A

Project report on

"SMART GARBAGE DUSTBIN MANAGEMENT USING IOT"

Submitted in partial fulfilment of the Requirements for the award of the Degree of

BACHELOR OF TECHNOLOGY

In

ELECTRONICS & COMMUNICATION ENGINEERING

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

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CERTIFICATE

This is to Certify that the Main Project Report Entitled

"SMART GARBAGE DUSTBIN MANAGEMENT USING IOT"

Being Submitted by

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In Partial Fulfilment of the requirements for the award of the Degree of the Bachelor of Technology in **ELECTRONICS & COMMUNICATION ENGINEERING**. It is Record of Bonafide work, Carried out by them under esteemed guidance and supervision of

Dr.R. RAMAN, M.Tech,PhD

Signature Of the Project Guide	**Signature Of the Head of the Department**
Dr.R. RAMAN, M.Tech,PhD	**Dr. G. RAMA KRISHNA, M.Tech, PhD**

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DECLARATION

We here By Declare that the discussion entitled "**SMART GARBAGE DUSTBIN MANAGEMENT USING IOT**" being submitted by us towards the partial fulfilment of the degree of Bachelor of Technology in the Electronics & Communication Engineering is a Project work carried by us under the supervision of **Dr. R. Raman** and have not been submitted anywhere else.

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ABSTRACT

Pictures of garbage bins being overfull and the garbage being spilled out from the bins can be seen all around. This leads to various diseases as large number of insects and mosquitoes breed on it. A big challenge in the urban cities is solid waste management. Hence, smart dustbin is a system which can eradicate this problem or at least reduce it to the minimum level

This project IOT Garbage Monitoring system is a very innovative system which will help to keep the cities clean. This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins via a Blynk based IOT Application. For this the system uses ultrasonic sensors placed over the bins to detect the garbage level and compare it with the garbage bins depth. The system makes use of Arduino microcontroller board, LCD screen, WIFI modem – Node MCU for sending data and a buzzer. The LCD screen is used to display the status of the level of garbage collected in the bins. IoT Blynk Server is used to Monitor the Realtime status Level of the Bins. The system puts on the buzzer and Visual Red Led Indication, when the level of garbage collected crosses the set limit. This system is also equipped with Automatic Opening and Closing of Bin Door, if it detect any person standing near the bin to throw waste materials. Opening and Closing of the bins is done using Servo Motor and Ultrasonic Sensor. The power supply setup of the system contains a step-down transformer.

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INTRODUCTION

1.1 INTRODUCTION

Nowadays, garbage issues have become a serious thing in maintaining the cleanliness of the city. Many of the city areas are still without public garbage bins so the garbage is thrown at the roadside or at the corners in the locality, which creates ugliness at the corners. Due to no garbage bins, garbage is thrown in the small water reservoirs or the drainage water which creates blockages. In the rainy season, these blockages damage the water flowing system and then water overflows through the roads. In some areas the overflowed water blocks all the ways of transport or small floods within the city are generated. The open garbage containers pose problems for the people living in that vicinity as it becomes the breeding ground for insects like mosquitoes, germs, etc. which spreads numerous diseases. These open garbage areas create unhygienic conditions in those areas.

In many of these areas, the garbage bins are not cleaned at regular intervals which means that no proper maintenance is kept in cleaning the bins. To avoid this, **smart waste management and monitoring systems** should be adopted. And for the adoption of these smart systems, there should be a paradigm shift towards the **"Internet of things"** i.e. IoT technology. This will help in optimizing the garbage management system and also in reducing the consumption of the fuel by the current system. Some of the projects on smart garbage management and monitoring system have been implemented using IoT technology and has been proved to be very effective for environmental issues.

The Internet of Things (IoT) is shaping and touching our lives in every sphere. **IoT based garbage monitoring system** is an innovative project idea for maintaining the clean environment of the city. The smart garbage bins have **Ultrasonic Sensors** placed on the lid which detects the garbage level

in the bins. By this, the garbage bins can be monitored and the monitoring information can be obtained through the webpage. The level of the garbage is compared with the depth of the bins. This system comprises of an AVR family Microcontroller, Wi-fi modem, LCD display along with a buzzer & also a 12V transformer associated with it.

1.2 Internet of Things

The **Internet of things** (**IoT**) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), 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 or controlled remotely across existing network infrastructure,[4] creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. 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.

Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine (M2M) communications and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid,[13] and expanding to areas such as smart cities.

"Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters,[16] automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring[17] or field operation devices that assist firefighters in search and rescue operations.[18] Legal scholars suggest to look at "Things" as an "inextricable mixture of hardware, software, data and service".These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include home automation (also known as smart home devices) such as the control and automation of lighting, heating (like smart thermostat), ventilation, air conditioning (HVAC) systems, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens or refrigerators/freezers that use Wi-Fi for remote monitoring.

As well as the expansion of Internet-connected automation into a plethora of new application areas, IoT is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively. IoT is one of the platforms of today's Smart City, and Smart Energy Management Systems.

CHAPTER - 2

LITERATURE SURVEY

[1]. Prof R.M. sahu et. al. has built a framework in which a Camera will be set at each garbage collection point alongside load cell sensor at base of the trash can. The camera will take continuous snapshots of the garbage can. A threshold level is set which compares the output of camera and load sensor. The comparison is done with help of microcontroller. After analyzing the image an idea about level of garbage in the can and from the load cell sensor, weight of garbage can be known. Accordingly, information is processed that is controller checks if the threshold level is exceeded or not. This is convenient to use but economically not reliable.

[2] Meghana et.al. proposed a system in which Infrared sensor is used, which can detect the level of garbage. IR sensor emits the light, which is invisible to naked eye but the electronic components can detect it. It consists of IR transmitter and IR receiver. Sensor senses level of the bin and gives the output of what level of garbage is filled. When the level in a bin reaches the threshold, the LED placed at the location of the bin starts blinking. When the blinking LED is clicked, a display opens showing the location of the bin,
status of the bin, data and time when the bin gets filled, mobile number and the text to send to the concerned person. But this system does not ensure whether garbage is cleaned or not and transportation cost is another issue.

[3]. Jaekeun et.al. proposed an IOT-based smart garbage system to reduce the amount of food waste. In an SGS, battery-based smart garbage bins (SGBs) exchange information with each other using wireless mesh networks, and a router and server collect and analyze the information for service provisioning.
Furthermore, the SGS includes various IOT skills considering user convenience and increases the battery lifetime through two types of energy-efficient operations of the SGBs: stand-alone operation and cooperation -based operation. The proposed SGS had been functioned as a pilot

project in Gangnam district, Seoul, Republic of Korea, for a one-year period. The test demonstrated that the normal measure of food waste could be decreased by 33%.

CHAPTER - 3

PROPOSED WORK

Smart bins are an intelligent waste management system. They have wireless ultrasonic fill-level sensors embedded inside which detect how full the bin is and then, through the IoT, this data is sent to a cloud-based monitoring and analytics platform. On the basis of this data, waste collection services can optimize their routes and frequency.

This project IOT Garbage Monitoring system is a very innovative system which will help to keep the cities clean. This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins via a Blynk based IOT Application. For this the system uses ultrasonic sensors placed over the bins to detect the garbage level and compare it with the garbage bins depth. The system makes use of Arduino microcontroller board, LCD screen, WIFI modem – Node MCU for sending data and a buzzer. The LCD screen is used to display the status of the level of garbage collected in the bins. IoT Blynk Server is used to Monitor the Realtime status Level of the Bins. The system puts on the buzzer and Visual Red Led Indication, when the level of garbage collected crosses the set limit (OR Bin Full) and Green LED will glow in Empty and Half bin Condition. This system is also equipped with Automatic Opening and Closing of Bin Door, if it detects any person standing near the bin to throw waste materials. Opening and Closing of the bins is done using Servo Motor and Ultrasonic Sensor.

The power supply setup of the system contains a step down transformer of 230/12V, used to step down the voltage to 12VAC. To convert it to DC, a bridge rectifier is used. Capacitive filter is used which makes use of 7805 voltage regulator to regulate it to +5V that will be needed for microcontroller and other components operation, in order to remove ripple.

Thus this system helps to keep the city clean by informing about the garbage levels of the bins by providing Real-time Level of Garbage bin over Blynk based IoT platform

3.1 BLOCK DIAGRAM

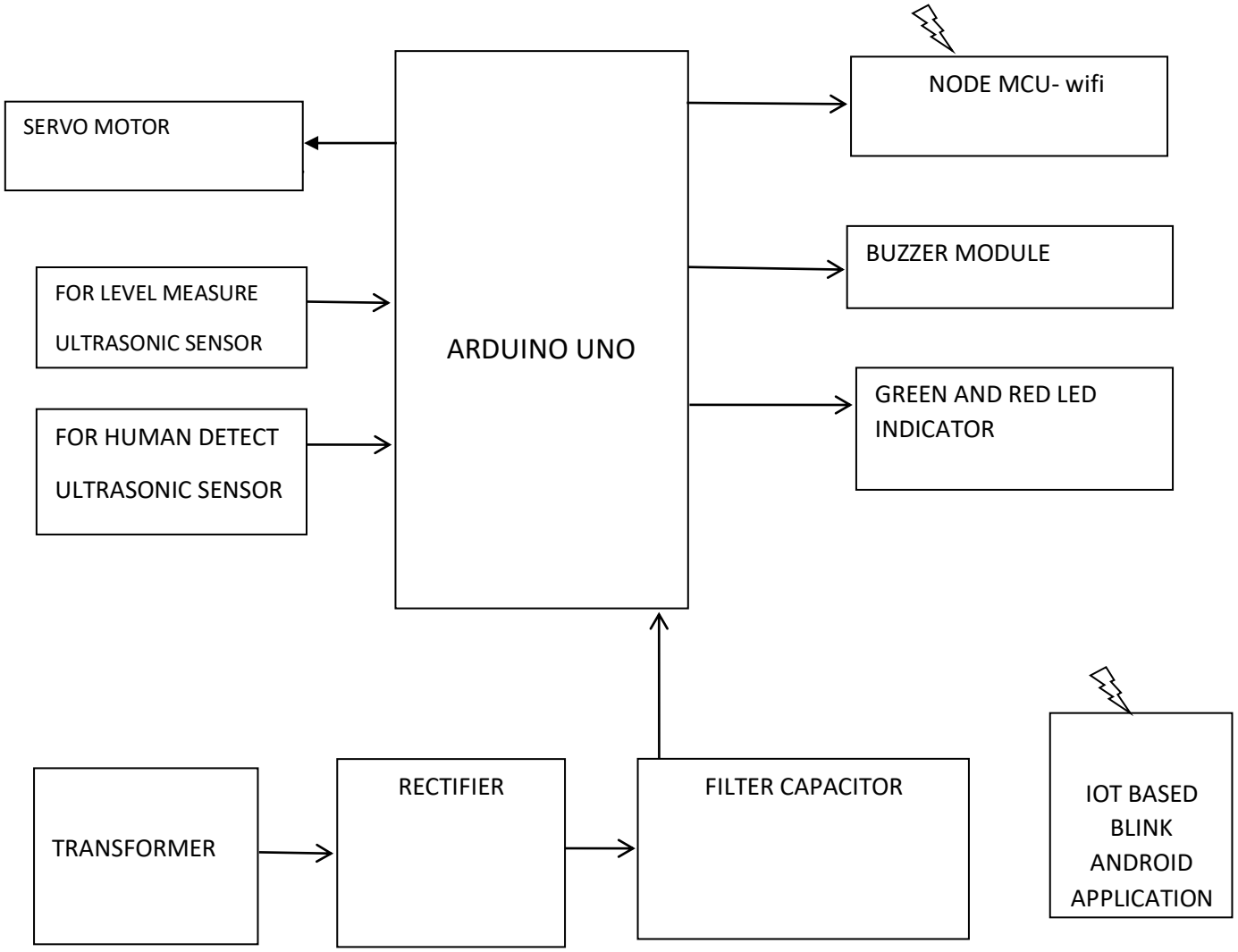


Fig 3.1: Block diagram

3.2 SOFTWARE REQUIREMENT

3.2.1 ARDUINO

Fig 3.2.1: Arduino

Arduino is common term for a software company, project, and user community that designs and manufactures computer open-source hardware, open-source software, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices.

The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can interface to various expansion boards (termed *shields*) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named *Processing*, which also supports the languages C and C++.

The first Arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators.

Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio.[19][20]

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages *Processing* and *Wiring*. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism to compile and load programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch".[21]

The Arduino IDE supports the languages C and C++ using special rules to organize code. The Arduino IDE supplies a software library called Wiring from the Wiring project, which provides many common input and output procedures. A typical Arduino C/C++ sketch consist of two functions that are compiled and linked with a program stub *main()* into an executable cyclic executive program:

- *setup()*: a function that runs once at the start of a program and that can initialize settings.
- *loop()*: a function called repeatedly until the board powers off.

After compiling and linking with the GNU toolchain, also included with the IDE distribution, the Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

3.2.2 BLYNK APPLICATION

Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet.

It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets.

It's really simple to set everything up and you'll start tinkering in less than 5 mins.

Blynk is not tied to some specific board or shield. Instead, it's supporting hardware of your choice. Whether your Arduino or Raspberry Pi is linked to the Internet over Wi-Fi, Ethernet or this new ESP8266 chip, Blynk will get you online and ready for the **Internet Of Your Things**.

Create a Blynk Project

Click the “Create New Project” in the app to create a new Blynk app. Give it any name.

Blynk works with hundreds of hardware models and connection types. Select the Hardware type. After this, select connection type. In this project we have select WiFi connectivity.

The ***Auth Token*** is very important – you’ll need to stick it into your ESP8266’s firmware. For now, copy it down or use the “E-mail” button to send it to yourself.

Widgets To The Project

Then you’ll be presented with a blank new project. To open the widget box, click in the project window to open.

We are selecting a button to control Led connected with Node MCU.

1. Click on Button.

2. Give name to Button say led.
3. Under OUTPUT tab- Click pin and select the pin to which led is connected to Node MCU, here it is digital pin 2, hence select digital and under pin D2. And Click continue.

Under MODE tab- Select whether you want this button as "push button" or "Switch".

You have successfully created a GUI for Arduino

Upload The Firmware

Now that your Blynk project is set-up, open Arduino and navigate to the ESP8266_Standalone example in the File > Examples > Blynk > Boards WiFi > ESP8266_Standalone menu

Execution

After the app has uploaded, open the serial monitor, setting the baud rate to 9600. Wait for the “Ready” message.

Then click the “Run” button in the top right corner of the Blynk app. Press the button and watch the LED

Then add more widgets to the project. They should immediately work on the ESP8266 without uploading any new firmware.

3.3 HARDWARE REQUIREMENTS

3.3.1 ARDUINO UNO - Details

The Uno is a microcontroller board based on the ATmega328PIt has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Technical specs

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6

DC Current per I/O Pin	50 mA
DC Current for 3.3V Pin	32KB (ATmega328)
Flash Memory	of which 0.5 KB used by bootloader
SRAM	2KB(ATmega328P)
EEPROM	
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Fig 3.3.1: Technical Specifications

3.3.2 ELECTROLYTE CAPACITOR

Fig 3.3.2: Electrolyte Capacitor

An electrolytic capacitor is a type of capacitor that uses an electrolyte to achieve a larger capacitance than other capacitor types. An electrolyte is a liquid or gel containing a high concentration of ions. Almost all electrolytic capacitors are polarized, which means that the voltage on the positive terminal must always be greater than the voltage on the negative terminal.

The benefit of large capacitance in electrolytic capacitors comes with several drawbacks as well. Among these drawbacks are large leakage currents, value tolerances, equivalent series resistance and a limited lifetime. Electrolytic capacitors can be either wet-electrolyte or solid polymer. They are commonly made of tantalum or aluminum, although other materials may be used. Supercapacitors are a special subtype of electrolytic capacitors, also called double-layer electrolytic capacitors, with capacitances of hundreds and thousands of farads. This article will be based on aluminum electrolytic capacitors. These have a typical capacitance between 1µF to 47mF and an operating voltage of up to a few hundred volts DC. Aluminum electrolytic capacitors are found in many applications such as power supplies, computer motherboards and many domestic appliances. Since they are polarized, they may be used only in DC circuits.

Characteristics

Capacitance drift

The capacitance of electrolytic capacitors drifts from the nominal value as time passes, and they have large tolerances, typically 20%. This means that an aluminum electrolytic capacitor with a nominal capacitance of 47µF is expected to have a measured value of anywhere between 37.6µF and 56.4µF. Tantalum electrolytic capacitors can be made with tighter tolerances, but their maximum operating voltage is lower so they cannot be always used as a direct replacement.

Polarity and safety

Due to the construction of electrolytic capacitors and the characteristics of the electrolyte used, electrolytic capacitors must be forward biased. This means that the positive terminal must always be at a higher voltage than the negative terminal. If the capacitor becomes reverse-biased (if the voltage polarity on the terminals is reversed), the insulating aluminum oxide, which acts as a

dielectric, might get damaged and start acting as a short circuit between the two capacitor terminals. This can cause the capacitor to overheat due to the large current running through it. As the capacitor overheats, the electrolyte heats up and leaks or even vaporizes, causing the enclosure to burst. This process happens at reverse voltages of about 1 volt and above. To maintain safety and prevent the enclosure from exploding due to high pressures generated under overheat conditions, a safety valve is installed in the enclosure. It is typically made by making a score in the upper face of the capacitor, which pops open in a controlled manner when the capacitor overheats. Since electrolytes may be toxic or corrosive, additional safety measures may need to be taken when cleaning after and replacing an overheated electrolytic capacitor.

There is a special type of electrolytic capacitors for AC use, which is designed to withstand reverse polarisation. This type is called the non-polarized or NP type.

Construction and properties of electrolytic capacitors

Aluminum electrolytic capacitors are made of two aluminum foils and a paper spacer soaked in electrolyte. One of the two aluminum foils is covered with an oxide layer, and that foil acts as the anode, while the uncoated one acts as a cathode. During normal operation, the anode must be at a positive voltage in relation to the cathode, which is why the cathode is most commonly marked with a minus sign along the body of the capacitor. The anode, electrolyte-soaked paper and cathode are stacked. The stack is rolled, placed into a cylindrical enclosure and connected to the circuit using pins. There are two common geometries: axial and radial. Axial capacitors have one pin on each end of the cylinder, while in the radial geometry, both pins are located on the same end of the cylinder.

Electrolytic capacitors have a larger capacitance than most other capacitor types, typically 1µF to 47mF. There is a special type of electrolytic capacitor, called a double-layer capacitor or a supercapacitor, whose capacitance can reach thousands of farads. The capacitance of an aluminum electrolytic capacitor is determined by several factors, such as the plate area and the thickness of the electrolyte. This means that a large capacitance capacitor is bulky and large in size.

It is worth mentioning that electrolytic capacitors made using old technology didn't have a very long shelf life, typically only a few months. If left unused, the oxide layer deteriorates and has to be rebuilt in a process called capacitor reforming. This can be performed by connecting the capacitor to a voltage source through a resistor and slowly increasing the voltage until the oxide layer has been fully rebuilt. Modern electrolytic capacitors have a shelf life of 2 years or more. If the capacitor is left unpolarized for longer periods, they must be reformed prior to use.

Applications for electrolytic capacitors

There are many applications which do not need tight tolerances and AC polarization, but require large capacitance values. They are commonly used as filtering devices in various power supplies to reduce the voltage ripple. When used in switching power supplies, they are often the critical component limiting the usable life of the power supply, so highquality capacitors are used in this application.

They may also be used in input and output smoothing as a low pass filter if the signal is a DC signal with a weak AC component. However, electrolytic capacitors do not work well with large amplitude and high frequency signals due to the power dissipated at the parasitic internal resistance called equivalent series resistance (ESR). In such applications, low-ESR capacitors must be used to reduce losses and avoid overheating.

A practical example is the use of electrolytic capacitors as filters in audio amplifiers whose main goal is to reduce mains hum. Mains hum is a 50Hz or 60Hz electrical noise induced from the mains supply which would be audible if amplified.

3.3.3 CRYSTAL OSCILLATOR

An electronic circuit or electronic device that is used to generate periodically oscillating electronic signal is called as an electronic oscillator. The electronic signal produced by an oscillator is typically a sine wave or square wave. An electronic oscillator converts the direct current signal into an alternating current signal. The radio and television transmitters are broadcasted using the signals generated by oscillators. The electronic beep sounds and video game sounds are generated by the oscillator signals. These oscillators generate signals using the principle of oscillation.

There are different types of oscillator electronic circuits such as Linear oscillators – Hartley oscillator, Phase-shift oscillator, Armstrong oscillator, Clapp oscillator, Colpitts oscillator, and so on, Relaxation oscillators – Royer oscillator, Ring oscillator, Multivibrator, and so on, and Voltage Controlled Oscillator (VCO). In this article, let us discuss in detail about Crystal oscillator like what is crystal oscillator, crystal oscillator circuit, working, and use of crystal oscillator in electronic circuits.

What is Crystal Oscillator?

Fig 3.3.3: Crystal Oscillator

An electronic circuit that is used to generate an electrical signal of precise frequency by utilizing the vibrating crystal's mechanical resonance made of piezoelectric material. There are different types of piezoelectric resonators, but typically, quartz crystal is used in these types of oscillators. Hence, these oscillator electronic circuits are named as crystal oscillators.

Crystal Oscillator Circuit Diagram

The quartz crystal oscillator circuit diagram can be represented as follows:

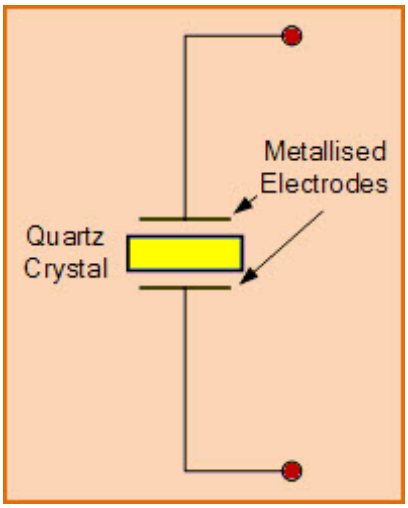


Fig3.3.3 (a): Quartz Crystal oscillator circuit diagram

Electronic Symbol for Piezoelectric Crystal Resonator

The above diagram represents the electronic symbol for a piezoelectric crystal resonator which consists of two metalized electrodes and quartz crystal.

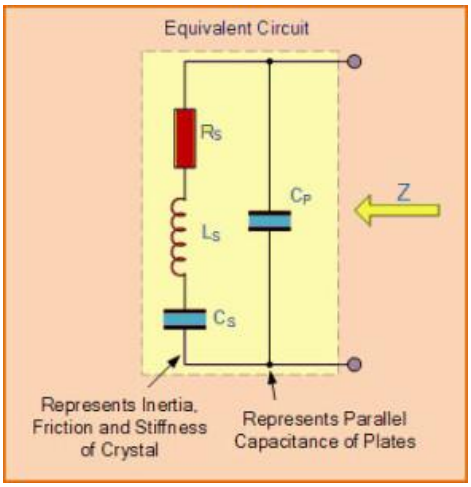


Fig3.3.3 (b): Equivalent Circuit Diagram of Quartz Crystal

The above figure shows the equivalent circuit diagram of quartz crystal in an electronic oscillator that consists of resistor, inductor, and capacitors which are connected as shown in the figure.

Use of Crystal Oscillator

In general, we know that, crystal oscillators are used in the microprocessors and microcontrollers for providing the clock signals. Let us consider AVR Microcontroller for which an external crystal oscillator circuit of 12MHz is essential, even though (based on model) AVR requires 12 clock cycles for one machine cycle, such . that to give effective cycle rate at 1MHz (considering 12MHz clock) to 3.33MHz (considering maximum 16MHz clock). This crystal oscillator is used to generate clock pulses required for the synchronization of all the internal operations.

There are numerous applications for crystal oscillator in various fields and a few crystal oscillator applications are shown below:

APPLICATIONS

Application of Crystal Oscillator in Military and Aerospace

The use of crystal oscillator in military and aerospace, is to establish an efficient communication system, for the navigation purpose, electronic warfare, in the guidance systems, and so on.

Use of Crystal Oscillator in Research and Measurement

The crystal oscillator is used in research and measurement for celestrial navigation, space tracking purpose, in the measuring instruments and medical devices, and so on.

Industrial Applications of Crystal Oscillator

There are a huge number of industrial applications of crystal oscillator such as in computers, digital systems, instrumentation, phase locked loop systems, marine, modems, sensors, telecommunications, disk drives, and so on.

Use of Crystal Oscillator in Automotive

Crystal oscillator is used for engine controlling, stereo, clock and to trip computer, and in GPS system.

Consumer Applications of Crystal Oscillator

Crystal oscillators are used in many consumer goods such as cable television systems, personal computers, video cameras, toys and video games, radio systems, cellular phones, and so on.

3.3.4 LCD 2X16 MODULE

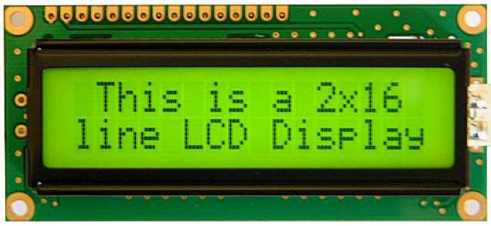


Fig 3.3.4: LCD 2x16 module

A **liquid-crystal display** (**LCD**) is a flat-panel display or other electronic visual display that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as DVD players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in nearly all applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.

The LCD screen is more energy-efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment more efficiently than CRTs. It is an electronically modulated optical device made up of any number of segments controlling a layer of liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome.

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment

LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **20x4 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

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

The JHD162A has two built in registers namely data register and command register. Data register is for placing the data to be displayed , and the command register is to place the commands. The 16×2 LCD module has a set of commands each meant for doing a particular job with the display.

Pin Description:

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Fig 3.3.4 : Pin Description

High logic at the RS pin will select the data register and Low logic at the RS pin will select the command register. If we make the RS pin high and the put a data in the 8 bit data line (DB0 to DB7) , the LCD module will recognize it as a data to be displayed . If we make RS pin low and put a data on the data line, the module will recognize it as a command.

R/W pin is meant for selecting between read and write modes. High level at this pin enables read mode and low level at this pin enables write mode.

E pin is for enabling the module. A high to low transition at this pin will enable the module.

DB0 to DB7 are the data pins. The data to be displayed and the command instructions are placed on these pins.

LED+ is the anode of the back light LED and this pin must be connected to Vcc through a suitable series current limiting resistor. LED- is the cathode of the back light LED and this pin must be connected to ground.

16×2 LCD module commands.

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

LCD initialization.

The steps that has to be done for initializing the LCD display is given below and these steps are common for almost all applications.

- Send 38H to the 8 bit data line for initialization
- Send 0FH for making LCD ON, cursor ON and cursor blinking ON.
- Send 06H for incrementing cursor position.
- Send 01H for clearing the display and return the cursor.

Command	Function
0F	LCD ON, Cursor ON, Cursor blinking ON
01	Clear screen
02	Return home
04	Decrement cursor
06	Increment cursor
0E	Display ON ,Cursor blinking OFF
80	Force cursor to the beginning of 1st line
C0	Force cursor to the beginning of 2nd line
38	Use 2 lines and 5×7 matrix
83	Cursor line 1 position 3
3C	Activate second line
08	Display OFF, Cursor OFF
C1	Jump to second line, position1
OC	Display ON, Cursor OFF
C1	Jump to second line, position1
C2	Jump to second line, position2

Fig 3.3.4(a) : LCD Module Commands

Sending data to the LCD.

The steps for sending data to the LCD module is given below. I have already said that the LCD module has pins namely RS, R/W and E. It is the logic state of these pins that make the module to determine whether a given data input is a command or data to be displayed.

- Make R/W low.
- Make RS=0 if data byte is a command and make RS=1 if the data byte is a data to be displayed.
- Place data byte on the data register.
- Pulse E from high to low.
- Repeat above steps for sending another data.

3.3.5 NON- ELECTROLYTIC CAPACITOR

Fig 3.3.5: Non-Electrolytic Capacitor

Non-Electrolytic capacitors are non-polarised, i.e they can be connected either way in a circuit without having to worry about + & -. The most common is the disc-type capacitor that we normally use in electronics. The other types are ceramic, mica etc. In almost all applications we use the

disctype capacitor which is brown in color and has the shape of a disc. Its value ranges between about a few pF to as high as 1uF. (You also get non-polarised capacitors of higher values and such capacitors have 'NP' written on them indicating Non Polarised)

The symbol for non-electrolytic capacitor is:

where the dark lines indicate the two plates, and the thin lines represent the two terminals.

Non-Electrolytic:

Some capacitors have their values printed in them. Unfortunately, there are various formats for printing the values and only a few can be discussed here:

1) If the printed value is like 101,102,103,204 etc then the value of the capacitor= (first 2 digits X 10 raised to the 3rd digit) pF.
For example if the value is 104 then capacitance = (10X 10e4) pF = 10e5 pF = 10e-7 F = 0.1uF
Remember a few of them: 104 = 0.1uF , 224=0.22uF , 103= 0.01uF, 102= 0.001uF

2) If the printed value is like 1K5, 100,220,10K etc,
Then capacitance = (printed value) pF
For example if the value is 10K then capacitance = 10K pF = 10X10e3 pF= 10e-8 F= 0.01uF
1K5 means 1.5K pF and so on.

CERAMIC CAPACITOR

A **ceramic capacitor** is a non-polarized fixed capacitor made out of two or more alternating layers of ceramic and metal in which the ceramic material acts as the dielectric and the metal acts as the electrodes. The ceramic material is a mixture of finely ground granules of paraelectric or ferroelectric materials, modified by mixed oxides that are necessary to achieve the capacitor's desired characteristics.

The electrical behavior of the ceramic material is divided into two stability classes:

- Class 1 ceramic capacitors with high stability and low losses compensating the influence of temperature in resonant circuit application. Common EIA/IEC code abbreviations are C0G/NP0, P2G/N150, R2G/N220, U2J/N750 etc.
- Class 2 ceramic capacitors with high volumetric efficiency for buffer, by-pass and coupling applications Common EIA/IEC code abbreviations are: X7R/2XI, Z5U/E26, Y5V/2F4, X7S/2C1, etc.

The great plasticity of ceramic raw material works well for many special applications and enables an enormous diversity of styles, shapes and great dimensional spread of ceramic capacitors. The smallest discrete capacitor, for instance, is a "01005" chip capacitor with the dimension of only 0.4 mm × 0.2 mm.

The construction of ceramic multilayer capacitors with mostly alternating layers results in single capacitors connected in parallel. This configuration increases capacitance and decreases all losses and parasitic inductances. Ceramic capacitors are well-suited for high frequencies and high current pulse loads.

Because the thickness of the ceramic dielectric layer can be easily controlled and produced by the desired application voltage, ceramic capacitors are available with rated voltages up to the 30 kV range.

Some ceramic capacitors of special shapes and styles are used as capacitors for special applications, including RFI/EMI suppression capacitors for connection to supply mains, also known as safety capacitors, X2Y® and three-terminal capacitors for bypassing and decoupling applications, feed-through capacitors for noise suppression by low-pass filters[and ceramic power capacitors for transmitters and HF applications.

FILM CAPACITORS

Film capacitors or plastic film capacitors are non-polarized capacitors with an insulating plastic film as the dielectric. The dielectric films are drawn to a thin layer, provided with metallic electrodes and wound into a cylindrical winding. The electrodes of film capacitors may be metallized aluminum or zinc, applied on one or both sides of the plastic film, resulting in metallized film capacitors or a separate metallic foil overlying the film, called film/foil capacitors.

Metallized film capacitors offer self-healing properties. Dielectric breakdowns or shorts between the electrodes do not destroy the component. The metallized construction makes it possible to produce wound capacitors with larger capacitance values (up to 100 µF and larger) in smaller cases than within film/foil construction.

Film/foil capacitors or metal foil capacitors use two plastic films as the dielectric. Each film is covered with a thin metal foil, mostly aluminium, to form the electrodes. The advantage of this construction is the ease of connecting the metal foil electrodes, along with an excellent current pulse strength.

A key advantage of every film capacitor's internal construction is direct contact to the electrodes on both ends of the winding. This contact keeps all current paths very short. The design behaves like a large number of individual capacitors connected in parallel, thus reducing the internal ohmic losses (ESR) and ESL. The inherent geometry of film capacitor structure results in low ohmic losses and a low parasitic inductance, which makes them suitable for applications with high surge currents (snubbers) and for AC power applications, or for applications at higher frequencies.

The plastic films used as the dielectric for film capacitors are Polypropylene (PP), Polyester (PET), Polyphenylene sulfide (PPS), Polyethylene naphthalate (PEN), and Polytetrafluoroethylene or Teflon (PTFE). Polypropylene film material with a market share of something about 50% and Polyester film with something about 40% are the most used film materials. The rest of something about 10% will be used by all other materials including PPS and paper with roughly 3%, each.

3.3.6 RESISTOR

Fig 3.3.6: Resistor

A **resistor** is a passivetwo-terminalelectrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels, bias active elements, and terminate transmission lines among other uses. High-power resistors, that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits.

Resistor units

The electrical resistance of a resistor is measured in **ohms**. The symbol for an ohm is the greek capital-omega: Ω. The (somewhat roundabout) definition of 1Ω is the resistance between two points where 1 volt (1V) of applied potential energy will push 1 ampere (1A) of current.

As SI units go, larger or smaller values of ohms can be matched with a prefix like kilo-, mega-, or giga-, to make large values easier to read. It's very common to see resistors in the kilohm (kΩ) and megaohm (MΩ) range (much less common to see miliohm (mΩ) resistors). For example, a 4,700Ω resistor is equivalent to a 4.7kΩ resistor, and a 5,600,000Ω resistor can be written as 5,600kΩ or (more commonly as) 5.6MΩ.

Types of Resistors

Resistors come in a variety of shapes and sizes. They might be through-hole or surface-mount. They might be a standard, static resistor, a pack of resistors, or a special variable resistor.

Termination and mounting

Resistors will come in one of two termination-types: through-hole or surface-mount. These types of resistors are usually abbreviated as either PTH (plated through-hole) or SMD/SMT (surface-mount technology or device).

Through-hole resistors come with long, pliable leads which can be stuck into a breadboard or hand-soldered into a prototyping board or printed circuit board (PCB). These resistors are usually more useful in breadboarding, prototyping, or in any case where you'd rather not solder tiny, little 0.6mm-long SMD resistors. The long leads usually require trimming, and these resistors are bound to take up much more space than their surface-mount counterparts.

The most common through-hole resistors come in an axial package. The size of an axial resistor is relative to its power rating. A common ½W resistor measures about 9.2mm across, while a smaller ¼W resistor is about 6.3mm long.

Surface-mount resistors are usually tiny black rectangles, terminated on either side with even smaller, shiny, silver, conductive edges. These resistors are intended to sit on top of PCBs, where

they’re soldered onto mating landing pads. Because these resistors are so small, they’re usually set into place by a robot, and sent through an oven where solder melts and holds them in place.

SMD resistors come in standardized sizes; usually either 0805 (0.8mm long by 0.5mm wide), 0603, or 0402. They’re great for mass circuit-board-production, or in designs where space is a precious commodity. They take a steady, precise hand to manually solder, though!

Measurement

The value of a resistor can be measured with an ohmmeter, which may be one function of a multimeter. Usually, probes on the ends of test leads connect to the resistor. A simple ohmmeter may apply a voltage from a battery across the unknown resistor (with an internal resistor of a known value in series) producing a current which drives a meter movement. The current, in accordance with Ohm's law, is inversely proportional to the sum of the internal resistance and the resistor being tested, resulting in an analog meter scale which is very non-linear, calibrated from infinity to 0 ohms. A digital multimeter, using active electronics, may instead pass a specified current through the test resistance. The voltage generated across the test resistance in that case is linearly proportional to its resistance, which is measured and displayed. In either case the low-resistance ranges of the meter pass much more current through the test leads than do high-resistance ranges, in order for the voltages present to be at reasonable levels (generally below 10 volts) but still measurable.

Applications of Resistors

In electronic circuits, resistors play an important role to limit the current and provide only the required biasing to the vital active parts like the transistors and the ICs. We will try to find out what is the function of a resistor in electronics through the following illustrations:

Transistor Biasing: Through one of my previous articles you must have acquired a good knowledge regarding transistors. A transistor basically needs a small base voltage (>0.6) to make a large voltage flow through its collector/ emitter terminals. But the base of a transistor is quite

vulnerable to high currents, so a resistor is incorporated here to limit the current and provide a safe biasing voltage.

The value of the base resistor of a transistor may be calculated through the below given formula:

$R = (V – 0.6).Hfe / I,$

Here V = source voltage to the base resistor, I = the collector load current, Hfe = forward gain of a transistor (150 nominal) and 0.6 = minimum transistor biasing voltage.

LED Current Limit:

Just like transistors, LEDs too are very sensitive to high currents. A resistor when placed in series with the LEDs regulates a proper flow of current through them. To calculate the value of a series LED resistor, the following formula may be used:

$R = V –(N.V_{LED})/ I$

3.3.7 TRANSFORMER

Fig 3.3.7: Transformer

A **transformer** is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Electromagnetic induction produces an electromotive force

across a conductor which is exposed to time varying magnetic fields. Commonly, transformers are used to increase or decrease the voltages of alternating current in electric power applications.

A varying current in the transformer's primary winding creates a varying magnetic flux in the transformer core and a varying magnetic field impinging on the transformer's secondary winding. This varying magnetic field at the secondary winding induces a varying electromotive force (EMF) or voltage in the secondary winding due to electromagnetic induction.

A Transformer takes in electricity at a higher voltage and lets it run through lots of coils wound around an iron core. ". A single-phase Transformer can operate to either increase or decrease the voltage applied to the primary winding. Because the current is alternating, the magnetism in the core is also alternating. Also around the core is an output wire with fewer coils. The magnetism changing back and forth makes a current in the wire. Having fewer coils means less voltage. When it is used to "decrease" the voltage on the secondary winding with respect to the primary it is called a **Step-down Transformer**. When a Transformer is used to "increase" the voltage on its secondary winding with respect to the primary, it is called a **Step-up Transformer**.

However, a third condition exists in which a transformer produces the same voltage on its secondary as is applied to its primary winding. In other words, its output is identical with respect to input. This type of Transformer is called an **"Impedance Transformer"** and is mainly used for impedance matching or the isolation of adjoining electrical circuits.

Types

Various specific electrical application designs require a variety of transformer types. Although they all share the basic characteristic transformer principles, they are customize in construction or electrical properties for certain installation requirements or circuit conditions.

- *Autotransformer*: Transformer in which part of the winding is common to both primary and secondary circuits.[88]
- *Capacitor voltage transformer*: Transformer in which capacitor divider is used to reduce high voltage before application to the primary winding.
- *Distribution transformer, power transformer*: International standards make a distinction in terms of distribution transformers being used to distribute energy from transmission lines and networks for local consumption and power transformers being used to transfer electric energy between the generator and distribution primary circuits.[88][89][q]
- *Phase angle regulating transformer*: A specialised transformer used to control the flow of real power on three-phase electricity transmission networks.
- *Scott-T transformer*: Transformer used for phase transformation from three-phase to two-phase and vice versa.[88]

Applications

Transformers are used to increase (or step-up) voltage before transmitting electrical energy over long distances through wires. Wires have resistance which loses energy through joule heating at a rate corresponding to square of the current. By transforming power to a higher voltage transformers enable economical transmission of power and distribution. Consequently, transformers have shaped the electricity supply industry, permitting generation to be located remotely from points of demand. All but a tiny fraction of the world's electrical power has passed through a series of transformers by the time it reaches the consumer.[44]

Transformers are also used extensively in electronic products to decrease (or step-down) the supply voltage to a level suitable for the low voltage circuits they contain. The transformer also electrically isolates the end user from contact with the supply voltage.

Signal and audio transformers are used to couple stages of amplifiers and to match devices such as microphones and record players to the input of amplifiers. Audio transformers allowed telephone circuits to carry on a two-way conversation over a single pair of wires. A balun

transformer converts a signal that is referenced to ground to a signal that has balanced voltages to ground, such as between external cables and internal circuits.

3.3.8 VOLTAGE REGULATORS

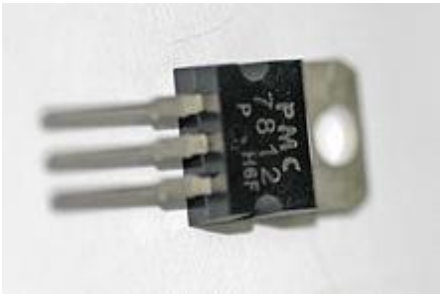


Fig 3.3.8: Voltage Regulators

A **voltage regulator** is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedbackcontrol loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

The **78xx** (sometimes **L78xx**, **LM78xx**, **MC78xx**...) is a family of self-contained fixed linear voltage regulatorintegrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost. For ICs within the family, the *xx* is replaced with two digits, indicating the output voltage (for example, the 7805 has a 5-volt output, while the 7812 produces 12 volts). The 78xx line are positive voltage regulators: they produce a voltage that is positive relative to a common ground. There is a related line of **79xx**

devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide positive and negative supply voltages in the same circuit.

78xx ICs have three terminals and are commonly found in the TO-220 form factor, although they are available in surface-mount, TO-92, and TO-3 packages. These devices support an input voltage anywhere from around 2.5 volts over the intended output voltage up to a maximum of 35 to 40 volts depending on the model, and typically provide 1 or 1.5 amperes of current (though smaller or larger packages may have a lower or higher current rating).

Advantages

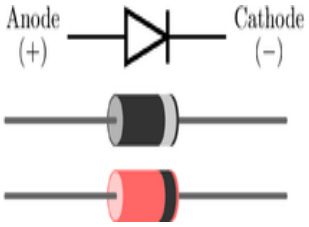
- 78xx series ICs do not require additional components to provide a constant, regulated source of power, making them easy to use, as well as economical and efficient uses of space. Other voltage regulators may require additional components to set the output voltage level, or to assist in the regulation process. Some other designs (such as a switched-mode power supply) may need substantial engineering expertise to implement.
- 78xx series ICs have built-in protection against a circuit drawing too much current. They have protection against overheating and short-circuits, making them quite robust in most applications. In some cases, the current-limiting features of the 78xx devices can provide protection not only for the 78xx itself, but also for other parts of the circuit.

7805 is a **voltage regulator** integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The **voltage regulator IC** maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

Pin Description:

Pin No	Function	Name
1	Input voltage (5V-18V)	Input
2	Ground (0V)	Ground
3	Regulated output; 5V (4.8V-5.2V)	Output

Fig 3.3.8: Pin Description



3.3.9 DIODE

A diode is an electronic component with two electrodes (connectors). It allows electricity to go through it only in one direction.

Fig3.3.9 : Diode

Diodes can be used to convert alternating current to direct current (Diode bridge). They are often used in power supplies and sometimes to decode amplitude modulation radio signals (like in a crystal radio). Light-emitting diodes (LEDs) are a type of diode that produce light.

Today, the most common diodes are made from semiconductor materials such as silicon or sometimes germanium.

Construction

Semiconductor diodes are made of two types of semiconductors connected to each other. One type has atoms with extra electrons (called the n-side). The other type has atoms that want electrons

(called the p-side). Because of this, the electricity will flow easily from the side with too many electrons to the side with too few. However, electricity will not flow easily in the reverse direction. Silicon with arsenic dissolved in it makes a good n-side semiconductor, while silicon with aluminum dissolved in it makes a good p-side semiconductor, but other materials can also work.

The connector to the n-side is called the cathode, the connector to the p-side is called the anode.

Function of a diode

Positive voltage at p-side

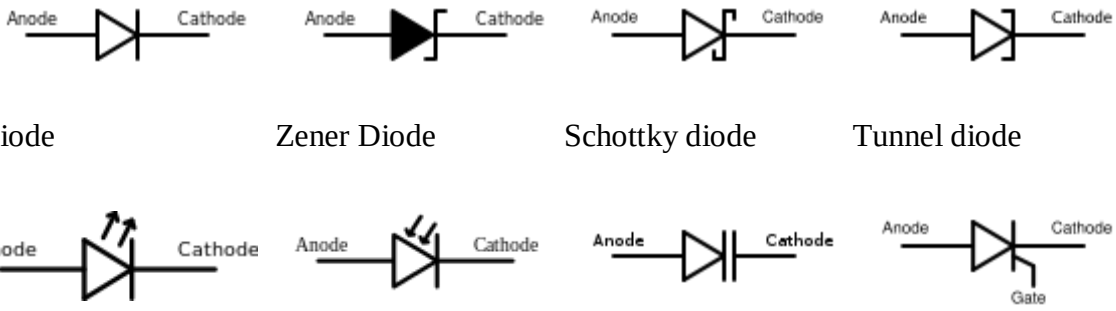
If you give positive voltage to the p-side and negative voltage to the n-side, the electrons in the n-side will want to go to the positive voltage at the p-side and the holes of the p-side will want to go to the negative voltage at the n-side. Because of this, current flow is able to exist, but it takes a certain amount of voltage to get this started (very small amount of voltage is not enough to get the electric current to flow). This is called the cut-in voltage. The cut-in voltage of a silicon diode is at about 0.7 V. A germanium diode needs a cut-in voltage at about 0.3 V.

Negative voltage at p-side

If you instead give negative voltage to the p-side and positive voltage to the n-side, the electrons of the n-side want to go to the positive voltage source instead of the other side of the diode. Same thing happens on the p-side. So, current will not flow between the two sides of the diode. Increasing the voltage will eventually force electric current to flow (this is the break-down voltage). Many diodes will be destroyed by a reverse flow but some are made that can survive it.

Types of diodes

Here are some common semiconductor diode symbols used in schematic diagrams:



Diode Zener Diode Schottky diode Tunnel diode

Light-emitting diode Photodiode Varicap Silicon controlled rectifier

Fig 3.3.9(a): Types of Diodes

Functions of Diodes

The most common function of a diode is to allow an electric current to pass in one direction (called the diode's *forward* direction), while blocking current in the opposite direction (the *reverse* direction). Thus, the diode can be viewed as an electronic version of a check valve. This unidirectional behavior is called rectification, and is used to convert alternating current to direct current, including extraction of modulation from radio signals in radio receivers—these diodes are forms of rectifiers.

However, diodes can have more complicated behavior than this simple on–off action, due to their nonlinear current-voltage characteristics. Semiconductor diodes begin conducting electricity only if a certain threshold voltage or cut-in voltage is present in the forward direction (a state in which the diode is said to be *forward-biased*). The voltage drop across a forward-biased diode varies only a little with the current, and is a function of temperature; this effect can be used as a temperature sensor or as a voltage reference.

A semiconductor diode's current–voltage characteristic can be tailored by selecting the semiconductor materials and the doping impurities introduced into the materials during manufacture. These techniques are used to create special-purpose diodes that perform many

different functions. For example, diodes are used to regulate voltage (Zener diodes), to protect circuits from high voltage surges (avalanche diodes), to electronically tune radio and TV receivers (varactor diodes), to generate radio-frequencyoscillations (tunnel diodes, Gunn diodes, IMPATT diodes), and to produce light (light-emitting diodes). Tunnel, Gunn and IMPATT diodes exhibit negative resistance, which is useful in microwave and switching circuits.

Applications of Diodes

- Radio demodulation
- Power conversion
- Over-voltage protection
- Logic gates
- Temperature measurement

3.3.10 NODE MCU

Fig 3.3.10: Node MCU

NodeMCU is an open source LUA based firmware developed for ESP8266 wifi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. Since NodeMCU is open source platform, their hardware design is open for edit/modify/build.

NodeMCU Dev Kit/board consist of ESP8266 wifi enabled chip. The **ESP8266** is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer ESP8266 WiFi Module.

There is Version2 (V2) available for NodeMCU Dev Kit i.e. **NodeMCU Development Board v1.0 (Version2)**, which usually comes in black colored PCB.

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

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

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

NodeMCU Development board is featured with wifi capability, analog pin, digital pins and serial communication protocols.

To get start with using NodeMCU for IoT applications first we need to know about how to write/download NodeMCU firmware in NodeMCU Development Boards. And before that where this NodeMCU firmware will get as per our requirement.

There is online NodeMCU custom builds available using which we can easily get our custom NodeMCU firmware as per our requirement.

Difference in using ESPlorer and Arduino IDE

Well, there is a programming language difference we can say while developing application for NodeMCU using ESPlorer IDE and Arduino IDE.

We need to code in C\C++ programming language if we are using Arduino IDE for developing NodeMCU applications and Lua language if we are using ESPlorer IDE.

Basically, NodeMCU is Lua Interpreter, so it can understand Lua script easily. When we write Lua scripts for NodeMCU and send/upload it to NodeMCU, and then they will get executes

sequentially. It will not build binary firmware file of code for NodeMCU to write. It will send Lua script as it is to NodeMCU to get executes.

In Arduino IDE when we write and compile code, ESP8266 tool chain in background creates binary firmware file of code we wrote. And when we upload it to NodeMCU then it will flash all NodeMCU firmware with newly generated binary firmware code. In fact, it writes the complete firmware.

That's the reason why NodeMCU not accept further Lua scripts/code after it is getting flashed by Arduino IDE. After getting flashed by Arduino sketch/code it will be no more Lua interpreter and we got error if we try to upload Lua scripts. To again start with Lua script, we need to flash it with NodeMCU firmware.

Since Arduino IDE compiles and upload/writes complete firmware, it takes more time than ESPlorer IDE.

Development Board

NodeMCU Development Kit/Board consist of ESP8266 wifi chip. ESP8266 chip has GPIO pins, serial communication protocol, etc. features on it.

ESP8266 is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer ESP8266 WiFi Module.

The features of ESP8266 are extracted on NodeMCU Development board. NodeMCU (LUAbased firmware) with Development board/kit that consist of ESP8266 (wifi enabled chip) chip combines NodeMCU Development board which make it stand-alone device in IoT applications.

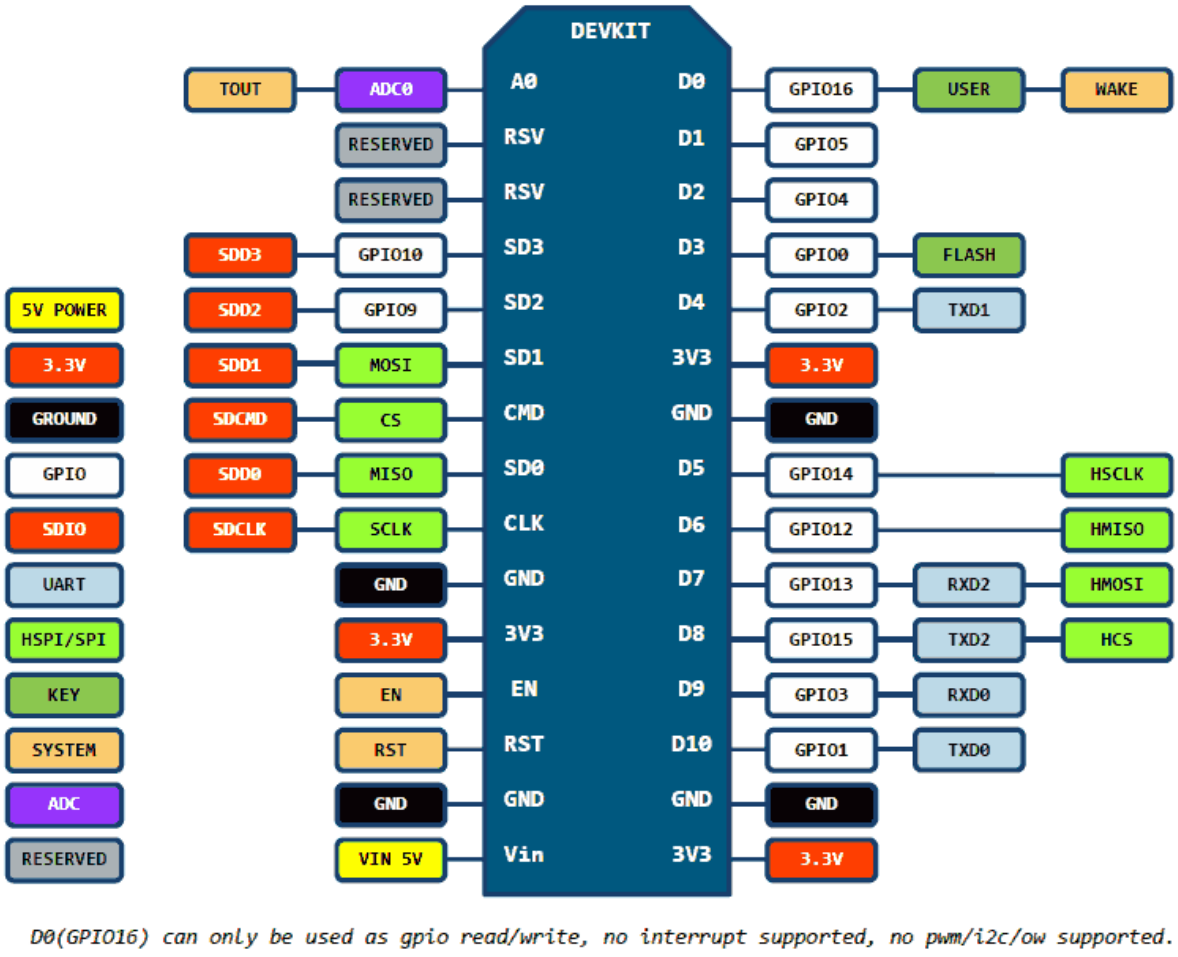


Fig3.3.10: Pin Definition

NodeMCU Dev Kit v1.0 pin descriptions

GPIO (General Purpose Input Output) Pins:

NodeMCU has general purpose input output pins on its board as shown in above pinout diagram. We can make it digital high/low and control things like LED or switch on it. Also, we can generate PWM signal on these GPIO pins.

ADC (Analog to Digital Converter) channel (A0):

NodeMCU has one ADC channel/pin on its board.

SPI (Serial Peripheral Interface) Pins:

NodeMCU based ESP8266 has Hardware SPI (HSPI) with four pins available for SPI communication. It also has SPI pins for Quad-SPI communication. With this SPI interface, we can connect any SPI enabled device with NodeMCU and make communication possible with it.

I2C (Inter-Integrated Circuit) Pins:

NodeMCU has I2C functionality support on ESP8266 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.

UART (Universal Asynchronous Receiver Transmitter) Pins:

NodeMCU based ESP8266 has two UART interfaces, UART0 and UART1. Since UART0 (RXD0 & TXD0) is used to upload firmware/codes to board, we can't use them in applications while uploading firmware/codes.

Difference in between 1st and 2nd version NodeMCU Board

We can make difference in 1st and 2nd version of NodeMCU Development board by their boards design and ESP modules on it.

- In 1st version of NodeMCU Dev Kit v0.9, CH341SER USB to Serial converter is used whereas in 2nd version of NodeMCU Dev Kit v1.0, CP2102 USB to Serial converter is used.
- 1st version uses ESP-12 and 2nd version uses ESP-12E (Enhanced version).
- Extra 6 pins (MTDO, MTDI, SD_3, MTMS, MTCK, SD_2) brought out on ESP-12E version of ESP-12 modules as shown in below figure. Though Quad SPI pins are brought

out, they are internally used for flash memory access.Also, there slight antenna design difference in ESP-12 versions like ESP12-E & ESP-12F as.shown in fig below

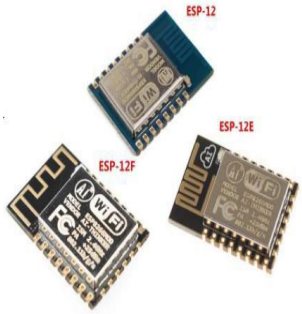


Fig 3.3.10(a): ESP-12 versions

3.3.11 LED – Light Emitting diode

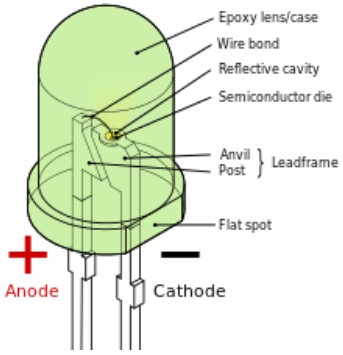


Fig 3.3.11: Light Emitting Diode(LED)

A **light-emitting diode** (**LED**) is a two-leadsemiconductorlight source. It is a p–n junctiondiode, which emits light when activated.[4] When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

An LED is often small in area (less than 1 mm^2) and integrated optical components may be used to shape its radiation pattern.[5]

Appearing as practical electronic components in 1962,[6] the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity, and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.

Early LEDs were often used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of seven-segment displays, and were commonly seen in digital clocks.

developments in LEDs permit them to be used in environmental and task lighting. LEDs have many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Light-emitting diodes are now used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, camera flashes and lighted wallpaper. As of 2015, LEDs powerful enough for room lighting remain somewhat more expensive, and require more precise current and heat management, than compact fluorescent lamp sources of comparable output.

Working principle

A P-N junction can convert absorbed light energy into a proportional electric current. The same process is reversed here (i.e. the P-N junction emits light when electrical energy is applied to it). This phenomenon is generally called electroluminescence, which can be defined as the emission of light from a semi-conductor under the influence of an electric field. The charge carriers recombine in a forward-biased P-N junction as the electrons cross from the N-region and

recombine with the holes existing in the P-region. Free electrons are in the conduction band of energy levels, while holes are in the valence energy band. Thus the energy level of the holes will be lesser than the energy levels of the electrons. Some portion of the energy must be dissipated in order to recombine the electrons and the holes. This energy is emitted in the form of heat and light.

The electrons dissipate energy in the form of heat for silicon and germanium diodes but in gallium arsenide phosphide (GaAsP) and gallium phosphide (GaP) semiconductors, the electrons dissipate energy by emitting photons. If the semiconductor is translucent, the junction becomes the source of light as it is emitted, thus becoming a light-emitting diode, but when the junction is reverse biased no light will be produced by the LED and, on the contrary, the device may also be damaged.

Types

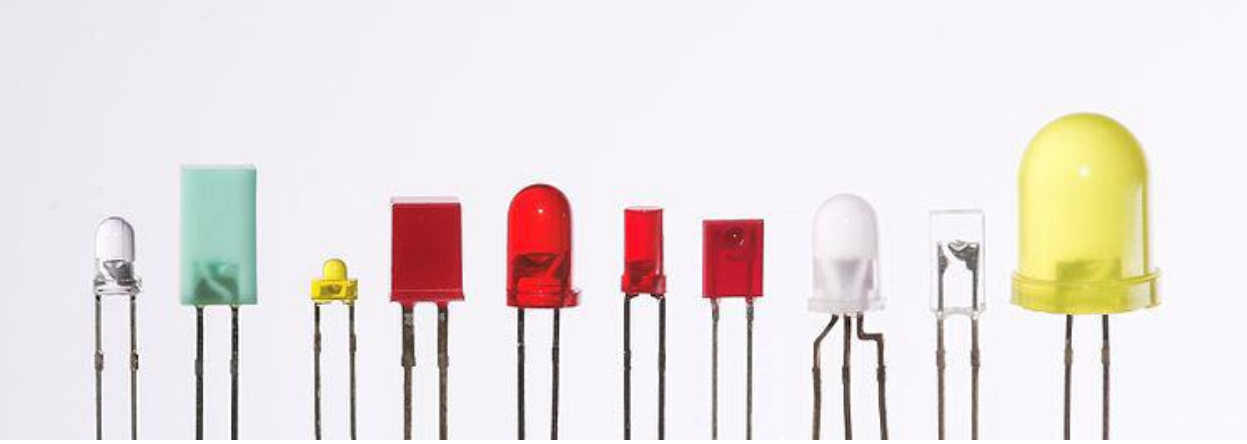


Fig3.3.11(a): Types of LED's

The main types of LEDs are miniature, high-power devices and custom designs such as alphanumeric or multi-color

Miniature

These are mostly single-die LEDs used as indicators, and they come in various sizes from 2 mm to 8 mm, through-hole and surface mount packages. They usually do not use a separate heat sink. Typical current ratings range from around 1 mA to above 20 mA. The small size sets a natural upper boundary on power consumption due to heat caused by the high current density and need for a heat sink.

Common package shapes include round, with a domed or flat top, rectangular with a flat top (as used in bar-graph displays), and triangular or square with a flat top. The encapsulation may also be clear or tinted to improve contrast and viewing angle.

Researchers at the University of Washington have invented the thinnest LED. It is made of two-dimensional (2-D) flexible materials. It is three atoms thick, which is 10 to 20 times thinner than three-dimensional (3-D) LEDs and is also 10,000 times smaller than the thickness of a human hair. These 2-D LEDs are going to make it possible to create smaller, more energy-efficient lighting, optical communication and nano lasers.[118]

There are three main categories of miniature single die LEDs:

Low-current

Typically rated for 2 mA at around 2 V (approximately 4 mW consumption)

Standard

20 mA LEDs (ranging from approximately 40 mW to 90 mW) at around:

- 1.9 to 2.1 V for red, orange, yellow, and traditional green
- 3.0 to 3.4 V for pure green and blue
- 2.9 to 4.2 V for violet, pink, purple and white

Ultra-high-output

20 mA at approximately 2 or 4–5 V, designed for viewing in direct sunlight

5 V and 12 V LEDs are ordinary miniature LEDs that incorporate a suitable seriesresistor for direct connection to a 5 V or 12 V supply.

Applications of LED

LED uses fall into four major categories:

- Indicators and signs
- Lighting
- Data communication and other signaling
- Sustainable lighting
- Energy consumption

3.3.12 BUZZER

A **buzzer** or **beeper** is an audio signaling device, which may be mechanical, Electromechanical or piezoelectric . Typical uses of buzzers and beepers include time alarms and timers and confirmation of user input such as a mouse click or keystroke.

Type of buzzers

Electromechanical

Early devices were based on an electromechanical system identical to an electric bell without the metal gong. Similarly, a relay may be connected to interrupt its own actuating current, causing the contacts to buzz. Often these units were anchored to a wall or ceiling to use it as a sounding board. The word "buzzer" comes from the rasping noise that electromechanical buzzers made.

Fig 3.3.12: Electro mechanical Buzzer

Mechanical

A joy buzzer is an example of a purely mechanical buzzer. They require drivers.

Piezoelectric

Fig 3.3.12: Piezoelectric disk beeper

A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep.

Modern applications

While technological advancements have caused buzzers to be impractical and undesirable, there are still instances in which buzzers and similar circuits may be used. Present day applications include:

- Novelty uses
- Educational purposes

- Annunciator panels
- Electronic metronomes
- Game show lock-out device
- Microwave ovens and other household appliances
- Sporting events such as basketball games
- Electrical alarms
- Joy buzzer- a mechanical buzzer used for pranks

3.3.13 SERVO MOTOR

- A **servomotor** is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.
- Servomotors are not a specific class of motor although the term *servomotor* is often used to refer to a motor suitable for use in a closed-loop control system.
- Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.
- **Mechanism**

- A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.
- The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.
- The very simplest servomotors use position-only sensing via a potentiometer and bang-bang control of their motor; the motor always rotates at full speed (or is stopped). This type of servomotor is not widely used in industrial motion control, but it forms the basis of the simple and cheap servos used for radio-controlled models.
- More sophisticated servomotors use optical rotary encoders to measure the speed of the output shaft and a variable-speed drive to control the motor speed.[3] Both of these enhancements, usually in combination with a PID control algorithm, allow the servomotor to be brought to its commanded position more quickly and more precisely, with less overshooting
- **Motors**
- The type of motor is not critical to a servomotor and different types may be used. At the simplest, brushed permanent magnet DC motors are used, owing to their simplicity and low cost. Small industrial servomotors are typically electronically commutated brushless motors. For large industrial servomotors, AC induction motors are typically used, often with variable frequency drives to allow control of their speed. For ultimate performance in a compact package, brushless AC motors with permanent magnet fields are used, effectively large versions of Brushless DC electric motors.[11]

- Drive modules for servomotors are a standard industrial component. Their design is a branch of power electronics, usually based on a three-phase MOSFET or IGBT H bridge. These standard modules accept a single direction and pulse count (rotation distance) as input. They may also include over-temperature monitoring, over-torque and stall detection features.[12]As the encoder type, gearhead ratio and overall system dynamics are application specific, it is more difficult to produce the overall controller as an off-the-shelf module and so these are often implemented as part of the main controller.

- **Types of Servo Motor**
- Servo motors are classified into different types based on their application, such as AC servo motor, DC servo motor, brushless DC servo motor, positional rotation, continuous rotation and linear servo motor etc. Typical servo motors comprise of three wires namely, power control and ground. The shape and size of these motors depend on their applications. RC servo motor is the most common type of servo motor used in hobby applications, robotics due to their simplicity, affordability and reliability of control by microprocessors.
- **Servo Motor Working**
- A unique design for servo motors is proposed in controlling the robotics and for control applications. They are basically used to adjust the speed control at high torques and accurate positioning. Parts required are motor position sensor and a highly developed controller. These motors can be categorized according the servo motor controlled by servomechanism. If DC motor is controlled using this mechanism, then it is named as a DC servo motor. Servo motors are available in power ratings from fraction of a watt to 100 watts. The rotor of a servo motor is designed longer in length and smaller in diameter so that it has low inertia.

CHAPTER - 4

CONCLUSION

The solution to the optimization of waste collection process lies in generation of real time data about the filling up of waste bins placed at different distant locations. This real time information will help the waste managers to effectively route and schedule the movement of collection machinery. The overflowing of waste bins will also be avoided. The proposed IoT methodology can easily provide this information. The proposed hardware can serve the purpose for all type of bins. The technology is robust, cheaper and easy to use due to the low cost of the sensors used. Advancements in technology in various sectors of life has created avenues of sophisticated service delivery.

FUTURE SCOPE

The main aim of this project is to reduce human resources and efforts along with the enhancement of a smart city vision. We have often seen garbage spilling over from dustbins on to streets and this was an issue that required immediate attention. The proverb “Cleanliness is next to god and clean city is next to heaven” inspired us to conceptualized the project.

Smart dustbin helps us to reduce the pollution. Many times garbage dustbin is overflow and many animals like dog or rat enters inside or near the dustbin. This creates a bad scene. Also some birds are also trying to take out garbage from dustbin. This project can avoid such situations. And the message can be sent directly to the cleaning vehicle instead of the contractor’s office.

CHAPTER - 5

APPENDIX

```
#define BLYNK_PRINT Serial

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "YourAuthToken";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "YourNetworkName";
char pass[] = "YourPassword";
void setup()
{
  // Debug console
  Serial.begin(9600);
Blynk.begin(auth, ssid, pass);
}

void loop()
{
  Blynk.run();
}
```

Fig

CHAPTER - 6

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