UNDERGROUND CABLE FAULT DETECTOR

Project Report

submitted by

PREMKUMAR M
(III-MCT– 1915408)

AJITHKUMARAN D
(III-ECE-B – 1445013)

TAMILARASAN R
(II-IT-B – 2021202)

VARSHINI C
(II-IT-B – 2021207)

for

50 EC L01 – Internet of Things (IoT) – Open Elective

2021 – 2022 (Even Semester)

K.S.RANGASAMY COLLEGE OF TECHNOLOGY TIRUCHENGODE – 637 215

(An Autonomous Institution, Affiliated to Anna University Chennai and Approved by AICTE, New Delhi)

K.S.RANGASAMY COLLEGE OF TECHNOLOGY
TIRUCHENGODE – 637 215

BONAFIDE CERTIFICATE

Certified that this project report titled **"UNDERGROUND CABLE FAULT DETECTOR"** is the bonafide work of *PREMKUMART M (1915408), AJITHKUMARAN D(1915401),TAMILARASAN R (2021202,) VARSHINI C(2021207)*who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE

Mr.T. PRABU

SUPERVISOR

Assistant Professor Dept. of Electronics

and Communication Engineering

K.S. Rangasamy College

of Technology - Tiruchengode-637 21

Submitted for the viva-voce examination held on ……

INTERNAL EXAMINER **EXTERNALEXAMINER**

ABSTRACT

The main objective of this project is to detect the faults and abnormalities occurring in underground cables using an Arduino.

The basic idea behind the working of this project is ohms's law .At the feeder end ,when a DC voltage is applied, based on the location of fault in the cable ,the value of current also changes. So in case of a short circuit fault like L-G or L-L fault the change in voltage value measured across the resistor is then fed to the in-built ADC of the Arduino.

This value is processed by the Arduino and the fault is calculated in terms of distance from the base station. This value is sent to the LCD interfaced to the Arduino board and it displays exact location of the fault from the base station in kilometers for all the three phases.

This project is arranged with a set of resistors which represent the length of the cable. At every known kilometer fault switches are placed to induce faults manually. Finally the fault distance can be determined.

LIST OF TABLES

1.INTRODUCTION

An bundle of electrical conductors used for carrying electricity is called as a cable. An underground cable generally has one or more conductors covered with suitable insulation and a protective cover. Commonly used materials for insulation are varnished cambric or impregnated paper.

Fault in a cable can be any defect or non-homogeneity that diverts the path of current or affects the performance of the cable. So it is necessary to correct the fault. Power Transmission can be done in both overhead as well as in underground cables. But unlike underground cables the overhead cables have the drawback of being easily prone to the effects of rainfall, snow, thunder, lightning etc.

This requires cables with reliability, increased safety, ruggedness and greater service. So underground cables are preferred in many areas specially in urban places.

When it is easy to detect and correct the faults in over head line by mere observation, it is not possible to do so in an underground cable .As they are buried deep in the soil it is not easy to detect the abnormalities in them. Even when a fault is found to be present it is very difficult to detect the exact location of the fault.

This leads to dragging of the entire area to detect and correct the fault which in turn causes wastage of money and manpower. So it is necessary to know the exact location of faults in the underground cables. Whatever the fault is, the voltage of the cable has the tendency to change abruptly whenever a fault occurs. We make use of this voltage change across the series resistors to detect the fault.

2.LITERATURE SURVEY

Presented Design & Implementation Of Fault Identification In Underground Cables Using IOT .

This project is to determine the distance of underground cable fault from the base station in kilometres and displayed over the internet. Underground cable system is a common followed in major areas in Metro cities. While a fault occurs for some reason, at that time the fixing process related to that particular cable is difficult due to exact unknown location of the fault in the cable.

This Technology is used to find out the exact location of the fault and to send data in graphical format to our website using a GSM module at the same time it display on the LCD screen.

The project uses the standard theory of Ohms law, i.e., when a low DC voltage is applied at the feeder end through a series resistor (Cable lines),then the current would vary depending upon the location of the fault in the cable as the resistance is proportional to the distance. In case there is a short circuit (Line to Ground), the voltage across series resistors changes according to the resistance that changes with distance .

This is then fed to an ADC to develop precise digital data which the programmed microcontroller of the 8051 family displays in

3.FAULTS IN UNDERGROUND

3.1 OPEN CIRCUIT FAULTS

These faults occur due to the failure of one or more conductors. The most common causes of these faults include joint failures of cables and overhead lines, and failure of one or more phase of circuit breaker and also due to melting of a fuse or conductor in one or more phases. Open circuit faults are also called as series faults. These are unsymmetrical or unbalanced type of faults except three phase open fault

3.2 SHORT CIRCUIT FAULTS

A short circuit can be defined as an abnormal connection of very low impedance between two points of different potential, whether made intentionally or accidentally. These are the most common and severe kind of faults, resulting in the flow of abnormal high currents through the equipment or transmission lines. If these faults are allowed to persist even for a short period, it leads to the extensive damage to the equipment. Short circuit faults are also called as shunt faults. These faults are caused due to the insulation failure between phase conductors or between earth and phase conductors or both.

The various possible short circuit fault conditions include three phase to earth, phase to phase, single phase to earth, two phase to earth and phase to phase .In single line to ground fault,

fault occurs between any one of the three lines and the ground. In double line to ground fault, fault occurs between any two of the three lines and the ground. In line to line fault, fault occurs between any two lines.

When fault occurs there is an abrupt change in voltage. This change in voltage may cause serious damages to the system if not corrected in time. So immediate step of fault correction is isolation of the faulty part from the rest of the system.

4.FAULT DETECTION METHODS

4.1 ONLINE METHOD

This method utilizes and processes the sampled voltages and current to determine the fault points. Online method for underground cable are less common than overhead lines.

4.2 OFFLINE METHOD

In this method special instrument is used to test out service of cable in the field. This offline method can be divided into two methods .They are tracer method and terminal method.

4.3. TRACER METHOD

In this method fault point is detected by walking on the cable lines. Fault point is indicated from audible signal or electromagnetic signal. It is used to pinpoint fault location very accurately.

4.4 TERMINAL METHOD

It is a technique used to detect fault location of cable from one or both ends without tracing. This method use to locate general area of fault, to expedite tracing on buried cable.

5.PROPOSED SYSTEM

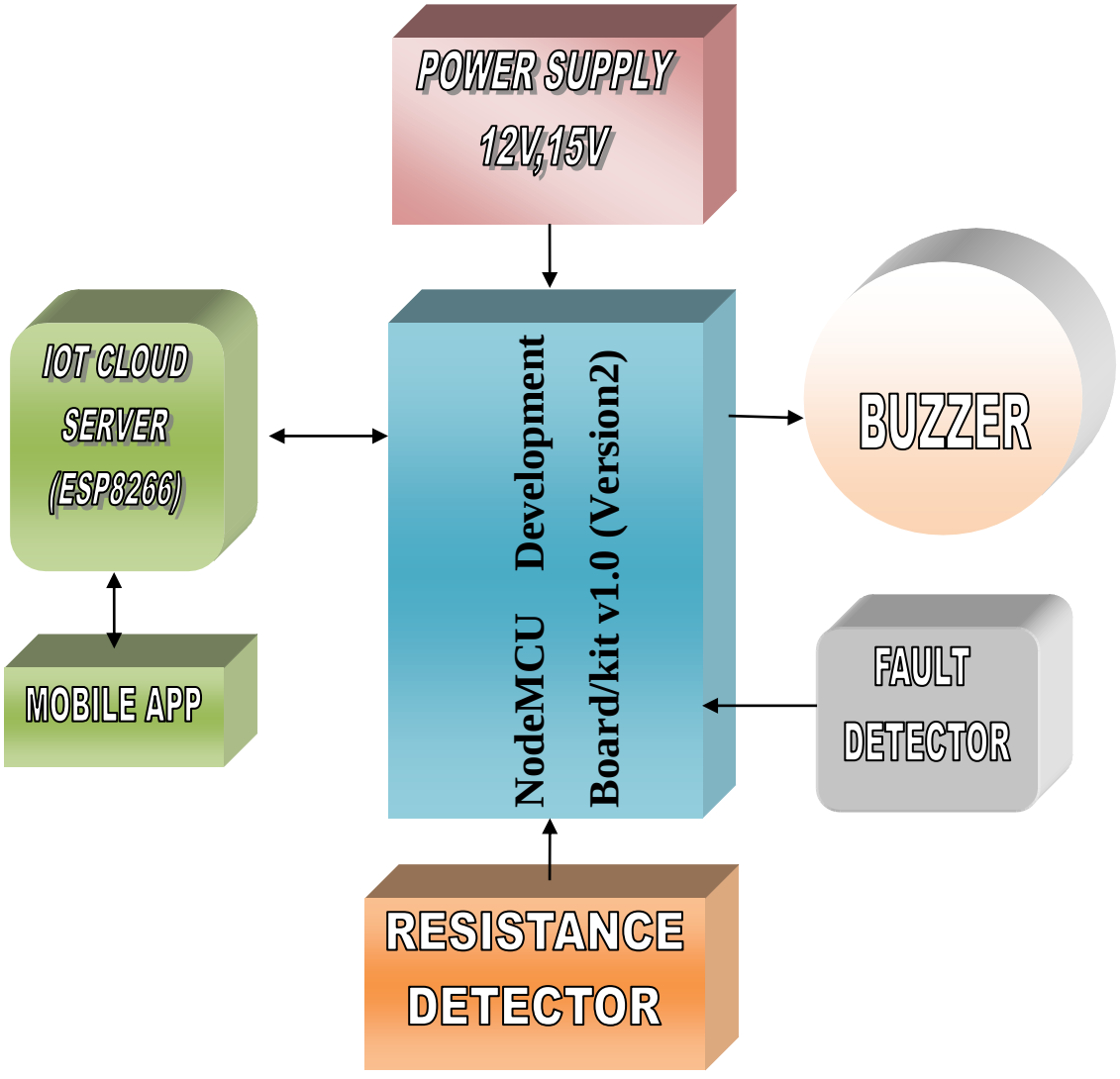
The circuit consists of a power supply, 4 line display, Arduino and resistance measurement circuit. To induce faults manually in the kit ,fault switches are used. About 12 fault switches are used which are arranged in three rows with each row having 4 switches .The 3 rows represent the 3 phases namely R,Y and B. The fault switches have 2 positions-No fault position(NF) and fault position(F).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 50 Ohm.

These 4 sets of resistances represent the three phases and the neutral. Short circuit faults, Symmetrical and unsymmetrical faults can be determined by this method.

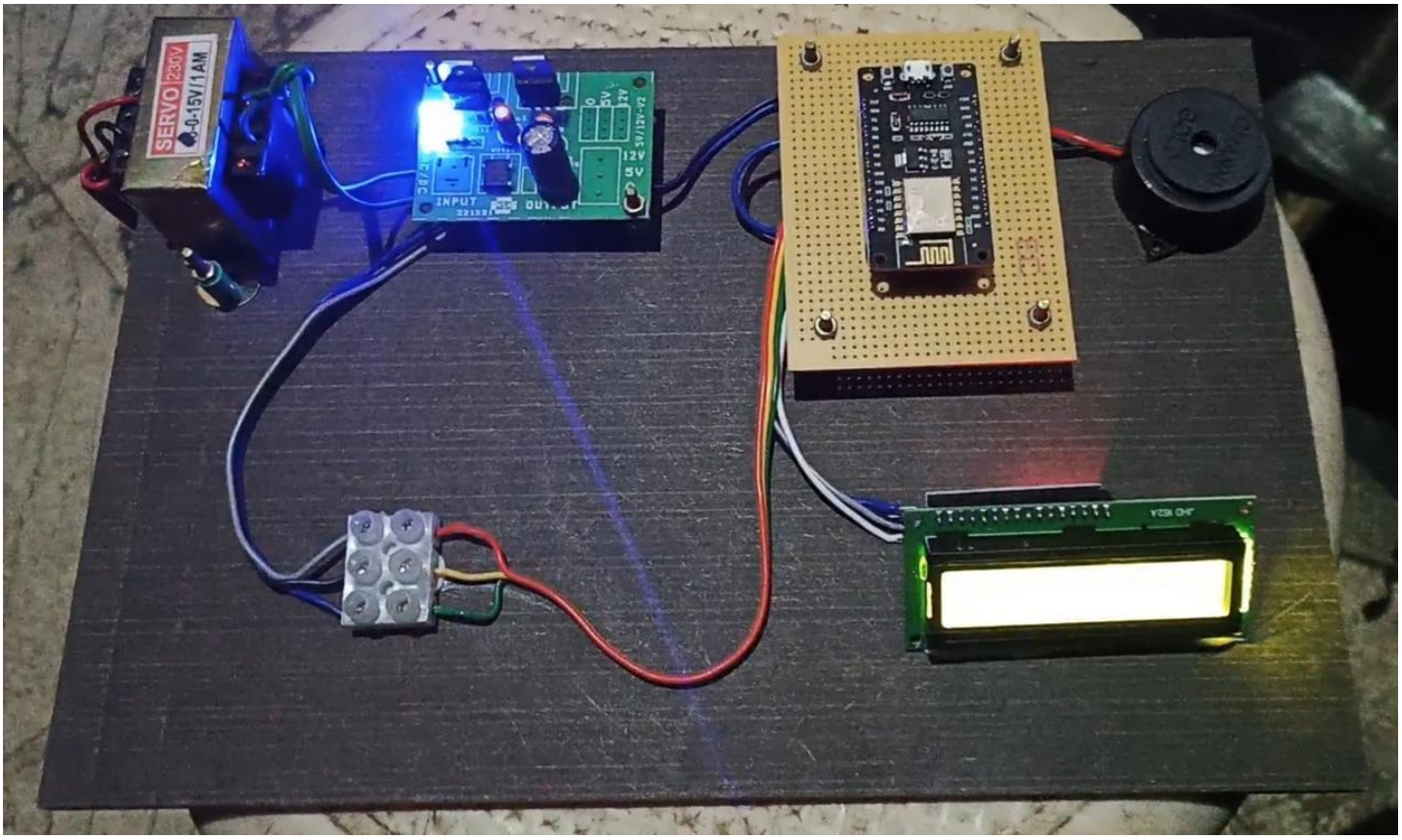
This project uses three set of resistances in series (ie)R10-R11-R12-R12,R17-R16-R14R21,R20-R19-R18- R25 one for each phase. Each series resistor represents the resistance of the

underground cable for a particular distance and so here four resistances in series represent 1-4kms.Value of each resistance is 10kΩ.

6.BLOCK DIAGRAM



7.HARDWARE KIT



8.HARDWARE AND SOFTWARES

- ✓ NodeMCU Development Board/kit v1.0 (Version2)
- ✓ Buzzer
- ✓ ESP8266
- ✓ LCD
- ✓ TRANSFORMER
- ✓ Blynk colud platform
- ✓ SWETCH
- ✓ REGULATOR

8.1.NODEMCU DEVELOPMENT BOARD/KIT V1.0 (VERSION2)

8.1.1.Introduction :

NodeMCU is an open source LUA based firmware developed for ESP8266 wifi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board.

NodeMCU Development Board/kit v1.0 (Version2)

NodeMCU Dev Kit has Arduino like Analog (i.e. A0) and Digital (D0-D8) pins on its board.

It supports serial communication protocols i.e. UART, SPI, I2C etc.

Using such serial protocols we can connect it with serial devices like I2C enabled LCD display, Magnetometer HMC5883, MPU-6050 Gyro meter + Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards etc.

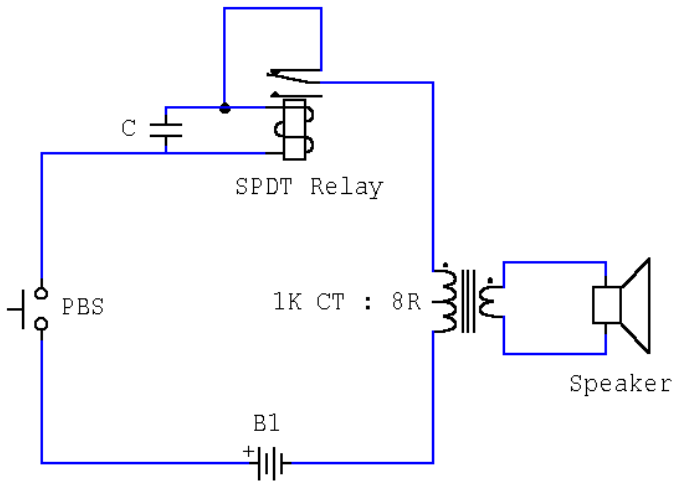
8.1.2.Pins

NodeMCU provides access to the GPIO (General Purpose Input/Output) and a pin mapping table is part of the API documentation.

I/O index	ESP8266 pin
0 [*]	GPIO16
1	GPIO5
2	GPIO4
3	GPIO0
4	GPIO2
5	GPIO14
6	GPIO12
7	GPIO13
8	GPIO15
9	GPIO3
10	GPIO1
11	GPIO9
12	GPIO10

8.2. Buzzer

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.



This novel buzzer circuit uses a relay in series with a small audio transformer and speaker. When the switch is pressed, the relay will operate via the transformer primary and closed relay contact. As soon as the relay operates the normally closed contact will open, removing power from the relay, the contacts close and the sequence repeats, all very quickly...so fast that the pulse of current causes fluctuations in the transformer primary, and hence secondary. The speakers tone is thus proportional to relay operating frequency. The capacitor C can be used to "tune" the note. The nominal value is 0.001uF, increasing capacitance lowers the buzzers tone.

8.3.LCD

A **liquid crystal display** (commonly abbreviated **LCD**) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

8.3.1Overview

Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each other. With no liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

The surfaces of the electrodes that are in contact with the liquid crystal material are treated so as to align the liquid crystal molecules in a particular direction. This treatment typically consists of a thin polymer layer that is

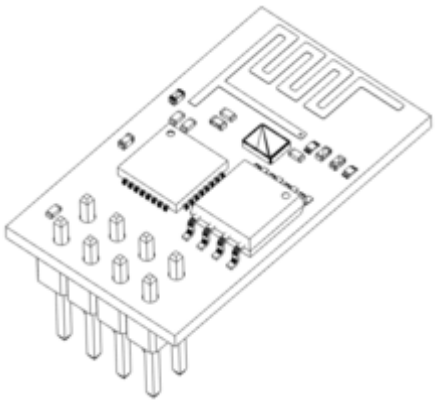
unidirectionally rubbed using, for example, a cloth. The direction of the liquid crystal alignment is then defined by the direction of rubbing.

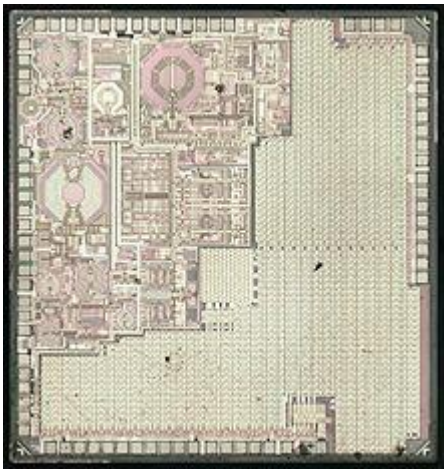
8.3.2SPECIFICATIONS

Important factors to consider when evaluating an LCD monitor:

- ✓ **Resolution:** The horizontal and vertical size expressed in pixels (e.g., 1024x768). Unlike CRT monitors, LCD monitors have a native-supported resolution for best display effect.
- ✓ **Dot pitch:** The distance between the centers of two adjacent pixels. The smaller the dot pitch size, the less granularity is present, resulting in a sharper image. Dot pitch may be the same both vertically and horizontally, or different (less common).
- ✓ **Viewable size:** The size of an LCD panel measured on the diagonal (more specifically known as active display area).
- ✓ **Response time:** The minimum time necessary to change a pixel's color or brightness.
- ✓ **Matrix type:** Active or Passive
- ✓ **Viewing angle**: (coll., more specifically known as viewing direction).
- ✓ **Color support:** How many types of colors are supported (coll., more specifically known as color gamut).
- ✓ **Brightness:** The amount of light emitted from the display (coll., more specifically known as luminance).
- ✓ **Contrast ratio:** The ratio of the intensity of the brightest bright to the darkest dark.
- ✓ **Aspect ratio:** The ratio of the width to the height (for example, 4:3, 16:9 or 16:10).Input ports (e.g., DVI, VGA, LVDS, or even S-Video and HDMI).

8.4. ESP8266





The ESP8266 is a low-cost Wi-Fi microchip, with built-in TCP/IP networking software, and microcontroller capability, produced by Espressif Systems[1] in Shanghai, China.

The chip was popularized in the English-speaking maker community in August 2014 via the ESP-01 module, made by a third-party manufacturer Ai-Thinker.

This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at first, there was almost no English-language documentation on the chip and the commands it accepted.

The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, the chip, and the software on it, as well as to translate the Chinese documentation.[3]

The ESP8285 is a similar chip with a built-in 1 MiB flash memory, allowing the design of single-chip devices capable of connecting via Wi-Fi.[4]

These microcontroller chips have been succeeded by the ESP32 family of devices.

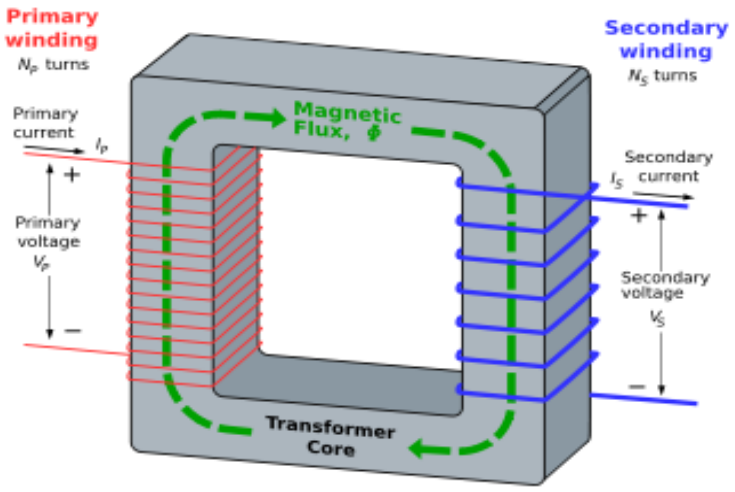
8.5. TRANSFORMER:

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled wires. A changing current in the first circuit (the primary) creates a changing magnetic field; in turn, this magnetic field induces a changing voltage in the second circuit (the secondary). By adding a load to the secondary circuit, one can make current flow in the transformer, thus transferring energy from one circuit to the other. The secondary induced voltage V_S is scaled from the primary V_P by a factor ideally equal to the ratio of the number of turns of wire in their respective windings:

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

By appropriate selection of the numbers of turns, a transformer thus allows an alternating voltage to be stepped up — by making N_S more than N_P or stepped down, by making it less.

A key application of transformers is to reduce the current before transmitting electrical energy over long distances through wires. Most wires have resistance and so dissipate electrical energy at a rate proportional to the square of the current through the wire. By transforming electrical power to a high-voltage, and therefore low-current form for transmission and back again afterwards, transformers enable the economic transmission of power over long distances. Consequently, transformers have shaped the electricity supply industry, permitting generation to be located remotely from points of demand.



All but a fraction of the world's electrical power has passed through a series of transformers by the time it reaches the consumer.

Transformers are some of the most efficient electrical 'machines', with some large units able to transfer 99.75% of their input power to their output.

secondary coil as well as the primary coil.

8.5.1.INDUCTION LAW:

The voltage induced across the secondary coil may be calculated from Faraday's law of induction, which states that

$$V_S = N_S \frac{d\Phi}{dt}$$

8.5.2.CLASSIFICATION

The many uses to which transformers are put lead them to be classified in a number of different ways:

- ✓ **By power level:** from a fraction of a volt-ampere (VA) to over a thousand MVA;
- ✓ **By frequency range:** power-, audio-, or radio frequency;
- ✓ **By voltage class:** from a few volts to hundreds of kilovolts;
- ✓ **By cooling type:** air cooled, oil filled, fan cooled, or water cooled;
- ✓ **By application function:** such as power supply, impedance matching, output voltage and current stabilizer, or circuit isolation;
- ✓ **By end purpose:** distribution, rectifier, arc furnace, amplifier output;
- ✓ **By winding turns ratio:** step-up, step-down, isolating (near equal ratio), variable.

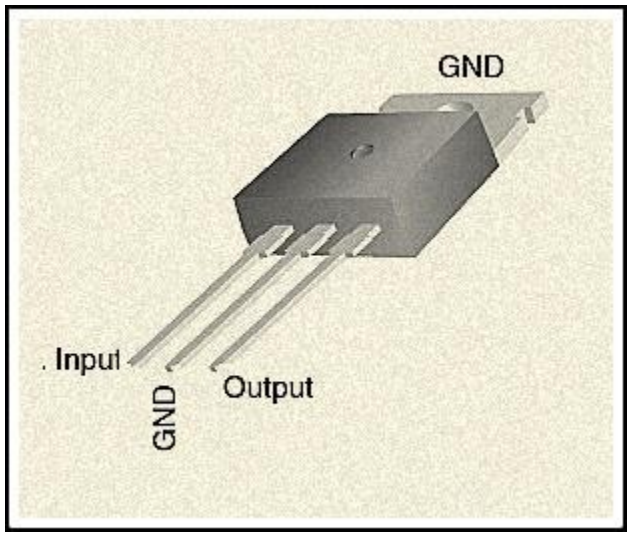
8.6. SWETCH

In electrical engineering, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The mechanism of a switch may be operated directly by a human operator to control a circuit (for example, a light switch or a keyboard button), may be operated by a moving object such as a door-operated switch, or may be operated by some sensing element for pressure, temperature or flow. A relay is a switch that is operated by electricity. Switches are made to handle a wide range of voltages and currents; very large switches may be used to isolate high-voltage circuits in electrical substations.

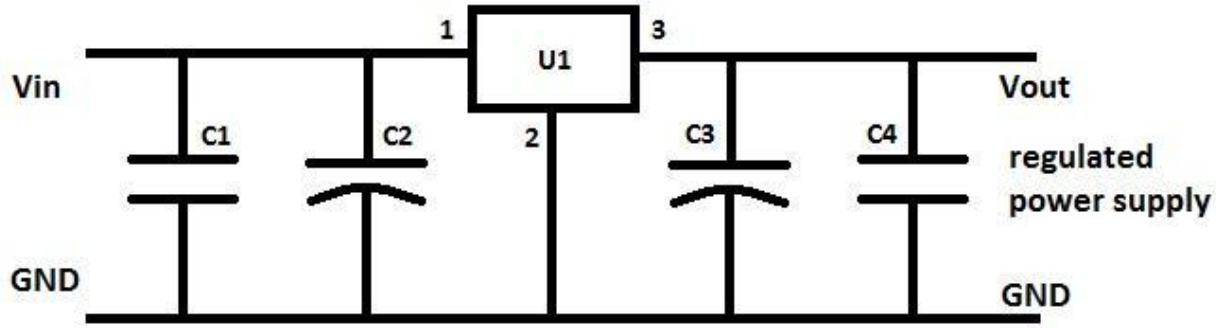
8.7.REGULATOR

A regulated power supply is very much essential for several electronic devices due to the semiconductor material employed in them have a fixed rate of current as well as voltage. The device may get damaged if there is any deviation from the fixed rate. The AC power supply gets converted into constant DC by this circuit. By the help of a voltage regulator DC, unregulated output will be fixed to a constant voltage. The circuit is made up of linear voltage regulator 7805 along with capacitors and resistors with bridge rectifier made up from diodes. From giving an unchanging voltage supply to building confident that output reaches uninterrupted to the appliance, the diodes along with capacitors handle elevated efficient signal conveyed.

As we have previously talked about that regulated power supply is a device that mechanized on DC voltages and also it can uphold its output accurately at a fixed voltage all the time although if there is a significant alteration in the DC input voltage.



ICs regulator is mainly used in the circuit to maintain the exact voltage which is followed by the power supply. A regulator is mainly employed with the capacitor connected in parallel to the input terminal and the output terminal of the IC regulator. For the checking of gigantic alterations in the input as well as in the output filter, capacitors are used. While the bypass capacitors are used to check the small period spikes on the input and output level. Bypass capacitors are mainly of small values that are used to bypass the small period pulses straightly into the Earth. A circuit diagram having regulator IC and all the above discussed components arrangement revealed in the figure below.



IC 7805 is a DC regulated IC of 5V. This IC is very flexible and is widely employed in all types of circuit like a voltage regulator. It is a three terminal device and mainly called input, output and ground. Pin diagram of the IC 7805 is shown in the diagram below.

9.ADVANTAGES

- Less maintenance
- It has higer efficiency
- Less fault occur in underground cable
- This method is applicable to all types of cable form ranging from 1kv to 500kv
- It can detect other types of cable fault such as Short circuit fault, cable cuts, Resistive fault, Sheath faults, Water trees, Partial discharges.

10.CONCLUSIONS

Thus the project on Underground cable fault detection using Arduino was done and the distance of the fault from the base station in kilometers was displayed for the three individual phases R,Y and B. Circuit can be tested with different resistor values to simulate various fault conditions In this project faults upto a distance of 4km can be detected. When the fault switches are operated to fault condition then the phase corresponding to that particular switch is considered as the faulty phase. So the faulty section can easily be located.

11. FUTURE SCOPE

In this project we detect the exact location of short circuit fault in the underground cable from feeder end in km by using arduino. In future, this project can be implemented to calculate the impedance by using a capacitor in an AC circuit and thus measure the open circuit fault

12. REFERENCES

[1] R. Saravana Kumar, K. Vinoth Kumar, Dr. K.K. Ray, Fuzzy logic based fault detection in induction machine using Labview, IJCSNS International Journal of Computer Science and Network Security, 9(9), September 2009. [2] Penman J., Sedding, H.G, Lloyd, B.A. and Fink, W.T (1994), Detection & Location of Interturn Short Circuit in the Stator Winding of Operating Motor, IEEE Transection on Energy Conversion, 9, 652–658. [3] Spectrum analysis basics- Agilent technologies, http://Cp.litreture.agilent.com/litweb/pdf/5952- 0902 pdf. [4] Anant G. Kulkarni1, Dr. Manoj Jha, Dr. M. F. Qureshi, Simulation of Fault Diagnosis of Induction Motor Based on Spectral Analysis of Stator Current Signal Using Fast Fourier Transform, IJSET International Journal of Innovative Science, Engineering & Technology, 1(4), June-2014,