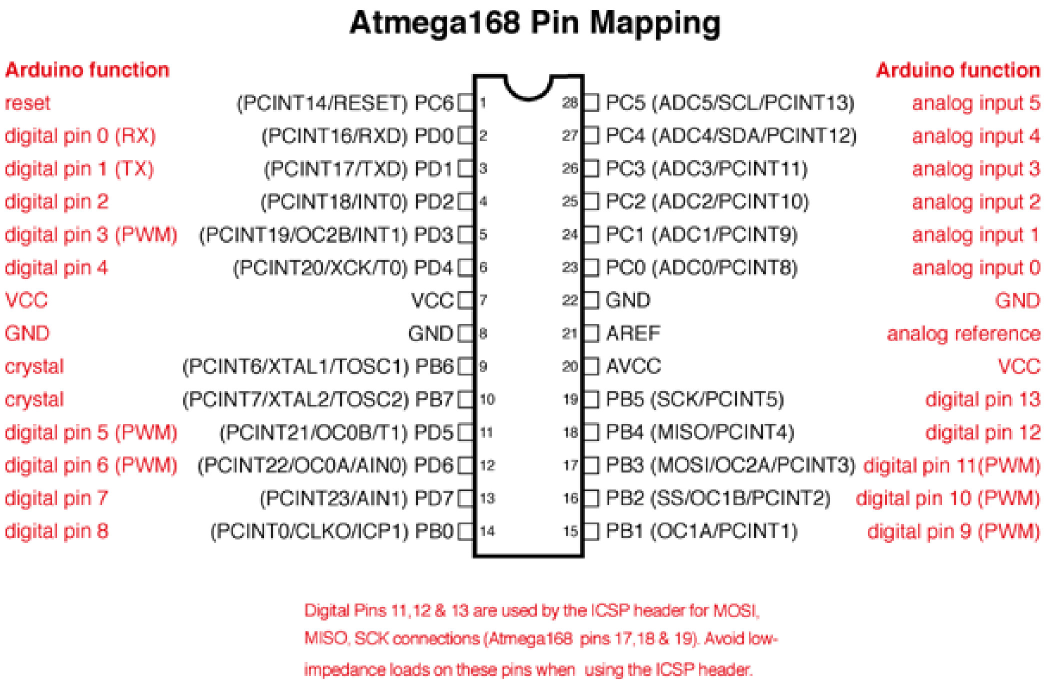
The Uno is one of the more popular boards in the Arduino family and a great choice for beginners. We'll talk about what's on it and what it can do later in the tutorial.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

Arduino Pin Diagram

A typical example of Arduino board is Arduino Uno. It consists of ATmega328- a 28 pin microcontrollers.



Arduino Uno consists of 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button

Power Jack: Arduino can be power either from the pc through a USB or through external source like adaptor or a battery. It can operate on a external supply of 7 to 12V. Power can be applied externally through the pin Vin or by giving voltage reference through the IO Ref pin.

Digital Inputs: It consists of 14 digital inputs/output pins, each of which provide or take up 40mA current. Some of them have special functions like pins 0 and 1, which act as Rx and Tx respectively, for serial communication, pins 2 and 3-which are external interrupts, pins 3,5,6,9,11 which provides pwm output and pin 13 where LED is connected.

Analog inputs: It has 6 analog input/output pins, each providing a resolution of 10 bits.

A Ref: It provides reference to the analog inputs

Reset: It resets the microcontroller when low.

LCD DISPLAY

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 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 (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

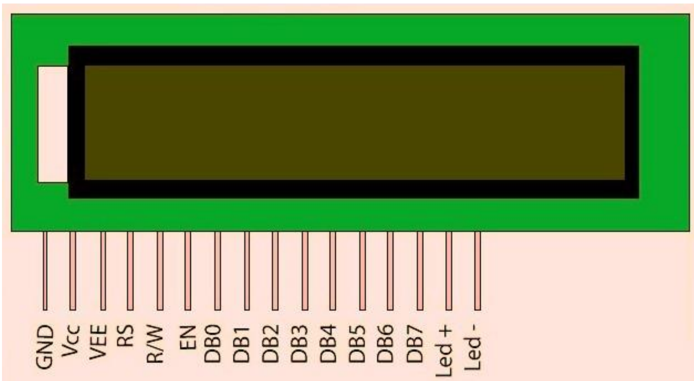


Fig:3.8 LCD display

Pin Description:

<table>
<tr><th>Pin No</th><th>Function</th><th>Name</th></tr>
<tr><td>1</td><td>Ground (0V)</td><td>Ground</td></tr>
<tr><td>2</td><td>Supply voltage; 5V (4.7V – 5.3V)</td><td>Vcc</td></tr>
<tr><td>3</td><td>Contrast adjustment; through a variable resistor</td><td>V_{EE}</td></tr>
<tr><td>4</td><td>Selects command register when low; and data register when high</td><td>Register Select</td></tr>
<tr><td>5</td><td>Low to write to the register; High to read from the register</td><td>Read/write</td></tr>
<tr><td>6</td><td>Sends data to data pins when a high to low pulse is given</td><td>Enable</td></tr>
<tr><td>7</td><td rowspan="6">8-bit data pins</td><td>DB0</td></tr>
<tr><td>8</td><td>DB1</td></tr>
<tr><td>9</td><td>DB2</td></tr>
<tr><td>10</td><td>DB3</td></tr>
<tr><td>11</td><td>DB4</td></tr>
<tr><td>12</td><td>DB5</td></tr>
</table>

13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

ALL LCD HAVE

Eight(8) Data pins

VCC (Apply 5v here)

GND (Ground this pin)

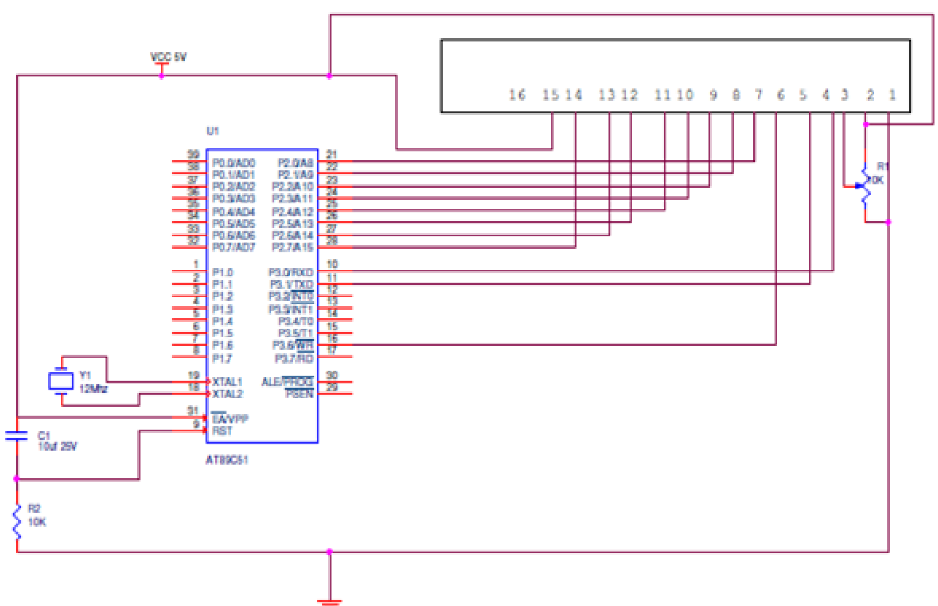
RS (Register select)

RW (read - write)

EN (Enable)

V0 (Set Lcd contrast)

Interfacing LCD



Circuit Diagram of Interfacing LCD to AT89C51

VEE pin is meant for adjusting the contrast of the LCD display and the contrast can be adjusted by varying the voltage at this pin. This is done by connecting one end of a POT to the Vcc (5V), other end to the Ground and connecting the center terminal (wiper) of of the POT to the VEE pin. See the circuit diagram for better understanding.

16×2 LCD module has a set of preset command instructions. Each command will make the module to do a particular task. The commonly used commands and their function are given in the table below.

Command	Function
0F	LCD ON, Cursor ON, Cursor blinking ON
01	Clear screen
02	Return home
04	Decrement cursor
06	Increment cursor
0E	Display ON ,Cursor blinking OFF
80	Force cursor to the beginning of 1st line
C0	Force cursor to the beginning of 2nd line
38	Use 2 lines and 5×7 matrix
83	Cursor line 1 position 3
3C	Activate second line

08	Display OFF, Cursor OFF
C1	Jump to second line, position1
OC	Display ON, Cursor OFF
C1	Jump to second line, position1
C2	Jump to second line, position2

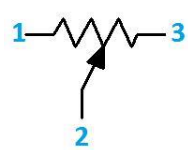
POTENTIOMETER

Potentiometer is a small sized electronic component whose resistance can be adjusted manually. Increasing or decreasing the value of resistance controls the amount of current flowing in a circuit. The potentiometer is used in various electronics, for example: is used as volume knob in music systems, as fan regulators etc. Potentiometer has two strips made on it resistive and conductive. Resistive strip is made of carbon and is responsible for potentiometer's resistance variance feature. Conductive strip helps the potentiometer to carry the current into the circuit in accordance with the resistance. To understand the theory of our humble potentiometers (or pots), let us know the **parts of the potentiometer:**

· Lugs**:** Potentiometers by convention have three lugs

Resistive Strip: This is the heart of the potentiometer. It is a carbon strip that is printed on a phenolic strip. There are metal contacts in the end to connect it to the lugs.

Metal Wiper: When we rotate the shaft, it in turn rotates a metallic wiper which connects the lug 1 and lug2.



Working of Potentiometers

The metallic wiper acts as a conducting path between the lug 1 and lug 2. So the resistance between the left lug and the center lug is the resistance of the part of carbon strip over which the metallic wiper has traversed. When we rotate the shaft of the potentiometer, we actually rotate the metallic wiper attached to it and hence change the resistance. This way the pot acts as a variable resistance

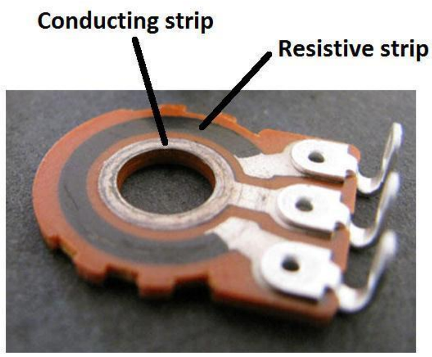


Fig :3.10 Potentiometer

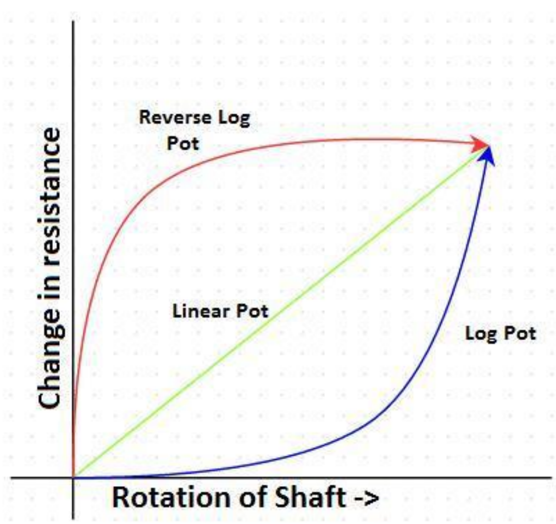
Taper

The relation between the position of wiper and the resistance is called the taper of the potentiometer. In other words, taper decides how the resistance will vary when we turn the pot. Taper divides potentiometers broadly into two types:

· Linear Pots: In these pots, the resistance between lug 1 and lug 2 is directly proportional to the distance moved by the wiper. These are the common pots found in labs and are inexpensive.

· Logarithmic Pots: In these pots, the resistance between lug1 and lug 2 is a logarithmic function of the wiper position. Actually, their taper graph looks more like a 10^x graph. They are expensive and not readily available. Also, there are reverse logarithmic pots which are similar to logarithmic pots, which have a taper opposite to that of log pots. More about logarithmic pots in the next section

How to check the taper with an ohm meter? Set the pot to the center position (50% rotation) and measure the resistance between the center pin and each of the outer pins. If the resistance is equal (50% of the pots value) the pot is linear. If the values are not equal, the pot is a log taper.



Graph 3.1 Taper

Logarithmic Pots

These pots are extensively used in audio electronics and hence are also called audio pots. The reason for their wide use in audio electronics especially in volume control owes to the perception of loudness by human ears. If two sources produce sound, then the human ear will perceive one source twice as loud as the other only if the intensity of sound of one source is ten times the other. So by using audio pots we are able to achieve perceivable change in loudness by slight turning of the pot. If a linear pot is used instead, we will notice that loudness changes only when the pot is turned to its full extent.

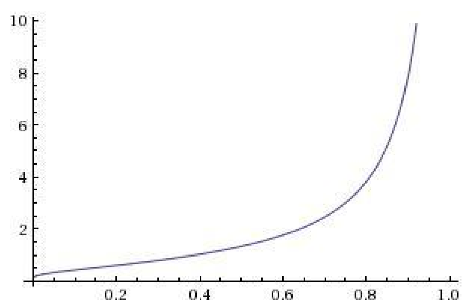
How to make a linear pot behave like a logarithmic pot? Log pots are expensive and tough to find. One idea is to make a circuit whose transfer function is *not exactly but similar* to logarithmic function. One such circuit is as follows:

Let the total resistance of the pot be R, R1 be the resistance between lug 3 and lug 1 and R2 be the resistance between lug 1 and lug 2. R3 is a resistance put in parallel to R2. We define x=R2/R (the fraction of resistance swept by the wiper) and y=R3/R.

The relation between input voltage Vin and output voltage across R3 come out to be

$$\frac{Vout}{Vin} = \frac{1}{\frac{1}{x} + \frac{1-x}{y}}$$

Below is the graph of Vin/Vout when y=4 and x is varied between 0 to 1 which looks similar to a log graph (isn't it?)



Graph 3.2 V input/V output

The only catch here is that using the above circuit in place of a log pot will reduce the input resistance that the source voltage will see. So some amount of experimentation should be done to choose the value of y. Similarly, **reverse log pots** can be emulated using linear pot by simply putting R3 resistance across R1 and taking the output voltage across R2.

RELAY DRIVER IC ULN2003

A Relay driver IC is an electro-magnetic switch that will be used whenever we want to use a low voltage circuit to switch a light bulb ON and OFF which is connected to 220V mains supply. The required current to run the relay coil is more than can be supplied by various integrated circuits like Op-Amp, etc. Relays have unique properties and are replaced with solid state switches that are strong than solid-state devices. High current capacities, capability to stand ESD and drive circuit isolation are the unique properties of Relays. There are various ways to drive relays. Some of the Relay Driver ICs are as below.

High side toggle switch driver

Low side toggle switch driver

Bipolar NPN transistor driver

N-Channel MOSFET driver and

Darlington transistor driver

ULN2003 driver

Relay Driver IC Circuit

In order to drive the relay, we use transistor and only less power can be possibly used to get the relay driven. Since, transistor is an amplifier so the base lead receives sufficient current to make more current flow from Emitter of Transistor to Collector. If the base once gets power that is sufficient, then the transistor conduct from Emitter to Collector and power the relay.

The Transistor’s emitter-to-collector channel will be opened even though no input current or voltage is applied to Base lead of Transistor. Therefore, blocking current flows through relay coil.

The emitter-to-collector channel will be opened and allows current to flow through relay’s coil if enough current or voltage is applied as input to the base lead. AC or DC Current can be used to power the relay and circuit.Relays are electromagnetic devices which allow low-power circuit to switch a high current ON and OFF switching devices with the help of an armature that is moved by an electromagnet.

Driver Circuit is used to boost or amplify signals from micro-controllers to control power switches in semi-conductor devices. Driver circuits take functions that include isolating the control circuit and the power circuit, detecting malfunctions, storing and reporting failures to the control system, serving as a precaution against failure, analyzing sensor signals and creating auxiliary voltages.

Driver Circuits

A typical digital logic output pin supplies only tens of MA of current. External devices such as high-power LEDs, motors, speakers, light bulbs, buzzers, solenoids and relays can require hundreds of MA and they need same voltages. In order to control small devices which use DC, a transistor-based driver circuit is used to amplify current to the required levels. If the voltage and current levels are in perfect range, the transistor acts like a high-current switch controlled by the lower current digital logic signal. A discrete BJT is used at times in place of MOSFET transistor especially on older or low voltage circuits as shown below.

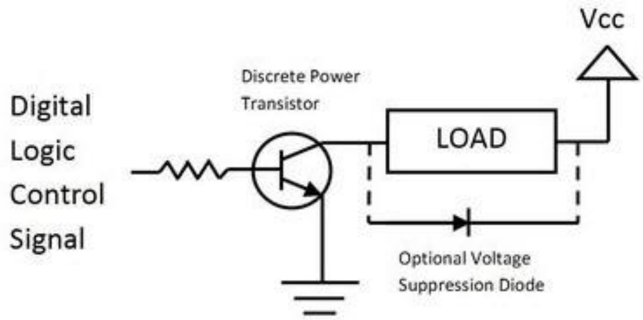


Fig 3.11 Driver Circuits

RELAY

Basic design and operation.

A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctancepath for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two in the relay pictured). The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

When an electric current is passed through the coil it generates a magnetic field that activates the armature, and the consequent movement of the movable contact(s) either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing.

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit components. Such diodes were not widely used before the application of transistors as relay drivers, but soon became ubiquitous as early germanium transistors were easily destroyed by this surge. Some automotive relays include a diode inside the relay case.

A relay can be compared to a vacuum tube and solid state transistor amplifier because both can use a small voltage and current in one circuit to control a large voltage and current in another circuit. However, unlike tubes and transistors, a relay cannot produce a variable output; It can only switch on and off similar to a logic circuit in a computer. But the relay has the advantage of being able to completely isolate its input circuit from its output.

Below is a drawing of a Single Pole Double Throw (SPDT) relay. A single contact called the Common contact switches between a Normally Closed contact and a Normally Open contact. The Common contact is attached to an armature which is a strip of metal that is hinged at one end and has electrical contacts, usually made of silver, at the other end. A spring pulls the armature up so its contact connects to the Normally Closed contact. An electromagnet below the armature attracts the armature when it is energized and pulls it down so its contact disconnects from the Normally Closed contact and connects to the Normally Open contact instead.

The electromagnet is made of a coil of fine enameled copper wire wound on a plastic bobbin that has an iron core in its center. A magnetic field is created in the iron core when current flows through the coil. The number of turns in the coil and the wire size determine the voltage that must applied to it. Relays are available for operation at almost any voltage but the most common are 5, 6, 9, 12, 24 and 48 volts DC. The coil current also depends on the number of turns and wire size and usually ranges from 30 to 200 milliamperes.

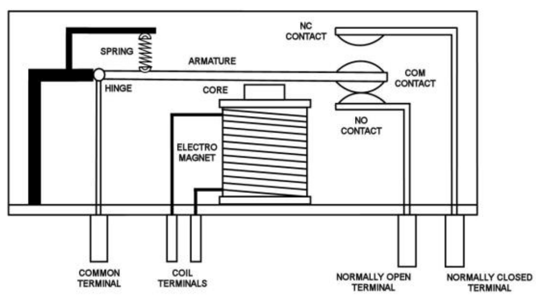


Fig 3.12 Relay

There is no connection between the coil and any of the contacts. The contacts are completely electrically isolated from the circuit that powers the coil.

In a device using a relay where the relay contacts are brought out to a terminal block or other termination, the contacts can be used to switch any type of DC or AC load that is within the voltage and current ratings of the contacts. This is usually marked on the relay.

A relay does not provide power for a load, it just switches power from a power source, on and off, similar to how a wall switch turns a lamp on and off but does not itself provide the power that lights the lamp**.** Relays are made in many configurations, sizes and shapes, coil voltage and current, contact voltage and current. They are available as:

Single Pole Single Throw SPST either Normally Open or Normally Closed
Single Pole Double Throw SPDT as above
Double Pole Single Throw DPST either Normally Open or Normally Closed
Double Pole Double Throw DPDT

1N4007

Diodes are used to convert AC into DC these are used as half wave rectifier or full wave rectifier. Three points must he kept in mind while using any type of diode. Maximum forward current capacity, Maximum reverse voltage capacity, Maximum forward voltage capacity

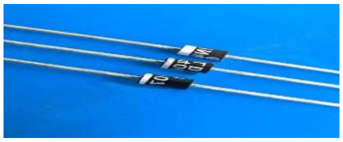


Fig3.13 Diode

The number and voltage capacity of some of the important diodes available in the market are as follows:

Diodes of number IN4001, IN4002, IN4003, IN4004, IN4005, IN4006 and IN4007 have maximum reverse bias voltage capacity of 50V and maximum forward current capacity of 1 Amp.

Diode of same capacities can be used in place of one another. Besides this diode of more capacity can be used in place of diode of low capacity but diode of low capacity cannot be used in place of diode of high capacity. For example, in place of IN4002; IN4001 or IN4007 can be used but IN4001 or IN4002 cannot be used in place of IN4007.The diode BY125made by company BEL is equivalent of diode from IN4001 to IN4003. BY 126 is equivalent to diodes IN4004 to 4006 and BY 127 is equivalent to diode IN4007.

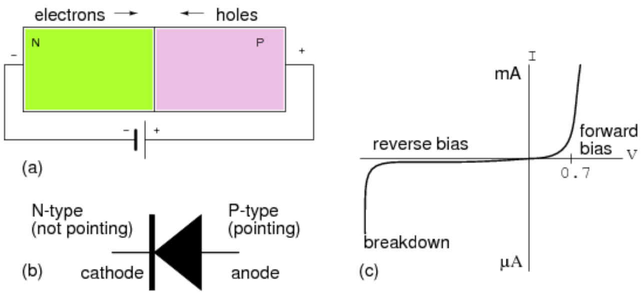


Fig:PN Junction diode

RESISTORS

A resistor is a two-terminal electronic component designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law:

$$V = IR$$

Resistors are used as part of electrical networks and electronic circuits. They are extremely commonplace in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel/chrome).

Fig 3.15 Resistor

The primary characteristics of resistors are their resistance and the power they can dissipate. Other characteristics include temperature coefficient, noise, and inductance. Less well-known is critical resistance, the value below which power dissipation limits the maximum permitted current flow, and above which the limit is applied voltage. Critical resistance depends upon the materials constituting the resistor as well as its physical dimensions; it's determined by design.

Resistors can be integrated into hybrid and printed circuits, as well as integrated circuits. Size, and position of leads (or terminals) are relevant to equipment designers; resistors must be physically large enough not to overheat when dissipating their power.

A resistor is a two-terminal passive electronic component which implements electrical resistance as a circuit element. When a voltage V is applied across the terminals of a resistor, a current I will flow through the resistor in direct proportion to that voltage. The reciprocal of the constant of proportionality is known as the resistance R, since, with a given voltage V, a larger value of R further "resists" the flow of current I as given by Ohm's law:

$$I = \frac{V}{R}$$

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.

The series inductance of a practical resistor causes its behavior to depart from ohms law; this specification can be important in some high-frequency applications for smaller values of resistance. In a low-noise amplifier or pre-amp the noise characteristics of a resistor may be an issue. The unwanted inductance, excess noise, and temperature coefficient are mainly dependent on the technology used in manufacturing the resistor. They are not normally specified individually for a particular family of resistors manufactured using a particular technology.[1] A family of discrete resistors is also characterized according to its form factor, that is, the size of the device and position of its leads (or terminals) which is relevant in the practical manufacturing of circuits using them.

LED

LEDs are semiconductor devices. Like transistors, and other diodes, LEDs are made out of silicon. What makes an LED give off light are the small amounts of chemical impurities that are added to the silicon, such as gallium, arsenide, indium, and nitride. When current passes through the LED, it emits photons as a byproduct. Normal light bulbs produce light by heating a metal filament until its white hot. Because LEDs produce photons directly and not via heat, they are far more efficient than incandescent bulbs. Not long-ago LEDs were only bright enough to be used as indicators on dashboards or electronic equipment. But recent advances have made LEDs bright enough to rival traditional lighting technologies. Modern LEDs can replace incandescent bulbs in almost any application.

LEDs are based on the semiconductor diode. When the diode is forward biased (switched on), electrons are able to recombine with holes and energy is released in the form of light. This effect is called electroluminescence and the color of the light is determined by the energy gap of the semiconductor. The LED is usually small in area (less than 1 mm2) with integrated optical components to shape its radiation pattern and assist in reflection.

Fig 3.15 LED Light

LEDs present many advantages over traditional light sources including lower energy consumption, longer lifetime, improved robustness, smaller size and faster switching. However, they are relatively expensive and require more precise current and heat management than traditional light sources.

Applications of LEDs are diverse. They are used as low-energy and also for replacements for traditional light sources in well-established applications such as indicators and automotive lighting. The compact size of LEDs has allowed new text and video displays and sensors to be developed, while their high switching rates are useful in communications technology. So here the role of LED is to indicate the status of the components like relays and power circuit etc.…

CAPACITORS

A capacitor or condenser is a passive electronic component consisting of a pair of conductors separated by a dielectric. When a voltage potential difference exists between the conductors, an electric field is present in the dielectric. This field stores energy and produces a mechanical force between the plates. The effect is greatest between wide, flat, parallel, narrowly separated conductors.

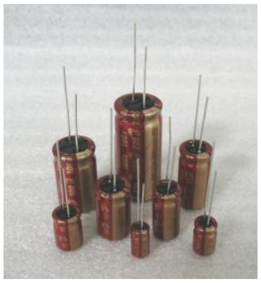


Fig3.16 Capacitor

An ideal capacitor is characterized by a single constant value, capacitance, which is measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them. In practice, the dielectric between the plates passes a small amount of leakage current. The conductors and leads introduce an equivalent series resistance and the dielectric has an electric field strength limit resulting in a breakdown voltage.

The properties of capacitors in a circuit may determine the resonant frequency and quality factor of a resonant circuit, power dissipation and operating frequency in a digital logic circuit, energy capacity in a high-power system, and many other important aspects.

A capacitor (formerly known as condenser) is a device for storing electric charge. The forms of practical capacitors vary widely, but all contain at least two conductors separated by a non-conductor. Capacitors used as parts of electrical systems, for example, consist of metal foils separated by a layer of insulating film.

Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass, in filter networks, for smoothing the output of power supplies, in the resonant circuits that tune radios to particular frequencies and for many other purposes.

A capacitor is a passive electronic component consisting of a pair of conductors separated by a dielectric (insulator). When there is a potential difference (voltage) across the conductors, a static electric field develops in the dielectric that stores energy and produces a mechanical force between the conductors. An ideal capacitor is characterized by a single constant value, capacitance, measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them.

Theory of operation

Main article: Capacitance

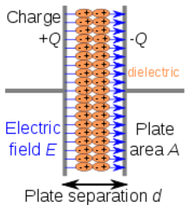


Fig3.17 Capacitor

Charge separation in a parallel-plate capacitor causes an internal electric field. A dielectric (orange) reduces the field and increases the capacitance.

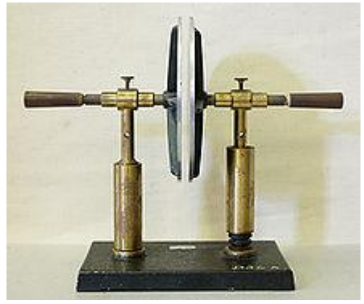


Fig3.18 Parallel plate capacitor

A simple demonstration of a parallel-plate capacitor

The capacitor is a reasonably general model for electric fields within electric circuits. An ideal capacitor is wholly characterized by a constant capacitance C, defined as the ratio of charge ±Q on each conductor to the voltage V between them:[8]

$$C = \frac{Q}{V}$$

Sometimes charge build-up affects the capacitor mechanically, causing its capacitance to vary. In this case, capacitance is defined in terms of incremental changes:

$$C = \frac{\mathrm{d}q}{\mathrm{d}v}$$

Working:

Project is to determine the distance of underground cable fault from base station in kilometers USING AN Arduino board. While a fault occurs for some reason, the repairing process related to that particular cable is difficult due to not knowing the exact location of the cable 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 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 inbuilt ADC of Arduino board to develop precise digital data for display in kilometers.

It 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.

CHAPTER 4

WORKING

This project deals with Line to Ground fault. Our intention is to find the distance at which fault has occurred. For this we need to first find the resistance of the cable because we know the direct proportionality between the resistance and length. We also find the voltage drop across the resistor. We know the given input voltage and the resistances hence using voltage divider formula V0=R2/(R1+R2)*Vin. We can notice that as resistance increases, voltage increases.

As this is a demo project, we are using 5v dc supply and not 230 v, 440v. We will be substituting this supply and then detect the fault. In this program we have considered the distance between the two resistors (used as faults for sample here) to be 5km in all the three phases (R, Y, B). We create a fault manually by the slide switch connected across the resistors and then check the distance at which fault has occurred. Once the fault is sensed at a certain distance the relay trips and isolates the rest of the circuit. A reset button is used to erase and display the latest button.

We use relays to trip so that the resistor does not heat much and damage and the relay isolates the circuit hence displaying 0 v on the analog read.

BLOCK DIAGRAM:

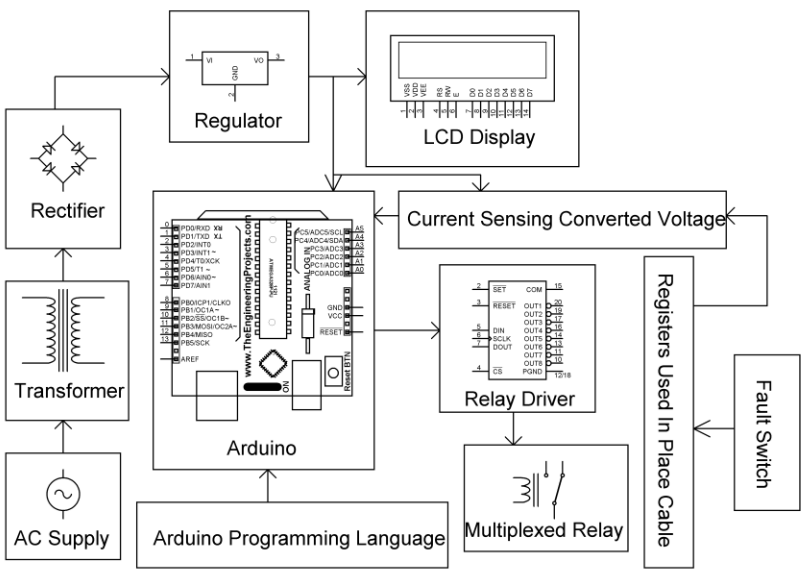


Fig 4.1:Block diagram of under ground fault detector using arduino

Hardware Requirement: - ARDUINO controller, LCD, Crystal, Relays, Relay driver IC, Transformers, Diodes, Voltage Regulator, Resistors, Capacitors, LEDs, Switches.

ARDUINO PROGRAM

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(4, 2, 5, 6, 7, 8);//RS,EN,D4,D5,D6,D7

const int analogInPin0 = A5;  // Analog input pin that the potentiometer is attached to

const int analogInPin1 = A4;

const int analogInPin2 = A3;

int RED2    = 9;

int BLUE2  = 11;

int YELLOW2 = 10;

int RR=0,YY=0,BB=0;

int REDR = 0;

int BLUEB = 0;

int YELLOWY=0;

void setup()

{

   lcd.begin(16, 2);

   Serial.begin(9600);

   pinMode(RED2, OUTPUT);

   pinMode(BLUE2, OUTPUT);

   pinMode(YELLOW2, OUTPUT);

   digitalWrite (RED2,HIGH);

   digitalWrite (BLUE2,HIGH);

   digitalWrite (YELLOW2,HIGH);

     lcd.setCursor(0, 0); // top left

   lcd.print("UNDERGRAUND CABLE    ");

   lcd.setCursor(0, 1);

   lcd.print("FAULT DETECTION ");
```

```
    delay(3000);
    lcd.clear();
    lcd.setCursor(0, 0); // top left
    lcd.print("R=0 Km");
    lcd.setCursor(9, 0); // top left
    lcd.print("Y=0 Km");
    lcd.setCursor(0, 1); // top left
    lcd.print("B=0 Km");
  }
void loop()
{
  while(1)
  {
    REDR =    analogRead(analogInPin0);
    YELLOWY =  analogRead(analogInPin1);
    BLUEB = analogRead(analogInPin2);
    RED1();
    YELLOW1();
    BLUE1();
   }
}
void RED1()
{
  if(RR==0)
  {
     REDR =    analogRead(analogInPin0);
  if(REDR>=820 && REDR<=825 )
```

```
{
 digitalWrite (RED2,LOW);
 Serial.println("R=25Km");
 lcd.setCursor(0, 0); // top left
 lcd.print("R=25Km");
 RR=1;
}
else
if(REDR>=765 && REDR<=770 )
{
  Serial.println("R=20Km");
  lcd.setCursor(0, 0); // top left
 lcd.print("R=20Km");
  digitalWrite (RED2,LOW);
  RR=1;
}
else
if(REDR>=670 && REDR<=695 )
{
 Serial.println("R=15Km");
 lcd.setCursor(0, 0); // top left
 lcd.print("R=15Km");
  digitalWrite (RED2,LOW);
  RR=1;
}
else
if(REDR>=510 && REDR<=515 )
```

```
  {
   Serial.println("R=10Km");
   lcd.setCursor(0, 0); // top left
  lcd.print("R=10Km");
   digitalWrite (RED2,LOW);
   RR=1;
  }
  else
  if( REDR<=400 )
  {
   Serial.println("R=5Km");
   lcd.setCursor(0, 0); // top left
  lcd.print("R=5Km");
   digitalWrite (RED2,LOW);
   RR=1;
  }
   }
}
void YELLOW1()
{
if(YY==0)
 {
  YELLOWY =  analogRead(analogInPin1);
 if(YELLOWY>=820 && YELLOWY<=825 )
  {
  Serial.println("Y=25Km");
  lcd.setCursor(9, 0); // top left
```

```
 lcd.print("Y=25Km");
 digitalWrite (YELLOW2,LOW);
 YY=1;
}
else
if(YELLOWY>=765 && YELLOWY<=770 )
{
  Serial.println("Y=20Km");
  lcd.setCursor(9, 0); // top left
 lcd.print("Y=20Km");
 digitalWrite (YELLOW2,LOW);
 YY=1;
}
else
if(YELLOWY>=670 && YELLOWY<=695 )
{
 Serial.println("Y=15Km");

lcd.setCursor(9, 0); // top left
 lcd.print("Y=15Km");
 digitalWrite (YELLOW2,LOW);
 YY=1;
 }
else
if(YELLOWY>=510 && YELLOWY<=515 )
{
  Serial.println("Y=10Km");
```

```
  lcd.setCursor(9, 0); // top left
 lcd.print("Y=10Km");
 digitalWrite (YELLOW2,LOW);
 YY=1;
}
else
if(YELLOWY<=400 )
{
  Serial.println("Y=5Km");
  lcd.setCursor(9, 0); // top left
 lcd.print("Y=5Km");
 digitalWrite (YELLOW2,LOW);
 YY=1;
}
 }
}
void BLUE1()
{
   if(BB==0)
  {
   BLUEB = analogRead(analogInPin2);
  if(BLUEB>=820 && BLUEB<=825 )
  {
   Serial.println("B=25Km");
   lcd.setCursor(0, 1); // top left
   lcd.print("B=25Km");
   digitalWrite (BLUE2,LOW);
```

```
 BB=1;
}
else
if(BLUEB>=765 && BLUEB<=770 )
{
  Serial.println("B=20Km");
  lcd.setCursor(0, 1); // top left
 lcd.print("B=20Km");
 digitalWrite (BLUE2,LOW);
 BB=1;
}
else
if(BLUEB>=670 && BLUEB<=695 )
{
 Serial.println("B=15Km");
 lcd.setCursor(0, 1); // top left
 lcd.print("B=15Km");
 digitalWrite (BLUE2,LOW);
 BB=1;
}
else
if(BLUEB>=510 && BLUEB<=515 )
{
  Serial.println("B=10Km");
  lcd.setCursor(0, 1); // top left
 lcd.print("B=10Km");
 digitalWrite (BLUE2,LOW);
```

```
 BB=1;
 }
 else
 if(BLUEB<=400 )
 {
  Serial.println("B=5Km");
  lcd.setCursor(0, 1); // top left
 lcd.print("B=5Km");
 digitalWrite (BLUE2,LOW);
 BB=1;
} } }
```

CHAPTER 5

RESULT & CONCLUSION

Thus, the underground cable fault using AT Mega 328 Microcontroller was identified in the underground cable from feeder end in a km. To measure the particular distance and location an individual resister is connected between zones. Solid State relay is a sensing device it will work in a particular location of cable and intimate the fault to microcontroller and distance of fault is displayed in the LCD display.

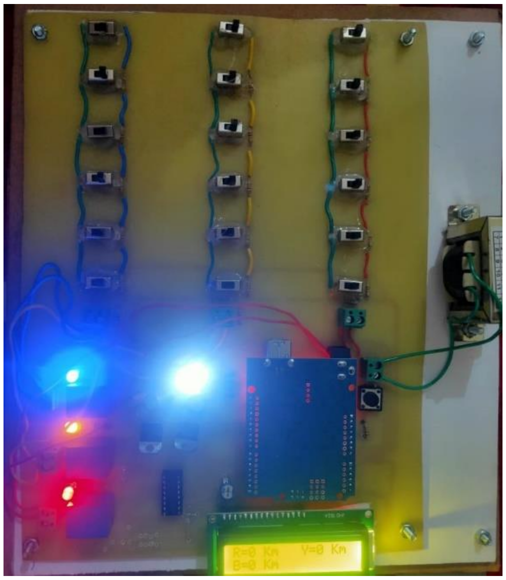


Fig:5.1 Working of underground fault detector when no fault has occurred

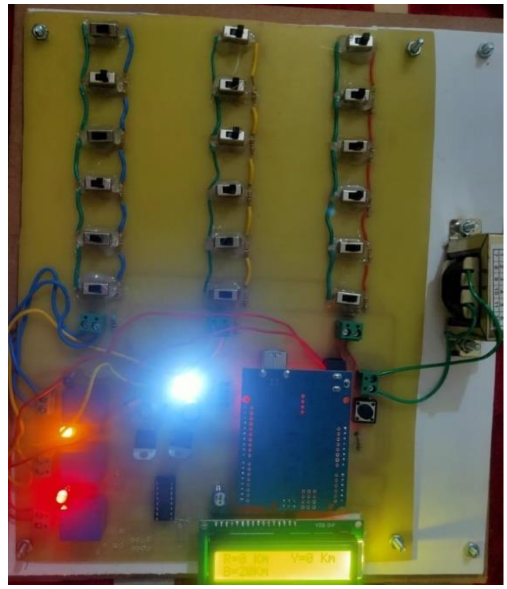


Fig:5.2 Fault detected in B phase at 20 km

Conclusion In this paper we detect the exact location of short circuit fault in the underground cable from feeder end in km by using microcontrollerATmega328. For this we use simple concept of OHM’s law so fault can be easily detected and repaired. Thus, the project on Underground cable fault detection using AT Mega 16 Micro controller was done. We have proposed a low-cost solution to enhance the fault detection of underground cable. It is secure, robust and power consuming. It can be used to all types of cables so as to avoid fault occurring in the underground cables 5.2 Future Scope In this project we detect only the location of short circuit fault in underground cable line, but we 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.

CHAPTER 6

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