Iot based underground cable breakdown fault detector

This project report submitted in partial fulfillment of the requirements

for the Award of Degree of

Bachelor of Science in Electrical and Electronic Engineering

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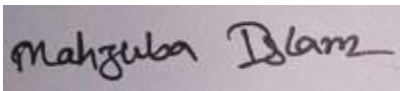
FACULTY OF ENGINEERING

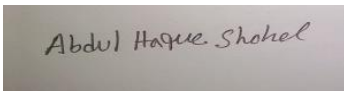## DAFFODIL INTERNATIONAL UNIVERSITY

February 2020

Certification

This is to Certify that this Project entitled **"Iot based underground cable fault detection and Current monitoring system"**Is Done By The Following Student Under My Direction Supervision And This Work Has Been Carried By The Laboratories Of The Department Of Electrical And Electronic Engineering Under The Faculty Of Engineering Of Daffodil International University In Partial Fulfillment Of The Requirements For The Degree Of Bachelor Of Science In Electrical And Electronic Engineering .The Presentation Of The Work Was Held on February 2020.

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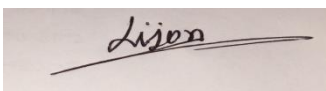**Signature of The Supervisor**

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Dedicated to

Our Parents

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LIST OF FIGURES

ACKNOWLEDGEMENT

First Of All, We Give Thanks To Allah. It Is A Great Intention For Authors To Express Their Unfettered Gratification, Sincere Appreciation And A Great Honor To Our Respective CO-Supervisor **Mrs. Mahzuba Islam, Sr. Lecturer**,Department of Electrical &Electronic Engineering, Daffodil International University, for his constructive suggestion, scholastic guidance, constant inspiration, valuable advices and kind cooperation for the successful completion of work on "**Iot based underground cable fault detection and Current monitoring system**". This could not be possible without his help. Space does not allow us to mention each person by name, but we are deeply grateful to everyone associated with this project and thesis. We also wish to complement all our respective concern teachers & staffs of our department of their direct and indirect assistance at different times.

ABSTRACT

The development and advance in technology, many thing are changes. The technology laid out to understand its importance like in urban areas, the electrical cable to go underground instead of overhead lines, which grab less space and is consider as the effective and efficient way of transmission. But the problem ascend when any fault befall in the underground cable and it's also difficult to detect the proper location of the fault during the process of repairing that especial cable and the methods existed till now follows some algorithm in order to scan the location of the fault. The raised system which constitute of current sensors, microcontroller (Node MCU) and Wi-Fi modem which creates a course between the combined hardware and internet so that the real time data can be successively communicated towards server its being successively communicate with towards server and along with this everything becomes smart and interconnected with the help of IoT (internet of things) those are real time data can be retrieved in pc or mobile phones from the server. Hitherward by using useful stage provided by IoT any one can recover information whenever they necessary. By implementing the proposed system life of the cable will also get by grown because after implementing the system the supply transmission of the power can be closed till the fault gets mend and through this the inessential losses which are developed though the leakage of current can be avoided.

CHAPTER 1

INTRODUCTION

1.1 Introduction:

Underground Cable line protection is an important issue in power system engineering because 85-87% of power system faults are occurring in Underground lines. This paper is quick on the security schemes and Identify various types of defects in a transmission line and for reliable management Provides a technique for classifying.

Discrimination among different types of faults on the Underground lines is achieved by application of evolutionary programming tools. PSCAD/EMTDC software is used to simulate different operating and fault conditions on high voltage Underground line, namely single phase to ground fault, line to line fault, double line to ground and three phase short circuit. The discrete wavelet transforms (DWT) is applied for decomposition of fault transients, because of its ability to extract information from the transient signal, simultaneously both in time and frequency domain. Data sets obtained from DWT are used for SVM architecture training and testing. After removing useful features from the measured signals, a fault or a fault is decided at any stage or multiple stage of the transmission line using three SVM classifiers. The ground detection function is performed by the proposed ground index. The Gaussian radial base kernel function (RBF) has been used, and The performances of the classifiers were evaluated on the basis of fault classification accuracy. To determine the optimal parameter settings for an SVM classification (such as the type of kernel function, its associated parameters, and Regularization parameter C), fivefold cross-validation has been applied to the training organization. It has been observed that an SVM with an RBF kernel provides better fault classification accuracy than an SVM with a multivariate kernel. It was found that the proposed project is very fast And Accurate and It has proven to be a powerful classifier for digital distance protection.

1.2 Earlier Research

The vast majority of the systems in our project are computerized systems. Programmed system work is once in a while required. Considering work pay, the system will profit a great deal (Internet of Things).In this system, Iot based underground cable fault detection and Current observing system.

A man can see underground cable fault detection and furthermore Current checking system. What's more, The line fault and line current states of the earth can be found in a lcd show on the project.

In addition, this information can be checked from anyplace on the planet through the Internet.

1.3 State of the art technology

Iot system Methods Iot based underground cable fault detection and Current monitoring system varies in different ways throughout the year It is important to consider properly that the use of cable fault is being given priority in developing countries in different countries.

1.4 Iot System

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The definition of the Internet of Things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.
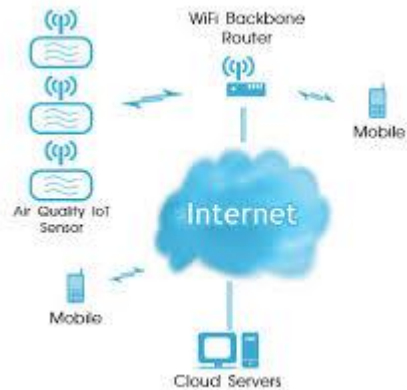
Figure1.1 :Iot System

Conventional fields of inserted systems, wireless sensor systems, control systems, robotization (counting home and building computerization), and others all add to empowering the Internet of Things. In the customer showcase, IoT innovation is generally synonymous with items relating to the idea of the "**Iot based underground cable fault identification and Current checking system** ", covering devices and machines, (for example, lighting apparatuses, indoor regulators, home security systems and cameras, and other home apparatuses) that help at least one normal ecosystems, and can be controlled by means of devices related with that ecosystem, for example, PDAs and shrewd speakers. There are various genuine worries about risks in the development of IoT, particularly in the territories of protection and security; and thus industry and administrative moves to start to address these.

1.5 LITERATURE REVIEW

Cable faults are harm to cables which sway a resistance in the connection. At whatever point allowed to endure, this can incite a voltage breakdown. There are different sorts of connection issues, which ought to at first be requested before they can be found. The insulation of the connection expect a basic activity in this. While paper-impregnated cables are particularly helpless against external invention and warm impacts, in high-voltage PE or XLPE cables the polyethylene insulation of the conductor is affected, prompting fragmentary breakdowns and parts that "expend" the insulation.

Screening faults

A contact among conductor and screen creates a varying resistance.

Phase faults

The contact between various conductors produces a varying resistance.

Sheath faults

Sheath faults are harm of the link sheath that permits the environment contact with the link screen.

Faults due to moisture

Water penetrates into the cable sheath and contacts the conductors. Impedance changes at the fault location make measuring more difficult. The resistance usually lies in the low-ohmic range.

Disruptions

Combination of series and parallel resistances, usually in the form of a wire break. The

Voltage is interrupted, i.e. $\Omega=\infty$.

Cable testing

To locate a fault in the cable, the cable must first be tested for faults. Cable testing is therefore usually performed first in cable fault location. During the cable test, flash-over's are generated at the weak points in the cable, which can then be localized.

Locating the cable fault

Fault location technique on-site

The measures necessary for determining fault locations can be subdivided into individual steps.

Fault classification

Insulation and resistance measurement provides information on the fault characteristics. An insulation test gauges the insulation obstruction among conductor and screen; from the occasional estimation of opposition you can determine the retention properties of the protecting material.

Pre-location

Pre-location is used to determine the fault distance. There are predominantly two methods for this.

Pulse reflection method

A pulse incited at the beginning finish of the cable arrives at the cable issue with a speed of v/2 and afterward is reflected back toward the beginning finish of the cable. The elapsed time multiplied by the diffusion speed v/2 gives the distance to the source of the fault.

Transient method

In the transient method, a breakdown is activated at the cable deficiency. This impacts a low-resistance cut off a couple of milliseconds. This thusly creates two voyaging waves diffusing in inverse ways. These waves are reflected at the cable closures with the goal that they at that point travel toward one another again toward the cable deficiency. The waves can't pass the shortcoming on account of the bend created by the short out, so they are accordingly reflected back again likewise with the heartbeat reflection method, which because of the consuming short out outcomes in an inversion of extremity. There are different approaches to decouple and investigate these transients source of the issue.

Route tracing and pinpointing

Route tracing is utilized to figure out where the faulty cable lies and pinpointing is the way toward deciding the careful situation of the cable fault.

Cable identification

In cable identification, the faulty cables are identified from the fault-free cables at the already determined site.

1.5 METHODOLOGY

  I.   We have collected project related data from the internet.
 II.   We have collected necessary equipment from local market and online shop.
III.   Before implementing the project we designed a circuit.
 IV.   As a programming device we have used NodeMcu microcontroller.
  V.   we used the programming language c.
 VI.   Finally we were able to launch the project in a pilot.

1.6 Objectives of the Project

I.   The main goal of our project is to easily find the transmission line fault that is below ground.

II. I can see which fault is near the pole.

III. I can monitor how much current is going on each line.

IV. Monitor line fault and line current from anywhere in the world through the Internet.

1.7 Summary

We have created a modern project to monitor the fault and current under the ground wire. We have worked with three phase lines here. We have made fault switches for each phase separately. From this fault switch we have brought the connection to the controller which is shown on the display by programming. Here we can monitor line current. We can monitor project data such as line fault and line current from anywhere on the Internet.

Chapter 2

THEORETICAL BACKGROUND

2.1 Microcontroller

A microcontroller (Node MCU) is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor underline self-sufficiency and cost-usefulness, in contrast to a general-purpose microprocessor (the kind used in a PC). A typical microcontroller contains all the memory and interfaces needed for facile application, whereas a general-purpose Microprocessor requires additional chips to provide these features. So, as they have all the IO and memory built on the chip it is very easy to use them in power and position limited conditions. And also as they are very cheap likened to typical PC microprocessors, they can be used almost everywhere. Now a day's almost all electronics products take on some form of microcontroller to make our life a lot easier by automation. Although they seem to be too slow and have insanely low amount of memory they are very energy proficient. And most of the jobs they do does not require very powerful processors. A microcontroller is a single integrated circuit with the following key Features:

a) Central processing unit - ranging from small and simple 8-bit processors to sophisticated 32- or 64-bit processors.
b) Input/output interfaces such as serial ports
c) Peripherals such as timers and watchdog circuits
d) RAM for data storage
e) ROM, EEPROM or Flash memory for program storage
f) Clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit.

2.2 History

The first single chip microprocessor was the 4 bit Intel 4004 released in 1971, with other more capable processors available over the next several years. These however all required external chip(s) to implement a working system, raising total system cost, and making it impossible to economically computerize appliances. The first computer system on a chip optimized for control applications - microcontroller was the Intel 8048 released in 1975, with both RAM and ROM on the same chip.

This chip would find its way into over one billion PC keyboards, and other numerous applications. Most microcontrollers at this time had two variants. One had an erasable EEPROM program memory, which was significantly more expensive than the PROM variant which was only programmable once. In 1993, the introduction of EEPROM memory allowed microcontrollers (beginning with the Microchip PIC16x84) to be electrically erased quickly without an expensive package as required for EPROM, allowing both rapid prototyping, and In System Programming. The same year, Atmel introduced the first microcontroller using Flash memory. Other

Companies rapidly followed suit, with both memory types. Cost has plummeted over time, with the cheapest 8-bit microcontrollers being available for under $0.25 in quantity (thousands) in 2009, and some 32-bit microcontrollers around $1 for similar quantities. Nowadays microcontrollers are low cost and readily available for hobbyists, with large online communities around certain processors.

2.3 Architecture of Microcontroller:
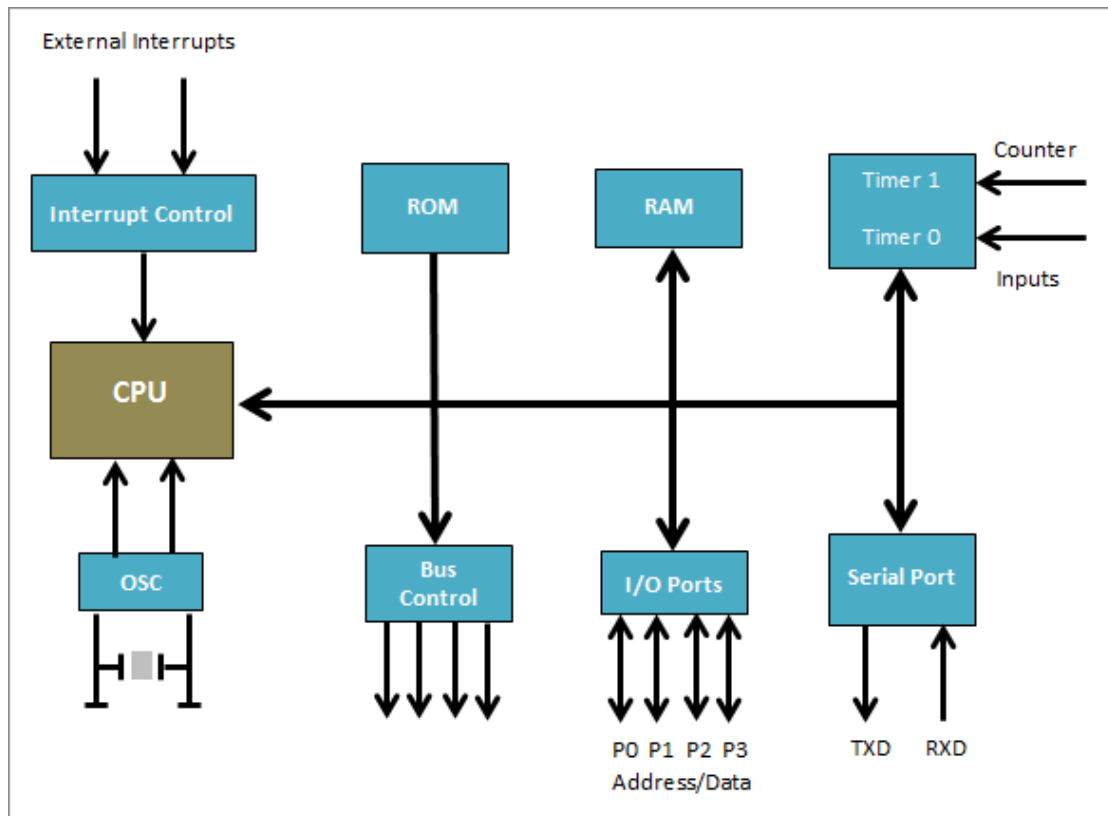
Figure: 2.1 Architecture of Microcontroller

2.4Uses

they are cheap and require very little power. So in almost every device has one of them nowadays. Any devices that require some form of control or logical operation has one. Microcontrollers are used in automatically controlled Microcontrollers are used to control electronic and electric equipment. This products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices

and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. Also as the development environment and the chips are cheap or free, a lot of students and hobbyists are getting into microcontrollers. As it allows them to create and test very interactive or interesting ideas and devices.

Some practical uses are given below:

I.   Automotive. Popular. This came about in MCU organizations planning MCUs for this industry as it were. Like Atmel makes Automotive AVRs.

II. Home machines. Practically all broilers, espresso machines, blenders, clothes washer's fridges and so on has one these days.

III. Almost the correspondence business utilizes MCUs. Telephones, mobiles and remote sets use them

IV. Prototyping and structure. Practically all CNC switches or 3D printers utilize various MCUs to enable them to gather information and for simple operation of various piece of the machines.

V. Sound frameworks use them for separating control and leveling sound output.

VI. Almost all IPS/UPS and battery chargers utilize micro-controllers these days. AS this take into consideration flawless charging control and detecting of various parameters.

VII. Billboard LED shows utilize many them to drive a large number of LED's to make that show work.

VIII.   And in light of the upheaval for gadget like Arduino general individuals are making at some point insane yet exceptionally cool devices utilizing MCUs.

2.4 Android Apps

The Blynk software is mainly operated over the Internet. This software has a specific server for sending data. This software has to be registered on the specified server, then login to the software with user name and password. Data is passed to the server through the controller's Internet head, the server sends software data, which we can monitor from anywhere.
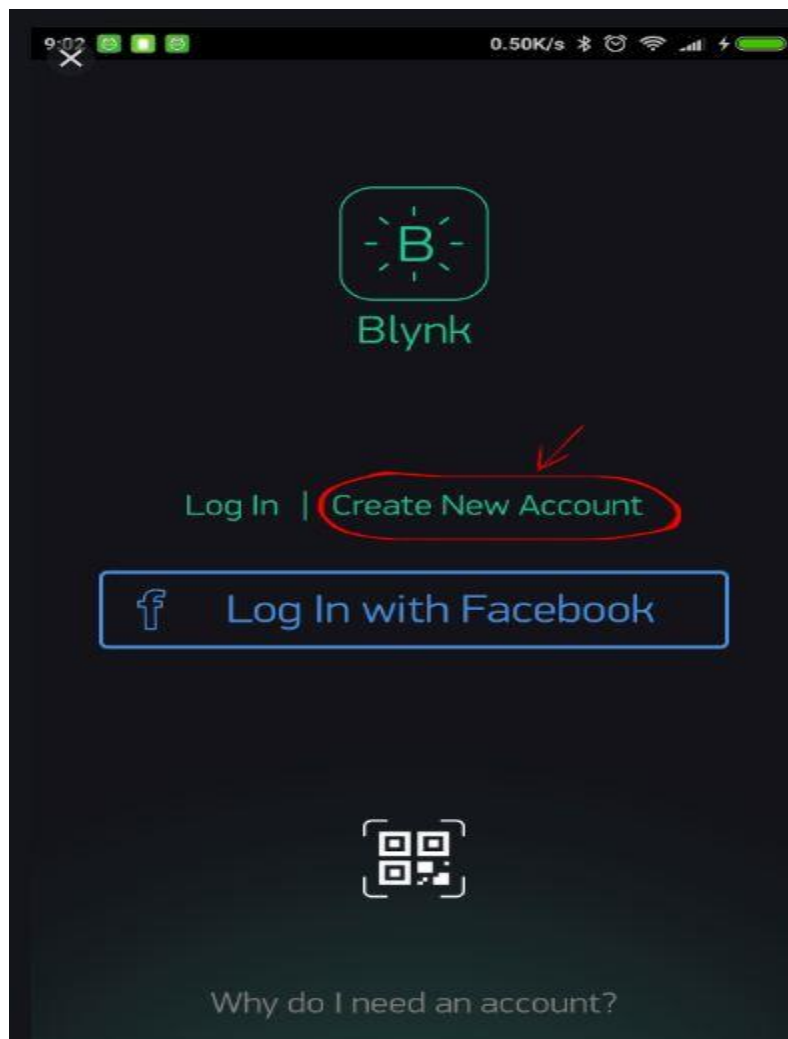

Figure2.2: Android Apps

Chapter 3

DESIGN, DEVELOPMENT

3.1 Introduction

Underground cables are vulnerable to various types of defects due to wear and tear, rats, etc. due to underground conditions. Fault sources are difficult to diagnose and the entire cable should be taken from the ground to verify and fix faults. The project work is for the purpose of detecting the fault location of the underground cable line from the base station in kilometers using the Node MCU controller. To detect an error in the cable, the cable must be checked for faults. This prototype uses the general concept of Ohms law. Depending on the cable's length, the current will vary. In urban areas, electric cables run underground instead of overhead lines. Whenever the fault occurs within the underground cable, it is difficult to identify the exact location of the fault in order to repair that particular cable. The proposed system finds the exact location of the error.

The prototype is made with a set of resistors that represent the length of the km, and the fault cream is made by a set of switches at each correct distance whose accuracy tests. In case of error, the voltage across the series resistor is changed accordingly, which is then fed to an ADC to develop precise digital data in a programmed node MCU that further shows the fault location. The fault that occurs in the distance ND current is displayed on a 20X04 LCD interfaced with a microcontroller. The IoT Wi-Fi module is used to display information on the Internet using ESP8266.A webpage is created using HTML coding, and information about the error type is displayed on a webpage.
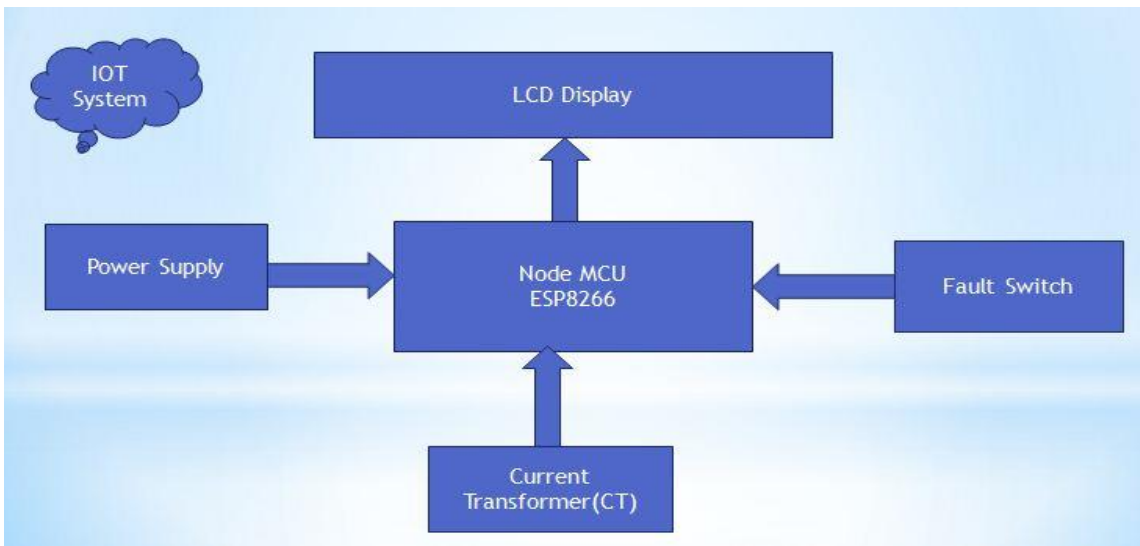
3.2 Full Block diagram

Figure: 3.1 Full Block diagram

3.3 Full Circuit diagram:
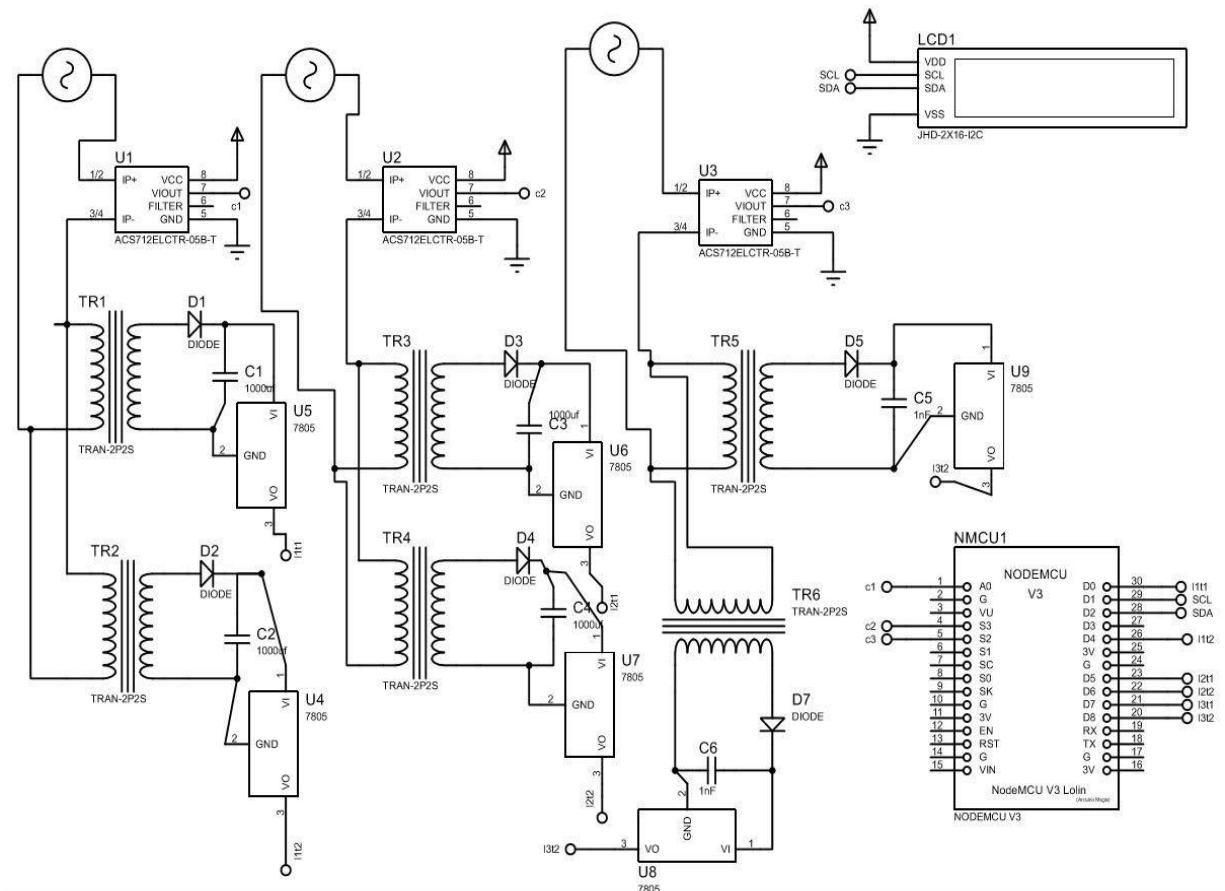
Figure: 3.2 Circuit diagram

3.4 Circuit description

The main goal of our project is to diagnose the underground cable fault, here we are for three phase lines, we have created two fault sensors on each line and we have connected the output of the fault sensor to the digital pin of the controller. Each fault sensor is created, a 6 volt step down transformer, Diode of a 1n4007 model,acapacitor,a voltage regulator 7805 model, a 10K registor adjustment. Which is shown in the project diagram. This is another aspect of our project Monitor the load current of each phase, we have used three current sensors to monitor the current of the three phases. Connected to the current sensor's output controller's analog pin. A display has also been attached to the project which is connected to the digital pin of the controller. Another special aspect of our project is the iot (internet of think) system. On this system we can monitor data via the Internet, For which we have to work with the server. Here, if any fault is present in any of our three phases, it will show directly on the display which fault has been faulted under the switch. At the same time we can monitor the Internet where the fault has occurred. Moreover, we can monitor the current current on the display and on the Internet. We have used the programming device here as nodemcu esp8266. Here we have developed the project using c programming.

3.5 Components

➢ Node MCU

➢ Connecting ware
➢ LM2596 Voltage Converter
➢ ACS712 Current Sensor
➢ Capacitor
➢ Diode
➢ Lm7805
➢ Resistor
➢ Transformer
➢ Rectifier

3.6 Tools

1)Glue gum

2)Wire Stripper

3)Pliers

4)Laptop

3.7 Node MCU

NodeMCU is an open source IoTplatform.It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS.

Figure-3.3: Node MCU

3.7.1 History

NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems began production of the ESP8266.The ESP8266 is a Wi-Fi SoC integrated with a TensilicaXtensa LX106 core,[citation needed] widely used in IoT applications (see related projects). NodeMCU started on 13 Oct 2014, when Hong committed the first file of nodemcu-firmware to GitHub.Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform, and committed to NodeMCU project, then NodeMCU was able to support the MQTT IoT protocol, using Lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glib to NodeMCU project, enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.

In summer 2015 the creators abandoned the firmware project and a group of independent contributors took over. By summer 2016 the NodeMCU included more than 40 different modules. Due to resource constraints users need to select the modules relevant for their project and build a firmware tailored to their needs.
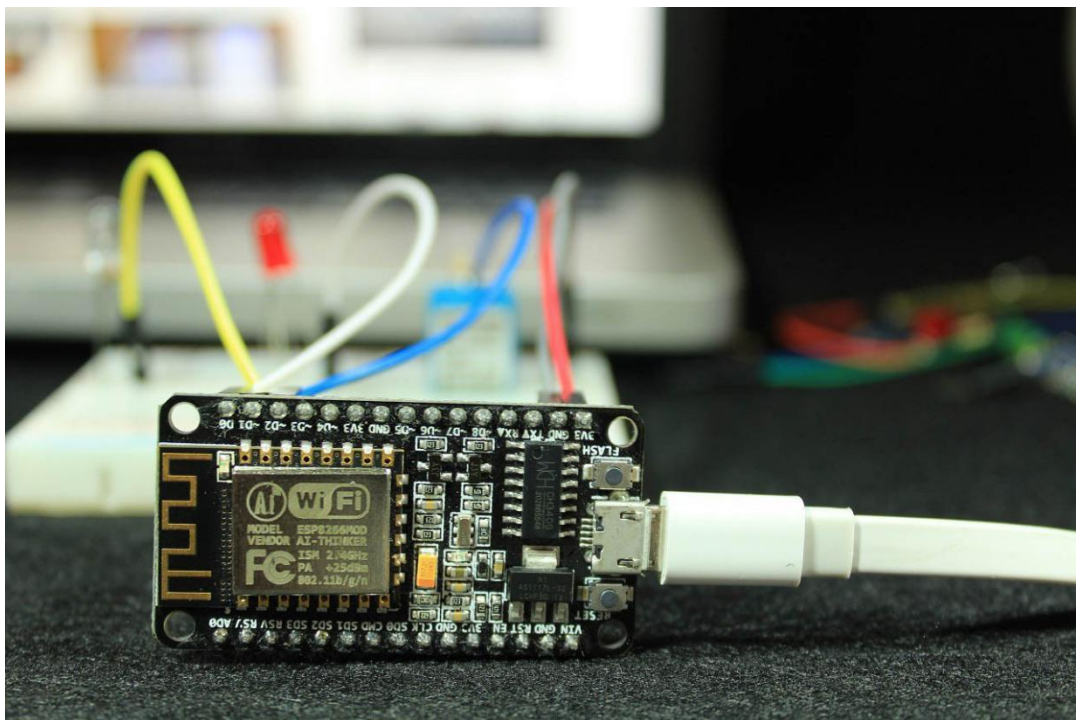
Figure-3.4: Node MCU

3.7.2 ESP8266 Arduino Core

As Arduino.cc started growing new MCU sheets dependent on non-AVR processors like the ARM/SAM MCU and utilized in the Arduino Due, they expected to adjust the Arduino IDE with the goal that it would be moderately simple to change the IDE to help exchange apparatus chains to permit Arduino C/C++ to be compiled for these new processors. They did this with the presentation of the Board Manager and the SAM Core. A "center" is the assortment of software parts required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source document for the objective MCU's machine language. Some ESP8266 fans built up an Arduino center for the ESP8266 WiFiSoC, prevalently called the "ESP8266 Core for the Arduino IDE".[16] This has become a main software advancement stage for the different ESP8266-based modules and improvement sheets, including NodeMCUs.

3.7.3 Introduction

   I.   Website: http://www.nodemcu.com/index_en.html
  II.   Forum: http://www.esp8266.com/viewforum.php?f=17
 III.   Firmware: https://github.com/nodemcu/nodemcu-firmware
 IV.   Hardware: https://github.com/nodemcu/nodemcu-devkit
  V.   Flasher: https://github.com/nodemcu/nodemcu-flasher

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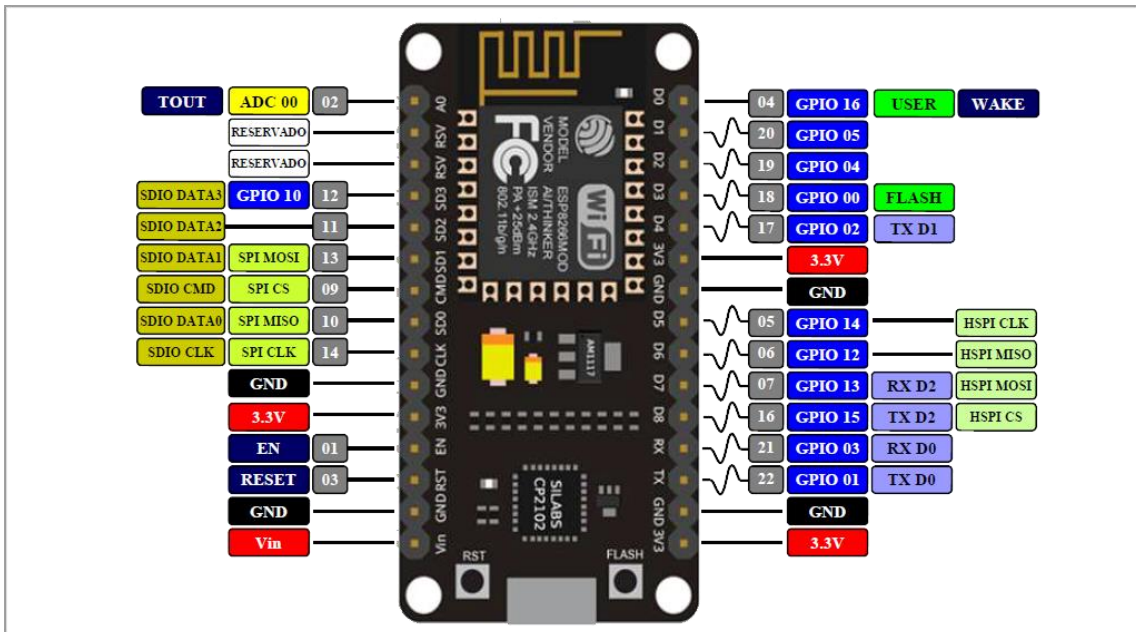
Figure-3.5: Pinout of Node MCU

3.7.4 Summary

- Easy to access wireless router
- Based on Lua 5.1.4 (without debug, os module.)
- Event-Drive programming preferred.
- Build-in json, file, timer, pwm, i2c, spi, 1-wire, net, mqtt, coap, gpio, wifi, adc, uart and system api.
- GPIO pin re-mapped, use the index to access gpio, i2c, pwm.
- Both Floating Point and Integer versions of the firmware can be built.

3.7.5 Features

Wi-Fi Module – ESP-12E module similar to ESP-12 module but with 6 extra GPIOs.

USB – micro USB port for power, programming and debugging

Headers – 2x 2.54mm 15-pin header with access to GPIOs, SPI, UART, ADC, and power pins

Misc – Reset and Flash buttons

Power – 5V via micro USB port

Dimensions – 49 x 24.5 x 13mm

3.7.6 Documentation

You can discover the firmware source code and documentation on Github, just as nodemcu-flasher, a Windows just apparatuses to streak the firmware to a module. There's likewise a different device called esptool that will let you streak nodemcu from Linux. On the off chance that you discover the documentation is everywhere, you may need to checkout NodeMCU video instructional exercise below.Nodemcu.com is the official site for the undertaking, yet you'll discover more data on Github.

3.7.8 Specification

- Wi-Fi Module – ESP-12E module similar to ESP-12 module but with 6 extra GPIOs.
- USB – micro USB port for power, programming and debugging
- Headers – 2x 2.54mm 15-pin header with access to GPIOs, SPI, UART, ADC, and power pins
- Misc – Reset and Flash buttons
- Power – 5V via micro USB port
- Dimensions – 49 x 24.5 x 13mm

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3.7.9 Software

A program for Node MCU equipment might be written in any programming language with compilers that produce binary machine code for the objective processor. Atmel gives an improvement situation to their 8-bit AVR and 32-bit ARM Cortex-M based micro-controllers: AVR Studio (older) and Atmel Studio (more up to date).

3.7.10 IDE

The NodeMCU integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It began from the IDE for the languages Processing and Wiring. It incorporates a code manager with highlights, for example, content reordering, looking and supplanting content, programmed indenting, support coordinating, and grammar featuring, and gives basic a single tick components to compile and transfer programs to an Arduino board. It additionally contains a message territory, a book support, a toolbar with catches for normal capacities and a progression of operation menus. The source code for the IDE is released under the GNU General Public License, version 2.
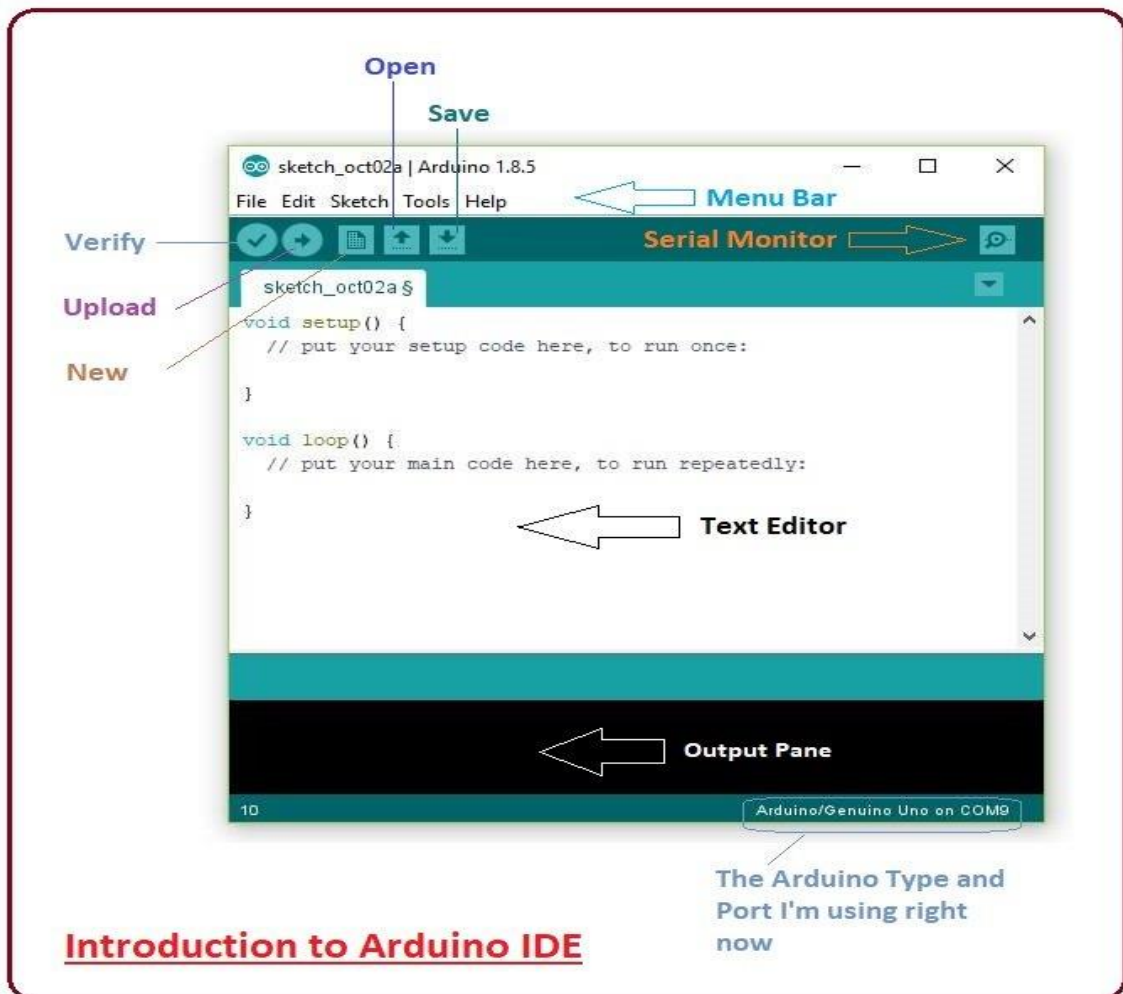

Figure-3.6: IDE software

20

The Arduino IDE underpins the languages C and C++ utilizing extraordinary guidelines of code organizing. The Arduino IDE supplies a software library from the Wiring venture, which gives numerous basic input and output methods. Client composed code just requires two fundamental capacities, for beginning the sketch and the primary program circle, that are arranged and connected with a program stub principle() into an executable cyclic official program with the GNU device chain, additionally included with the IDE appropriation. The Arduino IDE utilizes the program avrdude to change over the executable code into a book document in hexadecimal encoding that is stacked into the Arduino board by a loader program in the board's firmware.

3.7.11 Sketch

A sketch is a program written with the ArduinoIDE.Sketches are saved on the development computer as text files with the file extension .ino. Arduino Software (IDE) pre-1.0 saved sketches with the extension .pde.

A minimal Arduino C/C++ program consists of only two functions:

setup(): This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch. It is analogous to the function main().

loop(): After setup() function exits (ends), the loop() function is executed repeatedly in the main program. It controls the board until the board is powered off or is reset. It is analogous to the function while(1).

3.7.12 Blink example

Most Arduino sheets contain a light-producing diode (LED) and a present constraining resistor associated between pin 13 and ground, which is an advantageous element for some tests and program functions. A commonplace program utilized by amateurs, much the same as Hello, World!, is "flicker", which over and again squints the on-board LED incorporated into the Arduino board. This program utilizes the functions pin Mode(), advanced Write(), and deferral(), which are given by the inward libraries remembered for the IDE condition. This program is generally stacked into another Arduino board by the producer.

Start play:

```
ip = wifi.sta.getip()

print(ip)

-- nil

wifi.setmode(wifi.STATION)

wifi.sta.config("SSID","password")
```

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```
ip = wifi.sta.getip()

print(ip)

-- 192.168.18.110

pin = 1

gpio.mode(pin,gpio.OUTPUT)

gpio.write(pin,gpio.HIGH)

print(gpio.read(pin))

-- A simple http client

conn=net.createConnection(net.TCP, 0)

conn:on("receive", function(conn, payload) print(payload) end )

conn:connect(80,"115.239.210.27")

conn:send("GET / HTTP/1.1\r\nHost: www.baidu.com\r\n"

   .."Connection: keep-alive\r\nAccept: */*\r\n\r\n")

-- A simple http server

srv=net.createServer(net.TCP)

srv:listen(80,function(conn)

conn:on("receive",function(conn,payload)

print(payload)

conn:send("<h1> Hello, NodeMcu.</h1>")

end)

conn:on("sent",function(conn) conn:close() end)

end).
```

3.8 Power Supply

A power supply is an electrical device that supplies electric power to an electrical load. The essential function of a power supply is to change over electric flow from a source to the right voltage, flow, and frequency to power the load. Accordingly, power supplies are once in a while alluded to as electric power converters. Some power supplies are independent bits of gear, while others are incorporated with the load apparatuses that they power. Instances of the last incorporate power supplies found in work stations and buyer gadgets devices. Different functions that power supplies may perform incorporate restricting the flow attracted by the load to safe levels, stopping the flow in case of an electrical fault, power molding to forestall electronic commotion or voltage floods on the input from arriving at the load, power-factor remedy, and putting away vitality so it can keep on powering the load in case of a transitory break in the source power (uninterruptible power supply).

All power supplies have a power input association, which gets energy as electric flow from a source, and at least one power output associations that convey flow to the load. The source power may originate from the electric power lattice, for example, an electrical outlet, energy stockpiling devices, for example, batteries or power devices, generators or alternators, sun based power converters, or another power supply. The input and output are generally designed circuit associations, however some power supplies utilize remote energy move to power their loads without wired associations. Some power supplies have different kinds of inputs and outputs also, for functions, for example, outer observing and control.

3.8.1 DC power supply

A DC power supply is one that supplies a constant DC voltage to its load. Contingent upon its structure, a DC power supply might be powered from a DC source or from an AC source, for example, the power mains.

3.8.2 AC-to-DC supply

Schematic of essential AC-to-DC power supply, appearing (from L-R) transformer, full-wave connect rectifier, channel capacitor and resistor load DC power supplies use AC mains power as an energy source. Such power supplies will utilize a transformer to convert the input voltage to a sequential AC voltage. A rectifier is utilized to convert the transformer output voltage to a shifting DC voltage, which thusly is gone through an electronic channel to convert it to an unregulated DC voltage.

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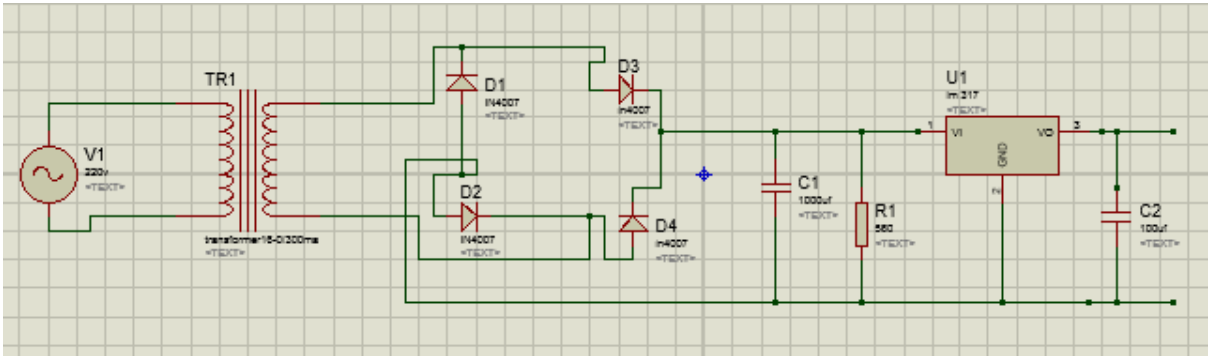
Figure: 3.7 AC to DC Converter

The filter expels most, yet not the entirety of the AC voltage varieties; the rest of the AC voltage is known as ripple. The electric load's resilience of ripple directs the base measure of filtering that must be given by a power supply. In certain applications, high ripple is endured and in this manner no filtering is required. For instance, in some battery charging applications it is conceivable to execute a mains-powered DC power supply with just a transformer and a solitary rectifier diode, with a resistor in arrangement with the output to confine charging current.

3.9Transformer

we've observed simulations of transformers where the primary and secondary windings were of identical inductance, giving approximately equal voltage and current levels in both circuits. Equality of voltage and current between the primary and secondary sides of a transformer, however, is not the norm for all transformers. If the inductances of the two windings are not equal.

Notice how the secondary voltage is approximately ten times less than the primary voltage (0.9962 volts compared to 10 volts), while the secondary current is approximately ten times greater (0.9962 mA compared to 0.09975 mA). What we have here is a device that steps voltage down by a factor of ten and current up by a factor of ten: (Figure below)

Figure-3.8 Transformer

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© Daffodil International University

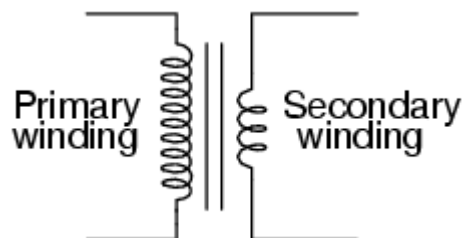This is an exceptionally valuable device, without a doubt. With it, we can without much of a stretch increase or separation voltage and current in AC circuits. Without a doubt, the transformer has made long-separation transmission of electric power a pragmatic reality, as AC voltage can be "ventured up" and flow "ventured down" for decreased wire resistance power misfortunes along power lines associating producing stations with loads. At either end (both the generator and at the loads), voltage levels are diminished by transformers for more secure operation and more affordable hardware. A transformer that builds voltage from essential to auxiliary (more optional winding turns than essential winding turns) is known as a stage up transformer. Then again, a transformer intended to do the polar opposite is known as a stage down transformer.

Transformer cross-segment indicating essential and optional winding is a couple of inches tall (roughly 10 cm). This is a stage down transformer, as confirm by the high turn check of the essential winding and the low turn tally of the optional. As a stage down unit, this transformer converts high-voltage, low-current power into low-voltage, high-current power. The bigger measure wire utilized in the optional winding is fundamental because of the expansion in current. The essential winding, which doesn't need to direct as a lot of current, might be made of littler check wire.

On the off chance that you were pondering, it is conceivable to work both of these transformer types in reverse (powering the optional winding with an AC source and letting the essential winding power a load) to play out the contrary function: a stage up can function as a stage down and visa-versa. Nonetheless, as we found in the main segment of this section, proficient operation of a transformer necessitates that the individual winding inductance be built for explicit working scopes of voltage and current, so if a transformer is to be utilized "in reverse" like this it must be utilized inside the first plan parameters of voltage and current for each winding, in case it end up being wasteful (or in case it be harmed by unreasonable voltage or current!).

Transformers are often constructed so that it isn't evident which wires lead to the essential winding and which lead to the optional. One show utilized in the electric power industry to help mitigate perplexity is the utilization of "H" assignments for the higher-voltage winding (the essential winding in a stage down unit; the optional winding in a stage up) and "X" assignments for the lower-voltage winding. Along these lines, a basic power transformer will have wires named "H1", "H2", "X1", and "X2". There is generally huge to the numbering of the wires (H1 versus H2, and so on.), which we'll investigate somewhat later in this part.

The way that voltage and current get "ventured" in inverse headings (one up, the other down) bodes well when you review that power is equivalent to voltage times current, and understand that transformers can't deliver power, just convert it. Any device that could output more power than it took in would abuse the Law of Energy Conservation in material science, to be specific that energy can't be made or wrecked, just converted. Likewise with the main transformer model we saw, power move proficiency is generally excellent from the essential to the auxiliary sides of the device.

3.10 Rectifier

In the past Power Diodes instructional exercise we talked about methods for decreasing the ripple or voltage minor departure from an immediate DC voltage by connecting smoothing capacitors over the load resistance.

While this strategy might be reasonable for low power applications it is unacceptable to applications which need a "relentless and smooth" DC supply voltage. One technique to enhance this is to utilize each half-cycle of the input voltage rather than each other half-cycle. The circuit which permits us to do this is known as a Full Wave Rectifier.

Like the half wave circuit, a full wave rectifier circuit delivers an output voltage or current which is absolutely DC or has some predetermined DC part. Full wave rectifiers have some essential focal points over their half wave rectifier counterparts. The normal (DC) output voltage is higher than for half wave, the output of the full wave rectifier has substantially less ripple than that of the half wave rectifier delivering a smoother output waveform.

In a Full Wave Rectifier circuit two diodes are now used, one for each half of the cycle. A multiple winding transformer is used whose secondary winding is split equally into two halves with a common centre tapped connection, ©. This configuration results in each diode conducting in turn when its anode terminal is positive with respect to the transformer centre point C producing an output during both half-cycles, twice that for the half wave rectifier so it is 100% efficient as shown below.
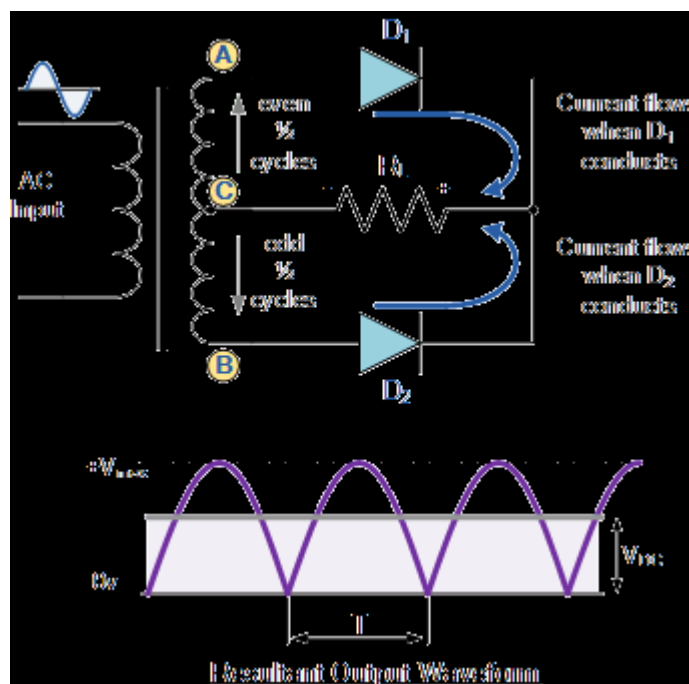

Figure:3.9 Rectifier

The full wave rectifier circuit comprises of two power diodes associated with a solitary load resistance (RL) with every diode taking it thus to supply current to the load. At the point when point An of the transformer is sure regarding point C, diode D1 leads the forward way as showed by the arrows.

At the point when point B is positive (in the negative portion of the cycle) regarding point C, diode D2 leads the forward way and the present coursing through resistor R is a similar way for both half-cycles. As the output voltage over the resistor R is the phasor whole of the two waveform joined, this kind of full wave rectifier circuit is otherwise called a "bi-stage" circuit.

We can see this affect quite clearly if we run the circuit in the Partsim Simulator Circuit with the smoothing capacitor removed.

3.11 Capacitor

A capacitor is a latent two-terminal electrical part that stores potential energy in an electric field. The impact of a capacitor is known as capacitance. While some capacitance exists between any two electrical conduits in nearness in a circuit, a capacitor is a segment intended to add capacitance to a circuit. The capacitor was initially known as a condenser or condensator.[1] The first name is still generally The physical structure and development of viable capacitors fluctuate broadly and numerous capacitor types are in like manner use. Most capacitors contain at any rate two electrical channels often as metallic plates or surfaces isolated by a dielectric medium. A conduit might be a foil, slim film, sintered dab of metal, or an electrolyte. The no leading dielectric acts to build the capacitor's charge limit. Materials usually utilized as dielectrics incorporate glass, fired, plastic film, paper, mica, and oxide layers. Capacitors are broadly utilized as parts of electrical circuits in numerous basic electrical devices. In contrast to a resistor, a perfect capacitor doesn't disseminate energy.

At the point when two conductors experience a potential distinction, for instance, when a capacitor is joined over a battery, an electric field creates over the dielectric, making a net positive charge gather on one plate and net negative charge to gather on the other plate. No flow really courses through the dielectric, in any case, there is a progression of charge through the source circuit. On the off chance that the condition is kept up adequately long, the current through the source circuit stops. Be that as it may, if a period differing voltage is applied over the leads of the capacitor, the source encounters a progressing current because of the charging and releasing cycles of the capacitor. Capacitance is characterized as the proportion of the electric charge on every conduit to the potential distinction between them. The unit of capacitance in the International System of Units (SI) is the farad (F), characterized as one coulomb for each volt (1 C/V). Capacitance estimations of ordinary capacitors for use when all is said in done gadgets extend from around 1 picofarad (pF) ($10-12$ F) to around 1 millifarad (mF) ($10-3$ F).The capacitance of a capacitor is corresponding to the surface territory of the plates (conductors) and contrarily identified with the hole between them. Practically speaking, the dielectric between the plates passes a modest quantity of spillage flow. It has an electric field quality farthest point, known as the breakdown voltage. The conductors and leads present an undesired inductance and resistance.

3.12 LM2596 Voltage Converter

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.
Requiring a base number of external components, these regulators are easy to utilize and incorporate inside frequency pay, and a fixed frequency oscillator. The LM2596 arrangement works at an exchanging frequency of 150 kHz, in this manner permitting littler measured filter parts than what might be required with lower frequency exchanging regulators. Accessible in a standard 7-pin TO-220 bundle with a few diverse lead twist choices, and a 7-pin TO-263 surface mount bundle.
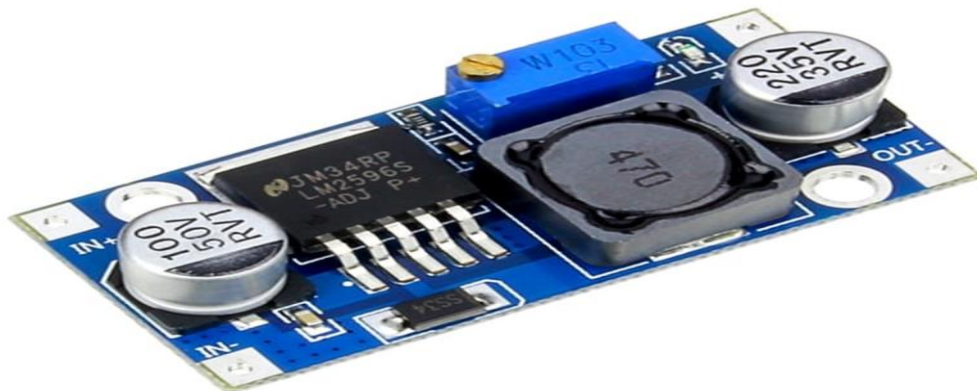
Figure: 3.10 LM2596 Voltage Converter

3.13 Lm7805

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

3.13.1 7805 IC Rating

Input voltage range 7V- 35V

Current rating Ic = 1A

Output voltage range   VMax=5.2V ,VMin=4.8V

Figure 3.11 LM7805

As you may have seen, there is a noteworthy distinction between the input voltage and the output voltage of the voltage controller. This contrast between the input and output voltage is discharged as warmth. The more noteworthy the distinction between the input and output voltage, more the warmth produced. In the event that the controller doesn't have a warmth sink to scatter this warmth, it can get decimated and malfunction. Henceforth, it is fitting to restrict the voltage to a li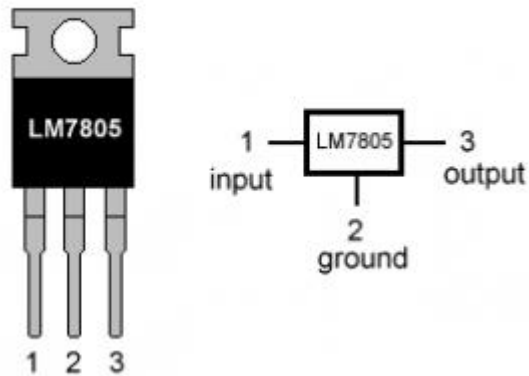mit of 2-3 volts over the output voltage. Along these lines, we presently have 2 choices. Either structure your circuit with the goal that the input voltage going into the controller is constrained to 2-3 volts over the output managed voltage or spot a proper warmth sink that can proficiently scatter heat.

3.13.2 What to do with all the heat?

7805 is not very efficient and has drop-out voltage problems. A lot of energy is wasted in the form of heat. If you are going to be using a heatsink, better calculate the heatsink size properly. The below formula should help in determining appropriate heatsink size for such applications.

Heat generated = (input voltage – 5) x output current

If we have a system with input 15 volts and output current required is .5 amperes, we have:

(15 – 5) x 0.5 = 10×0.5 =5W;

5W energy is being wasted as heat, hence an appropriate heatsink is required to disperse this heat. On the other hand, energy actually being used is:

(5 x 0.5Amp) = 2.5W.

So twice the energy, that is actually utilized is wasted. On the other hand, if 9V is given as input at the same amount of load:

(9-5) x 0.5 = 2W

2W energy will be wasted as heat.

What we learn: Higher the input voltage, less efficient your 7805 will be.

An estimated efficient input voltage would be at about 7.5V.

3.13.3 Other circuit components?

If your voltage regulator is situated more than 25cm (10 inches) from the power supply, capacitors are needed to filter residual AC noise. Voltage regulators work efficiently on clean DC signal being fed. The bypass capacitors help reduce AC ripple. Essentially, they short AC noise from the voltage signal and allow only DC voltage into the regulator. The two capacitors are not necessarily required and can be omitted if you are not concerned about line noise.

However, for a mobile phone charger or logic assessment, you require a nice clean DC line. Capacitors will be beneficial in this case as they are good at maximizing voltage regulation. The values of capacitors can also be changed slightly.

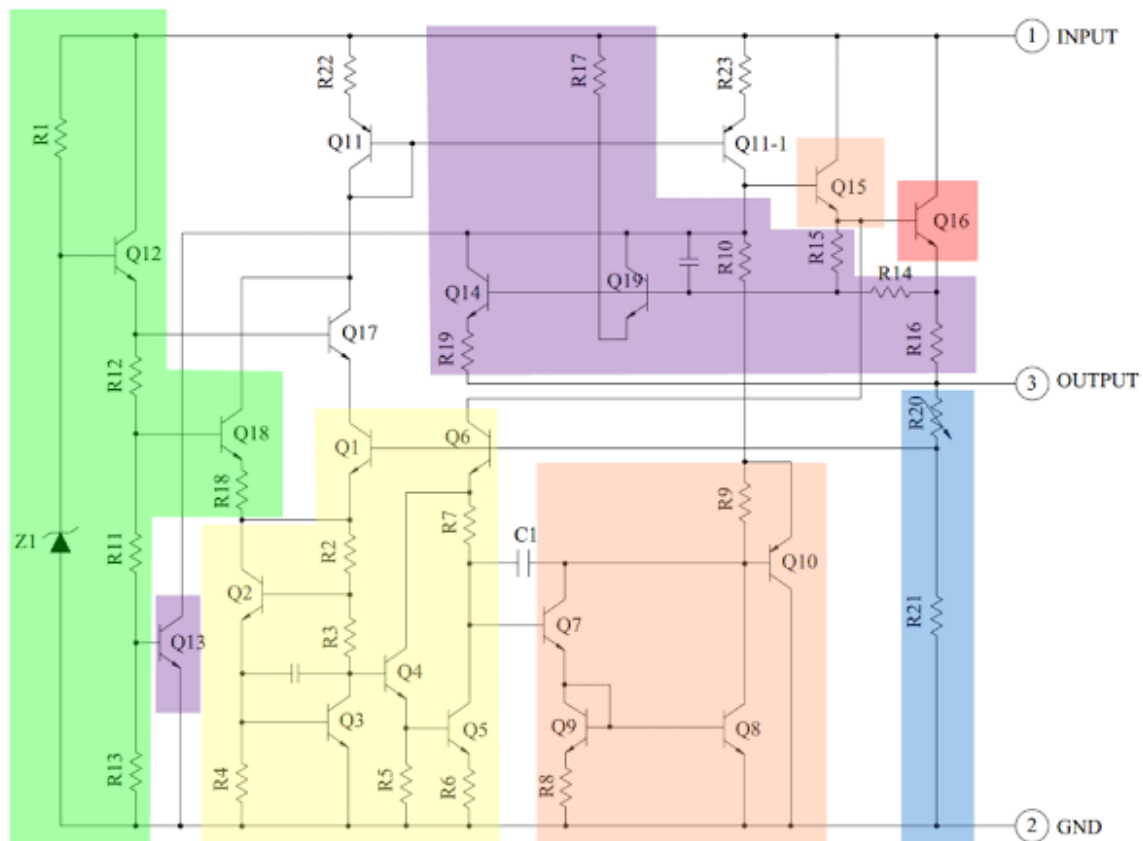Let's take a look at what makes the IC tick.

Fig: 3.12Schematic of 7805 IC

3.13.4 Schematic of 7805 IC

The heart of the 7805 IC is a transistor (Q16) that controls the current between the input and output and thus controlling the output voltage. The bandgap reference (yellow) keeps the voltage stable. It takes the scaled output voltage as input (Q1 and Q6) and provides an error signal (to Q7) for indication if the voltage is too high or low. The key task of the bandgap is to provide a stable and accurate reference, even as the chip's temperature changes.

The error signal from the bandgap reference is amplified by the error amplifier (orange). This amplified signal controls the output transistor through Q15. This closes the negative feedback loop controlling the output voltage. The startup circuit (green) provides initial current to the bandgap circuit, so it doesn't get stuck in an "off" state. The circuit in purple provides protection against overheating (Q13), excessive input voltage (Q19) and excessive output current (Q14). These circuits reduce the output current or shutdown the regulator, protecting it from damage in case of a fault. The voltage divider (blue) scales down the voltage on the output pin for use by the bandgap reference.

3.13.5 Scaling the output

The 7805's scaled output provides the input voltage (Vin) to the bandgap reference and the bandgap provides an error signal as the output. The 7805's bandgap circuit removes the feedback loop that exists inside a traditional bandgap reference. Instead, the entire chip becomes the feedback loop.

If the output voltage is correct (5V), then the voltage divider provides 3.75V at Vin. Any change in output voltage propagates through Q6 and R7, causing the voltage at the base of Q7 to rise or fall accordingly. This change is amplified by Q7 and Q8, generating the error output. The error output, in turn, decreases or increases the current through the output transistor. The negative feedback loop adjusts the output voltage until it is correct.

3.13.6 Application areas for 7805 IC

7805 IC is used in a wide range of circuits. The major ones being:

- Fixed-Output Regulator
- Positive Regulator in Negative Configuration
- Adjustable Output Regulator
- Current Regulator
- Adjustable DC Voltage Regulator
- Regulated Dual-Supply
- Output Polarity-Reversal-Protection Circuit
- Reverse bias projection Circuit

7805 IC also finds usage in building circuits for inductance meter, phone charger, portable CD player, infrared remote control extension and UPS power supply circuits.

3.14 Resistor:

The resistor is a passive electrical component to create resistance in the flow of electric current. In almost all electrical networks and electronic circuits they can be found. The resistance is measured in ohms. An ohm is the resistance that occurs when a current of one ampere passes through a resistor with a one volt drop across its terminals. The current is proportional to the voltage across the terminal ends. This ratio is represented by

Ohm's law:

formula with ohm's law: R=V/I

Resistors are used for many purposes. A few examples include delimit electric current, voltage division, heat generation, matching and loading circuits, control gain, and fix time constants. They are commercially available with resistance values over a range of more than nine orders of magnitude. They can be used to as electric brakes to dissipate kinetic energy from trains, or be smaller than a square millimeter for electronics.

Resistor definition and symbol

A resistor is a passive electrical component with the primary function to limit the flow of electric current.

The international IEC symbol is a rectangular shape. In the USA the ANSI standard is very common, this is a zigzag line (shown on the right).

Resistor symbol

Figure:3.13 Resistor Symbol

Overview of types and materials

Resistors can be divided in construction type as well as resistance material. The following breakdown for the type can be made:

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Fixed resistors

Variable resistors, such as the:

Potentiometer

Rheostat

Trimpot

Resistance dependent on a physical quantity:

Thermistors (NTC and PTC) as a result of temperature change

Photo resistor (LDR) as a result of a changing light level

Varistor (VDR) as a result of a changing voltage

Magneto resistor (MDR) as a result of a changing magnetic field

Strain Gauges as a result of mechanical load

For each of these types a standard symbol exists. Another breakdown based on the material and manufacturing process can be made:

Carbon composition

Carbon film

Metal film

Metal oxide film

Wirewound

Foil

The choice of material technology is a specific to the purpose. Often it is a trade-off between costs, precision and other requirements. For example, carbon composition is a very old technique with a low precision, but is still used for specific applications where high energy pulses occur. Carbon composition resistors have a body of a mixture of fine carbon particles and a non-conductive ceramic. The carbon film technique has a better tolerance. These are made of a non-conductive rod with a thin carbon film layer around it. This layer is treated with a spiral cut to increase and control the resistance value. Metal and metal oxide film are widely used nowadays, and have better properties for stability and tolerance. Furthermore, they are less influenced by temperature variations. They are just as carbon film resistors constructed with a resistive film around a cylindrical body. Metal oxide film is generally more durable. Wirewound resistors are probably the oldest type and can be used for both high precision as well as high power applications. They are constructed by winding a special metal alloy wire, such as nickel chrome, around a non-conductive core. They are durable, accurate and can have very low resistance value. A disadvantage is that they suffer from parasitic reactance at high frequencies. For the highest requirements on precision and stability, metal foil resistors are used. They are constructed by cementing a special alloy cold rolled film onto a ceramic substrate.

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Resistor characteristics

Subject to the application, the electrical architect determines various properties of the resistor. The main role is to constrain the progression of electrical flow; in this way the key parameter is the resistance esteem. The assembling exactness of this worth is shown with the resistor resilience in rate. Numerous different parameters that influence the resistance worth can be determined, for example, long haul solidness or the temperature coefficient. The temperature coefficient, typically indicated in high exactness applications, is dictated by the resistive material just as the mechanical plan.

In high frequency circuits, for example, in radio gadgets, the capacitance and inductance can prompt undesired impacts. Foil resistors by and large have a low parasitic reactance, while wire wound resistors are among the most exceedingly awful. For exact applications, for example, sound speakers, the electric commotion must be as low as could be expected under the circumstances. This is often indicated as microvolts clamor per volt of applied voltage, for a 1 MHz transfer speed. For high power applications the power rating is significant. This indicates the most extreme working power the part can deal with without changing the properties or harm. The power rating is generally determined in free air at room temperature. Higher power appraisals require a bigger size and may even require heat sinks. Numerous different characteristics can assume a job in the design particular. Models are the greatest voltage, or the pulse solidness. In circumstances where high voltage floods could happen this is a significant characteristic.

Some of the time the electrical properties are significant, yet the designer additionally needs to think about the mechanical vigor in unforgiving conditions. Military benchmarks at times offer direction to characterize the mechanical quality or the disappointment rate.

In the segment characteristics a full diagram is given of the fundamental properties to indicate a resistor.

Resistor standards

Many standards exist for resistors. The standards describe ways to measure and quantify important properties. Other norms exist for the physical size and resistance values. Probably, the most well known standard is the color code marking for axial leaded resistors.

Resistor color code

The resistance value and tolerance are indicated with several colored bands around the component body. This marking technique of electronic components was already developed in the 1920's. Printing technology was still not far developed, what made printed numerical codes too difficult on small components. Nowadays, the color code is still used for most axial resistors up to one watt. In the figure an example is shown with four color bands. In this example the two first bands determine the significant digits of the resistance value, the third band is the multiplying factor and the fourth band gives the tolerance. Each color represents a different number and can be looked up in a resistor color code chart.

Resistor Color Code Guide

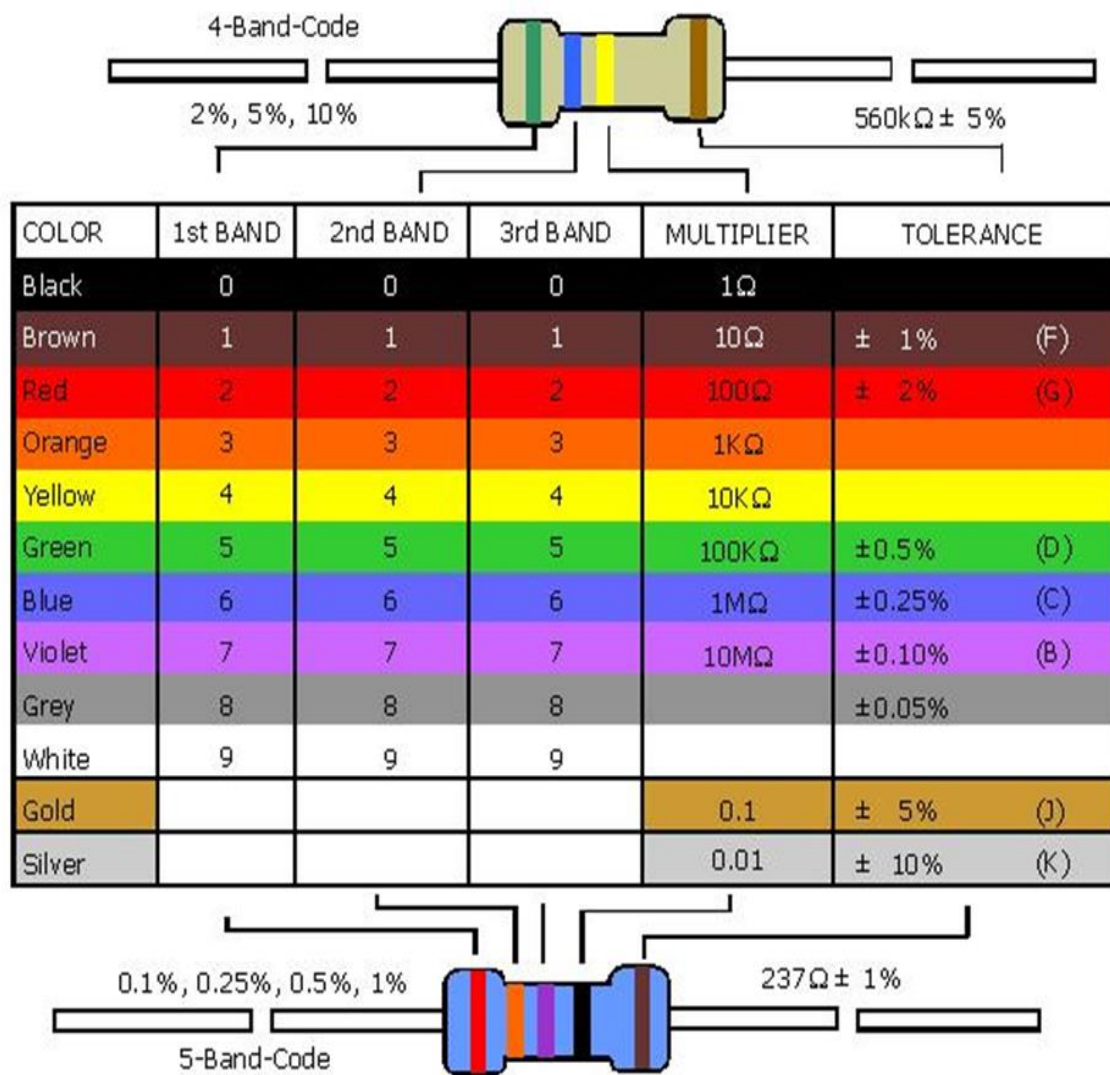| COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

Figure 3.14Resistor cooler code

Resistor applications

There is a huge variation in fields of applications for resistors; from precision components in digital electronics, till measurement devices for physical quantities. In this chapter several popular applications are listed.

Resistors in series and parallel

In electronic circuits, resistors are very often connected in series or in parallel. A circuit designer might for example combine several resistors with standard values (E-series) to reach a specific resistance value. For series connection, the current through each resistor is the same and the equivalent resistance is equal to the sum of the individual resistors. For parallel connection, the voltage through each resistor is the same, and the inverse of the equivalent resistance is equal to the sum of the inverse values for all parallel resistors. In the articles resistors in parallel and series a detailed description of calculation examples is given. To solve even more complex networks, Kirchhoff's circuit laws may be used.

Measure electrical current (shunt resistor)

Electrical current can be calculated by measuring the voltage drop over a precision resistor with a known resistance, which is connected in series with the circuit. The current is calculated by using Ohm's law. This is a called an ammeter or shunt resistor. Usually this is a high precision manganin resistor with a low resistance value.

Resistors for LEDs

LED lights need a specific current to operate. A too low current will not light up the LED, while a too high current might burn out the device. Therefore, they are often connected in series with resistors. These are called ballast resistors and passively regulate the current in the circuit.

Blower motor resistor

In cars the air ventilation system is actuated by a fan that is driven by the blower motor. A special resistor is used to control the fan speed. This is called the blower motor resistor. Different designs are in use. One design is a series of different size wirewound resistors for each fan speed. Another design

3.15 Diode

Diode, an electrical component that allows the flow of current in only one direction. In circuit diagrams, a diode is represented by a triangle with a line across one vertex.

The most common type of diode uses a p-n junction. In this type of diode, one material (n) in which electrons are charge carriers abuts a second material (p) in which holes (places depleted of electrons that act as positively charged particles) act as charge carriers. At their interface, a depletion region is formed across which electrons diffuse to fill holes in the p-side. This stops the further flow of electrons. When this junction is forward biased (that is, a positive voltage is applied to the p-side), electrons can easily move across the junction to fill the holes, and a current flows through the diode. When the junction is reverse biased (that is, a negative voltage is applied to the p-side), the depletion region widens and electrons cannot easily move across. The current remains very small until a certain voltage (the breakdown voltage) is reached and the current suddenly increases.

Light-emitting diodes (LEDs) are p-n junctions that emit light when a current flows through them. Several p-n junction diodes can be connected in series to make a rectifier (an electrical component that converts alternating current to direct current). Zener diodes have a well-defined breakdown voltage, so that current flows in the reverse direction at that voltage and a constant voltage can be maintained despite fluctuations in voltage or current. In varactor (or varicap) diodes, varying the bias voltage causes a variation in the diode's capacitance; these diodes have many applications for signal transmission and are used throughout the radio and television industries. (For more detail about these and other types of diodes, see semiconductor device.)

Early diodes were vacuum tubes, an evacuated glass or metal electron tube containing two electrodes—a negatively charged cathode and a positively charged anode. These were used as rectifiers and as detectors in electronic circuits such as radio and television receivers. When a positive voltage is applied to the anode (or plate), electrons emitted from the heated cathode flow to the plate and return to the cathode through an external power supply. If a negative voltage is applied to the plate, electrons cannot escape from the cathode, and no plate current flows. Thus, a diode permits electrons to flow from cathode to plate but not from plate to cathode. If an alternating voltage is applied to the plate, current flows only during the time when the plate is positive. The alternating voltage is said to be rectified, or converted to direct current.

Diode symbol:

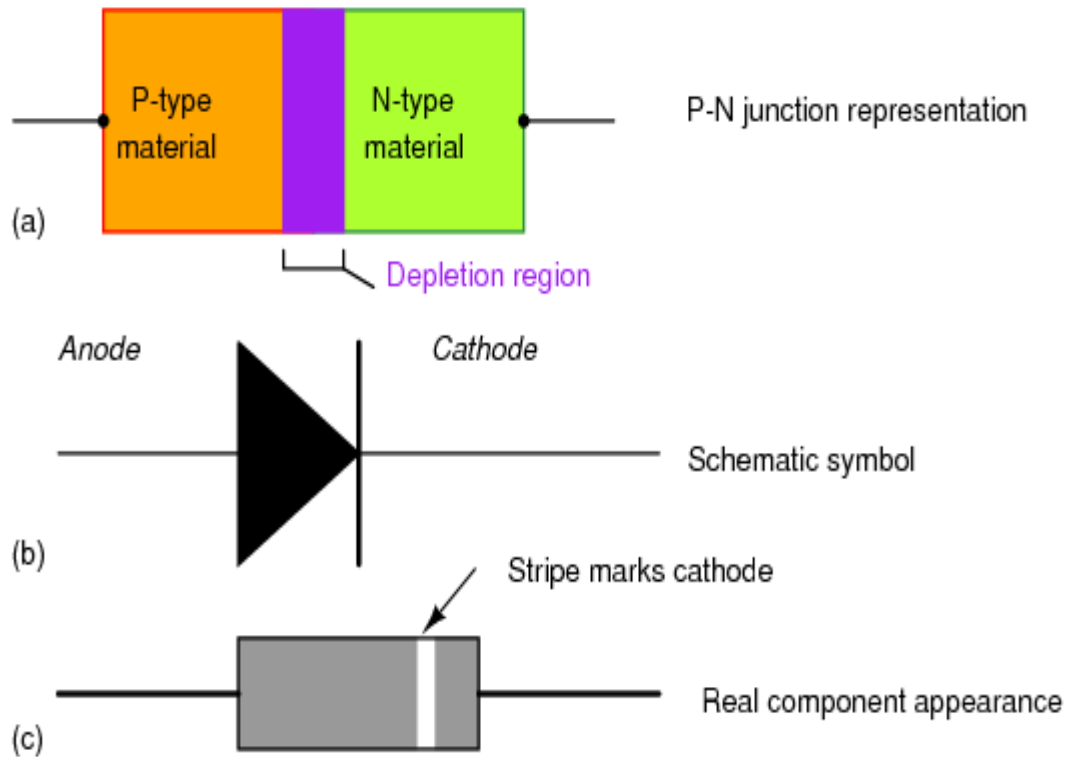The schematic symbol for a diode looks like this:

Figure 3.15Diode Symbol

The black arrow ▶ in the symbol points in the direction of the diode's forward current, \blueD ii, the direction where current flow happens. The diode's voltage, \goldDvv, is oriented with the ++ sign on the end where forward current comes into the diode. We use the sign convention for passive components. The optional curved orange arrow also indicates the voltage polarity.

3.16 LCD

LCD1602, or 1602 character-type liquid crystal display, is a kind of dot matrix module to show letters, numbers, and characters and so on. It's composed of 5x7 or 5x11 dot matrix positions; each position can display one character. There's a dot pitch between two characters and a space between lines, thus separating characters and lines. The model 1602 means it displays 2 lines of 16 characters.

Generally, LCD1602 has parallel ports, that is, it would control several pins at the same time. LCD1602 can be categorized into eight-port and four-port connections. If the eight-port connection is used, then all the digital ports of the SunFounder Uno board are almost completely occupied. If you want to connect more sensors, there will be no ports available. Therefore, the four-port connection is used here for better application.

Pin	Function
VSS	connected to ground
VDD	connected to a +5V power supply
VO	to adjust the contrast
RS	A register select pin that controls where in the LCD's memory you are writing data to. You can select either the data register, which holds what goes on the screen, or an instruction register, which is where the LCD's controller looks for instructions on what to do next.
R/W	A Read/Write pin to select between reading and writing mode
E	An enabling pin that reads the information when High level (1) is received. The instructions are run when the signal changes from High level to Low level.
D0-D7	to read and write data
A	Pins that control the LCD backlight. Connect A to 3.3v.
K	Pins that control the LCD backlight. Connect K to GND.

Table1 Display outline

Plug the pin headers onto a breadboard,
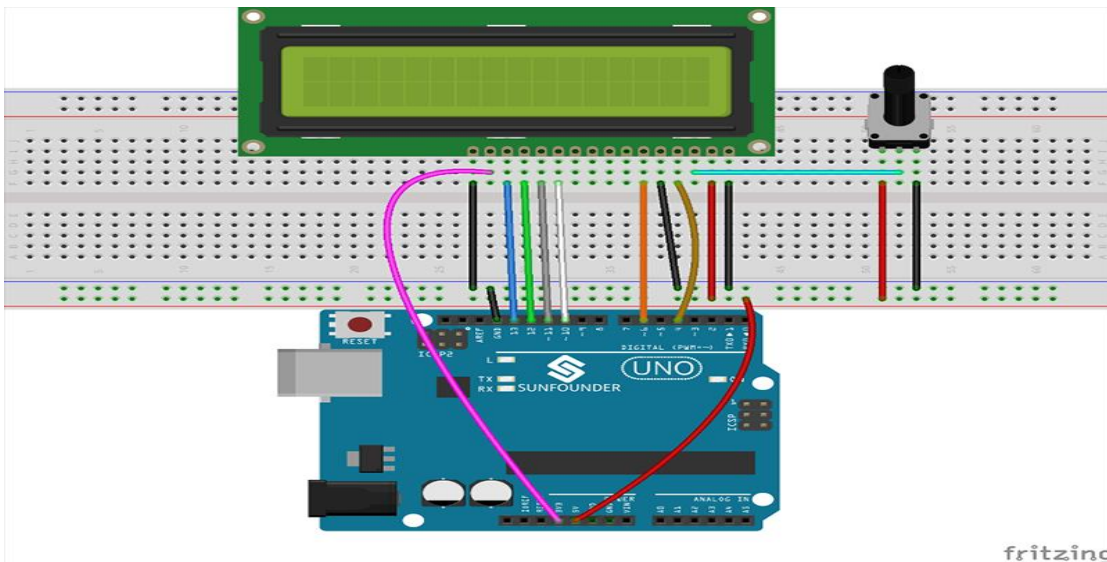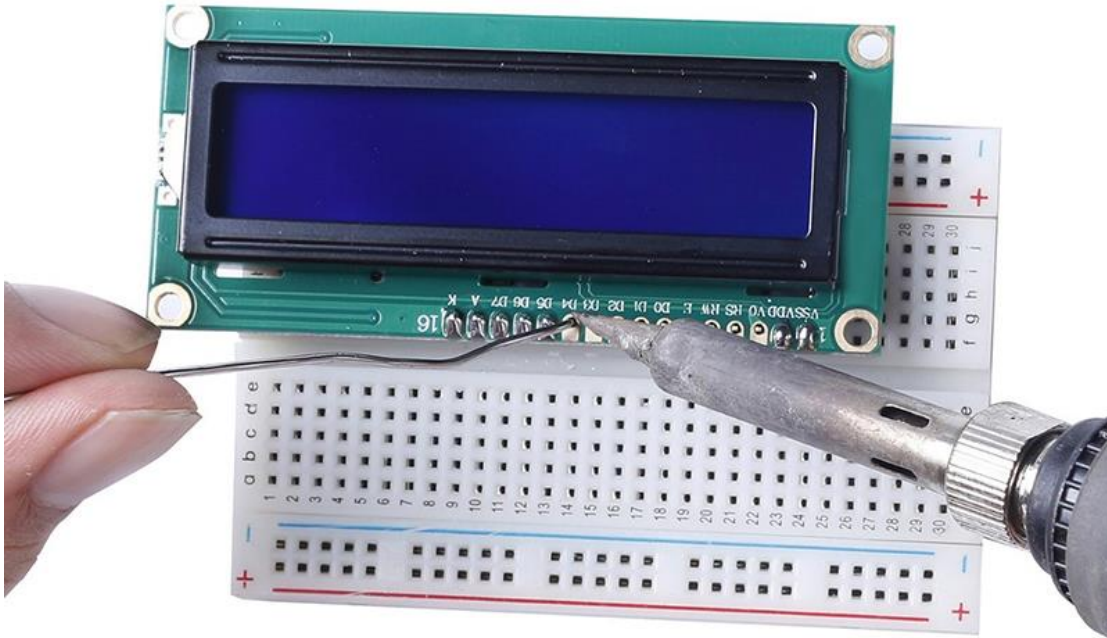and then put the LCD1602 on to it for easy soldering

Fig 3.16 LCD Display

3.17Current Sensor

The current transformer is an instrument transformer used to step-down the current in the circuit to measurable values and is thus used for measuring alternating currents. When the current in a circuit is too high to apply directly to a measuring instrument, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can in turn be conveniently connected to measuring and recording instruments. A current Transformer isolates the measuring instrument from what may be a very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays. Like any other transformer, a current transformer has a single turn wire of a very large cross-section as its primary winding and the secondary winding has a large number of turns, thereby reducing the current in the secondary to a fraction of that in the primary. Thus, it has a primary winding, a magnetic core and a secondary winding. The alternating current in the primary produces an alternating magnetic field in the magnetic core, which then induces an alternating current in the secondary winding circuit. An essential objective of a current transformer design is to ensure the primary and secondary circuits are efficiently coupled, so the secondary current is linearly proportional to the primary current.

Figure 3.19: Current Transformer

3.18 Connecting ware

An electrical connector is a device for joining electrical circuits together using a mechanical assembly. The connection may be temporary or serve as a permanent electrical joint between two wires.

There are hundreds of types of electrical connectors. Connectors may join two lengths of wire together or connect a wire to an electrical terminal.

Fig: 3.18 connecting wire

CHAPPTER 4

SOFTWARE

4.1 Introduction

Software part is one of the main part of the MCU based Single phase induction motor driving, controlling & protection system. The Algorithm is based on different conditions & measuring parameters. Total function of the system is controlled by the software. The code is written on C.

4.2 Software Tools

4.2.1 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.
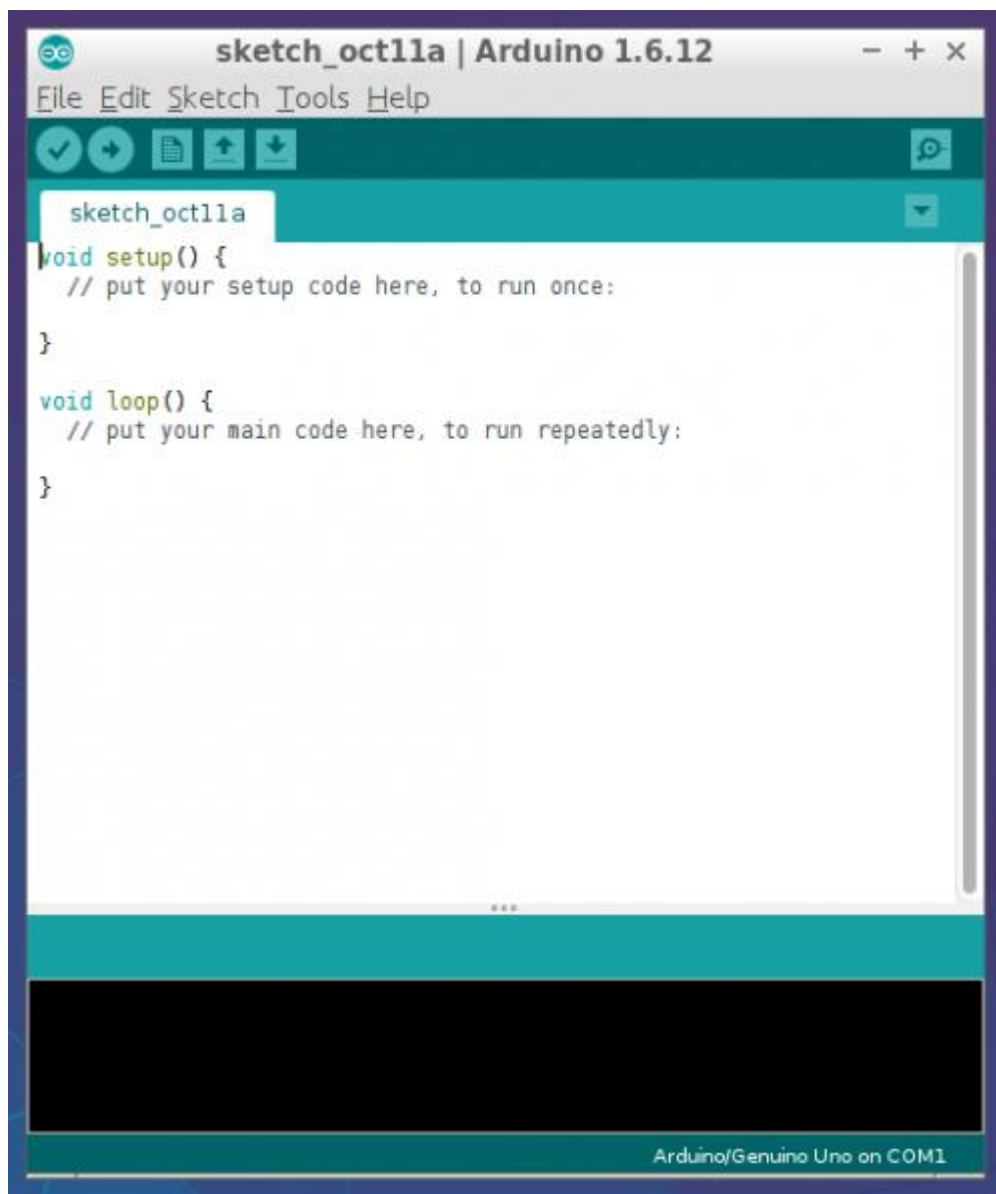

Figure:4.1 Software picture

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The source code for the IDE is discharged under the GNU General Public License, adaptation 2. The Arduino IDE underpins the languages C and C++ utilizing uncommon guidelines of code organizing. The Arduino IDE supplies a software library from the Wiring venture, which gives numerous regular input and output techniques. Client composed code just requires two essential functions, for beginning the sketch and the principle program circle, that are compiled and connected with a program stub primary() into an executable cyclic official program with the GNU apparatus chain, likewise included with the IDE dissemination. The Arduino IDE utilizes the program avrdude to convert the executable code into a book record in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

In October 2019 the Arduino association started giving early access to another Arduino Pro IDE with investigating and other propelled highlights.

4.2.2 Proteus8.1

Proteus 8 is best simulation software for various designs with microcontroller. It is mainly popular because of availability of almost all microcontrollers in it. So it is a handy tool to test programs and embedded designs for electronics hobbyist. You can simulate your programming of microcontroller in Proteus 8 Simulation Software.After simulating your circuit in Proteus 8 Software you can directly make PCB design with it so it could be a all in one package for students and hobbyists. So I think now you have a little bit idea about what is proteus software.
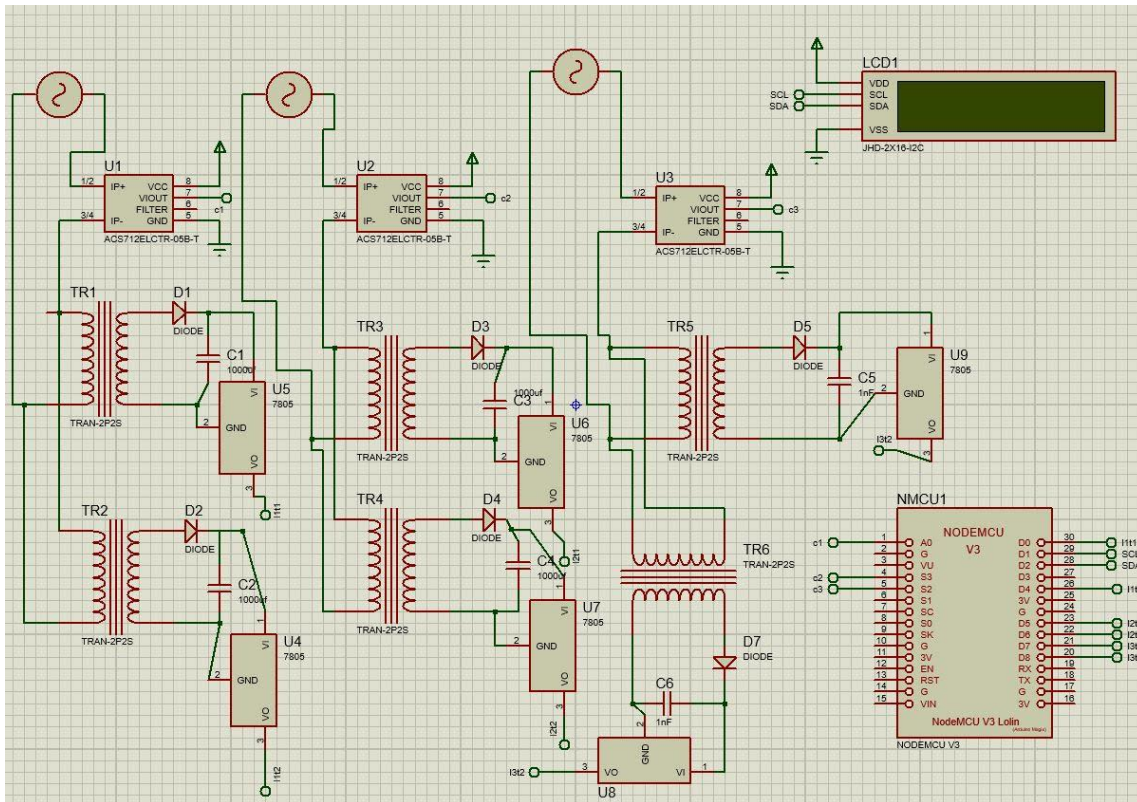
Figure 4.2: User interface of proteus 8.1

Proteus 7.0 is a Virtual System Modeling (VSM) that combines circuit simulation, animated components and microprocessor models to co-simulate the complete microcontroller based designs. This is the perfect tool for engineers to test their microcontroller designs before constructing a physical prototype in real time. This program allows users to interact with the design using on-screen indicators and/or LED and LCD displays and, if attached to the PC, switches and buttons. One of the main components of Proteus 7.0 is the Circuit Simulation -- a product that uses a SPICE3f5 analogue simulator kernel combined with an event-driven digital simulator that allow users to utilize any SPICE model by any manufacturer.

Proteus VSM comes with extensive debugging features, including breakpoints, single stepping and variable display for a neat design prior to hardware prototyping. In summary, Proteus 7.0 is the program to use when you want to simulate the interaction between software running on a microcontroller and any analog or digital electronic device connected to it.

CHAPTER 5

RESULT & OUTPUT OBSERVATIONS

5.1 System physical appearance

The below image is showing the total system is in OFF mode. There is no power is supplied & device is not connected with power.
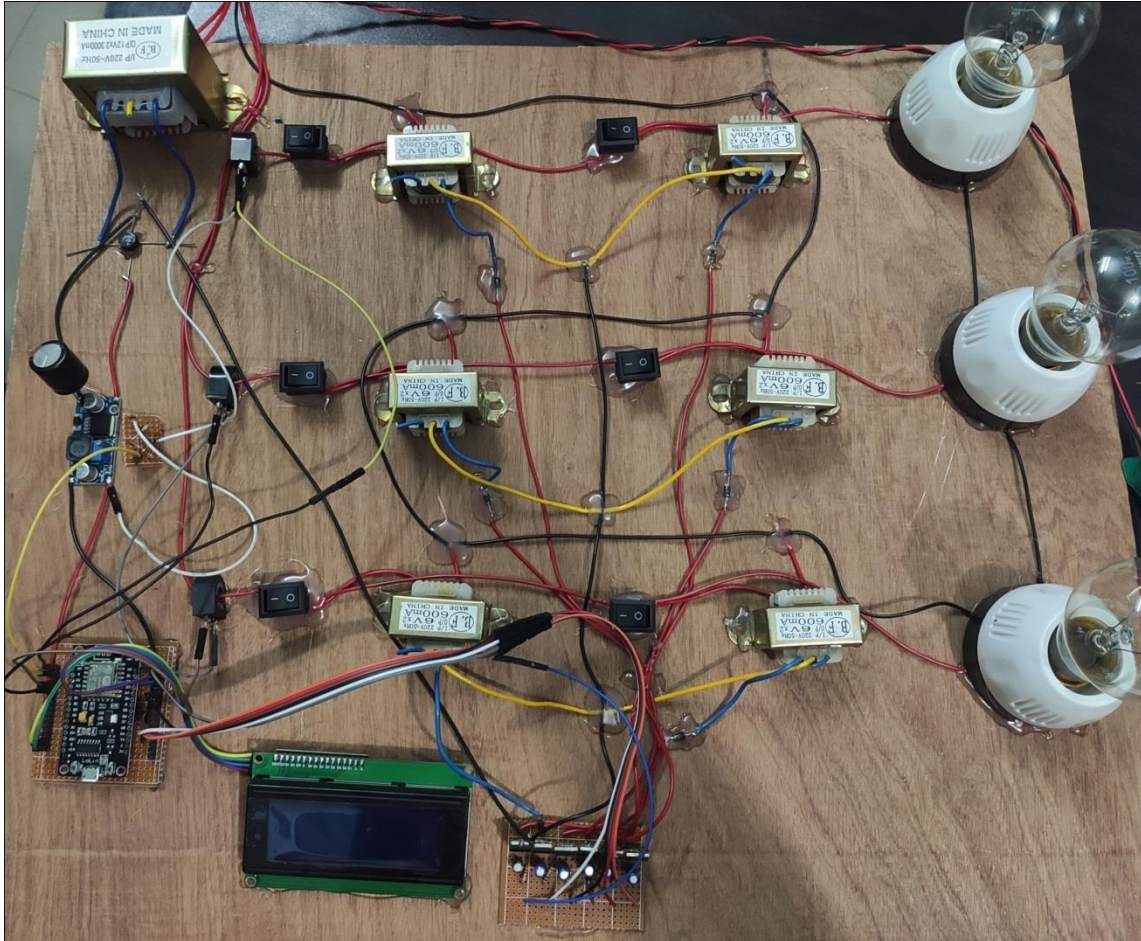

Figure-5.1:Project picture

5.2 System operation state (ON)

Figure-5.2: Sate On -01

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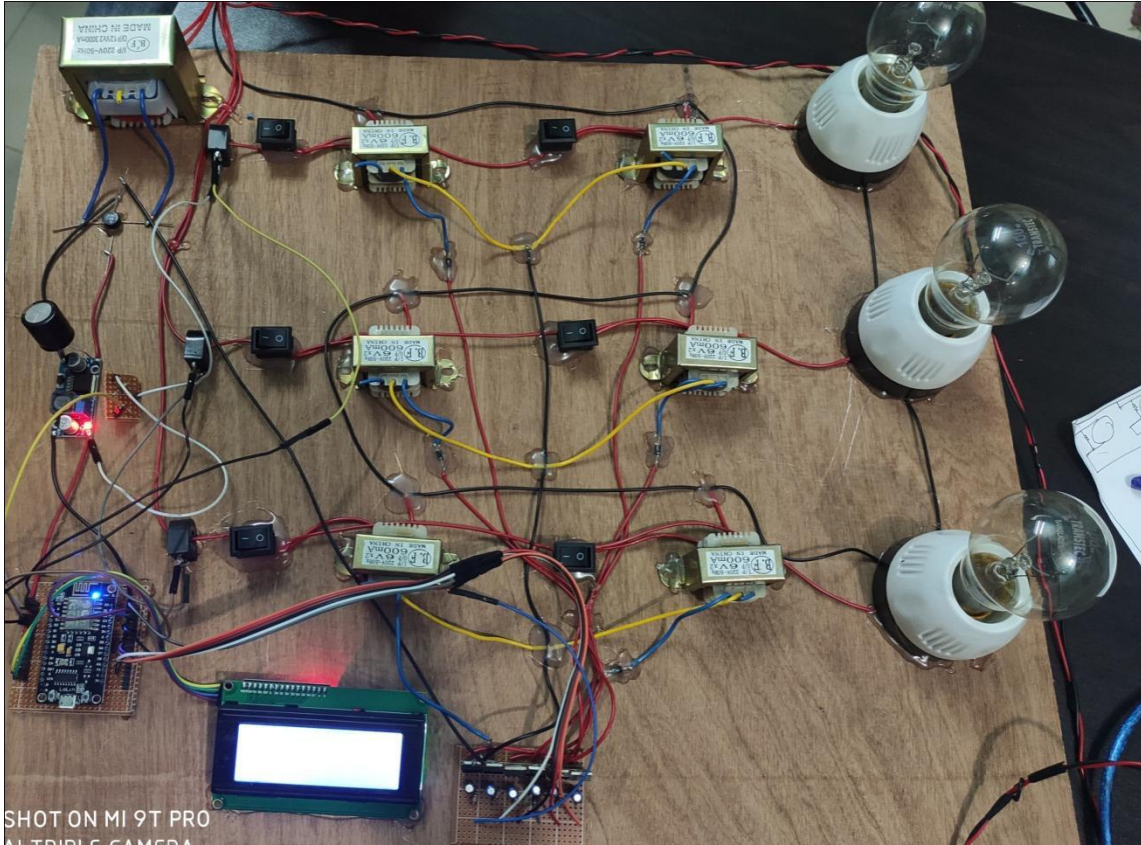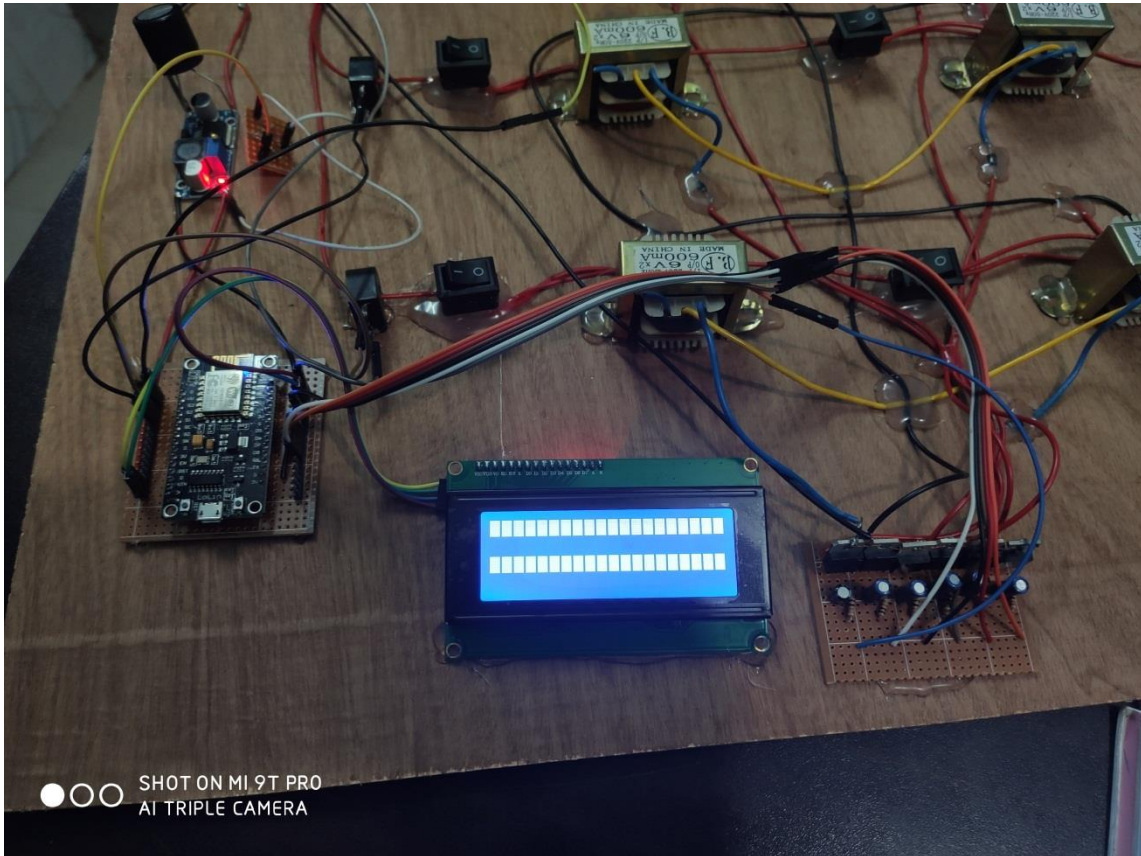
Figure-5.3: Sate On -02

5.3 Result

When the project is launched, we display and I can monitor all the data through the Internet.Here we display the fault and if there is a fault somewhere in the line monitoring can be done through the Internet.we can also see how much current is going on in each line.We can monitor the line fault and line current by Internet from anywhere in the world.

5.4 List of Components With Price

SL NO	COMPONENTS NAME	Quantity	Unite Price	Total Price (BDT)
1	NodeMCU-ESP8266	1	500	500
2	Transformer-3A	1	250	250
3	Rectifier	1	50	50
4	Capacitor	1	20	20
5	Buck Converter	1	70	70
6	Lcd Display	1	320	320
7	7805 IC	6	10	60
8	Current Sensor	3	220	660
9	Load	3	60	180
10	Transformer-0.6A	6	70	420
11	Others			1000
	Totally Cost			3530tk

Table02 -List of Components With Price

CHAPTER 6

Conclusions and Future Work

6.1 CONCULATION

We have created a modern project on underground cable fault.In this project we have a line taken directly from Ac Current to give us power,which flows as dc power in the project.Here we have basically created a dc power source.Using a step down transformer, we have converted the voltage to 24 volts,then these 24 volts are dc by using a rectifier.So when dc is created,little something goes from ac.So we got pure DC using a capacitor.Now we need 5 volts DC for the controller,we have 5 volts DC.Here we have taken a certain amount of voltage using a buck module.We have given the controller a certain amount of voltage.The main goal of our project is to diagnose the underground cable fault,here we are for three phase lines,we have created two fault sensors on each line and we have connected the output of the fault sensor to the digital pin of the controller.Each fault sensor is created, a 6 volt step down transformer,Diode of a 1n4007 model,acapacitor,a voltage regulator 7805 model,a 10K registor adjustment.Which is shown in the project diagram.This is another aspect of our project Monitor the load current of each phase,we have used three current sensors to monitor the current of the three phases.Connected to the current sensor's output controller's analog pin.A display has also been attached to the project which is connected to the digital pin of the controller.Another special aspect of our project is the iot (internet of think) system.On this system we can monitor data via the Internet,For which we have to work with the server.Here, if any fault is present in any of our three phases, it will show directly on the display which fault has been faulted under the switch.At the same time we can monitor the Internet where the fault has occurred.Moreover, we can monitor the current current on the display and on the Internet.We have used the programming device here as nodemcu esp8266. Here we have developed the project using c programming.

6.2Advantage:

The main advantage of this project is to **iot based three phase underground cable fault and current monitroring**System Project for The main purpose is to create a smart system so that we can take many benefits from one project.

I.   Can be easily created.
II.   Essential instruments, readily available in the market.
III. Where the fault in the line can be easily found.
IV.   Each line can be monitored by line current.
V.   A very useful system for underground and river tunnel lines.
VI.   The Internet can be monitored from anywhere in the world.
VII. People are less needed.
VIII. The cost is much less.

6.3 Applications

    I.   The transmission line below the ground.
   II.   Java transmission line in river / sea tunnels.
 III.   Substation.
 IV.   The system can also be installed on the transmission line.

6.4 Future Work

    I.   This system can be brought into the gsm system.
   II.   The number of fault switchers can be increased by keeping in mind the distance.
 III.   Line frequency monitoring systems can be connected.
 IV.   By researching the line fault system, new things can be discovered.

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6.5 Appendix

```
#include <LiquidCrystal.h>
LiquidCrystallcd(2, 3, 4, 5, 6, 7);
int l1t1 = 8;
int l1t2 = 9;
int l2t1 = 10;
int l2t2 = 11;
int l3t1 = 12;
int l3t2 = A5;




int l1t1data;
int l1t2data;
int l2t1data;
int l2t2data;
int l3t1data;
int l3t2data;




int RawValue1 = 0;
int RawValue2 = 0;
int RawValue3 = 0;


int ACSoffset1 = 2480;
int ACSoffset2 = 2480;
int ACSoffset3 = 2490;


double Voltage1 = 0;
```

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```
double Voltage2 = 0;

double Voltage3 = 0;


double Amps1 = 0;

double Amps2 = 0;

double Amps3 = 0;


void setup() {

Serial.begin(9600);

lcd.begin(20, 4);

pinMode(l3t1, INPUT);

pinMode(l3t2, INPUT);


}


void l1current()

{

  RawValue1 = analogRead(analogIn1);

  Voltage1 = (RawValue1 / 1024.0) * 5000; // Gets you mV

  Amps1 = ((Voltage1 - ACSoffset1) / mVperAmp);

if(Amps1<=0.1)

  {

    Amps1=0.00;

  }

lcd.setCursor(0, 0);

lcd.print("L1 C:");

lcd.print(Amps1);

}


void l2current()
```

```
{
 RawValue2 = analogRead(analogIn2);
 Voltage2 = (RawValue2 / 1024.0) * 5000; // Gets you mV
 Amps2 = ((Voltage2 - ACSoffset2) / mVperAmp);
if(Amps2<=0.1)
 {
  Amps2=0.00;
 }
lcd.setCursor(0, 1);
lcd.print("L2 C:");
lcd.print(Amps2);
}


void l3current()
{
 RawValue3 = analogRead(analogIn3);
 Voltage3 = (RawValue3 / 1024.0) * 5000; // Gets you mV
 Amps3 = ((Voltage3 - ACSoffset3) / mVperAmp);
if(Amps3<=0.1)
 {
  Amps3=0.00;
 }
lcd.setCursor(0, 2);
lcd.print("L3 C:");
lcd.print(Amps3);
}



void loop() {
```

```
l1current();

l2current();

l3current();


  //line 1 FAULT detect
if (l1t1data == 1 && l1t2data == 1)

  {

lcd.setCursor(11, 0);

lcd.print("T2 FAULT");

  }

if (l1t1data == 0 && l1t2data == 0)

  {

lcd.setCursor(11, 0);

lcd.print("T1 FAULT");

  }


  //line 2 FAULT detect
if (l2t1data == 1 && l2t2data == 1)

  {

lcd.setCursor(11, 1);

lcd.print("NO FAULT");

  } {

lcd.setCursor(11, 1);

lcd.print("T1 FAULT");

  }


//line 3 FAULT detect
if (l3t1data == 1 && l3t2data == 1)

  {

lcd.setCursor(11, 2);
```

```
lcd.print("NO FAULT");
  }
if (l3t1data == 1 && l3t2data == 0)
  {
lcd.setCursor(11, 2);
lcd.print("T2 FAULT");
  }
if (l3t1data == 0 && l3t2data == 0)
  {
lcd.setCursor(11, 2);
lcd.print("T1 FAULT");
  }

delay(2000);
lcd.clear();
}
```