**A**

**Project Stage I Report**

**On**

# AUTOMATIC AND INSTANTANEOUS POWER STATION POWER QUALITY MONITORING SYSTEM USING IOT

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**ELECTRICAL AND ELECTRONICS ENGINEERING**


**Submitted by**

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**GURU NANAK INSTITUTIONS TECHNICAL CAMPUS**

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**2024-2025**

# CERTIFICATE

This is to certify that the work embodies in this dissertation entitled **"AUTOMATIC AND INSTANTANEOUS POWER STATION POWER QUALITY MONITORING SYSTEM USUNG IOT"** is being presented with report by **K.SUCHITH PATEL (21WJ1A0229),G.SAISHARAN(22WJ5A0224),I.JAGADEESWAR (22WJ5A0227)** for partial fulfillment for the award of Degree of **Bachelor of Technology** in **Electrical and Electronics Engineering** to **Guru Nanak Institutions Technical Campus (Autonomous)** affiliated to Jawaharlal Nehru Technological University, Hyderabad during the academic Year 2024-2025.

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The training was conducted on **IOT** Technology for the completion of the project titled as **AUTOMATIC AND INSTANTANEOUS POWER STATION POWER QUALITY MONITORING SYSTEM USUNG IOT** in **2024-2025 academic year.** The project has been completed in all aspects.

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# DECLARATION

We declare that this Project stage-I report title **"AUTOMATIC AND INSTANTANEOUS POWER STATION POWER QUALITY MONITORING SYSTEM USUNG IOT"** is the work done by **K.SUCHITH PATEL, G.SAI SHARAN,I.JAGADEESWAR NAIK** bearing roll no **21WJ1A0229, 22WJ5A0224,22WJ5A0227** submitted partial fulfillment for the award of the Degree of Bachelor of Technology in **Electrical and Electronics Engineering** to the Guru Nanak Institutions Technical Campus, Ibrahimpatnam is a record of original work carried out us under the guidance of **Mr.R.SURESH BABU**, Assistant Professor, department of Electrical and Electronics Engineering, and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, due acknowledgement has been made whenever the findings of others have been cited.

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**In all Sincerity,**

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# ABSTRACT

Despite many efforts, Energy crisis is the present-day problem and it is getting worse day by day. To overcome this situation people are finding various energy efficient resources. Among them, power is the main concern which needs to be monitored and controlled. With the rise in power consumption in every part of the world there is a subsequent rise in power theft and over usage of power. This is a serious problem which is being faced by the power utilities. In this paper, a model is designed which aims to control and monitor power consumption of a particular area or sector. The designed model monitors the power consumption of the end users and cut off the power supply when it exceeds the set limit. The device sends the power consumption data to the supplier's blynk server using Internet of Things (IoT) technology. The designed model can be placed before the transmission of the load in each house of that particular area. It consists a meter that generates a continuous unit pulse which can communicate with network through an Internet gateway WI-FI. With the help of internet accessibility, communication will be possible between end-user and the supplier. The supplier can monitor and control the power consumption of the end user from a remote place. Along with that the device sends notification to the supplier about status of power consumed and data sheet will generate using LabVIEW.

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# ABBREVIATIONS

| List of Abbreviations | Abbreviations |
|---|---|
| CPU | Central Processing Unit |
| GPIO | General Purpose Input/Output |
| Interface SDIO | Secure Digital |
| UART | Universal Asynchronous Receiver Transmitter |
| PWM | Pulse Width Modulation |
| Modulation OLED | Organic Light Emitting Diode |
| ADC | Analog to Digital Converter |
| IOT | Internet of Things |

# CHAPTER 1
# INTRODUCTION

## 1.1 GENERAL

Due to fraud of electricity consumers power utilities lose large amount of money every year. Electricity fraud can be define as a dishonest or illegal use of electricity equipment or service with the intention to avoid billing charge. It is difficult to distinguish between honest and fraudulent customers. Realistically, electric utilities will never be able to eliminate fraud. It is possible, however to take measures to detect, prevent and reduce fraud. Investigations are undertaken by electric utility companies to assess the impact of technical losses in generation, transmission and distribution networks, and the overall performance of power networks. The installed capacity of the electricity sector in India is 344.00 Giga Watts as on 30 June 2018, which includes renewable and non renewable sources. The per capita electricity consumption in India in 2016- 2017 was 1,122 kWh. Every year 20-30 % average line loses according to WAPDA Company's loss more than RS.125 billion . India's T&D losses are almost 20% of generation, more than twice the world average and nearly three times large as T&D losses in the United States. Electricity losses are the result of technical inefficiency and theft, but in places with good technical efficiency and low theft, T&D losses generally range between 6% and 8%.

The work in finds the solution for monitoring the power theft happening in and around a particular locality. In analyses the current situation of Chinese building ceramics production lines and the development of the Internet of Things (IoT). The new research has been done for which concern about power consumption and smart prepaid energy meter are discussed. In author proposed the real-time monitoring system for residential energy meter is done using IOT. The significance of the research is to reduce manpower requirements. In author analyzed the solutions currently available for the implementation of urban IoT. At the time of purchasing the meter according to the requirement of customer the limit of meter will be set; in the same way the limit of transformer is also set according to the consumer requirement of the particular area. If the consumer uses the power beyond the limit of the meter in that case they have to pay the penalty. So in this paper we proposed a method to overcome above problem this paper mainly focusing on monitoring and controlling of power in the range of limit of the meter.

The IoT has recently become universal to highlight the vision of a global structure of interconnected physical objects. As a greater number of electricity-consuming products coming into daily lives, such as electrical vehicles (EVs) and advanced heating, ventilation, and air conditioning systems, load demand increases dramatically and power required at high amount.

## 2. EXISTING SYSTEM:

Current power station power quality monitoring systems often rely on manual inspections and periodic measurements, which may not provide real-time data or immediate alerts for power quality issues. This can lead to inefficiencies in power generation and distribution, as well as potential risks to equipment and electrical grids.

## 3. PROPOSED SYSTEM

In this project proposed a power consumption and monitoring system of the area that continuously monitor the consumption of consumer. If this consumption is beyond the limit of the meter in that case it cut off the power supply of the whole area. The whole process is based on the Ohm's law which states that," the electric power in watts associated with a complete electric circuit or a circuit component represents the rate at which energy is converted from the electrical energy of the moving charges to some other form, e.g., heat, mechanical energy, or energy stored in electric fields or magnetic fields".

# CHAPTER 2

# PROJECT DESCRIPTION

## 1. GENERAL INTRODUCTION TO EMBEDDED SYSTEM

An embedded system can be defined as a computing device that does a specific focused job. Appliances such as the air-conditioner, VCD player, DVD player, printer, fax machine, mobile phone etc. are examples of embedded systems. Each of these appliances will have a processor and special hardware to meet the specific requirement of the application along with the embedded software that is executed by
the processor for meeting that specific requirement. The embedded software is also called “firm ware”. The desktop/laptop computer is a general purpose computer. You can use it for a variety of applications such as playing games, *word* processing, accounting, software development and so on. In contrast, the software in the embedded systems is always fixed listed below:

· Embedded systems do a very specific task.

. Embedded systems have very limited resources, particularly the memory. Generally, they do not have secondary storage devices such as the CDROM or the floppy disk. Embedded systems have to work against some deadlines. A specific job has to be completed within a specific time. In some embedded systems, called real-time systems, the deadlines are stringent. Missing a deadline may cause a catastrophe-loss of life or damage to property. Embedded systems are constrained for power. As many embedded systems operate through a battery, the power consumption has to be very low.

· Some embedded systems have to operate in extreme environmental conditions such as very high temperatures and humidity.

## 2.2 APPLICATION AREAS

Nearly 99 per cent of the processors manufactured end up in embedded systems. The embedded system market is one of the highest growth areas as these systems are used in very market segment- consumer electronics, office automation, industrial automation,biomedical engineering, wireless communication, data communication, telecommunications, transportation, military and so on.

**Consumer appliances**:

At home we use a number of embedded systems which include digital camera, digital diary, DVD player, electronic toys, microwave oven, remote controls for TV and air-conditioner.

VCO player, video game consoles, video recorders etc. Today's high-tech car has about 20 embedded systems for transmission control, engine spark control, air-conditioning, navigation etc. Even wristwatches are now becoming embedded systems. The palmtops are powerful embedded systems using which we can carry out many general-purpose tasks such as playing games and word processing.

**Office Automation:**

The office automation products using embedded systems are copying machine, fax machine, key telephone, modem, printer, scanner etc.

**Industrial Automation**:

Today a lot of industries use embedded systems for process control.

These include pharmaceutical, cement, sugar, oil exploration, nuclear energy, electricity generation and transmission. The embedded systems for industrial use are designed to carry out specific tasks such as monitoring the temperature, pressure, humidity, voltage, current etc., and then take appropriate action based on the monitored levels to control other devices or to send information to a centralized monitoring station. In hazardous industrial environment, where human presence has to be avoided, robots are used, which are programmed to do specific jobs. The robots are now becoming very powerful and carry out many interesting and complicated tasks such as hardware assembly.

**Medical Electronics**:

Almost every medical equipment in the hospital is an embedded system.

These equipments include diagnostic aids such as ECG, EEG, blood pressure measuring devices, X-ray scanners; equipment used in blood analysis, radiation, colonoscopy, endoscopy etc. Developments in medical electronics have paved way for more accurate diagnosis of diseases.

**Computer Networking**:

Computer networking products such as bridges, routers, Integrated Services Digital Networks (ISDN), Asynchronous Transfer Mode (ATM), X.25 and frame relay switches are embedded systems which implement the necessary data communication protocols. For example, a router interconnects two networks. The two networks may be running different protocol stacks. The router's function is to obtain the data

packets from incoming pores, analyze the packets and send them towards the destination after doing necessary protocol conversion. Most networking equipments, other than the end systems (desktop computers) we use to access the networks, are embedded systems.

**Telecommunications**:

In the field of telecommunications, the embedded systems can be categorized as subscriber terminals and network equipment. The subscriber terminals such as key telephones, ISDN phones, terminal adapters, web cameras are embedded systems. The network equipment includes multiplexers, multiple access systems, Packet Assemblers Dissemblers (PADs), sate11ite modems etc. IP phone, IP gateway, IP gatekeeper etc. are the latest embedded systems that provide very low-cost voice communication over the Internet.

**Wireless Technologies**:

Advances in mobile communications are paving way for many interesting applications using embedded systems. The mobile phone is one of the marvels of the last decade of the 20'h century. It is a very powerful embedded system that provides voice communication while we are on the move. The Personal Digital Assistants and the palmtops can now be used to access multimedia service over the Internet. Mobile communication infrastructure such as base station controllers, mobile switching centers are also powerful embedded systems.

**Insemination:**

Testing and measurement are the fundamental requirements in all scientific and engineering activities. The measuring equipment we use in laboratories to measure parameters such as weight, temperature, pressure, humidity, voltage, current etc. are all embedded systems. Test equipment such as oscilloscope, spectrum analyzer, logic analyzer, protocol analyzer, radio communication test set etc. are embedded systems built around powerful processors. Thank to miniaturization, the test and measuring equipment are now becoming portable facilitating easy testing and measurement in the field by field-personnel.

**Security:**

Security of persons and information has always been a major issue. We need to protect our homes and offices; and also the information we transmit and store. Developing embedded systems for security applications is one of the most lucrative

businesses nowadays. Security devices at homes, offices, airports etc. for authentication and verification are embedded systems. Encryption devices are nearly 99 per cent of the processors that are manufactured end up in~ embedded systems. Embedded systems find applications in every industrial segment- consumer electronics, transportation, avionics, biomedical engineering, manufacturing, process control and industrial automation, data communication, telecommunication, defense, security etc. Used to encrypt the data/voice being transmitted on communication links such as telephone lines.

**Finance:**

Financial dealing through cash and cheques are now slowly paving way for transactions using smart cards and ATM (Automatic Teller Machine, also expanded as Any Time Money) machines. Smart card, of the size of a credit card, has a small micro-controller and memory; and it interacts with the smart card reader! ATM machine and acts as an electronic wallet. Smart card technology has the capability of ushering in a cashless society. Well, the list goes on. It is no exaggeration to say that eyes wherever you go, you can see, or at least feel, the work of an embedded system.

## 2.3 OVERVIEW OF EMBEDDED SYSTEM ARCHITECTURE

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the 'firmware'. The embedded system architecture can be represented as a layered architecture as shown in Fig. The operating system runs above the hardware, and the application software runs above the operating system. The same architecture is applicable to any computer including a desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system. For small appliances such as remote-control units, air conditioners, toys etc., there is no need *for* an operating system and you can write only the software specific to that application. For applications involving complex processing, it is advisable to have an operating system. In such a case, you need to integrate the application software with the operating system and then transfer the entire software on to the memory chip. Once the software is transferred to the

memory chip, the software will continue to run *for* a long time you don't need to reload new software.

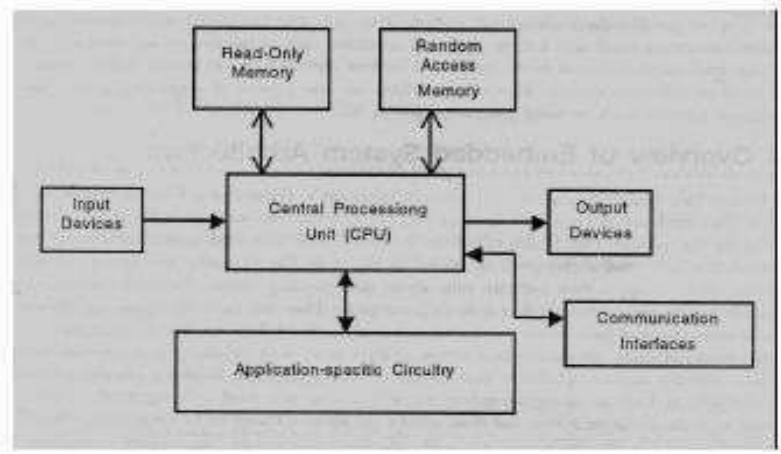



**FIG 2.3**

**Central Processing Unit (CPU):**

The Central Processing Unit (processor, in short) can be any of the following: microcontroller, microprocessor or Digital Signal Processor (DSP). A micro-controller is a low-cost processor. Its main attraction is that on the chip itself, there will be many other components such as memory, serial communication interface, analog-to digital converter etc. So, for small applications, a micro-controller is the best choice as the number of external components required will be very less. On the other hand, microprocessorsare more powerful, but you need to use many external components with them.

**Memory:**

The memory is categorized as Random Access 11emory (RAM) and Read Only Memory (ROM). The contents of the RAM will be erased if power is switched off to the chip, whereas ROM retains the contents even if the power is switched off. So, the firmware is stored in the ROM. When power is switched on, the processor reads the ROM; the program is program is executed.

**Input Devices**:

Unlike the desktops, the input devices to an embedded system have very limited capability. There will be no keyboard or a mouse, and hence interacting with the embedded system is no easy task. Many embedded systems will have a small keypad-you press one key to give a specific command. A keypad may be used to

any input device *for* user interaction; they take inputs *from* sensors or transducers 1'fnd produce electrical signals that are in turn fed to other systems.

**Output Devices**:

The output devices of the embedded systems also have very limited capability. Some embedded systems will have a *few* Light Emitting Diodes (LEDs) *to* indicate the health status of the system modules, or *for* visual indication of alarms. A small Liquid Crystal Display (LCD) may also be used to display *some* important parameters.

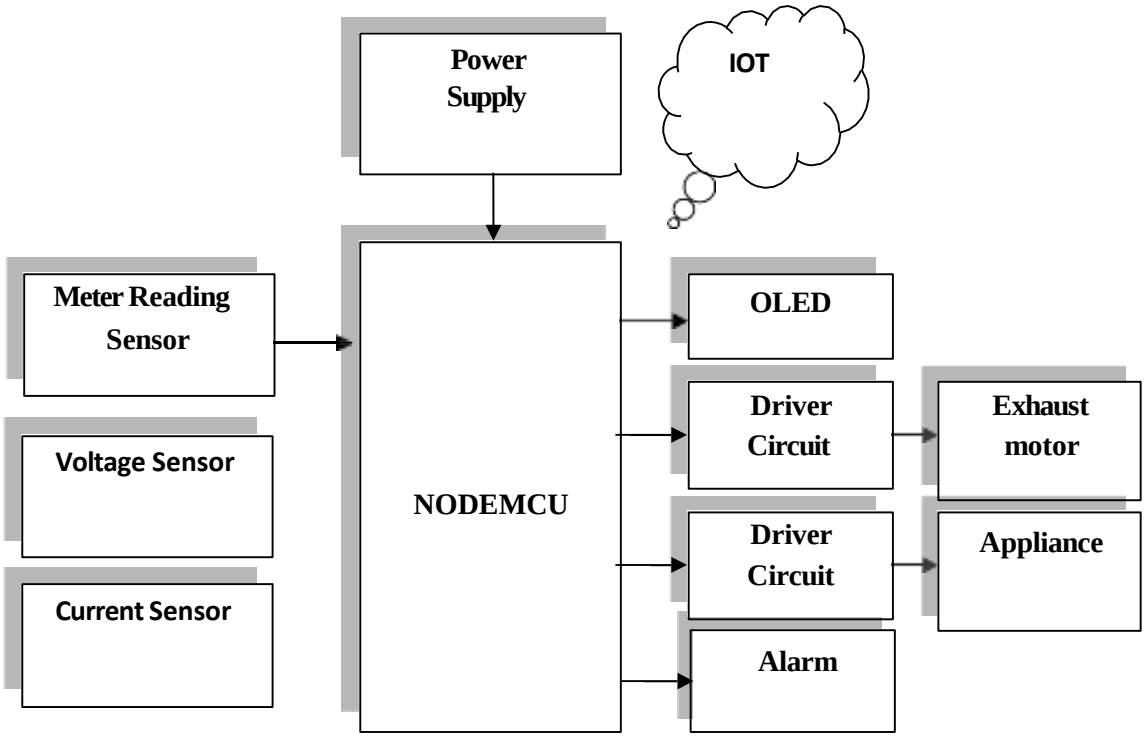
**Communication Interfaces**:

The embedded systems may need to, interact with other embedded systems at they may have to transmit data to a desktop. To facilitate this, the embedded systems are provided with one or a *few* communication interfaces such as RS232, RS422, RS485, Universal Serial Bus (USB), IEEE 1394, Ethernet etc.

**Application-Specific Circuitry**:

Sensors, transducers, special processing and control circuitry may be required fat an embedded system, depending on its application. This circuitry interacts with the processor to carry out the necessary work. The entire hardware has to be given power supply either through the 230 volts main supply or through a battery. The hardware has to design in such a way that the power consumption is minimized

## 2.4 BLOCK DIAGRAM




## 5. MODULES

### 1. Power Supply

The power supply section is the section which provide +5V for the components to work. The ac voltage, typically 220V, is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

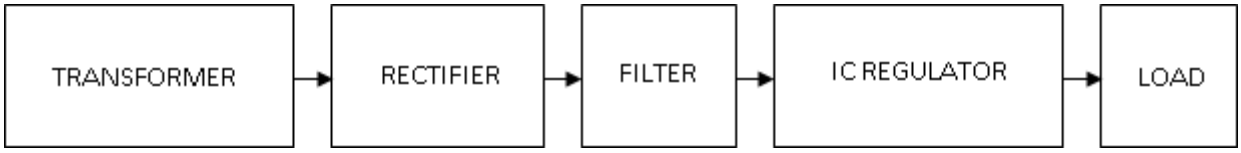



**Fig. 2.5.1** Block Diagram Of Power Supply

### 2.5.2 Transformer

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in India) to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The transformer will step down the power supply voltage (0-230V) to (0- 6V) level. Then the secondary of the potential transformer will be connected to the bridge rectifier, which is constructed with the help of PN junction diodes. The advantages of using bridge rectifier are it will give peak voltage output as DC.

### 3. Rectifier

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC.

### 4. Bridge Rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point. The positive potential at point A will forward bias D3 and reverse bias D4.

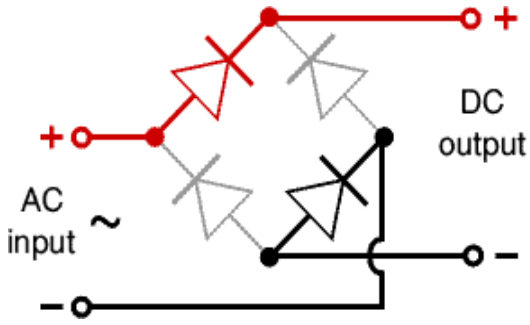



**Fig.2.5.4(a)** Bridge Rectifier

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

i. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below.

ii. The result is still a pulsating direct current but with double the frequency.

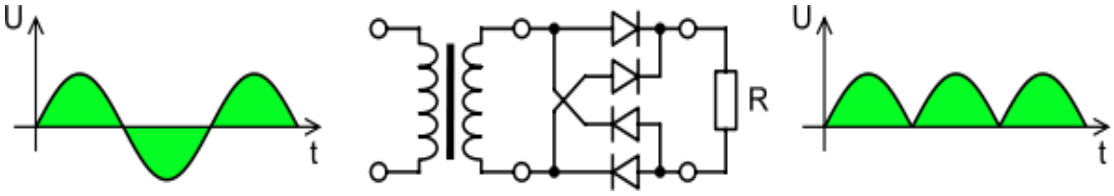



**Fig.2.5.4(b)** Output Waveform Of DC

## 5. Smoothing

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

## 6. Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units containthe circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts totens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

Regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1Amp regulator. They include a hole for attaching a heat sink if necessary.

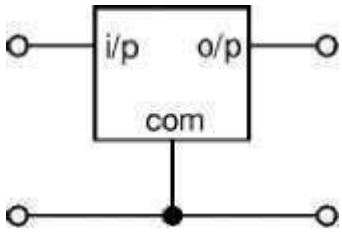



**Fig.2.5.6(a)** Regulator

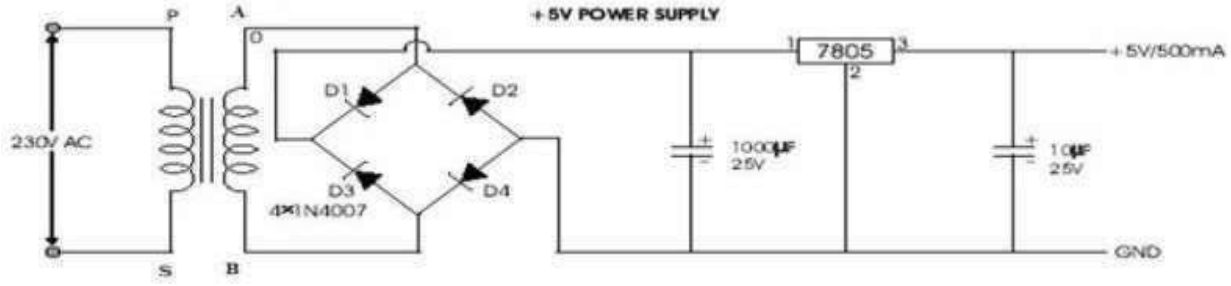



**Fig.2.5.6 (b)** Circuit Diagram Of Power Supply

## 2.6 MICROCONTROLLER

A **Microcontroller** (or **MCU**) is a computer-on-a-chip used electronicdevices. It is a type of microprocessor emphasizing self-sufficiency and cost- effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas a general purpose microprocessor requires additional chips to provide these functions.

**A microcontroller is a single integrated circuit with the following key features:**

- centralprocessing unit - ranging from small and simple 8-bit processorsto sophisticated 32- or 64-bit processors
- input/output interfaces such as serial ports
- peripherals such as timers and watchdog circuits
- RAM for data storage
- ROM, EEPROM or Flash memory for program storage
- clock generator - often an oscillator for a quartz timing crystal

Microcontrollers are inside many kinds of electronic equipment (see embedded system). They are the vast majority of all processor chips sold. Over 50% are "simple" controllers, and another 20% are more specialized digital signal processors (DSPs) (ref?). A typical home in a developed country is likely to have only one or two general-purpose microprocessors but somewhere between one and two dozen microcontrollers. A typical mid range vehicle has as many as 50 or more microcontrollers. They can also be found in almost any electricaldevice: washing machines, microwave ovens, telephones etc.

### 2.6.1 NodeMCU ESP8266

NodeMCU is an open-source Lua based firmware and **development board** specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espresso Systems, and hardware which is based on the ESP-12 module.

**Table 2.6.1 NodeMCU Development Board Pinout Configuration**

| **Pin Category** | **Name** | **Description** |
|---|---|---|
| Power | Micro-USB, 3.3V, GND, Vin | **Micro-USB:** NodeMCU can be powered throughthe USB port<br>**3.3V:** Regulated 3.3V can be supplied to this pin to power board<br>**GND:** Ground pins<br>**Vin:** External Power Supply |
| Control Pins | **EN, RST** | The pin and the button resetsthe microcontroller |
| Analog Pin | A0 | Used to measure analog voltage in the range of 0-3.3V |
| GPIO Pins | GPIO1 to GPIO16 | NodeMCU has 16 general purpose input-output pins on its board |
| SPI Pins | SD1, CMD, SD0, CLK | NodeMCU has four pins available for SPI communication. |
| UART Pins | TXD0, RXD0, TXD2, RXD2 | NodeMCU has two UART interfaces, UART0 (RXD0 & TXD and UART1 (RXD1 & TXD1). UART1 is used to upload t firmware/program. |
| I2C Pins | | NodeMCU has I2C functionality support but due to the inter functionality of these pins, you have to find which pin is I2C. |

**NodeMCU ESP8266 Specifications & Features**

2.6.1.1 Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106

2.6.1.2 Operating Voltage: 3.3V

2.6.1.3 Input Voltage: 7-12V

2.6.1.4 Digital I/O Pins (DIO): 16

2.6.1.5 Analog Input Pins (ADC): 1

2.6.1.6 UARTs: 1

2.6.1.7 SPIs: 1

2.6.1.8 I2Cs: 1

2.6.1.9 Flash Memory: 4 MB

2.6.1.10 SRAM: 64 KB

2.6.1.11 Clock Speed: 80 MHz

2.6.1.12 USB-TTLbased on CP2102 is included onboard, Enabling Plug n Play

2.6.1.13 PCB Antenna

2.6.1.14 Small Sized module to fit smartly inside your IoT projects

**Fig:2.6.1(a)** ESP8266 NodeMCU

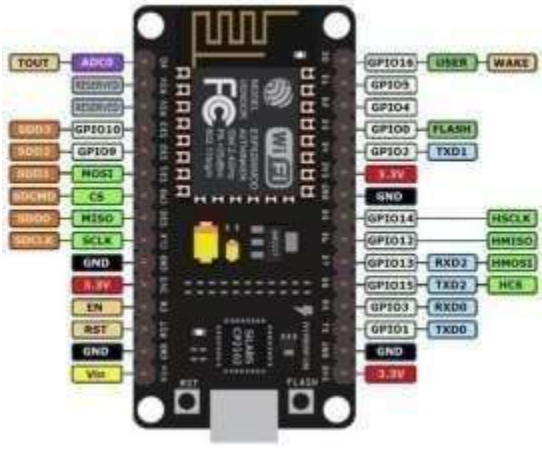



**Fig 2.6.1 (b)**NodeMCU ESP8266 Pinout

## 2. General Purpose Input/Output Interface (GPIO)

ESP8266EX has 17 GPIO pins which can be assigned to various functions by programming the appropriate registers. Each GPIO can be configured with internal pull-up or pull-down, or set to high impedance, and when configured as an input, the data are stored in software registers; the input can also be set to edge-trigger or level trigger CPU interrupts. In short, the IO pads are bi-directional, non- inverting and tristate, which includes input and output buffer with tristate control inputs.

These pins can be multiplexed with other functions such as I2C, I2S, UART, PWM,

IR Remote Control, etc.

## 3. Secure Digital Input/Output Interface (SDIO)

ESP8266EX has one Slave SDIO, the definitions of which are described below. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

Table:2.6.3

| Pin Name | Pin Num | IO | Function Name |
|---|---|---|---|
| SDIO_CLK | 21 | IO6 | SDIO_CLK |
| SDIO_DATA0 | 22 | IO7 | SDIO_DATA0 |
| SDIO_DATA1 | 23 | IO8 | SDIO_DATA1 |
| SDIO_DATA_2 | 18 | IO9 | SDIO_DATA_2 |
| SDIO_DATA_3 | 19 | IO10 | SDIO_DATA_3 |
| SDIO_CMD | 20 | IO11 | SDIO_CMD |

### 2.6.4 Serial Peripheral Interface (SPI/HSPI)

ESP8266EXhas 3 SPIs.
Onegeneral
Slave/Master SPI One
Slave SDIO/SPI

One general Slave/Master HSPI
Functions ofall these pins can be implemented via hardware. The pin definitions are described as below.

**General SPI (Master/Slave)**

Table2.6.4

| Pin Name | Pin Num | IO | Function Name |
|---|---|---|---|
| SDIO_CLK | 21 | IO6 | SPICLK |
| SDIO_DATA0 | 22 | IO7 | SPIQ/MISO |
| SDIO_DATA1 | 23 | IO8 | SPID/MOSI |
| SDIO_DATA_2 | 18 | 109 | SPIHD |
| SDIO_DATA_3 | 19 | IO10 | SPIWP |
| U0TXD | 26 | IO1 | SPICS1 |
| GPIOO | 15 | IO0 | SPICS2 |

### 2.6.5 I2CInterface

| Pin Name | Pin Num | IO | Function Name |
|---|---|---|---|
| MTMS | 9 | IO14 | I2C_SCL |
| GPIO2 | 14 | IO2 | I2C_SDA |

Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized via software programming, the clock frequency reaches 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.

### 2.6.6 I2S Interface

ESP8266EX has one I2S data input interface and one I2S data output interface. I2S interfaces are mainly used in applications such as data collection, processing, and transmission of audio data, as well as the input and output of serial data. For example, LED lights (WS2812 series) are supported. The pin definition of I2S is as below. I2S functionality can be enabled via software programming by using multiplexed GPIOs, and linked list DMA is supported.

### 2.6.7 Table of Universal Asynchronous Receiver Transmitter (UART)

ESP8266EXhas two UART interfaces UART0 and UART, the definitions are as below.

| Pin Type | Pin Name | Pin Num | IO | Function Name |
|---|---|---|---|---|
| UART0 | U0RXD | 25 | IO3 | U0RXD |
| | U0TXD | 26 | IO1 | U0TXD |
| | MTDO | 13 | IO15 | U0RTS |
| | MTCK | 12 | IO13 | U0CTS |
| UART1 | GPIO2 | 14 | IO2 | U1TXD |
| | SD_D1 | 23 | IO8 | U1RXD |

Data transfers to/from UART interfaces can be implemented via hardware. The data transmission speed via UART interfaces reaches 115200 x 40 (4.5 Mbps).

UART0 can be used for communication. It supports fluid control. Since UART1 features only datatransmit signal (Tx), it is usually used for printing log.

### 2.6.8 Pulse-Width Modulation (PWM)

ESP8266EX has four PWM output interfaces. They can be extended by users themselves.

The pin definitions of the PWM interfaces are defined as below.

| Pin Name | Pin Num | IO | Function Name |
|---|---|---|---|
| MTDI | 10 | IO12 | PWM0 |
| MTDO | 13 | IO15 | PWM1 |
| MTMS | 9 | IO14 | PWM2 |
| GPIO4 | 16 | IO4 | PWM3 |

The functionality of PWM interfaces can be implemented via software programming. For example, in the LED smart light demo, the function of PWM is realized by interruption of the timer, the minimum resolution reaches as much as 44 ns. PWM frequency range is adjustable from 1000 μs to 10000 μs, i.e., between 100Hz and 1 kHz. When the PWM frequency is 1 kHz, the duty ratio will be 1/22727, and over 14 bit resolution will be achieved at 1 kHz refresh rate.

### 2.6.9 IR Remote Control

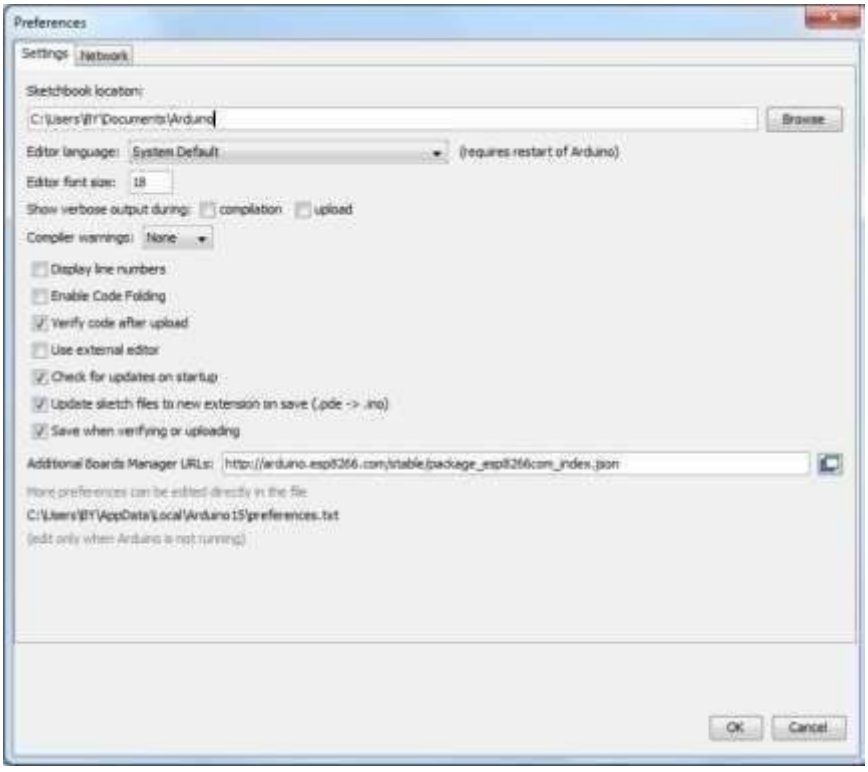
One Infrared remote-controlinterface is defined as below.

| Pin Name | Pin Num | IO | Function Name |
|---|---|---|---|
| MTMS | 9 | IO14 | IR Tx |
| GPIO5 | 24 | IO5 | IR Rx |

The functionality of Infrared remote-control interface can be implemented via software programming. NEC coding, modulation, and demodulation are used by this interface. The frequency of modulated carrier signal is 38 kHz, while the duty ratio of the square wave is 1/3. The transmission range is around 1m which is determined by two factors: one is the maximum value of rated current, the other is internal current-limiting resistance value in the infrared receiver. The larger the resistance value, the lower the current, so is the power, and vice versa. The transmission angle is between 15° and 30° which is determined by the radiation direction of the infrared receiver.Different from other IO interfaces, GPIO16(XPD_DCDC) belongs to the RTC.

**Install the ESP8266 Board Package**

Enter http://arduino.esp8266.com/stable/package_esp8266com_index.json into Additional Board Manager URLsfield in the Arduino v1.6.4+ preferences.




Click 'File' -> 'Preferences' to access this panel.

Next, use the Board manager to install the ESP8266 package.

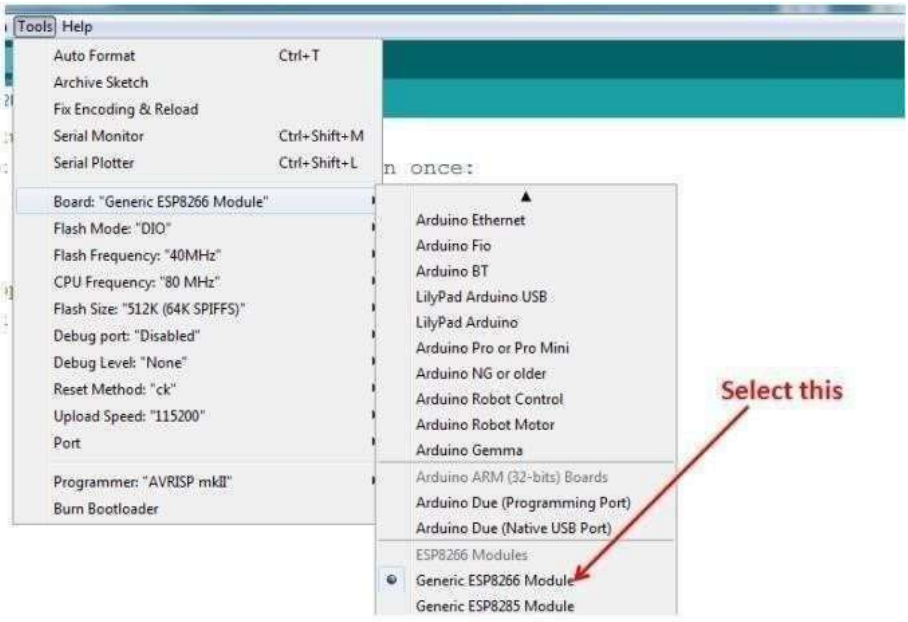
Click 'Tools' -> 'Board:' -> 'Board Manager…' to access this panel.

Scroll down to ‘esp8266 by ESP8266 Community’ and click “Install” button to install the ESP8266 library package.

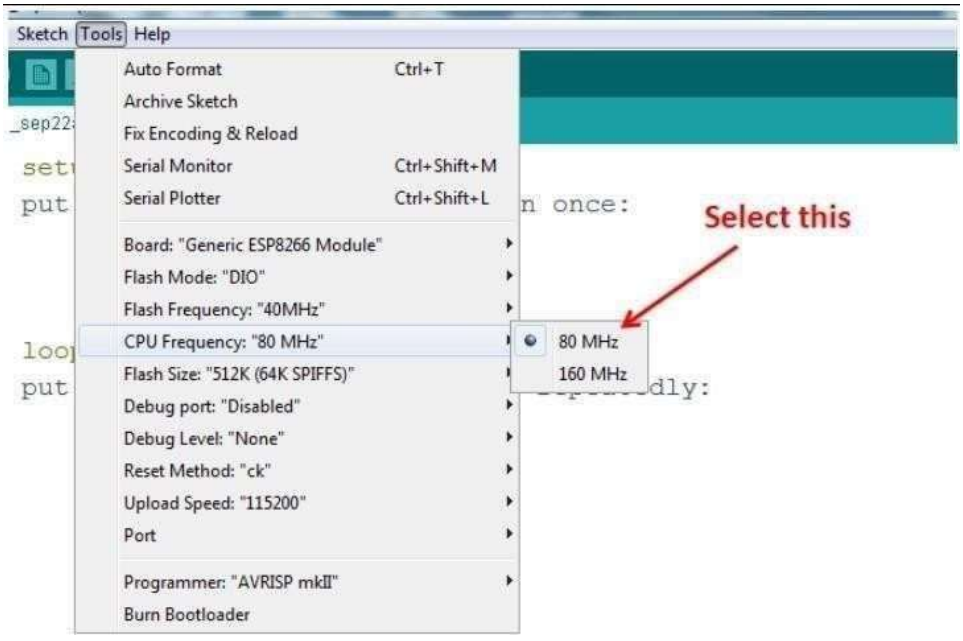
Once installation completed, close and re-open Arduino IDE for ESP8266 library to take effect.

**Setup ESP8266 Support**

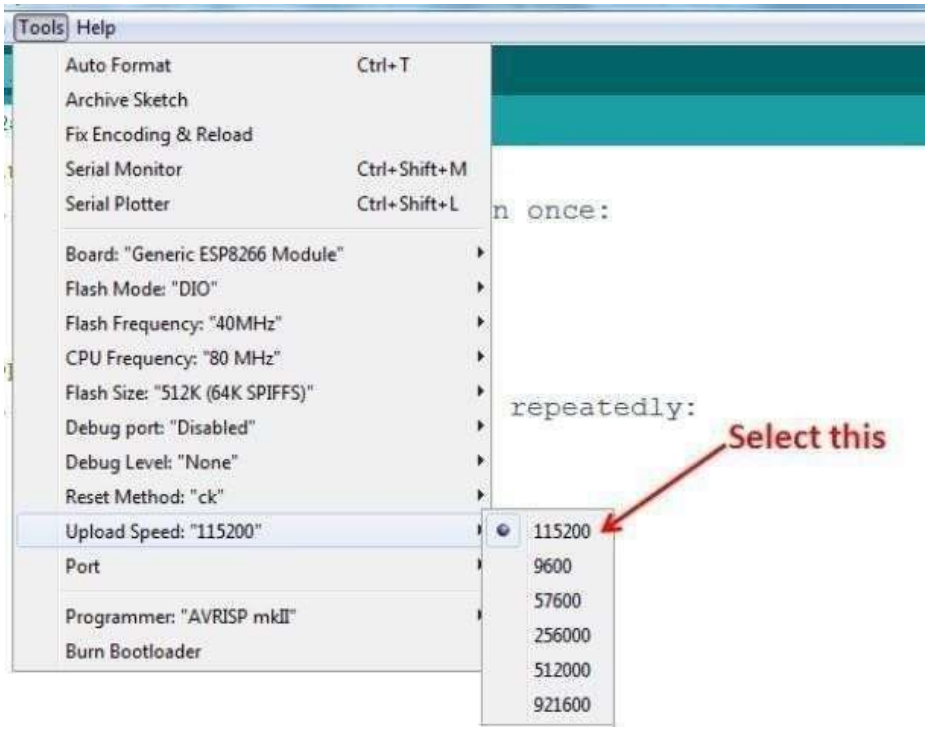
When you've restarted Arduino IDE, select ‘Generic ESP8266 Module’ from the ‘Tools’ -> ‘Board:’ dropdown menu.




Select 80 MHz as the CPU frequency (you can try 160 MHz overclock later)




Select ‘115200’ baud upload speed is a good place to start - later on you can try higher speeds but 115200 is a good safe place to start.




Go to your Windows 'Device Manager' to find out which Com Port 'USB-Serial CH340' is assigned to. Select the matching COM/serial port for your CH340 USB-Serial interface.

## 7. OLED (ORGANIC LIGHT EMITTING DIODES)

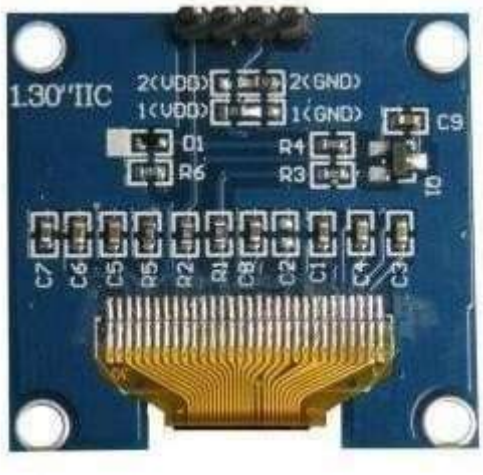
OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight).

OLED displays are not just thin and efficient - they provide the best image quality ever and they can also be made transparent, flexible, foldable and even rollable and stretchable in the future. OLEDs represent the future of display technology!

### 1. OLED vs LCD

An OLED display have the following advantages over an LCD display:

- Improved image quality - better contrast, higher brightness, fuller viewing
- Lower power consumption.
- Simpler design that enables ultra-thin, flexible, foldable and transparent displays
- Better durability - OLEDs are verydurable and can operate in a broadertemperature range


### 2.7.2 The future - flexible and transparent OLED displays

As we said, OLEDs can be used to create flexible and transparent displays. This is pretty exciting as it opens up a whole world of possibilities:

- Curved OLED displays, placed on non-flat surfaces
- Wearable OLEDs

- Transparent OLEDs embedded in windows or car windshdields
- And many more we cannot even imagine today...

Flexible OLEDs are alreadyon the market for many years (in smartphones, wearables and other devices) and since 2019, with the introduction of the Samsung Galaxy Fold, foldable devices are increasing in popularity. In 2019 LG also announced the world's first rollable OLED - its 65" OLED R TV that can roll into its base!

An OLED is made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. Click here for a more detailed view of the OLED technology.

OLED is the best display technology - and indeed OLED panels are used today to create the most stunning TVs ever - with the best image quality combined with the thinnest sets ever. And this is only the beginning, as in the future OLED will enable large rollable and transparent

TVs!

Currently the only company that produces OLED TV panels is LG Display. The Korean display maker is producing a wide range of OLED TV panels, offering these to LG Electronics, Panasonic, Sony, Philips and others.

### 2.7.3 OLED white lighting

OLEDs can be used to create excellent light source. OLEDs offer diffuse area lighting and can be flexible, efficient, light, thin, transparent, color-tunable and more. OLEDs enable new designs and these devices emit healthier light compared to CFLs and LED lighting devices.

### 2.7.4 Specifications

- ✓ Use CHIP No.SH1106
- ✓ Use 3.3V-5V POWER SUPPLY
- ✓ Graphic LCD 1.3” in width with 128x64 Dot Resolution
- ✓ White Display is used for the model OLED 1.3 I2C WHITE and blue Display.

**Table 2.7.4** shows name and function of Pin OLED

| Pin No. | Pin Name | Description |
|---|---|---|
| 1 | VDD | Pin Power Supply for LCD, using 3.3V-5V |
| 2 | GND | Pin Ground |
| 3 | SCK | Pin SCL of I2C Interface |
| 4 | SDA | Pin SDA of I2C Interface |

Example of connecting with Board Arduino This example illustrates how to connect together with Board Arduino, in this case, it is Board ET-BASE AVR EASY328. It is used together with Program Arduino and Library to connect and communicate to Module OLED. - Firstly, install Library“u8glib”; go to Menu Sketch > Include Library > Add.ZIP Library...


Go to Folder Lib_Arduino\u8glib in CD-ROM; next, choose hown in the picturebelow.

## 2.8 IR SENSOR

IR sensor is very useful if you are trying to make a obstacle avoider robot or a line follower. In this project we are going to make a simple IR sensor which can detect a object around 6-7 cm.

**Fig.2.8** IR Sensor

### 2.8.1 Features

- Fast response time
- Because it have goodrange which is fulfill our requirements.
- It is very low cost and can be constructedon general purpose.
- It is of very small size.
- You can increase numbers oftransmitter as you want for goodresult
- Goodimmunity to ambient light and waves are invisible to eyes.

### 2.8.2 Working of IR

Working of IR sensor is very simple and working principle is totally based on change in resistance of IR receiver. Here in this sensor we connect IR receiver in reverse bias so it give very high resistance if it is not exposed to IR light. the resistance in this case is in range of Mega ohms, but when IR light reflected back and fall on IR receiver. The resistance of Rx it comes in range between Kilo ohms to hundred of ohms. We convert this change in resistance to change in voltage . Then this voltage is applied to a comparator IC which compare it with a threshold level. if voltage of sensor is more than threshold then output is high else it is low which can be used directly for microcontroller.

### 2.8.3 Applications

Infrared radiation is the region of the electromagnetic spectrum between microwaves and visible light. In infrared communication an LED transmits the infrared signal as bursts of non- visible light. At the receiving end a photodiode or photoreceptor detects and captures the light pulses, which are then processed to retrieve the information they contain. Some common applications of infrared technology are listed below.

1. Augmentative communication devices
2. Car locking systems
3. Computers
   a. Mouse
   b. Keyboards
   c. Floppy disk drives
   d. Printers
4. Emergency response systems
5. Environmental control systems

a. Windows

b. Doors

c. Lights

d. Curtains

e. Beds

f. Radios

1. Headphones
2. Home securitysystems
3. Navigation systems
4. Signage
5. Telephones
6. TVs, VCRs, CD players, stereos.

## 9. VOLTAGE SENSOR

The Voltage Sensor is a device that converts voltage measured between two points of an electrical circuit into a physical signal proportional to the voltage. Voltage sensor circuit is a combination of various electronic component by using which the accurate voltage value can be achieved. The major component utilize in voltage sensor are potentiometer & ADC.

### 1. Potentiometer

A potentiometer informally a pot, is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. A potentiometer measuring instrument is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.

### 2. Analog To Digital Converter (ADC)

- In many applications data collected from sensor required to convert in digital form.
- The output signal generated from the voltage sensor is analog form. Hence, ADC is
- Being used to convert analog value of voltage sensor into digital value.
- Potentiometer (Variable resistor) is a dynamic resistor whose value can be varied with the help of adjustable knob. With the help of the variable resistor, we can increase or decrease the sensitivity of the voltage sensor which is being
- Interface with ADC.

### 2. Principle Of Use

For voltage measurements, a current proportional to the measured voltage must be passed through an external resistor R, which is selected by the user and installed in series with the primary circuit of the transducer.

### 4. Advantages

Low thermal drift
High immunity to external interference
Low disturbance in common mode.

**Applications**

AC variable speed drives and servo motor drives
Static convertersfor DC motor drives
Batterysupplied applications
Uninterruptible Power Supplies (UPS)

Power supplies for welding

## 10. CURRENT SENSOR

A current sensor is a device that detects and converts current to an easily measured output voltage, which is proportional to the current through the measured path. It can be then utilized to display the measured current in an ammeter or can be stored for further analysis in a data acquisition system or can be utilized for control purpose.

Current measurement is of vital importance in many power and instrumentation systems. Traditionally, current sensing was primarily for circuit protection and control. However, with the advancement in technology, current sensing has emerged as a method to monitor and enhance performance.

### 1. Sensing Principles:

When a current flows through a wire or in a circuit, voltage drop occurs. Also, a magnetic field is generated surrounding the current carrying conductor. Both of these phenomena are made use of in the design of current sensors. Thus, there are two types of current sensing: direct and indirect.

**Direct Sensing:** Direct Sensing involves measuring the voltage drop associated with the current passing through passive electrical components.

**Indirect Sensing:** Indirect Sensing involves measurement of the magnetic field surrounding a conductor through which current passes. protection and supervising circuits, current and voltage regulators, DC/DC converters, ground fault detectors, programmable current sources, linear and switch-

mode power supplies, communications devices , automotive power electronics, motor speed controls and overload protection, etc.

### 2.10.2 Application

Knowing the amount of current being delivered to the load can be useful for wide variety of applications. Current sensing is used in wide range of electronic systems, viz., Battery life indicators and chargers, 4-20 mA systems, over-current

### 2.10.3 Advantages

Cost efficiency

High measurement accuracy

Measurable current range fromvery low to medium

## 2.11 ULN2003

The ULN2003 is a monolithic IC consists of seven NPN darlington transistor pairs with high voltage and current capability. It is commonly used for applications such as relay drivers, motor, display drivers, led lamp drivers, logic buffers, line drivers, hammer drivers and other high voltage current applications. It consists of common cathode clamp diodes for each NPN darlington pair which makes this driver IC useful for switching inductive loads.

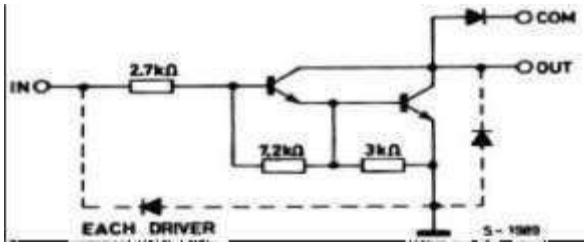



**fig:2.11(a)** ULN2003

The output of the driver is open collector and the collector current rating of each darlington pair is 500mA. Darlington pairs may be paralleled if higher current is required. The driver IC also consists of a 2.7KΩ base resistor for each darlington pair. Thus each darlington pair can be operated directly with TTL or 5V CMOS devices. This driver IC can be used for high voltage applications up to 50V.

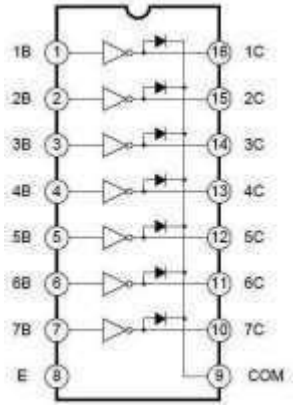



**Fig:2.11(b)** Logic Diagram of ULN2003

Note that the driver provides open collector output, so it can only sink current, cannot source. Thus when a 5V is given to 1B terminal, 1C terminal will be connected to ground via darlington pair and the maximum current that it can handle is 500A. From the above logic diagram we can see that cathode of protection diodes are shorted to 9th pin called COM. So for driving

inductive loads, it must connect to the supply voltage.

## 1. FEATURES

* 500mA rated collector current (Single output)
* High-voltage outputs: 50V
* Inputs compatible with various types of logic.
* Relay driver application

## 12. RELAY

### 1. INTRODUCTION

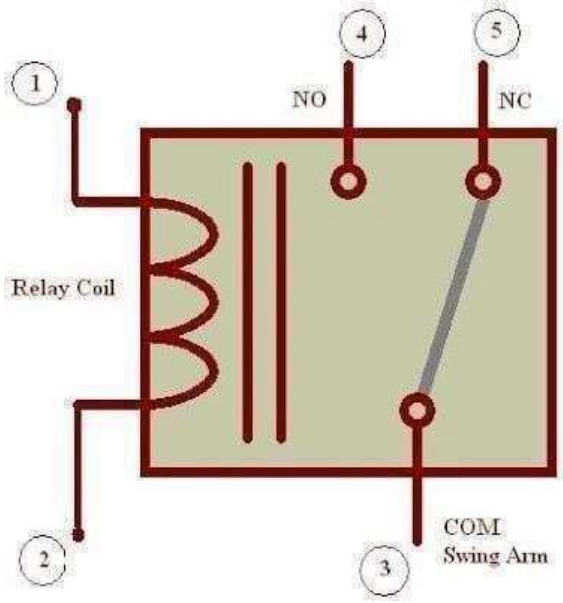
A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

**Fig:2.12.1(a)** Relay

### 2.12.2 History

The first relay was invented by Joseph Henry in 1835. The name relay derives from the French noun relays' that indicates the horse exchange place of the postman. Generally a relay is an electrical hardware device having an input and output gate. The output gate consists in one or more electrical contacts that switch when the input gate is electrically excited. It can implement a decoupled, a router or breaker for the electrical power, a negation, and, on the base of the wiring, complicated logical functions containing and, or, and flip-flop. In the past relays had a wide use, for instance the telephone switching or the railway routing and crossing systems. In spite of electronic progresses (as programmable devices), relays are still used in applications where ruggedness, simplicity, long life and high reliability are important factors (for instance in safety applications)

**2.12(b)Fig. Representation of Relay**



Whenever required power is applied to the inductor coil, the current flowing through the coil generates a magnetic field which is helpful to move the swing terminal and attached it to the normally open (NO) contact. Again when power is OFF, the spring restores the swing terminal position to NC.

### 2.12.3 Advantage of relay:

A relay takes small power to turn ON, but it can control high power devices to switch ON and OFF. Consider an example; a relay is used to control the ceiling FAN at our home. The ceiling FAN may runs at 230V AC and draws a current maximum of 4A. Therefore the power required is 4X230 = 920 watts. Off course we can control AC, lights, etc., depend up on the relay ratings. Relays can be used to control DC motors in ROBOTICs.

## 2.13 DC MOTOR

A DC motor in simple words is a device that converts direct current(electrical energy) into mechanical energy. It's of vital importance for the industry today.

A DC motor is designed to run on DC electric power. Two examples of pure DC designs are Michael Faraday's homo-polar motor (which is uncommon), and the ball bearing motor, which is (so far) a novelty.

By far the most common DC motor types are the brushed and brushless types, which use internal and external commutation respectively to create an oscillating AC current from the DC source—so they are not purely DC machines in a strict sense.

The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives.

**Fig. 2.13** Motor

### 2.13.1 Usage

The DC motor or Direct Current Motor to give it its full title, is the most commonly used actuator for producing continuous movement and whose speed of rotation can easily be controlled, making them ideal for use in applications were speed control, servo type control, and/or positioning is required. A DC motor consists of two parts, a "Stator" which is the stationary part and a "Rotor" which is the rotating part..

## 2.14 BUZZER

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, house hold appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches or sensors connected to a control determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.

In game shows it is also known as a "lockout system," because when one person signals ("buzzes in"), all others are locked out from signalling. Several game shows have large buzzer buttons which are identified as "plungers".

**Fig.2.15** Buzzer

### 2.14.1 USES

Annunciator panels

Electronic metronomes

Game shows

Microwave ovens and other household appliances

Sporting events such as basketball games

Electrical alarms

## 2.15 INTERNET OF THINGS (IOT)

Internet of things (IoT), is another advance technology in IT sector, provides internetworking for numerous of devices such as sensors, actuators, PLCs and other electronic embedded smart devices and controls, and various software's' and provides systems network configuration and connectivity, which enables communication between these numerous devices for information exchanging.

In 1995, "thing to thing" was coined by BILL GATES. In 1999, IoT (Internet of Things) was come up by EPC global. IOT interconnects human to thing, thing to thing and human to human. The goal of IoT is bring out a huge network by combining different types connected devices. IoT targets three aspects Communication, automation, cost saving in a system. IOT empowers people to carry out routine activities using internet and thus saves time and cost making them more productive. IOT enables the objects to be sensed and/or controlled remotely across existing network model. IOT in environmental monitoring helps to know about the air and water quality, temperature and conditions of the soil, and also monitor the intrusion of animals in to the field. IOT can also play a significant role in precision farming to enhance the productivity of the farm for environmental and ambient monitoring: one employing User Datagram Protocol (UDP)- based Wi-Fi communication, one communicating through Wi-Fi and Hypertext Transfer Protocol (HTTP), and a third one using Bluetooth Smart. All of the presented systems provide the possibility of recording data at remote locations and of visualizing them from every device with an Internet connection, enabling the monitoring of geographically large areas. The development details of these systems are described, along with the major differences and similarities between them. The feasibility of the three developed systems for implementing monitoring applications, taking into account their energy autonomy, ease of use, solution complexity, and Internet connectivity facility, was analysed, and revealed that they make good candidates for IoT-based solutions.

As IoT provides interconnectivity among various real-time sensing sensors and PLC and other intelligent devices, therefore this technology will be an entity indicated for the more advance cyber-systems encircling the significant developments, “such as smart grid, smart vehicle systems, smart medical systems, smart cities, and others smart systems.” In early future, IoT has striven to provide advance or smart connectivity for variety of electronic and intelligent equipment’s or devices, IT-based systems and the more advanced services through deploying of various traditional and real-time protocols, networks domains, and system software/hardware applications, which will be an work followed by machine-to-machine technological concept.

Through interconnection of various devices and managing of The internet of things (IoT) is the network of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracyand economic benefit.

When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

IoT is a system defines an environment that encompasses numerous of objects; sensors that connected with these objects are accessible over the Internet through employing of various Networks connections, such wired or wireless. IoT can be able to carry information from various embedded sensors attached with the

systems, and smart transportation systems; and will provide the information sharing facilities in order to make systems and peoples always updated.

## 1. What is the internet of things (IoT)?

The internet of things, or 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.

A *thing* in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol(IP) address and is able to transfer data over a network.

Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.

## 2. How does IoT work?

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.

IoT can also make use of artificial intelligence (AI) and machine learning to aid in making data collecting processes easier and more dynamic.

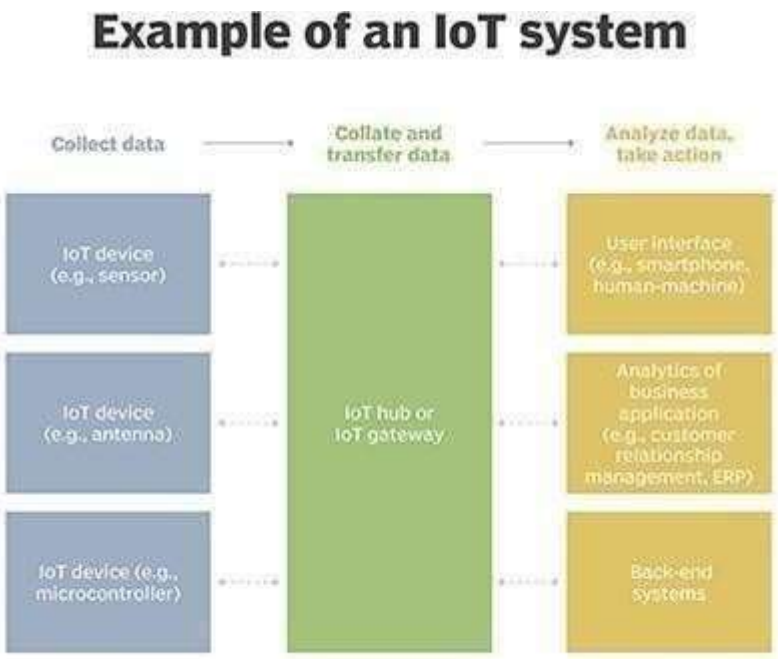



Fig:2.16.2

**3. Why is IoT important?**

The internet of things helps people live and work smarter, as well as gain complete control over their lives. In addition to offering smart devices to automate homes, IoT is essential to business.

IoT provides businesses with a real-time look into how their systems really work, delivering insights into everything from the performance of machines to supply chain and logistics.

IoT enables companies to automate processes and reduce labor costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions.

As such, IoT is one of the most important technologies of everyday life, and it will continue to pick up steam as more businesses realize the potential of connected devices to keep them competitive.

**4. What are the benefits of IoT to organizations?**

The internet of things offers several benefits to organizations. Some benefits are industry- specific, and some are applicable across multiple industries. Some of the common benefits of IoT enable businesses to:

- monitor their overall business processes;
- improve the customer experience (CX);

- enhance employee productivity;
- integrate and adapt business models;
- make better business decisions;
  andgenerate more revenue.

IoT encourages companies to rethink the ways they approach their businesses and gives them the tools to improve their business strategies.

Generally, IoT is most abundant in manufacturing, transportation and utility organizations, making use of sensors and other IoT devices; however, it has also found use cases for organizations within the agriculture, infrastructure and home automation industries, leading some organizations toward digital transformation.

IoT can benefit farmers in agriculture by making their job easier. Sensors can collect data on rainfall, humidity, temperature and soil content, as well as other factors, that would help automate farming techniques.

The ability to monitor operations surrounding infrastructure is also a factor that IoT can help with. Sensors, for example, could be used to monitor events or changes within structural buildings, bridges and other infrastructure. This brings benefits with it, such as cost saving, saved time, quality-of-life workflow changes and paperless workflow.

A home automation business can utilize IoT to monitor and manipulate mechanical and electrical systems in a building. On a broader scale, smart cities can help citizens reduce waste and energyconsumption.

IoT touches every industry, including businesses within healthcare, finance, retail and manufacturing.

### 2.15.5 What are the pros and cons of IoT?

Some ofthe advantages of IoT include the following:

- Ability to access information fromanywhere at any time on any device.
- Transferring data packetsover a connected network saving time and money.
- Automating tasks helping to improve the quality of a business's services.
- The need for human intervention.

Enterprises may eventually have to deal with massive numbers.

**IoT standards and frameworks**

There are several emerging IoT standards, including the following:

IP**v6 over Low-Power Wireless Personal Area Networks** is an open standard defined by the Internet Engineering Task Force (IETF). The 6LoWPAN standard enables any low-power radio to communicate to the internet,

**ZigBee** is a low-power, low-data rate wireless network used mainly in industrial settings. ZigBee is based onthe Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 standard. The ZigBee Alliance created Dotdot, the universal language IoT

In healthcare, IoT offers many benefits, including the ability to monitor patients more closely using an analysis of the data that's generated. Hospitals often use IoT systems to complete tasks

such as inventory management for both pharmaceuticals and medical instruments. Smart buildings can, for instance, reduce energy costs using sensors that detect how many occupants are in a room. The temperature can adjust automatically -- for example, turning the air conditioner on if sensors detect a conference room is full or turning the heat down if

everyone in the office has gone home.

In agriculture, IoT-based smart farming systems can help monitor, for instance, light, temperature, humidity and soil moisture of crop fields using connected sensors. IoT is also instrumental in automating irrigation systems.

In a smart city, IoT sensors and deployments, such as smart streetlights and smart meters, can help alleviate traffic, conserve energy, monitor and address environmental concerns, and improve sanitation.

### 2.15.6 IoT security and privacy issues

The internet of things connects billions of devices to the internet and involves the use of billions of data points, all of which need to be secured. Due to its expanded attack surface, IoT security and IoT privacy are cited as major concerns.

In 2016, one of the most notorious recent IoT attacks was Mirai, a botnet that infiltrated domain name server provider Dyn and took down many websites for an extended period of time in one of the biggest distributed denial-of-service (DDoS) attacks ever seen. Attackers gained access to the network by exploiting poorly secured IoT devices.

Because IoT devices are closely connected, all a hacker has to do is exploit one vulnerability to manipulate all the data, cybercriminals.

Additionally, connected devices often ask users to input their personal

Hackers aren't the only threat to the internet of things; privacy is another major concern for IoT users. For instance, companies that make and distribute consumer IoT devices could use those devices to obtain and sell users' personal data.

Beyond leaking personal data, IoT poses a risk to critical infrastructure, including electricity, transportation and financial services.

# CHAPTER 3

# SOFTWARE SPECIFICATION

## 1. Arduino Integrated Development Environment

Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

## 1. Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

NB: Versions of the Arduino Software (IDE) prior to 1.0 saved sketches with the extension .pde. It is possible to open these files with version 1.0, you will be prompted to save the sketch with the .ino extension on save.

*Verify*

Checks your code for errors compiling it.

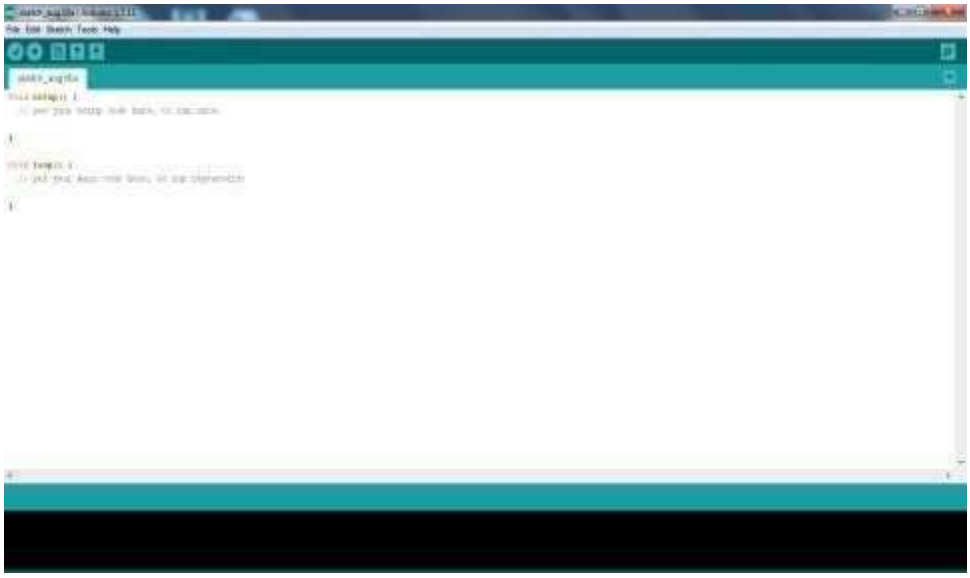
*Upload*

Compiles your code and uploads it to the configured board. See uploading below for details.

Note: If you are using an external programmer with your board, you can hold down the "shift" key on your computer when using this icon. The text will change to "Upload using Programmer"

*New*

Creates a new sketch.



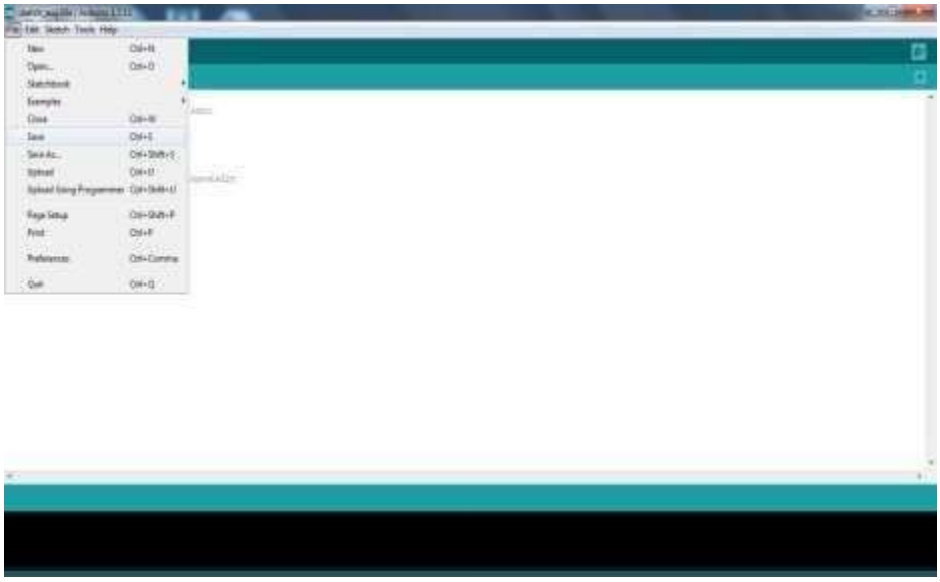
*Open*

Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content.

Note: due to a bug in Java, this menu doesn't scroll; if you need to open a sketch late in the list, use the File | Sketchbookmenu instead.

*Save*

Saves your sketch.



Serial Monitor

Opens the serial monitor.

Additional commands are found within the five menus: File, Edit, Sketch, Tools, Help. The menus are context sensitive, which means only those items relevant to the work currently being carried out are available.

### 3.1.2 FILE

- **New**

Creates a new instance of the editor, with the bare minimum structure of a sketch already in place.

- **Open**

Allows to load a sketch file browsing throughthe computer drives and folders.

- **Open Recent**

Providesa short list ofthe most recent sketches, readyto be opened.

- **Sketchbook**

Shows the current sketches within the sketchbook folder structure; clicking on any name opens the corresponding sketch in a new editor instance.

- **Example**

Any example provided by the Arduino Software (IDE) or library shows up in this menu item. All the examples are structured in a tree that allows easy access by topic or library.

- **Close**

Closes the instance ofthe Arduino Softwarefromwhich it is clicked.

- **Save**

Saves the sketch with the current name. If the file hasn't been named before, a name will be provided in a "Save as.." window.

- **Save as**...

Allows to save the current sketch with a different name.

- **Page Setup**

It showsthe Page Setup window for printing.

- **Print**

Sends the current sketch to the printer according to the settings defined in Page Setup.

- **Preferences**

Opens the Preferences window where some settings of the IDE may be customized, as the language of the IDE interface.

- **Quit**

Closes all IDE windows. The same sketches open when Quit was chosen will be automatically reopened the next time you start the IDE.

### 3.1.3 EDIT

- **Undo/Redo**

Goes back of one or more steps you did while editing; when you go back, you may go forward with Redo.

- **Cut**

Removes the selected text from the editor and places it into the clipboard.

- **Copy**

Duplicates the selected text in the editor and places it into the clipboard.

- **Copy for Forum**

Copies the code of your sketch to the clipboard in a form suitable for posting to the forum, complete with syntax coloring.

- **Copy as HTML**

Copies the code of your sketch the clipboard as HTML, suitable for embedding in web pages.

- ***Paste***

Puts the content of the clipboard at the cursor position, in the editor.

- **Select All**

Selects and highlights the whole content of the editor.

- **Comment/Uncomment**

Puts or removes the // comment marker at the beginning of each selected line.

- **Increase/Decrease Indent**

Adds or subtracts a space at the beginning of each selected line, moving the text one space on the right or eliminating a space at the beginning.

- **Find**

Opens the Find and Replace window where you can specify text to search inside the current sketch according to several options.

- **Find Next**

Highlights the next occurrence - if any - of the string specified as the search item in the Find window, relative to the cursor position.

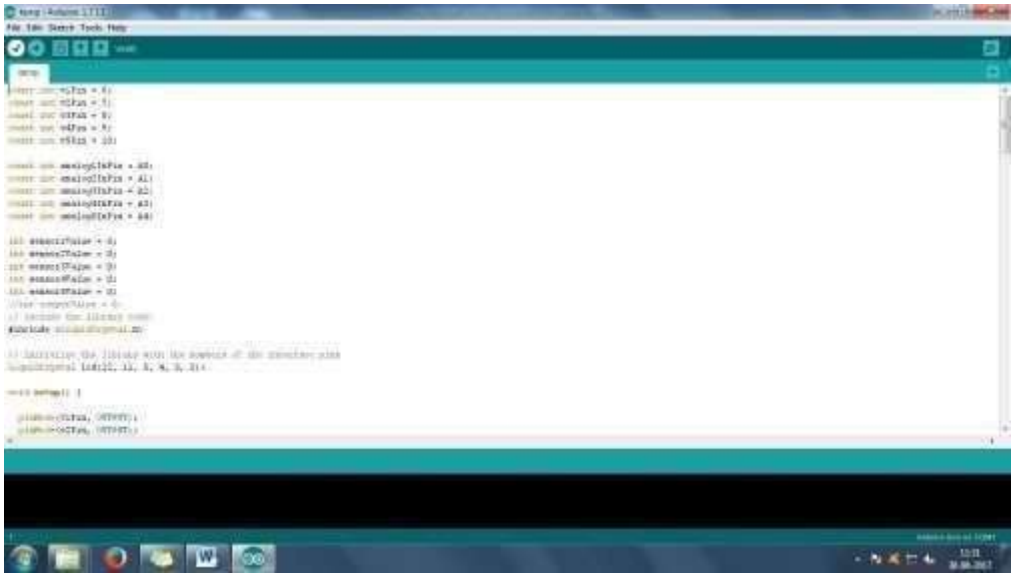
- **Find Previous**

Highlights the previousoccurrence - if any - ofthe string specified as the search item in the Find window relative to the cursor position.

### 3.1.4 SKETCH

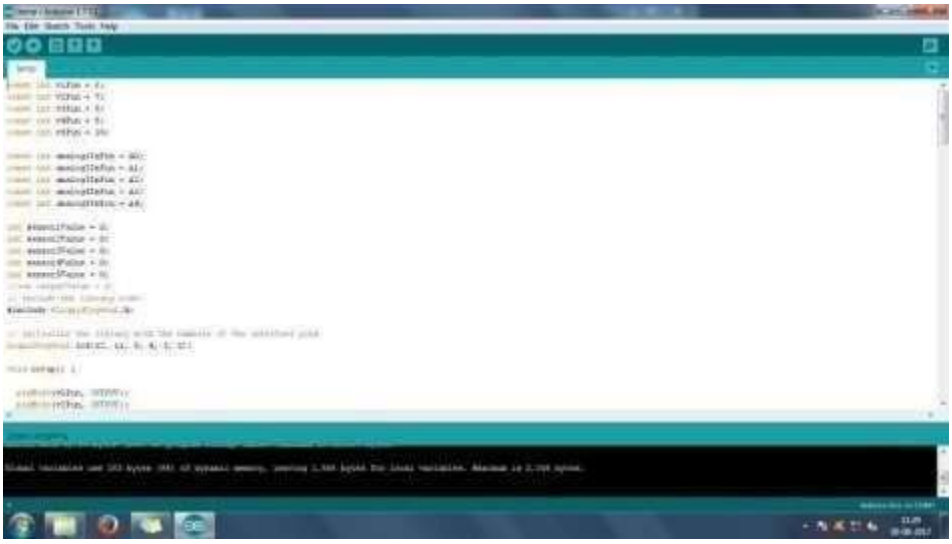
- **Verify/Compile**

Checks your sketchfor errorscompiling it; it will report memory usage for code and variables in the console area.



- **Upload**

Compiles and loads the binary file onto the configured boardthroughthe configured Port.



- **Upload Using Programmer**

This will overwrite the bootloader onthe board; you will need to use Tools > Burn Bootloader to restore it and be able to Upload to USB serial port again. However, it allows you to use the full capacity of the Flash memory for your sketch. Please note that this command will NOT burn the fuses. To do so a *Tools -> Burn Bootloader* command must be executed.

- **Export Compiled Binary**

Saves a .hex file that may be kept as archive or sent to the board using other tools.

- **Show Sketch Folder**

Opens the current sketch folder.

- **Include Library**

Adds a library to your sketch by inserting #include statements at the start of your code. For more details, see libraries below. Additionally, from this menu item you can access the Library Manager and import new libraries from .zip files.

- **Add File...**

Adds a source file to the sketch (it will be copied from its current location). The new file appears in a new tab in the sketch window. Files can be removed from the sketch using the tab menu accessible clicking on the small triangle icon below the serial monitor one on the right side o the toolbar.

### 3.1.5 TOOLS

- **Auto Format**

This formats your code nicely: i.e. indents it so that opening and closing curly braces line up, and that the statements inside curly braces are indented more.

- **Archive Sketch**

Archives a copy of the current sketch in .zip format. The archive is placed in the same directory as the sketch.

- **Fix Encoding & Reload**

Fixes possible discrepancies between the editor char map encoding and other operating systems char maps.

- **Serial Monitor**

Opens the serial monitor window and initiates the exchange of data with any connected board on the currently selected Port. This usually resets the board, if the board supports Reset over serial port opening.

- **Board**

Select the board that you're using. See below for descriptions ofthe various boards.

- **Port**

This menu contains all the serial devices (real or virtual) on your machine. It should automatically refresh every time you open the top-level tools menu.

- **Programmer**

For selecting a harware programmer when programming a boardor chip and not using the onboard USB-serial connection. Normally you won't need this, but if you're burning a bootloader to a new microcontroller, you will use this.

- **Burn Bootloader**

The items in this menu allow you to burn a bootloader onto the microcontroller on an Arduino board. This is not required for normal use of an Arduino or Genuino board but is useful if you purchase a new ATmega microcontroller (which normally come without a bootloader). Ensure that you've selected the correct board from the Boards menu before burning the bootloader on the target board. This command also set the right fuses.

**Help**

Here you find easy access to a number of documents that come with the Arduino Software (IDE). You have access to Getting Started, Reference, this guide to the IDE and other documents locally, without an internet connection. The documents are a local copy of the online ones and may link back to our online website.

- **Find in Reference**

This is the only interactive function of the Help menu: it directly selects the relevant page in the local copyof the Reference for the function or command under the cursor.

### 3.2 SKETCHBOOK

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File

>Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog.

Beginning with version 1.0, files are saved with a .ino file extension. Previous versions .pde extension. You may still open .pde named files in version 1.0 and later, the software will automatically rename the extension to .ino.

Tabs, Multiple Files, and Compilation
Allows you to manage sketches with more than one file (each of which appears in its own tab). These can be normal Arduino code files (no visible extension), C files (.c extension), C++ files

(.cpp), or header files (.h).

### 3.3 UPLOADING

Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. The boards are described below. On the Mac, the serial port is probably something like /dev/tty.usbmodem241 .

COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should be /dev/ttyACMx , /dev/ttyUSBx or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre- Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is

complete, or show an error.

When you upload a sketch, you're using the Arduino bootloader, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The bootloader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts(i.e. when the board resets).

### 3.4 LIBRARIES

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch Import Library menu. This will insert one or more #include statements at the topof the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #includestatements from the top of your code.

There is a list of libraries in the reference. Some Others libraries are included with the Arduino software can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third- party library.

To write your own library, see this tutorial.

Third-Party Hardware

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, bootloaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "arduino" as the sub-directory name or you'll override the built-in Arduino platform.) To uninstall, simply delete its directory.

For details on creating packages for third-party hardware, see the Arduino IDE 1.5 3rd party Hardware specification.

## 5. SERIAL MONITOR

Displays serial data being sent from the Arduino or Genuino board (USB or serial).

Send data to the board, enter text and click on the "send" button or press enter. Choose the baud rate from the drop-down that matches the rate passed to Serial.begin in your sketch. Note that on Windows, Mac or Linux, the Arduino or Genuino board will reset (rerun your sketch execution to the beginning) when you connect with the serial monitor.

You can also talk to the board from Processing, Flash, MaxMSP, etc.

## 6. PREFERENCES

Some preferences can be set in the preferences dialog (found under the Arduino menu on the Mac, or File on Windows and Linux). The rest can be found in the preferences file, whose location is shown in the preference dialog.

### 1. Language Support


Since version 1.0.1, the Arduino Software (IDE) has been translated into 30+ different languages. By default, the IDE loads in the language selected by your operating system. (Note: on Windows and possibly Linux, this is determined by the locale setting which controls currency and date formats, not by the language the operating system is displayed in.)

### 3.6.2 Boards

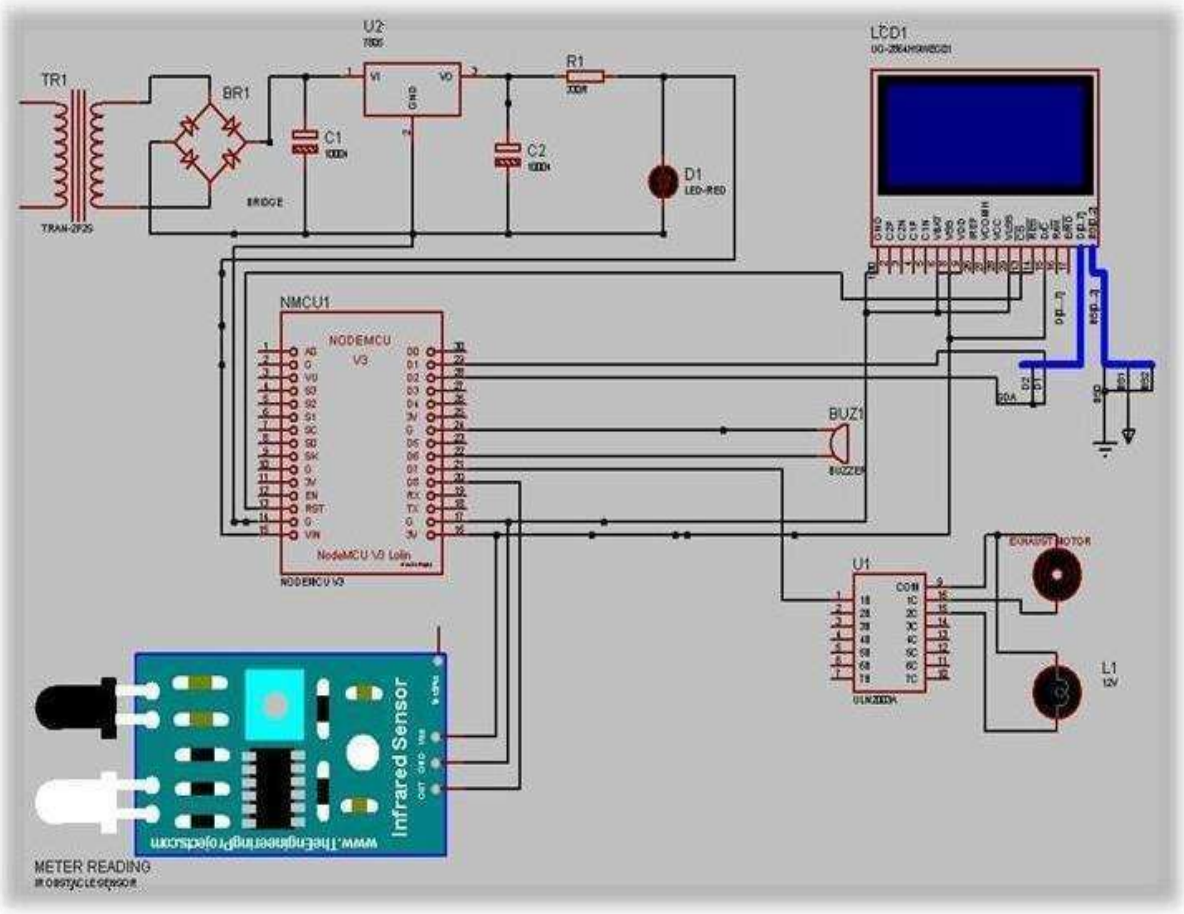
If you would like to change the language manually, start the Arduino Software (IDE) and open the Preferences window. Next to the Editor Language there is a dropdown menu of currently supported languages. Select your preferred language from the menu, and restart the software to use the selected language. If your operating system language is not supported, the Arduino Software (IDE) will default to English.

You can return the software to its default setting of selecting its language based on your operating system by selecting System Default from the Editor Language drop-down. This setting will take effect when you restart the Arduino Software.

# CHAPTER-4

# IMPLEMENTATION

## 4.1 CIRCUIT DIAGRAM



# CHAPTER-5

# OUTPUT

## 5.1 OUTPUT SCREEN SHOTS

- The components used are Microcontroller, sensors, Wi-Fi module, power supply
- Display module, Breadboard connecting wires.
- Connect the power supply to the microcontroller.
- Install the firmware in the system for communication.
- Connect the Sensors, Buzzer and LED on Breadboard.
- Dump the Code in Node MCU Controller to control the Sensors, to process the data and to transfer the data.
- Check the Sensors detects meter reading accurately.
- The Sensors will detect the meter reading and transfer data through Wi-Fi in an application called things speak.
- From that application we can know the meter reading.
- We can also observe the data in OLED displayed at the meter reading.

# CHAPTER 6
# CONCLUSION

With the help of designed model power consumption of a customer is monitored. When the user exceeds his limit of power consumption the supply of power will cut off automatically. The usage of every consumer in the region or sector is sent to the blynk server. Supplier will be notified about the power consumption of the entire region or sector. The supplier can monitor and control the power usage of the user as well as the entire region. The power consumption data sheet of the entire region is generated and analyzed using LabVIEW. If the generated data is provided to the customers, they can compare their usage with the data sheet. So this will help to identify the fraudulent user who is stealing the user's power by direct hooking method. As the Indian Government has also proposed formation of Smart Cities which will have an effective energy management, transportation, waste disposal and resource conservation strategy using primarily Internet of Things. This wireless IoT based technique is much useful to detect the stealing of the electricity worldwide. So in this work variable voltage and variable power will set according to electricity board section as well as it provide safety as the limit of meter will change by the authorized person

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5 Harsha Khandel , Suchitra Pandey , D. Reynolds , 2017, A Review on IOT Based Power Theft Detection and Control Systems, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering Vol. 5, Issue 9.

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