IoT Based Power Grid Monitoring and OperatingSystem



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Date of Submission: January 2023

Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled "**IoT Based Power Grid Monitoring and Operating System**" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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ACKNOWLEDGEMENT

The report titled as on "**IoT Based Power Grid Monitoring and Operating System**" has been prepared to fulfill the requirement of our practicum program. In the process of doing and preparing our practicum report, we would like to pay our gratitude to some persons for their enormous help and vast co-operation.

At first, we would like to show our gratitude to the University authority to permit us to do our practicum. Specially, we would like to thank to our honorable teacher **Md. RakibulAlam,** Assistant Professor, Department of Electrical & Electronics Engineering, SU–Sonargaon University, Dhaka, for his valuable and patient advice, sympathetic assistance, co-operation, contribution of new idea. Deep theoretical and hardware knowledge & keen interest of our supervisor in this field influenced us to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project.

Finally, we would like to thanks again to the respected **Vice- Chancellor of SU, Professor Dr. Md. Abul Bashar** also thanks to **Head of Department of SU , Electrical & Electronics Engineering, Professor Dr. M. Bashir Uddin** because they are designated such an environment for learning through which we got the opportunity to acquire knowledge under Bsc in EEE program, and that will be very helpful for our prospective career.

We are, indeed, grateful to all those from whom we got sincere cooperation and help for the preparation of this report.

ABSTRACT

This project describes the digitization of load energy usage readings over the internet. Theproposed system design eliminates the involvement of human in electricity maintenance. Theuser can monitor energy consumption in watts from a apps by providing a channel id for theload. Wi-Fi unit performs IOT operation by sending energy data of the load to the apps whichcan be accessed through the channel id of the device. In the proposed system, consumer cando power management by knowing energy usage time to time. This proposed system utilizesanArduinomicrocontroller.Theunitwhichisgeneratedcanbedisplayedontheappsthrough the Wi-Fi module. Smart grid is one of the features of smart city model. It is energyconsumption monitoring and management system. Smart grids are based on communicationbetween the provider and consumer. One of the main issues with today's outdated grid dealwith efficiency. The grid becomes overloaded during peak times or seasons. It is also possibleto hack the system, and basically, take free electricity. By using smart grid consumer andownergetdailyelectricityconsumptionreadingandownercancutelectricitysupplyremotely through internet if bill is not paid. One more thing, the data collected from the smartmeters should not be accessed by any unauthorized entities. We can monitor from anywherethrough the internet. We can also do this if we want to turn a system on or off. In case metertempering is happened then owner and consumer get message and then owner take the actionaccordingly. Fitting the circuit on customer's energy meter, from that energy consumptiondata can be acquired. After acquiring of data, that data can be updated on cloud service, sothatconsumer and provider canaccessthat datathroughinternet.

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Chapter1:Introduction

1.1 Introduction

Energygenerationcompaniessupplyelectricitytoallthehouseholdsviaintermediatecontrolled power transmission hubs known as Electricity Grid. Sometime problems arise dueto failure ofthe electricity grid leading to black out of an entire areawhich was gettingsupply from that particular grid. The project aims to solve this problem using IOT as themeansofcommunicationandalsotacklingvariousotherissueswhichasmartsystemcandealwitht oavoidunnecessarylossestotheenergyproceduresIOTsmartenergygridisbased on AT mega family controller which controls the various activities of the system. Thesystem communicates over internet by using Wi-Fi technology. The foremost thing that thisprojectfacilitatesisreconnectionoftransmissionlineofactivegrid.Ifanenergygridbecomes faulty and there is an another energy grid, the system switches the transmission linestowards this grid thus facilitating an interrupted electricity supply to that particular regionwhose energy grid went OFF. And this information of which grid is active updated over IOTsmartphoneappswheretheauthoritiescanloginandcanbetheupdates.Apartfrommonitoringth egrid,thisprojecthastheadvancecapabilitiesofmonitoringenergyconsumptionand even detects theft ofelectricity.

1.2 ObjectiveoftheProject

The main objective of this project is to“ Operating of Power Grid of IOT ’’ project for themainpurposeis tocreate asmartsystemso thatwecan takemanybenefitsfromoneproject.

- Remotemonitoringsystem
- Thelinecanbeclosed at dangerouslevels.
- Monitoringthepowerline current.
- Reducecostsfromconventionalsystems.

1.3 BackgroundoftheProject

- Thetitleofproject is“IoTBasedPower Grid Operating andMonitoringSystem”.
- In this project we have done voltage and frequency monitoring. As well as monitoringthecurrent of the system.
- Wecan monitorfrom anywherethroughtheinternet.
- Wecan also dothis if we wantto turn asystem on or off.

1.4 InternetofThings(IoT)

The Internet of Things (IoT) is a new revolution for Data Transfer and Storage. Objects thatmake themselves recognizable and they obtain intelligence by making or enabling contextrelated decisions to the situations. They can transfer information about themselves. They canaccess information that has been used by other things, or they can be components of otherservices.ThethreefactorsthatmakesIoTlookforwardareSensingNodes,EmbeddedProcessing and Communication. This transformation is accompanied by the emergence ofcloud computing capabilities supported by an increased storage capacity and high-end dataprocessing and the Machine-to-Machine communication for data transport with completesecurity for data. By introducing cloud computing, we can make a full call to the storageresource pool and computing resource pool in the cloud computing architecture, and providehigh reliability for IoT cloud storage service and efficient cloud computing services to users.This Machine-to-Machine service layer will provide the needed services like data transport,security, devices, management and device discovery in a harmonized manner across a verticaldomainto theapplication layer.

1.5 IoTSystem

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical anddigital 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 theconvergenceofmultipletechnologies,real-timeanalytics,machinelearning,commoditysensors,and embedded systems.

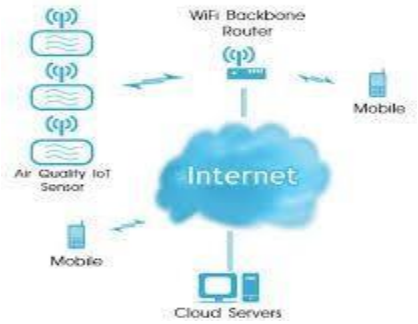


Fig-1.1:IoTSystem

Traditionalfieldsofembeddedsystems,wirelesssensornetworks,controlsystems,automation (including home and building automation), and others all contribute to enablingtheInternetofThings.Intheconsumermarket,IoTtechnologyismostsynonymouswith

products pertaining to the concept of the " Raspberry Based Weather Station ", coveringdevices and appliances (such as lighting fixtures, thermostats, home security systems andcameras, and other home appliances) that support one or more common ecosystems, and canbe controlled via devices associated with that ecosystem, such as smartphones and smartspeakers.

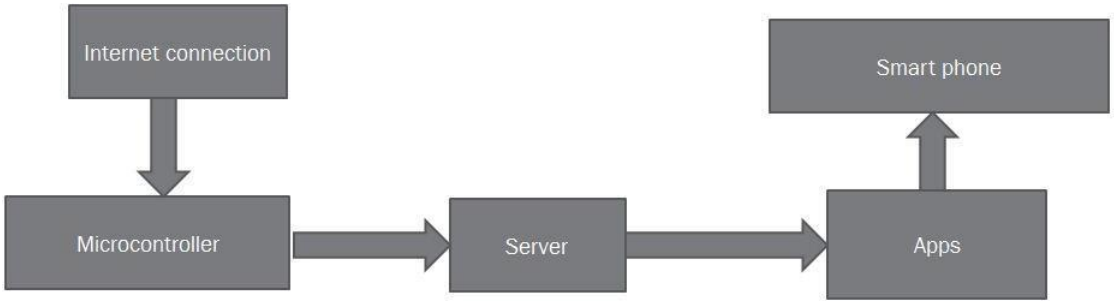


Fig-1.2:BlockDiagram ofIOT

There are a number of serious concerns about dangers in the growth of IoT, especially in theareas of privacy and security; and consequently industry and governmental moves to begin toaddressthese.

1.6 Methodology

Basically, the design and development of this project are divided into two main parts whichare hardware architecture and software details. In the hardware architecture, the design of thecircuit was constructed and the prototype of the project was built. While in the softwaredevelopment,thewhole complete prototypewasoperatedviaprogrammingcodes.

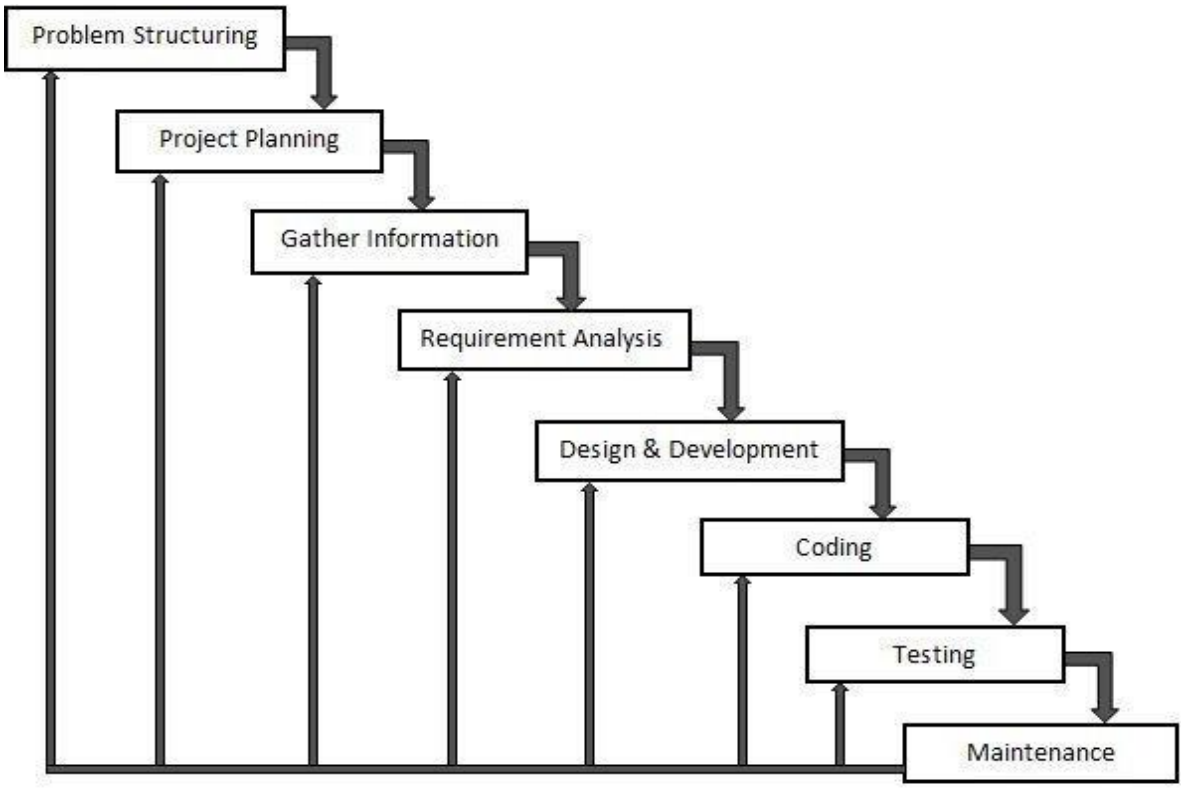


Fig-1.3:Methodology

1.7 MotivationforProject

A poorly motivated team has been known to unravel even the best project plan. A goodproject manager needs to know how to harness the initial excitement that comes with startinga project and use it to maintain motivation – leading to success throughout the project'slifecycle. We now know that contemporary project managers need to be more than justschedulers and contract managers. They need excellent skills in managing those complexhumanelements that havethe potential tobringany project down.

Chapter2:LiteratureReview

2.1 Introduction

Inthefuturegenerationofpowergridssensors,actuators,andtransducersareexpectedtoplay a crucial role in providing real-time energy monitoring and controlling services. IoT hasbecome an enabling technology to provide novel solutions to the challenges in the power gridsystem. IoT enabled sensors are used pervasively in the power grid system to share theirusefulinformationthroughinternetandmobileapplications,enablingimprovedgridmanagement.

The integration of Information and Communication Technologies (ICTs) and IoT in SGensurereliability,costeffectiveness,andintelligentfeatureswithminimalhumanintervention. Two-way communication is the key requirement in the paradigm of IoT amongsmartdevices andcomponents.

SmarthomesaredevelopedbytheintegrationofsmartelectricmetersandIoT.Fordeployment in smart cities, an IoT assisted real-time Zigbee mesh WSN based AutomaticMeter Reading (AMR) system is implemented in. The proposed system provides a reductioninpeakloadswithimprovedDemandSideManagement(DSM).Sensors,communication, and control mechanisms will play a vital role in achieving reliable and secure power grids. Asurvey on potential communication technologies for the connectivity of devices in the SG ispresentedin.

Motivated by the above progress inIoT and their deployment in power grids, we haveproposed an IoT assisted power monitoring and controlling system. It provides benefits toboth consumers and utility companies to analyze and manage their resources. This paperprovidesanimplementationofIoTbasedpowermonitoringusingblynksoftware.Aliterature review is provided that highlights existing research in the area of SG, IoT, and IoTaided SG.

Inthis paper,our contributionsinclude thefollowing:

- TheimplementationofIoTassistedpowermonitoringsystemisprovidedwiththeintegration ofan open-source IoT platform,whichprovidesto analyzeinformation.
- Thehardwaredesignenablestoaccessofelectricalparametersofloadsincludingcurrent,frequency, and voltageof connected loads.

An "IDMT over Current Relay" is a type of protective relay which operates when the loadcurrent exceeds a preset value. In a typical application the over current relay is used for overcurrent protection, connected to a current transformer and calibrated to operate at or above aspecificcurrent level.

This project will attempt to design and fabricate over current protection relay using microcontroller. The micro controller will cause the circuit breaker to trip when the current fromloadcurrent reaches the setting valuein themicrocontroller.

In order to design it, first the load current need to measure in order to monitor it using currentsensor including testing the fault (over current) and when such condition arise, it will isolatein the shortest time possible without harming the any other electrical devices. It will alsoincluding in developing the algorithm for instantaneous over current relay and IDMT (InverseDefiniteMinimumTime)relayforthecircuitbreakertotrip.Inthisproject,arduinomicrocontrollerwill beused tocontrol andoperatethetripping coilin circuitbreaker.

2.2 LiteratureSurvey

One year after the past edition of the Cluster book 2012 it can be clearly stated that theInternet of Things (IOT) has reached many different players and gained further recognition.Out of the potentialInternet of Things application areas, Smart Cities (and regions), SmartCar and mobility, Smart Home and assisted living, Smart Industries, Public safety, Energyenvironmental protection, Agriculture and Tourism as part of a future IoT Ecosystem haveacquired high attention. In line with this development, the majority of the governments inEurope, in Asia, and in the Americas consider now the Internet of Things as an area ofinnovationandgrowth.Althoughlargerplayersinsomeapplicationareasstilldonotrecognized the potential, many of them pay high attention or even accelerate the pace bycoining new terms for the IoT and adding additional components to it. Moreover, end-users inthe private and business domain have nowadays acquired a significant competence in dealingwithsmartdevicesandnetworkedapplications.AstheInternetofThingscontinuestodevelop, further potential is estimated by a combination with related technology approachesand concepts such as Cloud computing, Future Internet, Big Data, robotics and Semantictechnologies. The idea is of course not new as such but becomes now evident as those relatedconceptshave started torevealsynergiesbycombiningthem.However, theInternetofThingsisstillmaturing,inparticularduetoanumberoffactors,whichlimitthefullexploitationoftheIOT.Among thosefactorsthefollowingappear tobemost relevant

-No clear approach for the utilization of unique identifiers and numbering spaces for variouskindsof persistent and volatileobjects at aglobalscale.

-NoacceleratedanduseandfurtherdevelopmentofIOTreferencearchitectures.

-
Lessrapidadvanceinsemanticinteroperabilityforexchangingsensorinformationinheterogeneous environments.

-Difficulties in developing a clear approach for enabling innovation, trust and owner ship ofdatantheIOTwhileatthesametimerespectingsecurityandprivacyinacomplexenvironment.

-Difficulties in developing business which embracesthe full potentialof the Internet ofThings.

-Missinglarge-scaletestingandlearningenvironments,whichbothfacilitatetheexperimentation with complex sensor networks and stimulate innovation through reflectionandexperience.

Chapter3:HardwareImplementation

3.1 Introduction

Internet of Things (IoT) is widely used in monitoring, industrial automation, and a variety ofapplications. At various stages of power Grid(PG), IoT devices are deployed to monitor andcontrol grid statistics for reliable and efficient delivery of power. Although IoT integration inthe PG domain provides manifold benefits, the challenges in IoT-PG integration needs to besolved for the efficient operation of the grid. In this paper, firstly an overview of PG and IoTbased PG system is provided. This project describes the IoT based power monitoring systemthat is capable to measure and analyze the electrical parameters such as voltage, current, andfrequency consumption of loads. IoT based software application is used to obtain the real-time electricaldata of consumers. Basedonthisdata, the consumer andelectric powercompaniesinthePGparadigm canbettermanage theirconsumptiontoreducebilling costs.

The main aim of Micro-controller based Controlling of Power Grid of IOT. In above blockdiagram there are current sensor, voltage sensor, relay module,Wi-Fi module, optocoupler,LCDdisplayandarduinowhichwehaveusedforsensingwhenisdetectedtheparameter .Microcontrollercontinuously check the outputof sensor and gives signal tothe systemcircuitwhich drives theautomatic.

3.2 BlockDiagramofThisProject

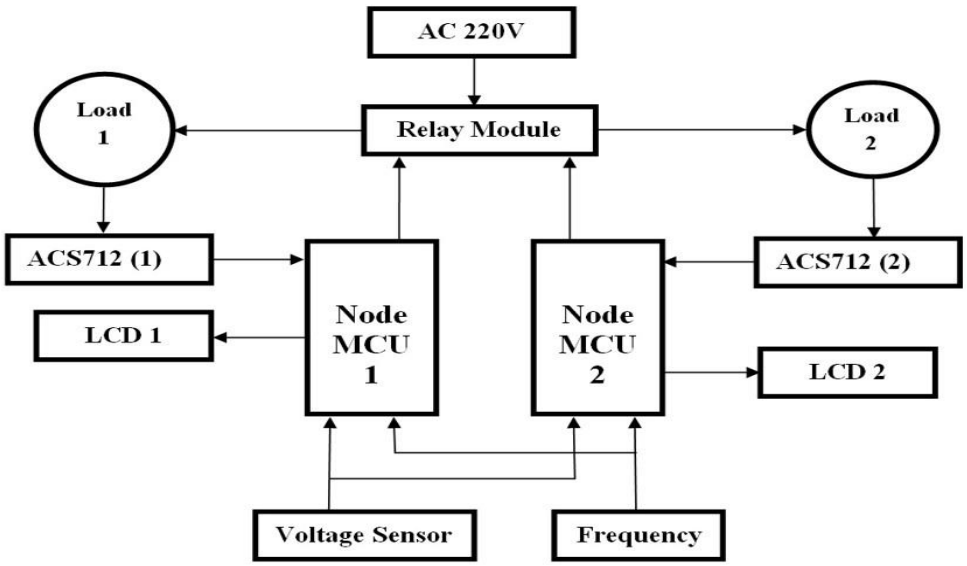


Fig:3.1BlockDiagram

3.3 CircuitDiagramofThisProject

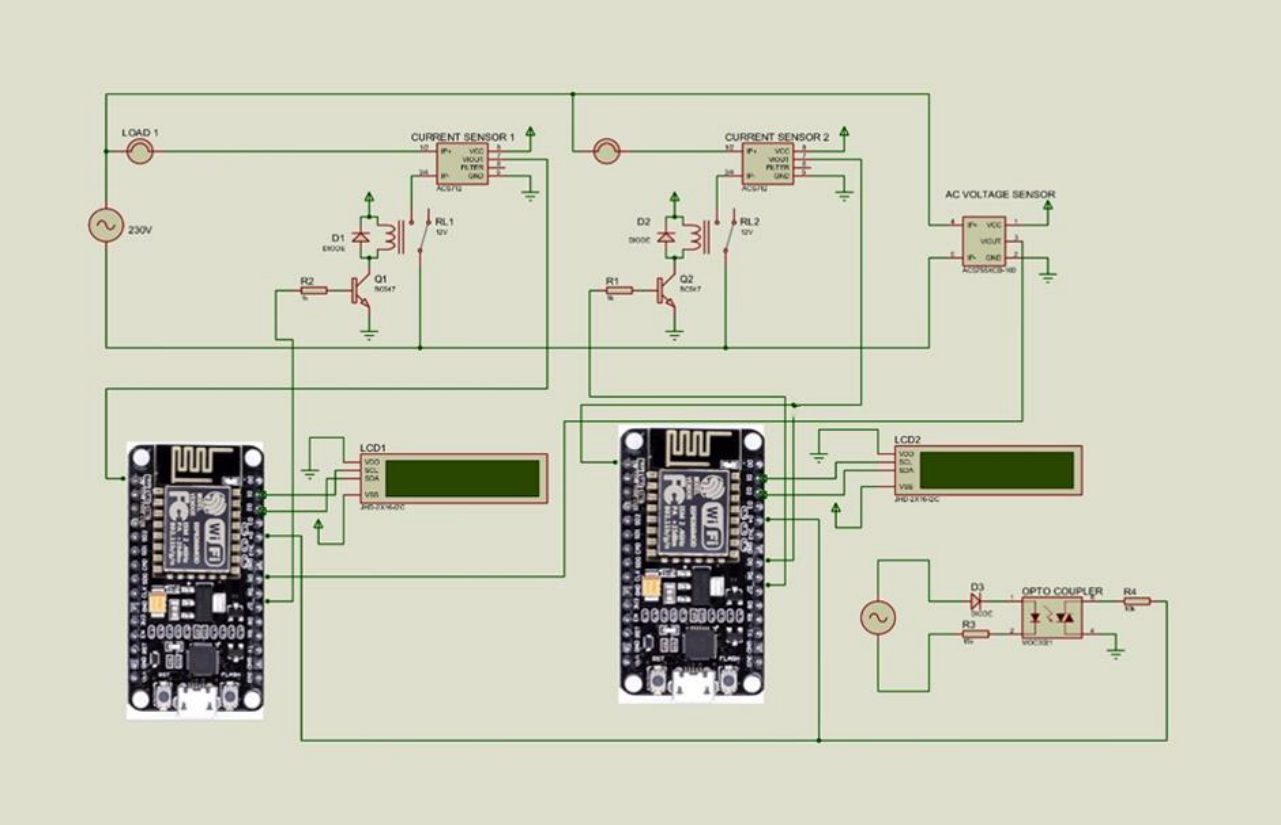


Fig:3.2CircuitDiagram

3.4 Thelistofdevicesusedintheprojectisgivenbelow

- NodeMCU.
- Adaptor.
- Optocoupler.
- VoltageSensor.
- LCDDisplay.
- RelayModule.
- LM2596 VoltageConverter
- CurrentSensor..
- WifiModule.

3.5 NodeMCU(ESP8266)

In the final model,Arduino UNO is replaced with a NodeMCU (shown in Figure 2.3).ArduinoUNOrequiresanEthernetShieldorESP8266WiFimoduletoconnecttointernet. The advantages of NodeMCU are that it requires less board space, cheaper in a way and

mostimportantlyithasbuil-inESP8266WiFimodule.NodeMCUisanopen-sourceLuabasedfirmware and development board specially targeted for IoT based Applications.It includesfirmwarethatrunsontheESP8266WiFiSoCfromEspressifSystems,andhardwarewhichis based on the ESP-12 module.The NodeMCU ESP8266 development board comes with theESP-12EmodulecontainingtheESP8266chiphavingTensilicaXtensa32-bitLX106RISCmicroprocessor.This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustableclockfrequency.NodeMCUhas128KBRAMand4MBofFlashmemorytostoredata and programs.Its high processing power with in-built WiFi / Bluetooth and Deep SleepOperatingfeaturesmakeitidealforIoTprojects[8].

NodeMCUcanbepoweredusingaMicroUSBjackandVINpin(ExternalSupplyPin).It supports UART, SPI, and I2C interface. The NodeMCU Development Board can be easilyprogrammed with Arduino IDE since it is easy to use.Programming NodeMCU with theArduinoIDEwillhardlytake5-10minutes.AllweneedistheArduinoIDE,aUSBcableand the NodeMCU board itself [8]. NodeMCU is required in this project so that the generatedOTPcanbesenttotheemailserver.

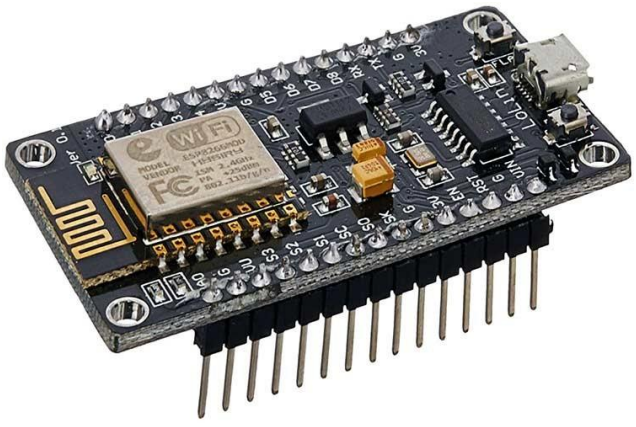


Figure2.3:ESP8266NodeMCU[9].

TherearesomedistinctdifferencesbetweenNodeMCUandArduinoUNO.Thesedifferencesareillustratedin Table2.3.

Table2.3:ComparisonofNodeMCUandArduinoUNO[9].

Aspects	NodeMCU V3	Arduino UNO
OperatingVoltage	3.3V	5V
Currentconsumption	15 A–400mA	45mA–80mA
Currentconsumption(DeepSleep)	0.5 A	35mA
DigitalandAnalogI/OPins	16and1	14and6
PWMI/OPins	16	6
FlashMemoryandSRAM	4MB,64KB	32KB,2KB
ClockSpeed	80MHz	16MHz

In most cases, NodeMCU is better performing and more advantageous. It is faster, hasmorememory,betterpowerperformanceandmoreconvenientforthisproject.

History:

NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems began production of the ESP8266. 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 the NodeMCU project, enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.

In the summer of 2015 the original creators abandoned the firmware project and a group of independent contributors took over. By the summer of 2016 the NodeMCU included more than 40 different modules.

Overview:

NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit). Strictly speaking, the term "NodeMCU" refers to the firmware rather than the associated development kits.[citation needed]

Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware 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.[10] Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a TensilicaXtensa LX106 core, widely used in IoT applications (see related projects).

Communication:

MQ Telemetry Transport (MQTT) is a popular low-overhead messaging protocol used by many IoT devices to communicate. This tutorial will show the user how to to set up a basic MQTT network using Python on his or her computer and an ESP8266 running the NodeMCU firmware. The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. NodeMCU has I2C functionality support on its GPIO pins. Due to internal functionality on ESP-12E, we cannot use all its GPIOs for I2C functionality. So, do tests before using any GPIO for I2C applications. Your router will give IP addresses to your MCUs during the connection. Launching the server you will see its IP address in the lower row of the OLED.

- Run an additional Arduino IDE.
- Open the "wifi_client_01. ...

Replace the asterisks "****" with the SSID and the password of your home WiFi router.

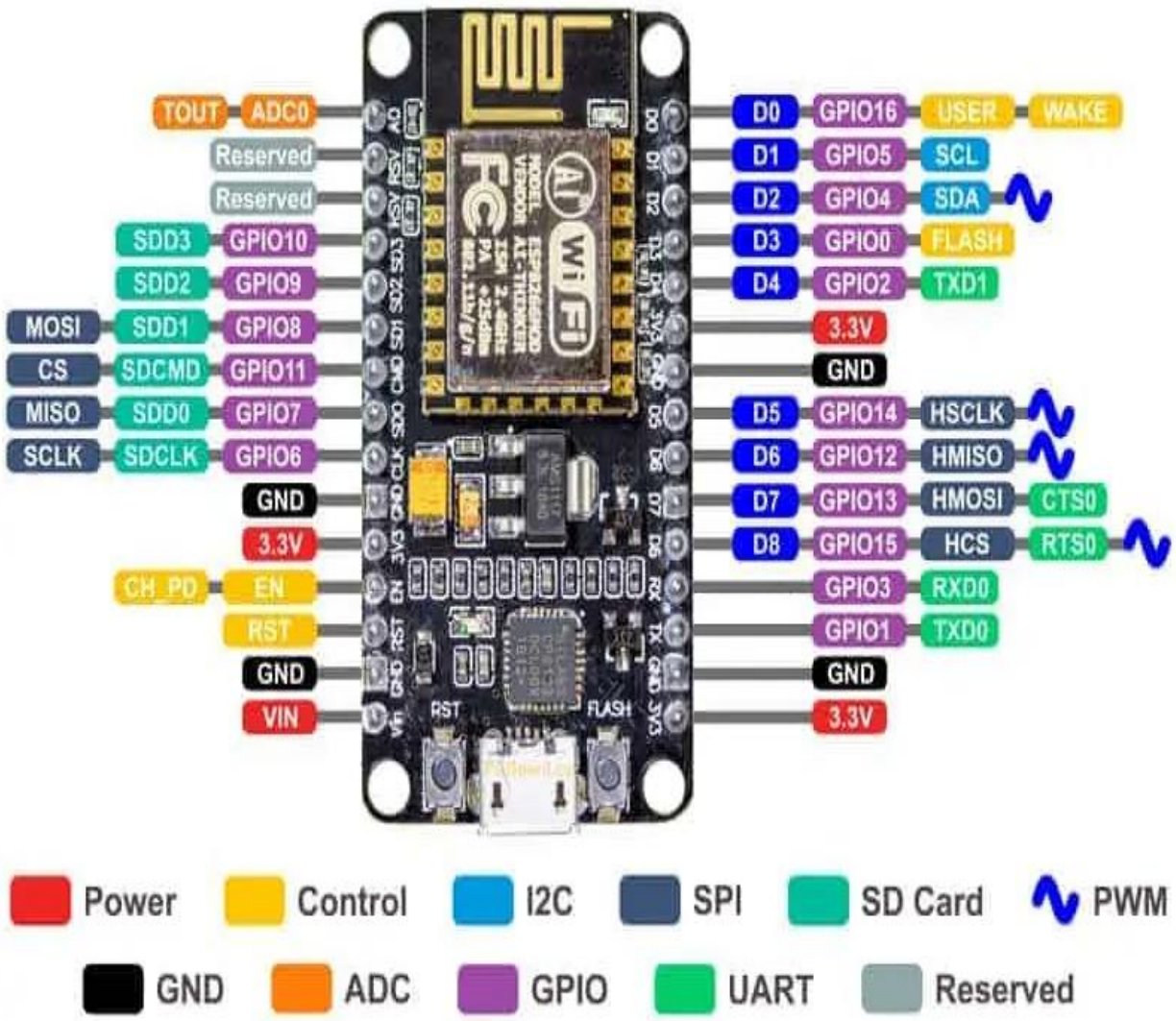


Fig-3.5:PinoutofNodeMCU

NodeMCU Pinout and Functions Explained :

Power Pins :There are four power pins. **VIN** pin and three **3.3V** pins.

- **VIN** can be used to directly supply the NodeMCU/ESP8266 and its peripherals. Power delivered on **VIN** is regulated through the onboard regulator on the NodeMCU module – you can also supply 5V regulated to the **VIN** pin
- **3.3V** pins are the output of the onboard voltage regulator and can be used to supply power to external components.

GND :Are the ground pins of NodeMCU/ESP8266

I2C Pins :Are used to connect I2C sensors and peripherals. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins :NodeMCU/ESP8266 has 17 GPIO pins which can be assigned to functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

ADC Channel :The NodeMCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART Pins :NodeMCU/ESP8266 has 2 UART interfaces (UART0 and UART1) which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

SPI Pins :NodeMCU/ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO

SDIO Pins :NodeMCU/ESP8266 features Secure Digital Input/Output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

PWM Pins :The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 µs to 10000 µs (100 Hz and 1 kHz).

Control Pins :are used to control the NodeMCU/ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.

- **EN:** The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.
- **RST:** RST pin is used to reset the ESP8266 chip.
- **WAKE:** Wake pin is used to wake the chip from deep-sleep.



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- **WAKE:** Wake pin is used to wake the chip from deep-sleep.

NodeMCU ESP8266 Datasheet :

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects
- Wi-Fi: Built-in 802.11 b/g/n

Material Needed :

For this tutorial, we will be flashing the onboard LED of the NodeMCU ESP8266 dev kit. So, let's gear up:

- A PC/Laptop running Windows/Linux
- USB Type-A to Micro-B Cable
- NodeMCU ESP8266-12E DevKit

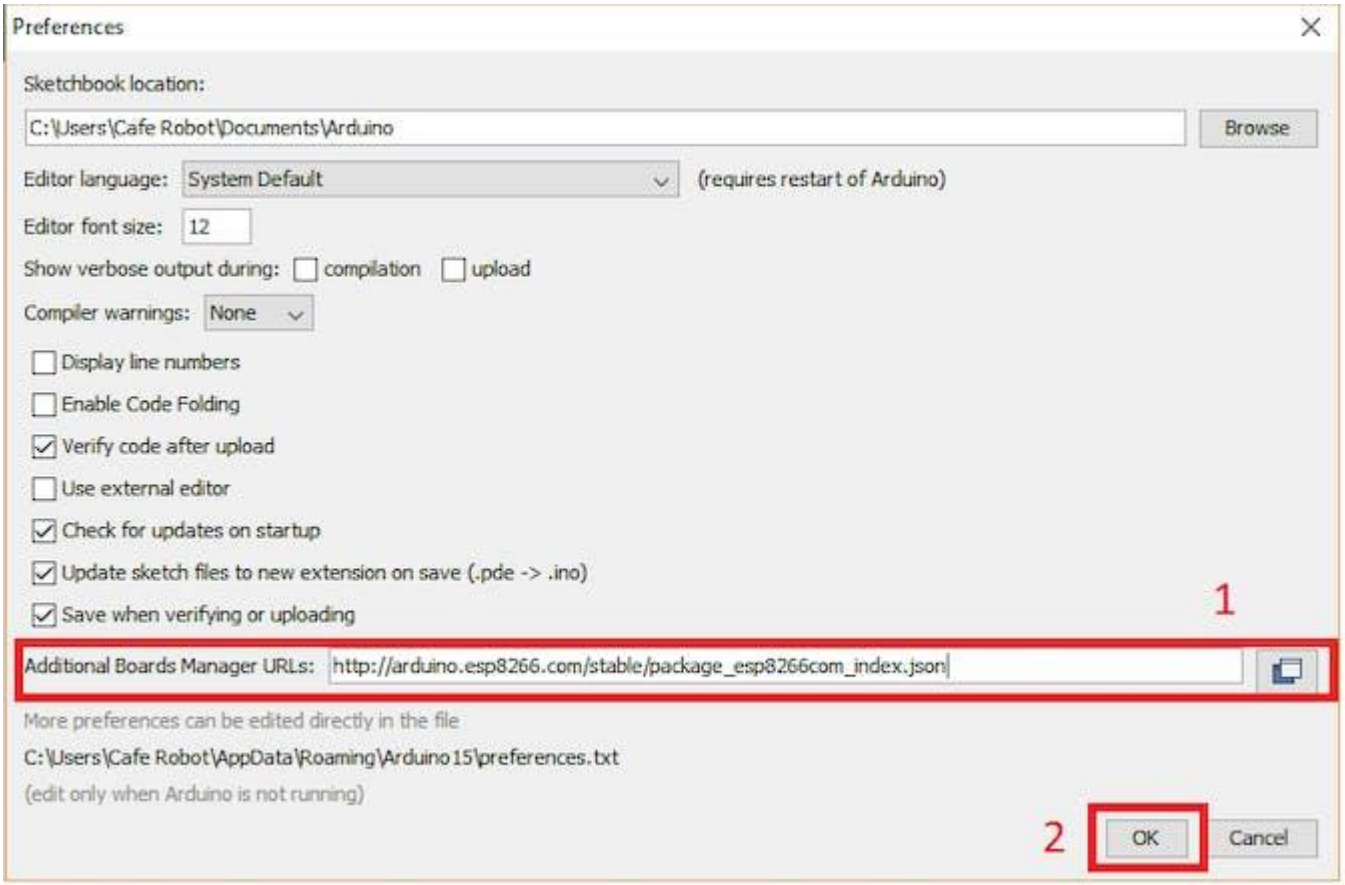
How to program NodeMCU using Arduino IDE :

In order to use Arduino IDE to program the NodeMCU, you have to introduce it to the software at first.

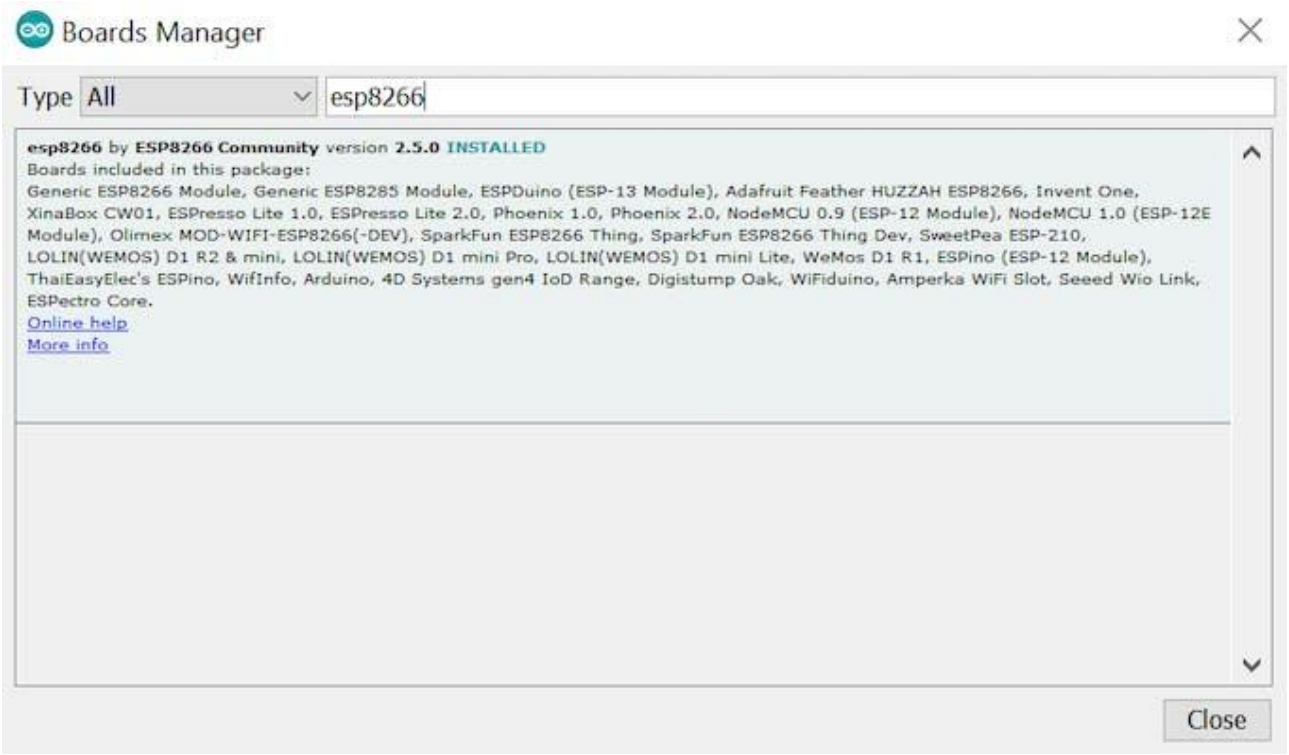
To do this copy the following code and follow the steps below:

http://arduino.esp8266.com/stable/package_esp8266com_index.json

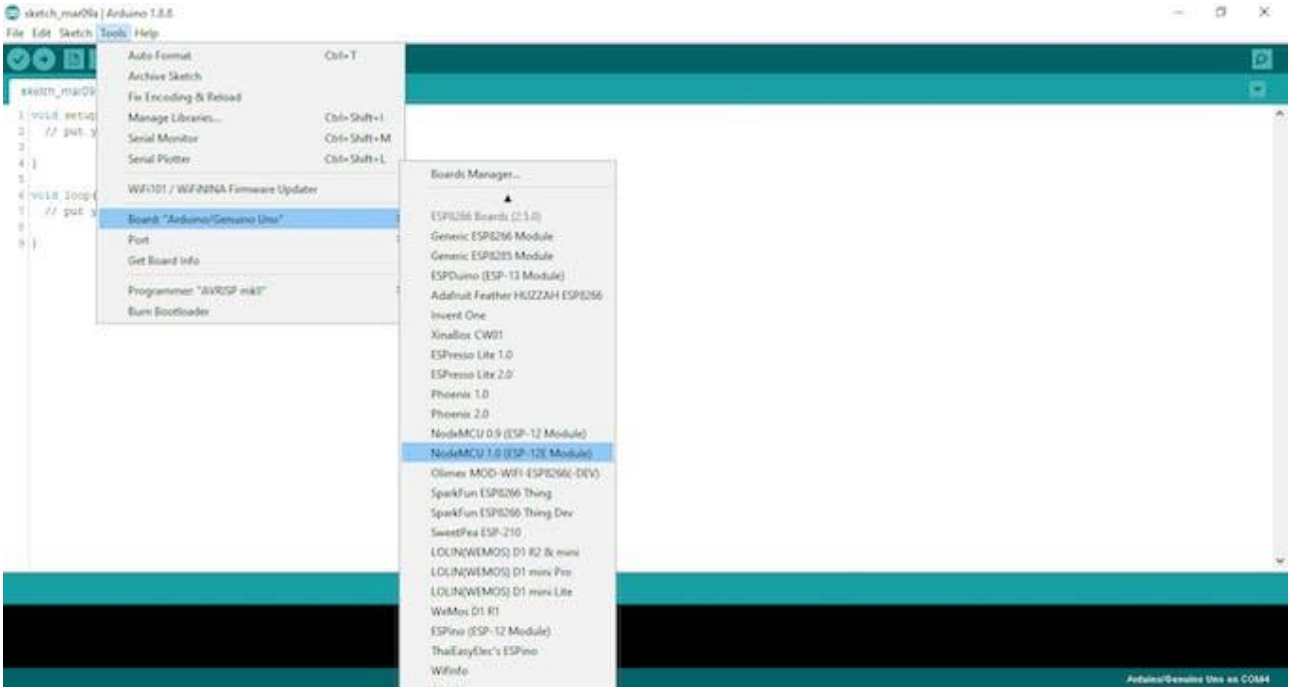
step1. Choose Preferences in the File menu and enter the copied code in Additional Board Manager URLs part. Then press OK.



Step2. Search the word ESP8266 in Boards>boards manager from Tools menu. Then install ESP8266 boards. After complete installation, you will see the INSTALLED label on ESP8266 boards.



After these two steps, you can see ESP8266 based boards such as NodeMCU in your Arduino IDE boards list, and you can choose your desired board to upload the code.



Applications:

- Internet Smoked Alarm.
- VR Tracker.
- Octopod.
- Serial Port Monitor.
- ESP Lamp.
- Incubator Controller.
- IoT home automation.
- Security Alarms.

3.6 Adaptor

- 12V 5A Micro Power Adpater. For using with Arduibo /Raspberry Pi 3 ModelA+/B/B+/Zeroand runningany otherhigh currentdevices.
- Specifications:
- Input:100V-240VAC,50Hz/60Hz
- Output:12V 5A



Fig-3.7:Adapter

3.7 Optocoupler

These are High Density Mounting Type Photocouplers used in Computer terminals,Systemappliances, measuring instruments,Registers, copiers, automatic vending machines,Electrichomeappliances, such asfan heaters etc.

Features:

Currenttransferratio(CTR:MIN.50%at IF=5mAVce=5V)

Highisolationvoltagebetweeninput andoutput (Viso:5300Vrms).



Fig-3.8:Optocoupler

3.8 VoltageSensor

A voltage sensor is a sensor is used to calculate and monitor the amount of voltage in anobject. Voltage sensors can determine both the AC voltage or DC voltage level. The input ofthis sensor can be the voltage whereas the output is the switches, analog voltage signal, acurrentsignal, anaudiblesignal, etc.

Sensors are basically a device which can sense or identify and react to certain types ofelectricalorsomeopticalsignals.Implementationofvoltagesensorandcurrentsensortechniquesh avebecomeanexcellentchoicetotheconventionalcurrentandvoltagemeasurementmethods.



Fig-3.9:VoltageSensor

Specification:

*Drive Voltage: 5VCharacteristics: Analog outputUp to 250V AC detection rangeCalibrationpotentiometer.

*Chipset: ZMPT101B.

*Mountingholes:M246/16mmPinpitch:2.54Connectors:ScrewTerminals.

*OperatingTemperature:-40°Cto85°C(unconfirmed)

This module is ideally suited to measuring an AC voltage. When connected to the screwterminals the sensor will sample the input and output an analog voltage, in the region of 0 -5V.This makesit easytouseinpower monitoringapplications and checkingsupplies.

3.9 LCDDisplay

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

LCD 16×2 Pin Diagram

The 16×2 LCD pinout is shown below.

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
- Pin 16 (-ve pin of the LED): This pin is connected to GND.

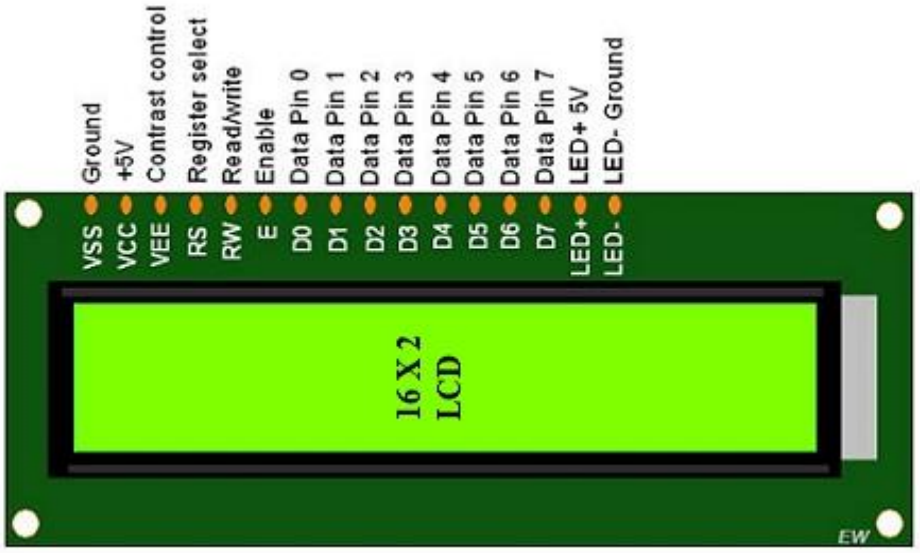


Fig-3.10:LCDDisplay

3.10 RelayModule

A relay is an electrically operated device. It has a control system and (also called input circuitorinputcontactor)andcontrolledsystem(alsocalledoutputcircuitoroutputcont.actor).Itis frequently used in automatic control circuit. To put it simply, it is an automatic switch tocontrollinga high-current circuit with a low-current signal.



Fig-3.11:RelayModule

The advantages of a relay lie in its lower inertia of the moving, stability, long-term reliabilityandsmallvolume.Itiswidelyadoptedindevicesofpowerprotection,automationtechnology,sport,remotecontrol,reconnaissanceandcommunication,aswellasindevicesof electro mechanics and power electronics. Generally speaking, a relay contains an inductionpart whichcanreflectinputvariablelike current, voltage, power,resistance,frequency,temperature, pressure, speed and light etc. It also contains an actuator module (output) whichcan energize or de-energize the connection of controlled circuit. There is an intermediary partbetweeninputpartandoutput partthatisused tocouplingandisolateinputcurrent,as well as

actuate the output. When the rated value of input (voltage, current and temperature etc.) isabovethecriticalvalue,thecontrolledoutputcircuitofrelaywillbeenergizedorde-energized.

NB: input into a relay can be divided into two categories: electrical quantities (includingcurrent, voltage, frequency, power etc.) and non- electrical quantities (including temperature,pressure,speed, etc.)

Features:
Thefeatures of1-Channel Relaymodule areas follow:

1) Goodinsafety.Inpowersystemandhighvoltagesystem,thelower currentcancontrolthehigherone.

2) 1-channelhighvoltagesystem output,meetingtheneeds ofsinglechannelcontrol

3) Widerangeof controllablevoltage.

4) Beingabletocontrolhighloadcurrent,whichcanreach240V,10A

5) With a normally-open (NO) contact and a normally-closed (NC) contactsInterfacespecifications:

The output contacts of a relay (including NO, NC, and the common port) works as a SPDT – SinglePoleDouble Throwswitch. Its operatingprinciple isasfollow: VCC --------5V,

GND--- forground

IN1 connects to the control valve which output 3V-

5VOutputcontacts: connecttoapplications
InterfaceConnectingandSetting:

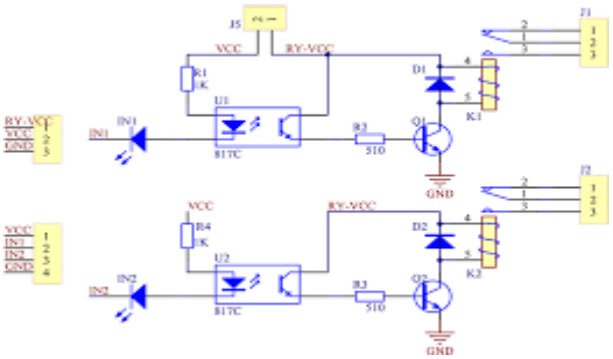


Fig-3.12:StematicOfRelayModule

GetStarted:
Firmware resources: Arduino board (any versions), wires, LED, 5v power supply. Softwareresource: Arduino IDE The one-channel relay can be programmed to realize the open andclose automatically. NB: customers can use any software or firmware tocontrol the moduleaslong as theIN1 of which can input avoltageof3V-5V.

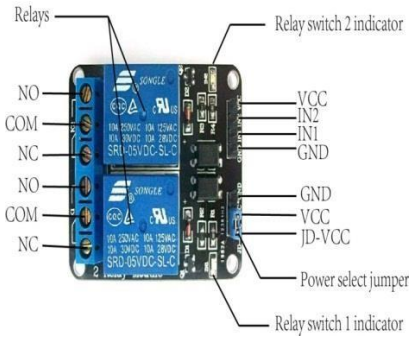


Fig-3.13:PinoutofRelayModule

you can do further development with the development tool you like as well as test it in theway of testing firmware. Firmware test: after the connection as in picture1-4, pay attention totheblink of LED,listen to theflicker of relay when it is working.Software test code:

```
 void
  setup(){pinMode(7,O
  UTPUT);
  }
  void
 loop(){pinMode(7,OU
 TPUT);delay(2000);di
 gitalWrite(7,LOW);del
 ay(2000);
 }
```

Feedbackoftest:
Aftertheuploadofcode,connecttheIN1pinstothe7thpinofArduinoboardseparately,youcanhearthe ticktackoftherelay(itkeepsopeningandclosing),inaddition,theLED-Gisblinking every 2s.

Note: notice that the module has a jumper cap connecting the VCC and JD-VCC pins; the oneshown here is blue, but yours may be a different color. The jumper cap allows you to choosewhether the circuit is physically connected to the Arduino circuit or not, and you can chooseto have it on or not. With the jumper cap on, the VCC and JD-VCC pins are connected. Thatmeans the relay electromagnet is directly powered from the Arduino's power pin, so the relaymodule and the Arduino circuits are not physically isolated from each other (this is theconfiguration we'll use). Without the jumper cap, you need to provide an independent powersource to power up the relay's electromagnet through the JD-VCC pin. That configurationphysicallyisolates therelays from theArduino withthe module'sbuilt-inopt coupler.

3.11 LM2596VoltageConverter

The LM2596 series of regulators are monolithic integrated circuits that provide all the activefunctionsforastep-down(buck) switching regulator, capableofdriving a 3-A load with

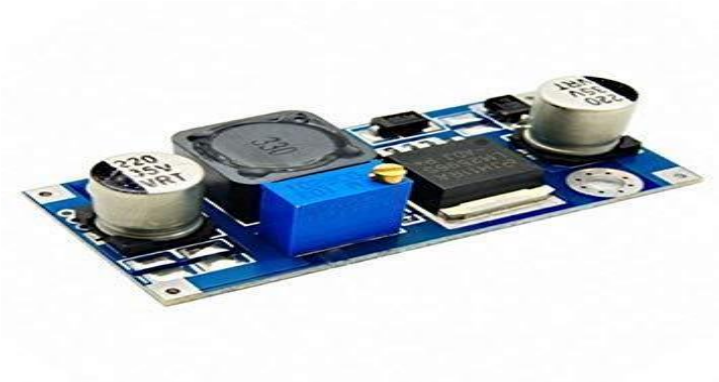


Fig:3.14:LM2596VoltageConverter

Excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5 V, 12 V, and an adjustable output version. Requiring a minimum number of externalcomponents, these regulators are simple to use and include internal frequency compensation,and a fixed frequency oscillator. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lowerfrequency switching regulators. Available in a standard 7-pin TO-220 package with severaldifferentlead bend options, and a7-pinTO-263 surfacemount package.

3.12 CurrentSensor

This current sensor board is based on the Allegro ACS712ELCTR-30A bi-directional hall-effect current sensor chip that detects positive and negative flowing currents in the range ofminus 30 Amps to positive 30 Amps. The board operates at 5V DC and the current flowthrough the sensor is converted toan output voltage starting at 1/2Vcc (or 2.5V) for nocurrent flow and moves up 66mV per amp for positive current or down -66mV per amp fornegativecurrent.



Fig-3.15:CurrentSensor

Description:

- Thecurrentsensor chips:acs712elc-20a;
- Pin5V powersupplyon boardpowerindicator;
- Themodulecanmeasurethepositiveandnegative20amps,correspondingtotheanalogoutput of 100mv / a;
- Notest currentthrough theoutputvoltageis VCC/ 2;
- PCBboard size:31 (mm)x13(mm);

3.13 Wi-FiModule

ESP8266ESP-Wi-fiModule.

Features:

I. 802.11 b / g /n
II. Wi-FiDirect(P2P),Soft-AP
III. IntegratedTCP/ IPprotocolstack
IV. IntegratedTRswitches,say,LNAs,poweramplifiersandmatchingnetworks
V. IntegratedPLL,regulator,DCXOandpowermanagement unit
VI. +19.5 dBm output power in 802.11b mode
VII. Power-downleakagecurrentof<10uA
VIII. 1MBof flashmemory
IX. Theintegratedlowpower32-bitCPUcan beusedasanapplicationprocessor
X. SDIO1.1/ 2.0,SPI, URT
XI. STBC,1 ×1 mmos, 2 ×1 mmos
XII. A-MPDUandA-MSDU sumand 0.4mmdeflectioninterval
XIII. Wakeupand sendpackets at<2mm
XIV. Standbypowerconsumption of<1.0mW(DTIM3)

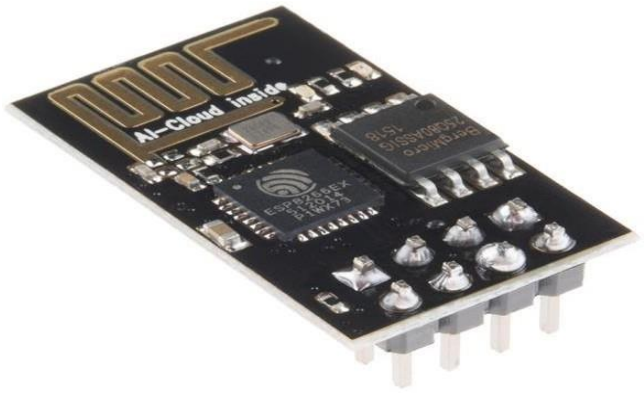


Fig-3.16:WifiModule

3.14 ProjectImplementationResult

Powergridrepresentsoneofthemostpromisingandprominentinternetofthingsapplicationsand Moreefficienttransmissionofelectricityand Quickerrestorationofelectricity after power disturbances. Reduced operations and management costs for utilities,and ultimately lower power costs for consume. A sensor is set at the heap to ascertain current,a circuit is utilized to figure voltage and with these two, power can be computed. Controlqualities are put away in cloud database. A apps facilitating and space is made to get theorders from android application and send them to arduino board at load, which triggers anelectromagnetic transfer to change the condition of the heap. This project permit to get thepowervaluesand controlgadgets from anyplaceon the planet.

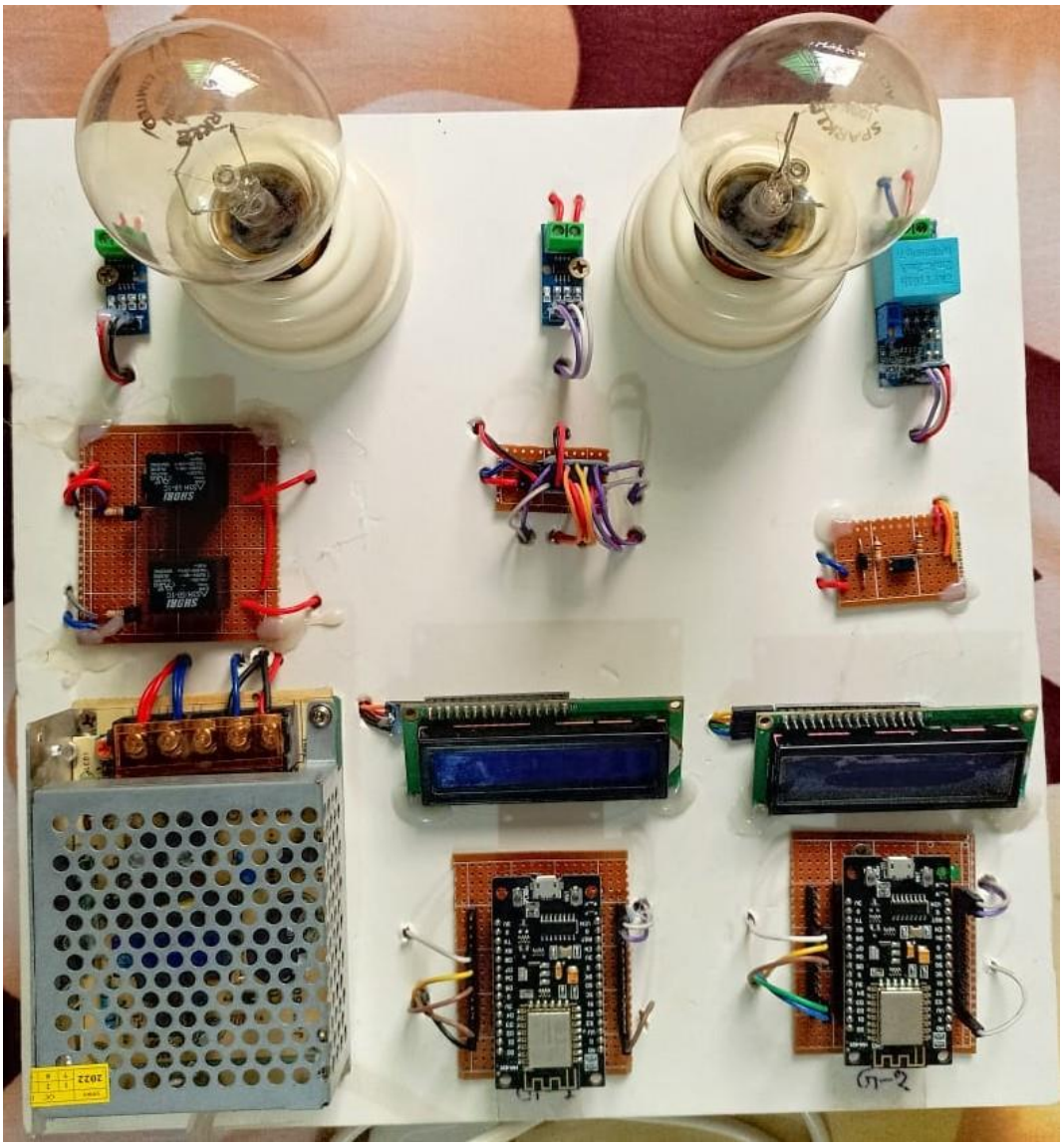


Fig-3.17:Projectpicture

3.15 ListofComponents WithPrice

SLNO	ComponentsName	Quantity	UnitePrice	TotalPrice(BDT)
1	NodeMCU	2	500	1000
2	Adaptor	1	350	350
3	LM2596Buck Module	1	100	100
4	RelayModule	1	150	150
5	CurrentSensor	2	220	440
6	LCDDisplay	2	250	500
7	WifiModule	1	350	350
8	VoltageSensor	1	350	350
9	Optocoupler	1	50	50
10	Load	2	100	200
11	Resistor			10
9	Others	1	500	500
	TotalCost			4,000tk

Table02-ListofComponentsWithPrice

Chapter4:Softwareand Simulation

4.1 Introduction

Software part is one of the main part of the Project. The Algorithm is based on differentconditions&measuringparameters.Totalfunctionofthesystemiscontrolledbythesoftware.Thecodeis written on C.

4.2 SoftwareTools

The software that is used to program the microcontroller is open-source-software and can bedownloaded for free on www.arduino.cc. With this “Arduino software” we can write littleprogramswith themicrocontroller. Theseprograms arecalled “Sketch”.

In the end the sketches are transferred to the microcontroller by USB cable andMore on thatlateron thesubject“programming”.

Installation

Now one after another the Arduino software and the USB driver for the board have to beinstalled.

InstallationandsetupoftheArduinosoftware

1. We have downloaded the Arduino software from www.arduino.cc and installed it on thecomputer (This was NOT connected to the PC). After that we opened the software file andinstalledthe program named arduino.exe.

Twosetupsontheprogramareimportantandshouldbeconsidered.

a) The board that we want to connect has tobe selected on the arduino software.The“ArduinoUno”is hereknown as“Arduino / Genuino Uno”.

b) We have to choose the right “Serial-Port”, to let the Computer know to which port theboardhasbeenconnected.ThatisonlypossibleiftheUSBdriverhasbeeninstalledcorrectly.It can bechecked this way:

At the moment the Arduino wasn’t connected to the PC. If we now choose “Port”, under thefield “Tool”, we will already see one or more ports here (COM1/ COM2/ COM3…). Thequantity of the shown ports doesn't depend on the quantity of the USB ports on the computer.Whenthe board gets connected to the computer,wewill findonemoreport.

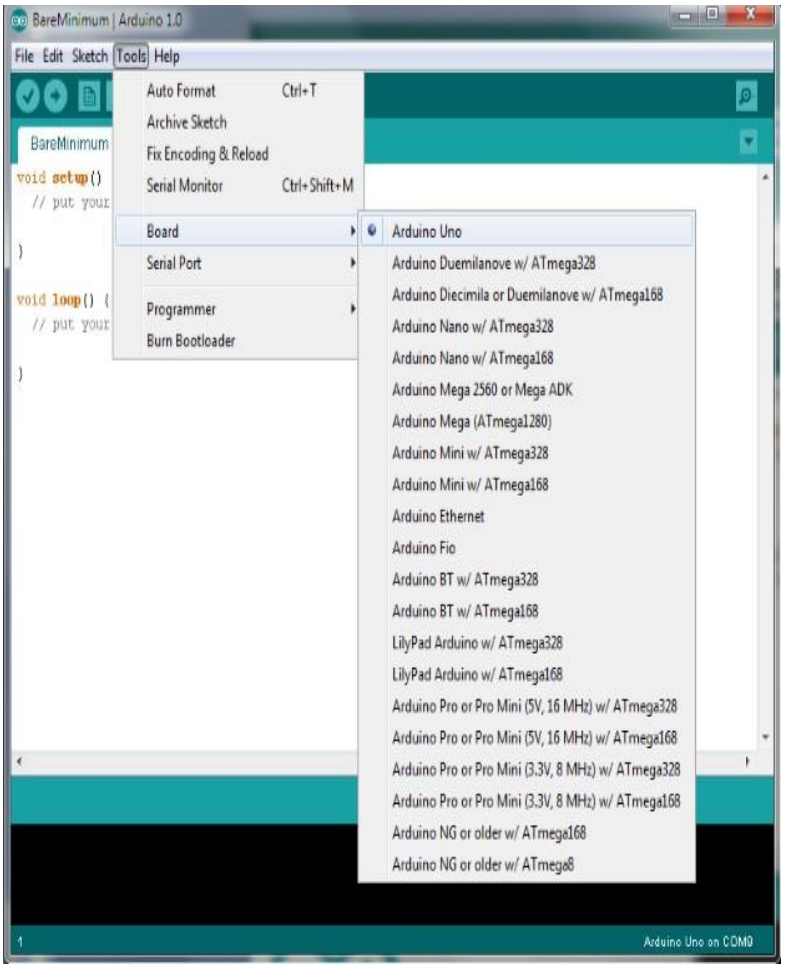


Fig.4.1:Programinstallationprocess

4.3 Programming

Thedevelopment cycleis divided into4 phases:

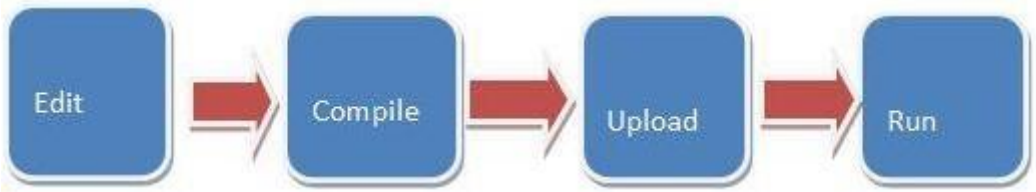


Fig-4.2:Flowchartofthe compilingprocess

Compile: Compilemeanstotranslatethesketchintomachinelanguage,alsoknownasobject.

Code Run: Arduino sketch is executed as soon as terminates the step of uploading on theboard.

4.4 ArduinoProgramDevelopments

- Basedon C++without 80%oftheinstructions.
- Ahandful ofnew commands.
- Programsarecalled'sketches'.
- Sketchesneedtwofunctions:
- voidsetup ()
- Void loop ( )
- Setup()runsfirst andonce.
- loop( )runs overandover, until poweris lost oranewsketchis loaded.

4.5 Proteus8.1

Proteus 8 is best simulation software for various designs with microcontroller. It is mainlypopularbecauseofavailabilityofalmostallmicrocontrollersinit.Soitisahandytooltotestprogramsandembeddeddesignsforelectronicshobbyist.Youcansimulateyourprogramming of microcontroller in Proteus 8 Simulation Software. After simulating yourcircuit in Proteus 8 Software you can directly make PCB design with it so it could be a all inone package for students and hobbyists. So I think now you have a little bit idea about whatisproteus software.

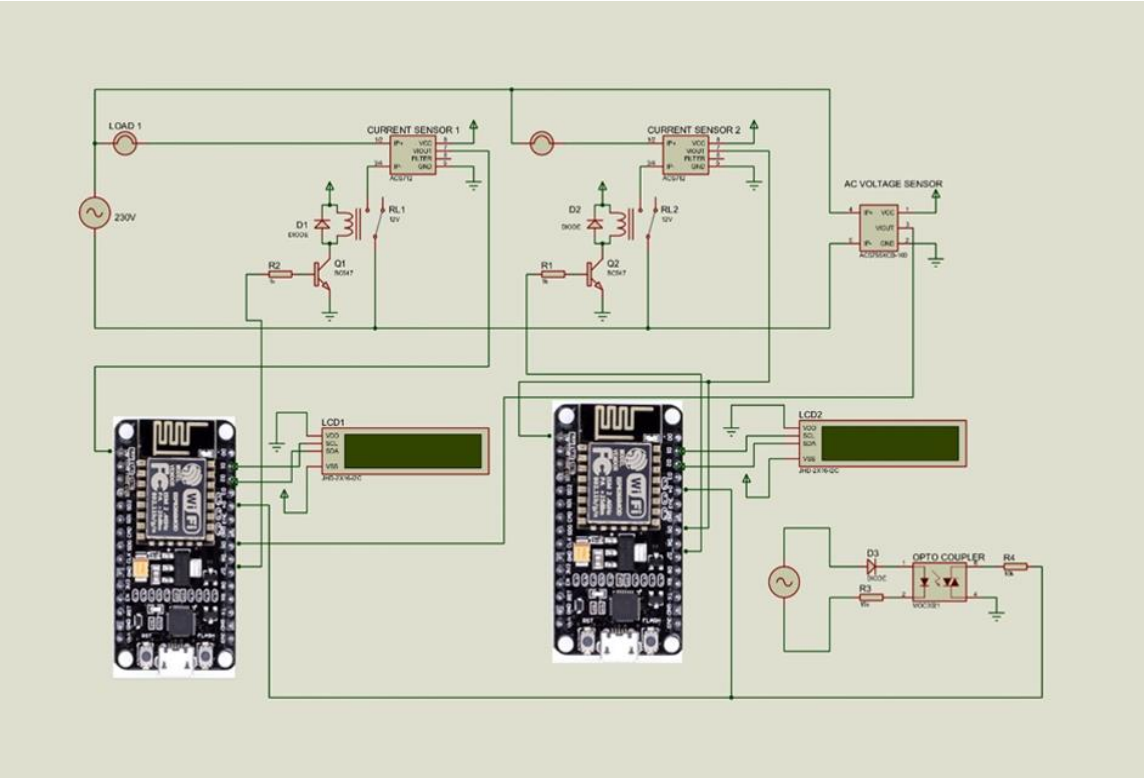


Fig-4.3:User interfaceof proteus8.1

Proteus 7.0 is a Virtual System Modeling (VSM) that combines circuit simulation, animatedcomponents and microprocessor models to co-simulate the complete microcontroller baseddesigns. This is the perfect tool for engineers to test their microcontroller designs beforeconstructing a physical prototype in real time. This program allows users to interact with thedesign using on-screen indicators and/or LEDandLCDdisplaysand,ifattachedtothePC,switchesandbuttons.One of the main components of Proteus 7.0 is the CircuitSimulation -- a product that uses a SPICE3f5 analogue simulator kernel combined with anevent-driven digital simulatorthatallowuserstoutilizeanySPICEmodelbyanymanufacturer.ProteusVSMcomeswith extensivedebuggingfeatures,includingbreakpoints, single steppingandvariabledisplayforaneatdesignpriortohardwareprototyping.In summary, Proteus 7.0 is the program to use when you want to simulate theinteractionbetweensoftwarerunningonamicrocontrollerandanyanalogordigitalelectronicde vice connected to it.

4.6 AndroidApps

For visualization and authentication, in this research work, the team has an Android App. TheAndroid Application does not restrict itself to Thing Speak but also has a Firebase loginsystem. Firebase is a Google-provided API to create a database and fetch from it in real time.It also provides enhanced security for the developed App. Also, it is used for backend supportand other functionalities like data storage, user authentication and hosting. Real-time datavariations are recorded automatically and updates are sent to clients. The HTTP protocolworks on a simple request and response system but firebase is different as its real-timedatabaseusesdata synchronization. Itcanbe usedforuser authenticationpurposes asthe user

credentials are securely stored using bcrypt. Firebase authentication to the android studio isadded using Firebase Android Studio tool. Whenever someone authenticates during the sign-in process either using an Email or Google, it handovers a firebase user object that representsthattheauthentication is successfully doneby theuser.



Fig-4.4:AndroidApps.

This object contains the basic information aboutthe user. Once the firebase API is includedin Android or iOS App, firebase features like Analytics, Authentication, Storage, Messaging,Hosting,Crash reporting,Real-time Databaseetc.

4.7 Discussions

Intelligentoperationsinpowersysteminfrastructurearecrucialneedsofmoderngridsystems. PG is a new and improved grid that solves various problems of efficiency andreliability in the traditional grid. In this paper, the implementation of an IoT based powermonitoring and controlling prototype is presented. Blynk apps is used as a software tool toaccess consumer load data at the remote end. The large scale installation of proposed designrequires to developed cost-effective power sensing and monitoring devices that can be easilyintegrated into the consumer premises. In the future, authors are interested to develop acloud-basedsmart metering system forthedeployment in smart cities.

4.8 Advantages

- Remotemonitoringsystem
- Thelinecanbeclosed at dangerouslevels.
- Voltageandcurrent canbemonitored.
- Lowcost andvery easy toimplement.

4.9 Applications

- PowerGrid.
- Industry.
- Substatio

Chapter5: Conclusions

5.2 Conclusions

A revolution in energy domain is underway, namely the Smart power Grid. Smart power Gridis owner as well as user friendly technology. Authority cancheckcurrent per systemfromany location using internet. Authority can control system power line from internet.

Smartpowergridrepresentsoneofthemostpromisingandprominentinternetofthingsapplications.

More efficient transmission of electricity. Quick errestoration of electricity afterpower disturbances. Reduced operations and management costs for utilities, and ultimatelylowerpower costs for consumers. Time saving technology.

5.2 Futureworks

- Sendingnotificationsviamessageas soonasaproblem iscreated ontheline.

References:

[1] Madhuri G.Hiremath1, Veeresh Pujari2, Dr. BaswarajGadgay. “IOT BasedEnergy Monitoring & Control Devices”, International Journal for Research inApplied Science & Engineering Technology (IJRASET), Volume 5 Issue VI,June2017

[2] Rajiv.K.BhatiaandVarshaBodade,"SmartGridSecurityandPrivacy:Challenges, Literature Survey and Issues", International Journal of AdvancedResearch in Computer Science and Software Engineering, Volume 4, Issue 1,January2014.

[3] MitaliMahadevRaut, 2Ruchira Rajesh Sable, 3Shrutika RajendraToraskar.“InternetofThings(IOT)BasedSmartGrid”,InternationalJournalofEngineering Trends and Technology (IJETT) , Volume 34 Number 1-April2016

[4] StamatisKarnouskos,"ThecooperativeInternetofThingsenabledSmartGrid",SAPResearch,Vincenz-PriessnitzStrasse1,D-76131,Karlsruhe,Germany,2013.

[5] https://en.wikipedia.org/wiki/Liquid-crystal_display

[6] https://www.eeweb.com/companyblog/allegro_microsystems/hall-effect-linear-currentsensor-ic

[7] http://esp8266.net

Appendix:

Program:

```
#defineBLYNK_PRINTSerial


#include<ESP8266_Lib.h>
#include
<BlynkSimpleShieldEsp8266.h>#include
<SoftwareSerial.h>
#include"EmonLib.h"             // Include Emon
Library#include<Wire.h>
#include<LiquidCrystal_I2C.h>

//foresp8266
SoftwareSerialEspSerial(7,8);//RX,TX

charauth[] =
"keN0TNT4BgDsSMyJYhqxqu65EskLTKyn";charssid[]
="student";
charpass[]="iotstudent";

#define ESP8266_BAUD
9600ESP8266wifi(&EspSerial)
;

EnergyMonitoremon1;             // Create an

instancefloatinvolt;


LiquidCrystal_I2Clcd(0x27,20,4);




// define for
Frequencyint input
=12;
inthigh_time;i
ntlow_time;
floattime_period;f
loatfreq;
floatfrequency;


floatpower;
floatsupplyVoltage;
```

```
//variable for current
sensor#defineacs712 A1
```

```
intacspower =5;
float amperage =
0.00;floatmean =0.0;


//current sample
countlong lastsample
= 0;long samplesum =
0;intsampleCount =
0;float vpc =
4.8828125;floatvalue;

//variable for current
sensor2#defineacs7121 A2
intacspower1 =5;
float amperage1 =
0.00;floatmean1 =0.0;


//current sample
countlong lastsample1
= 0;long samplesum1 =
0;int sampleCount1 =
0;float vpc1 =
4.8828125;floatvalue1;


//flag
int flag =
0;intflag1=0;

voidsetup(){

  pinMode(input,
  INPUT);pinMode(2,
  OUTPUT);pinMode(3,
  OUTPUT);digitalWrite(
  2,
  HIGH);digitalWrite(3,HI
  GH);

  Serial.begin(9600);
  lcd.begin();lcd.bac
  klight();

  emon1.voltage(0, 640.25, 1.7);// Voltage: input pin, calibration234.26,

  phase_shiftEspSerial.begin(ESP8266_BAUD);
  delay(10);

  Blynk.begin(auth,wifi,ssid,pass);
```

```
}
```

```
void loop(){

  emon1.calcVI(20,1000);         // Calculate all2000. No.of half wavelengths
(crossings),time-out
  //emon1.serialprint();
                                  //Printoutallvariables(realpower,apparentpower,Vrms,Irms
,powerfactor)



  floatsupplyVoltage= emon1.Vrms;                //extract Vrms into


  Variablehigh_time=pulseIn(input, HIGH);
  low_time=pulseIn(input,LOW);

  time_period = high_time +
  low_time;frequency=1000 /
  time_period;



  if (supplyVoltage<100.00)
  {
   supplyVoltage=0.0;
  }


  if(frequency >=60.0)
  {
   frequency=0.0;
  }


  //currentmeasure1

  for(sampleCount= 0;sampleCount<=1000; sampleCount++)
  {
   samplesum+=(analogRead(acs712) -508);
   //
        sampleCount++;
   delay(1);
  }

  mean=samplesum/ 1000;
  //Serial.println(mean);



  amperage=(mv/ 16);
```

```
samplesum=0;

  Serial.println("amp:"+String(amperage));


//currentmeasure2

for(sampleCount1=0;sampleCount1<=1000;sampleCount1++)
{
  samplesum1+=(analogRead(acs7121) -508);
  //
       sampleCount1++;
  delay(1);
}

mean1=samplesum1/1000;

}


amperage1=(mv1/ 16);



samplesum1=0;

Serial.println("amp1:"+String(amperage1));




Serial.println(supplyVoltage);
Serial.println(frequency);Seri
al.println("");

Blynk.virtualWrite(V0,
supplyVoltage);Blynk.virtualWrite(V1,
frequency);Blynk.virtualWrite(V2,
amperage);Blynk.virtualWrite(V3,
amperage1);


delay(1000);lcd.clear
();lcd.setCursor(0,
0);lcd.print("Voltage
:");
lcd.print(supplyVoltage);
lcd.print("V");

lcd.setCursor(0,
```

```
1);lcd.print("Frequency
:");
```

```
  lcd.print(frequency,
  1);lcd.print("Hz");

  lcd.setCursor(0,2);
  lcd.print("System
  1:");lcd.print(amperag
  e);lcd.print("A");

  lcd.setCursor(0,3);
  lcd.print("System
  2:");lcd.print(amperag
  e1);lcd.print("A");


}
```