CHAPTER -1

INTRODUCTION

The rapid advancement of electric vehicles (EVs) has underscored the need for efficient battery management systems (BMS) that not only optimize performance but also prioritize safety. The "Microcontroller based battery charge estimation and fire protection" addresses these critical needs by integrating various sensors to monitor essential battery parameters, including load, voltage, and temperature. This system employs real-time data transmission to the cloud for remote monitoring while facilitating immediate responses to hazardous conditions, such as overheating. With the incorporation of user-friendly displays and notifications, this innovative approach not only enhances the longevity and reliability of EV batteries but also ensures a safer

1.1 Embedded system:

Embedded system includes mainly two sections, they are

1. Hardware
2. Software

As with any electronic system, an embedded system requires a hardware platform on which it performs the operation. Embedded system hardware is built with a microprocessor or microcontroller. The embedded system hardware has elements like input output (I/O) interfaces, user interface, memory and the display. Usually, an embedded system consists of:

- Power Supply
- Processor
- Memory
- Timers
- Serial communication ports
- Output/Output circuits
- System application specific circuits

Embedded systems use different processors for its desired operation. Some of the processors.

1. Microprocessor

2. Microcontroller

3. Digital signal processor

1.2 Microprocessor vs. Microcontroller

Microprocessor

- **CPU** on a chip.
- We can attach required amount of ROM, RAM and I/O ports.
- Expensive due to external peripherals.
- Large in size
- general-purpose

Microcontroller

- **Computer** on a chip
- fixed amount of on-chip ROM, RAM, I/O ports
- Low cost.
- Compact in size.
- Specific –purpose

1.3 Embedded System Software:

The embedded system software is written to perform a specific function. It is typically written in a high level format and then compiled down to provide code that can be lodged within a non-volatile memory within the hardware. An embedded system software is designed to keep in view of the three limits:

- Availability of system memory

- Availability of processor's speed
- When the system runs continuously, there is a need to limit power dissipation for events like stop, run and wake up.

1.4 Bringing software and hardware together for embedded system:

To make software to work with embedded systems we need to bring software and hardware together .for this purpose we need to burn our source code into microprocessor or microcontroller which is a hardware component and which takes care of all operations to be done by embedded system according to our code. Generally we write source codes for embedded systems in assembly language, but the processors run only executable files. The process of converting the source code representation of your embedded software into an executable binary image involves three distinct steps:

1. Each of the source files must be compiled or assembled into an object file.
2. All of the object files that result from the first step must be linked together to produce a single object file, called the re-locatable program.
3. Physical memory addresses must be assigned to the relative offsets within the re-locatable program in a process called relocation.The result of the final step is a file containing an executable binary image that is ready to run on the embedded system.

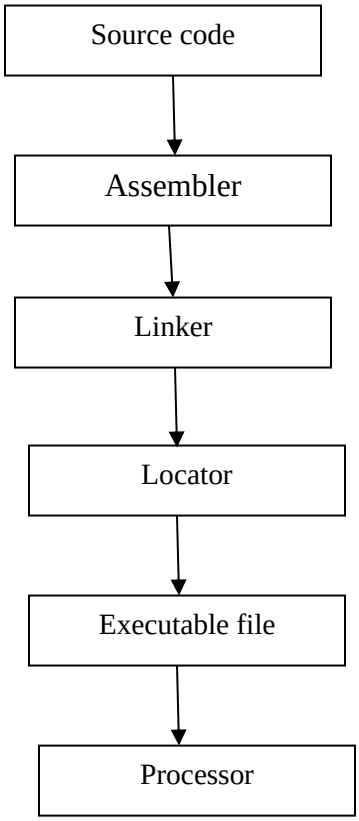

Fig 1.1 Flow of burning source code to processor

1.5 Applications:

Embedded systems have different applications. A few select applications of embedded systems are smart cards, telecommunications, satellites, missiles, digital consumer electronics, computer networking, etc.

Embedded Systems in Automobiles

- Motor Control System
- Engine or Body Safety
- Robotics in Assembly Line
- Mobile and E-Com Access

Embedded systems in Telecommunications

- Mobile computing
- Networking
- Wireless Communications

Embedded Systems in Smart Cards

- Banking
- Telephone
- Security Systems

1.6 Implementation flow:

Stage 1:

Considering the problems of existing methods and giving solution to that problem by considering the basic requirements for our proposed system

Stage 2:

Considering the hardware requirement for the proposed system

For this we need to select the below components:

1. Microcontroller

2. Inputs for the proposed system (ex: sensors, drivers etc..,)

3. Outputs (ex: relays, loads)

Stage 3:

After considering hardware requirements, now we need to check out the software requirements. Based on the microcontroller we select there exists different software for coding, compiling, debugging.

CHAPTER -2

LITERATURE SURVEY

1. **Author:**Pavithra,S.etal.

   Title: Smart Battery Management System for Electric Vehicles Using IoT
   Abstract: This paper discusses the design and implementation of a smart battery management system leveraging IoT technologies to enhance the monitoring and management of EV batteries. The system features real-time data acquisition and remote monitoring capabilities, improving battery life and safety.

2. **Author:**Bai,X.etal.

   Title: A Review of Battery Management Systems for Electric Vehicles
   Abstract: This review provides a comprehensive overview of current battery management systems utilized in electric vehicles, highlighting key technologies, challenges, and future directions in the field. Emphasis is placed on enhancing battery efficiency and safety through advanced monitoring techniques.

3. **Author:**Rahman,M.etal.

   Title: IoT-Based Smart Battery Management System for Electric Vehicles
   Abstract: The study presents an IoT-based battery management system designed to monitor battery parameters and optimize charging processes in electric vehicles. The integration of cloud computing allows for real-time data access, facilitating better battery performance and management.

4. **Author:**Ghosh,A.etal.

   Title: Temperature Management in Electric Vehicle Batteries: An Overview
   Abstract: This paper examines the critical role of temperature management in prolonging battery life and ensuring safety in electric vehicles. Various methods for monitoring and controlling temperature, including sensor technologies and system design, are discussed in detail.

CHAPTER -3

PROPOSED SYSTEM

3.1 Existing System:

Existing methods for battery management in electric vehicles often rely on basic monitoring systems that use standalone sensors for tracking voltage, current, and temperature. These systems may include simple alarms or visual indicators to alert users of abnormal conditions. However, they typically lack real-time data transmission and comprehensive analysis capabilities. They may not provide timely notifications for critical issues such as overheating or low voltage, leading to potential risks of battery damage or safety hazards. Additionally, these systems often do not integrate with remote monitoring platforms, limiting their effectiveness in providing proactive maintenance or emergency responses. The lack of automated load simulation and comprehensive charge management also means that these systems may not optimize battery performance or extend battery life effectively.

3.2 Proposed System:

The proposed method for an IoT-based electrical vehicle battery management system enhances battery monitoring and safety through a comprehensive, integrated approach. By utilizing a combination of sensors and controllers, including a current sensor to measure load, a voltage sensor to monitor battery voltage, and a Dallas temperature sensor to detect overheating, the system ensures precise and continuous monitoring. The NodeMCU facilitates real-time data transmission to the ThingSpeak platform, enabling remote monitoring and analysis. An LCD provides immediate visual feedback on battery status, while a buzzer alerts users to abnormal conditions. The CPU fan activates automatically if high temperatures are detected, and a set of LEDs indicate the battery's charge level. Additionally, multiple mobile chargers disconnect when the battery is fully charged, preventing overcharging. This method offers enhanced safety, real-time monitoring, and proactive management, addressing the limitations of existing methods and optimizing battery performance and lifespan.

3.3 Block Diagram:

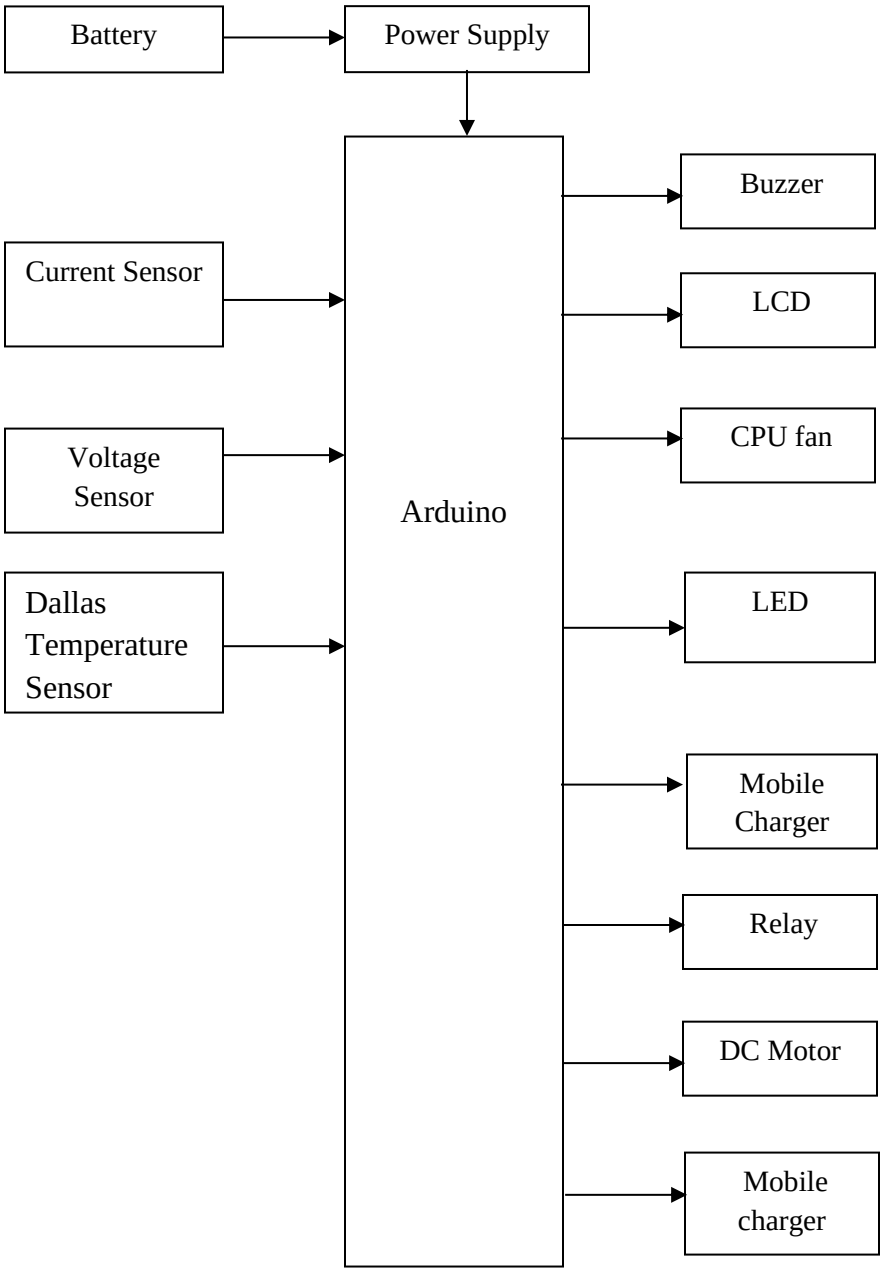

Fig 3.1 Embedded Block Diagram

CHAPTER -4

HARDWARE REQUIREMENTS

4.1 Hardware Components:

- Current Sensor
- Voltage Sensor
- Dallas Temp Sensor
- NodeMCU
- DC Motor
- Buzzer
- LCD
- CPU Fan
- LED
- Relay
- Mobile Charger
- Arduino

4.2Arduino UNO:

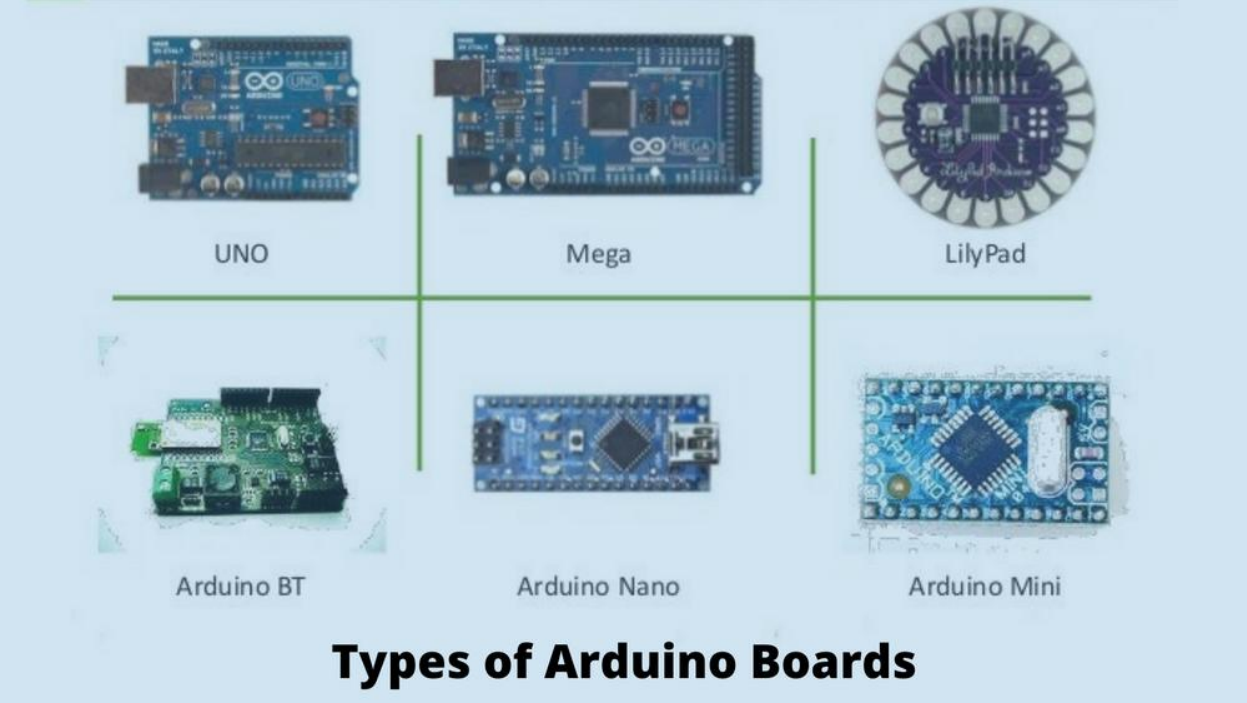

Fig 4.1 Arduino Uno

It is an open-source platform, means the boards and software are readily available and anyone can modify and optimize the boards for better functionality.The software used for Arduino devices is called IDE (Integrated Development Environment) which is free to use and required some basic skills to learn it. It can be programmed using C and C++ language. Some people get confused between **Microcontroller and Arduino**. While former is just an on system 40 pin chip that comes with a built-in microprocessor and later is a board that comes with the microcontroller in the base of the board, bootloader and allows easy access to input-output pins and makes uploading or burning of the program very easy.

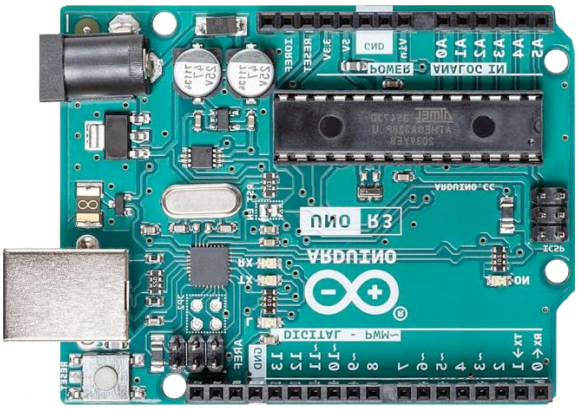

Fig 4.2 Arduino board and microcontroller

While learning microcontroller requires some expertise and skills. Nevertheless, we can say every Arduino is basically a microcontroller but not every microcontroller is an Arduino.

Introduction to Arduino

- **Arduino Uno** is a microcontroller board developed by Arduino.cc which is an open-source electronics platform mainly based on AVR microcontroller Atmega328.
- First Arduino project was started in Interaction Design Institute Ivrea in 2003 by David Cuartielles and Massimo Banzi with the intention of providing a cheap and flexible way to students and professional for controlling a number of devices in the real world.
- The current version of Arduino Uno comes with USB interface, 6 analog input pins, 14 I/O digital ports that are used to connect with external electronic circuits. Out of 14 I/O ports, 6 pins can be used for PWM output.
- It allows the designers to control and sense the external electronic devices in the real world
- This board comes with all the features required to run the controller and can be directly connected to the computer through USB cable that is used to transfer the code to the controller using IDE (Integrated Development Environment) software, mainly developed to program Arduino. IDE is equally compatible with Windows, MAC or Linux Systems, however, Windows is preferable to use. Programming languages like C and C++ are used in IDE.
- Apart from USB, battery or AC to DC adopter can also be used to power the board.

- Arduino Uno boards are quite similar to other boards in Arduino family in terms of use and functionality, however, Uno boards don't come with FTDI USB to Serial driver chip.
- There are many versions of Uno boards available, however, Arduino Nano V3 and Arduino Uno are the most official versions that come with Atmega328 8-bit AVR Atmel microcontroller where RAM memory is 32KB.
- When nature and functionality of the task go complex, Mirco SD card can be added in the boards to make them store more information.

Features of Arduino

Arduino Uno comes with USB interface i.e. USB port is added on the board to develop serial communication with the computer.Atmega328 microcontroller is placed on the board that comes with a number of features like timers, counters, interrupts, PWM, CPU, I/O pins and based on a 16MHz clock that helps in producing more frequency and number of instructions per cycle.

- It is an open source platform where anyone can modify and optimize the board based on the number of instructions and task they want to achieve.
- This board comes with a built-in regulation feature which keeps the voltage under control when the device is connected to the external device.
- Reset pin is added in the board that reset the whole board and takes the running program in the initial stage. This pin is useful when board hangs up in the middle of the running program; pushing this pin will clear everything up in the program and starts the program right from the beginning.
- There are 14 I/O digital and 6 analog pins incorporated in the board that allows the external connection with any circuit with the board. These pins provide the flexibility and ease of use to the external devices that can be connected through these pins. There is no hard and fast interface required to connect the devices to the board. Simply plug the external device into the pins of the board that are laid out on the board in the form of the header.
- The 6 analog pins are marked as A0 to A5 and come with a resolution of 10bits. These pins measure from 0 to 5V, however, they can be configured to the high range using analogReference() function and AREF pin.
- 13KB of flash memory is used to store the number of instructions in the form of code.

- Only 5 V is required to turn the board on, which can be achieved directly using USB port or external adopter, however, it can support external power source up to 12 V which can be regulated and limit to 5 V or 3.3 V based on the requirement of the project.

Arduino Pinout

- Arduino Uno is based on AVR microcontroller called Atmega328. This controller comes with 2KB SRAM, 32KB of flash memory, 1KB of EEPROM. Arduino Board comes with 14 digital pins and 6 analog pins. ON-chip ADC is used to sample these pins. A 16 MHz frequency crystal oscillator is equipped on the board. Following figure shows the pinout of the Arduino Uno Board

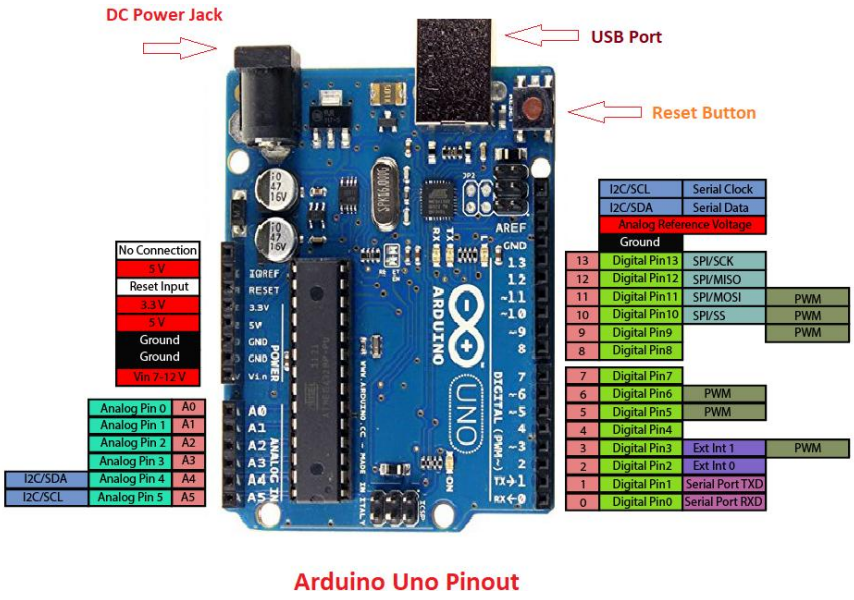

Fig 4.3 Arduino Uno pinout

Pin Description:

There are several I/O digital and analog pins placed on the board which operates at 5V. These pins come with standard operating ratings ranging between 20mA to 40mA. Internal pull-up resistors are used in the board that limits the current exceeding from the given operating conditions. However, too much increase in current makes these resisters useless and damages the device.**LED.** Arduino Uno comes with built-in LED which is connected through pin 13. Providing HIGH value to the pin will turn it ON and LOW will turn it OFF.**Vin.** It is the input voltage

provided to the Arduino Board. It is different than 5 V supplied through a USB port. This pin is used to supply voltage. If a voltage is provided through power jack, it can be accessed through this pin.**5V.** This board comes with the ability to provide voltage regulation. 5V pin is used to provide output regulated voltage. The board is powered up using three ways i.e. USB, Vin pin of the board or DC power jack.

1. **USB** supports voltage around 5V while Vin and Power Jack support a voltage ranges between 7V to 20V. It is recommended to operate the board on 5V. It is important to note that, if a voltage is supplied through 5V or 3.3V pins, they result in bypassing the voltage regulation that can damage the board if voltage surpasses from its limit. bypassing the voltage regulation that can damage .
2. **GND.** These are ground pins. More than one ground pins are provided on the board which can be used as per requirement.
3. **Reset.** This pin is incorporated on the board which resets the program running on the board. Instead of physical reset on the board, IDE comes with a feature of resetting the board through programming.
4. **IOREF.** This pin is very useful for providing voltage reference to the board. A shield is used to read the voltage across this pin which then select the proper power source.
5. **PWM.** PWM is provided by 3, 5, 6,9,10, 11pins. These pins are configured to provide 8-bit output PWM.
6. **SPI.** It is known as Serial Peripheral Interface. Four pins 10(SS), 11(MOSI), 12(MISO), 13(SCK) provide SPI communication with the help of SPI library.
7. **AREF.** It is called Analog Reference. This pin is used for providing a reference voltage to the analog inputs.
8. **TWI.** It is called Two-wire Interface. TWI communication is accessed through Wire Library. A4 and A5 pins are used for this purpose.
9. **Serial Communication.** Serial communication is carried out through two pins called Pin 0 (Rx) and Pin 1 (Tx).

10. Rx pin is used to receive data while Tx pin is used to transmit data. **External Interrupts.** Pin 2 and 3 are used for providing external interrupts. An interrupt.

Arduino Uno Technical Specifications

Microcontroller	ATmega328– 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB

Table 4.1 Arduino Uno Technical specifications

Communication and Programming:

Arduino Uno comes with an ability of interfacing with other other Arduino boards, microcontrollers and computer. The Atmega328 placed on the board provides serial communication using pins like Rx and Tx. The Atmega16U2 incorporated on the board provides

a pathway for serial communication using USB com drivers. Serial monitor is provided on the IDE software which is used to send or receive text data from the board. If LEDs placed on the Rx and Tx pins will flash, they indicate the transmission of data. Arduino Uno is programmed using Arduino Software which a cross-platform application called IDE is written in Java. The AVR microcontroller Atmega328 laid out on the base comes with built-in boot loader that sets you free from using a separate burner to upload the program on the board.

Fig 4.4 Arduino IDE

Applications:

Arduino Uno comes with a wide range of applications. A larger number of people are using Arduino boards for developing sensors and instruments that are used in scientific research. Following are some main applications of the board.

- Security and Defense System
- Embedded Systems
- Digital Electronics and Robotics
- Parking Lot Counter
- Weighing Machines
- Traffic Light Count Down Timer

4.3 Battery:

A rechargeable battery is an energy storage device that can be charged again after being discharged by applying DC current to its terminals. Rechargeable Batteries allow for multiple usages from a cell, reducing waste and generally providing a better long-term investment in terms of dollars spent for usable device time. This is true even factoring in the higher purchase price of rechargeable and the requirement for a charger.
A rechargeable battery is generally a more sensible and sustainable replacement to one-time use batteries, which generate current through a chemical reaction in which a reactive anode is consumed. The anode in a rechargeable battery gets consumed as well but at a slower rate, allowing for many charges and discharges. In use, rechargeable batteries are the same as conventional ones. However, after discharge the batteries are placed in a charger or, in the case of built-in batteries, an DC adapter is connected. While rechargeable batteries offer better long term cost and reduce waste, they do have a few cons. Many types of rechargeable cells created for consumer devices, including AA and AAA, C and D batteries, produce a lower voltage of 1.2v in contrast to the 1.5v of alkaline batteries. Though this lower voltage doesn't prevent correct operation in properly.

Fig 4.5 Battery

4.4 Voltage Sensor:

This sensor is used to monitor, calculate and determine the voltage supply. This sensor can determine the AC or DC voltage level. The input of this sensor can be the voltage whereas the output is the switches, analog voltage signal, a current signal, an audible signal, etc. Some sensors provide sine waveforms or pulse waveforms like output & others can generate outputs like AM, PM or FM. The measurement of these sensors can depend on the voltage divider.

Input Voltage (V)	0 to 25
Voltage Detection Range (V)	0.02445 to 25
Analog Voltage Resolution (V)	0.00489
Length (mm)	28
Width (mm)	14
Height (mm)	13
Weight (gm)	4

Table 4.2 Voltage Measurements

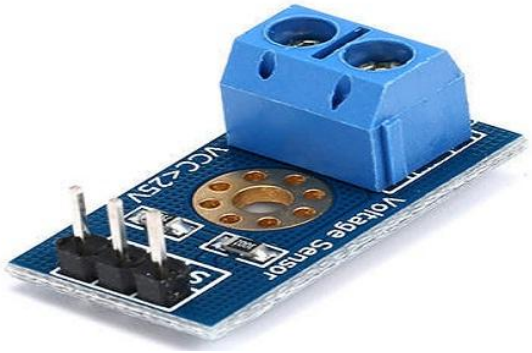

Fig 4.6 Voltage sensor

This sensor includes input and output. The input side mainly includes two pins namely positive and negative pins. The two pins of the device can be connected to the positive & negative pins of the sensor. The device positive & negative pins can be connected to the positive & negative pins of the sensor. The output of this sensor mainly includes supply voltage (Vcc), ground (GND), analog o/p data

Types of Voltage Sensors

These sensors are classified into two types like a resistive type sensor and capacitive type sensor**.**

1) Resistive Type Sensor

This sensor mainly includes two circuits like a voltage bridge & bridge circuit. The resistor in the circuit works as a sensing element. The voltage can be separated into two resistors like a reference voltage & variable resistor to make a circuit of the voltage divider. A voltage supply is applied to this circuit. The output voltage can be decided by the resistance used in the circuit. So the voltage change can be amplified.

The bridge circuit can be designed with four resistors. One of these resistors can be subjected to the voltage detector device. The change in voltage can be directly exhibited. This difference alone can be amplified but the difference within the voltage divider circuit not only amplified.

Vout = (R1/R1 + R2) * Vin

2) Capacitor Type Sensor

This type of sensor consists of an insulator and two conductors within the center. As the capacitor is power-driven with 5 Volt, then the flow of current will be there in the capacitor. This can create revulsion of electrons within the capacitor. The difference in capacitance indicates the voltage and the capacitor can be connected within the series.

Vout = (C1/C1 + C2) * Vin

This type of sensor consists of an insulator and two conductors within the center. As the capacitor is power-driven with 5 Volt, then the flow of current will be there in the capacitor. This can create revulsion of electrons within the capacitor. The difference in capacitance indicates the voltage and the capacitor can be connected within the This type of sensor consists of an insulator and two conductors within the center. As the capacitor is power-driven with 5 Volt, then the flow of current will be there in the capacitor. This can create revulsion of electrons within the capacitor. The difference in capacitance indicates the voltage and the capacitor can be connected within the series.

4.5 ACS712 Current Sensor:

Current flowing through a conductor causes a voltage drop. The relation between current and voltage is given by Ohm's law. In electronic devices, an increase in the amount of current above its requirement leads to overload and can damage the device.Measurement of current is necessary for the proper working of devices. Measurement of voltage is Passive task and it can be done without affecting the system. Whereas measurement of current is an Intrusive task which cannot be detected directly as voltage.

Specifications:

Current sensor chip	ACS712ELC-20A
Operating Voltage (V)	4.5V ~ 5.5V DC
Measure Current Range	-20 ~ +20A
Sensitivity	100mV/A
Length (mm)	32
Width (mm)	13
Height (mm)	13.5
Weight (gm)	5

Table 4.3 Current Specifications

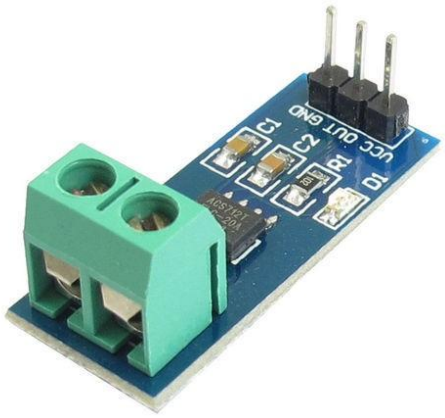

Fig 4.7 Current Sensor

For measuring current in a circuit, a sensor is required. ACS712 Current Sensor is the sensor that can be used to measure and calculate the amount of current applied to the conductor without affecting the performance of the system.

ACS712 Current Sensor is a fully integrated, Hall-effect based linear sensor IC. This IC has a 2.1kV RMS voltage isolation along with a low resistance current conductor.

Working Principle

Current Sensor detects the current in a wire or conductor and generates a signal proportional to the detected current either in the form of analog voltage or digital output.Current Sensing is done in two ways – Direct sensing and Indirect Sensing. In Direct sensing, to detect current, Ohm's law is used to measure the voltage drop occurred in a wire when current flows through it.A current-carrying conductor also gives rise to a magnetic field in its surrounding. In Indirect Sensing, the current is measured by calculating this magnetic field by applying either Faradays law or Ampere law. Here either a Transformer or Hall effect sensor or fibre optic current sensor are used to sense the magnetic field. ACS712 Current Sensor uses Indirect Sensing method to calculate the current. To sense current a liner, low-offset Hall sensor circuit is used in this IC. This sensor is located at the surface of the IC on a copper conduction path. When current flows through this copper conduction path it generates a magnetic field which is sensed by the Hall effect sensor. A voltage proportional to the sensed magnetic field is generated by the Hall sensor, which is used to measure current.The proximity of the magnetic signal to the Hall sensor decides the accuracy of the device. Nearer the magnetic signal higher the accuracy. ACS712 Current Sensor is available as a small, surface mount SOIC8 package. In this IC current flows from Pin-1 and Pin-2 to Pin-3 and Pin-4. This forms the conduction path where the current is sensed. Implementation of this IC is very easy.ACS712 can be used in applications requiring electrical isolation as the terminals of the conduction path are electrically isolated from the IC leads. Thus, this IC doesn't require any other isolation digital temperature sensor like DS18B20 follows single wire protocol and it can be used to measure temperature in the range of -67oF to +257oF or -55oC to +125oC with +-5% accuracy. The range of received data from the 1-wire can range from 9-bit to 12-bit. Because, this sensor follows the single wire protocol, and the controlling of this can be done through an only pin of Microcontroller. This is an advanced level protocol, where each sensor can be set with a 64-bit serial code which aids to control numerous sensors using a single pin of the microcontroller. This article discusses an overview of a DS18B20 temperature sensor

4.6 Temperature Sensor :

What is a DS18B20 Temperature Sensor?

The DS18B20 is one type of temperature sensor and it supplies 9-bit to 12-bit readings of temperature. These values show the temperature of a particular device. The communication of this sensor can be done through a one-wire which uses one data line to communicate with an inner micro processor Additionally, this sensor getst the power supply directly from the data line so that the need for an external power supply can be eliminated. The applications of the DS18B20 temperature sensor include industrial systems, consumer products, systems which are sensitive thermally, thermostatic controls, and thermometers.

Fig 4.8 Temperature Sensor

this sensor can be done through a one-wire which uses one data line to communicate with an inner micro processor Additionally, this sensor getst the power supply directly from the data line so that the need for an external power supply can be eliminated. The applications of the DS18B20 temperature sensor include industrial systems, consumer products, systems which are sensitive thermally, thermostatic controls, and thermometers.

Pin Configuration

No:	Pin Name	Description
1	Ground	Connect to the ground of the circuit
2	Vcc	Powers the Sensor, can be 3.3V or 5V
3	Data	This pin gives output the temperature value which can be read using 1-wire method

Table 4.4 Temperature sensor pin configuration

Specifications

The specifications of this sensor include the following.

- This sensor is a programmable and digital temperature sensor
- The communication of this sensor can be done with the help of a 1-Wire method
- The range of power supply is 3.0V – 5.5V
- Fahrenheit equal s to -67°F to +257°F
- The accuracy of this sensor is ±0.5°C
- The o/p resolution will range from 9-bit to 12-bit
- It changes the 12-bit temperature to digital word within 750 ms time
- This sensor can be power-driven from the data line
- Alarm options are programmable

Working Principle

The working principle of this DS18B20 temperature sensor is like a temperature sensor. The resolution of this sensor ranges from 9-bits to 12-bits. But the default resolution which is used to power-up is 12-bit. This sensor gets power within a low-power inactive condition.

4.7 Motor Driver:

A motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver act as an interface between Arduino and the motors. The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. We will be referring the motor driver IC as L293D only. L293D has 16 pins.

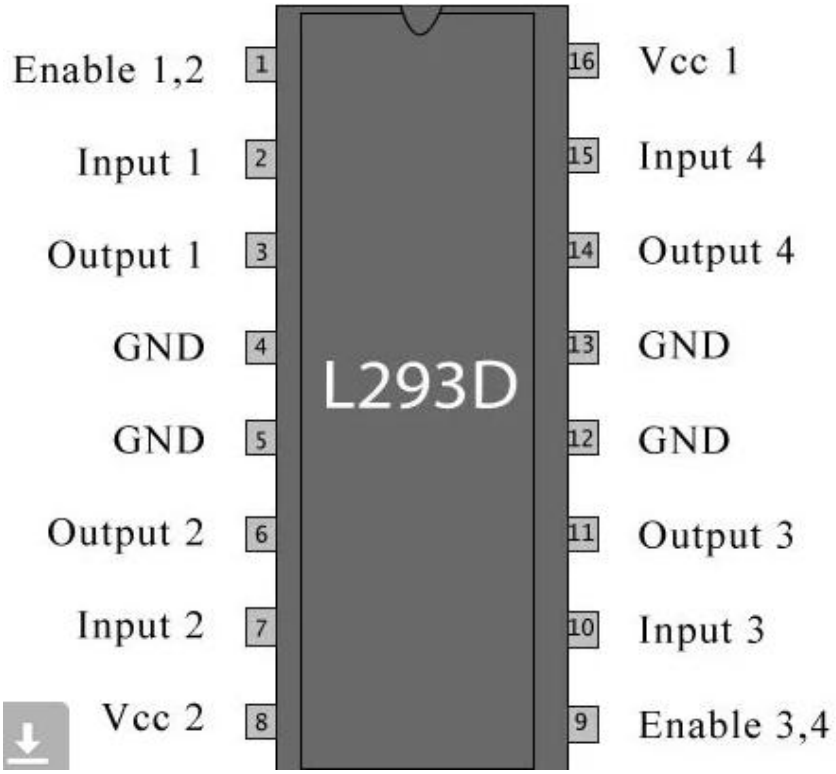

Fig 4.9 Motor Driver Pin Diagram

The L293D is a 16 pin IC, with eight pins, on each side, dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor.

Pin Number	Pin Name	Description
1	Enable 1,2	This pin enables the input pin Input 1(2) and Input 2(7)
2	Input 1	Directly controls the Output 1 pin. Controlled by digital circuits
3	Output 1	Connected to one end of Motor 1
4	Ground	Ground pins are connected to ground of circuit (0V)
5	Ground	Ground pins are connected to ground of circuit (0V)
6	Output 2	Connected to another end of Motor 1
7	Input 2	Directly controls the Output 2 pin. Controlled by digital circuits
8	Vcc2 (Vs)	Connected to Voltage pin for running motors (4.5V to 36V)
9	Enable 3,4	This pin enables the input pin Input 3(10) and Input 4(15)
10	Input 3	Directly controls the Output 3 pin. Controlled by digital circuits
11	Output 3	Connected to one end of Motor 2
12	Ground	Ground pins are connected to ground of circuit (0V)
13	Ground	Ground pins are connected to ground of circuit (0V)
14	Output 4	Connected to another end of Motor 2
15	Input 4	Directly controls the Output 4 pin. Controlled by digital circuits
16	Vcc2 (Vss)	Connected to +5V to enable IC function

Table 4.5 Motor driver pin Configuration

Working of L293D

There are 4 input pins for l293d, pin 2, 7 on the left and pin 15, 10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side

and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1.

In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor.

L293D Logic Table.

Let's consider a Motor connected on left side output pins (pin 3, 6). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

Pin 2 = Logic 1 and Pin 7 = Logic 0 | Clockwise Direction

Pin 2 = Logic 0 and Pin 7 = Logic 1 | Anticlockwise Direction

Pin 2 = Logic 0 and **Pin 7 = Logic 0** | Idle [No rotation] [Hi-Impedance state]

Pin 2 = Logic 1 and **Pin 7 = Logic 1** | Idle [No rotation]

Circuit Diagram for l293d motor driver IC controller

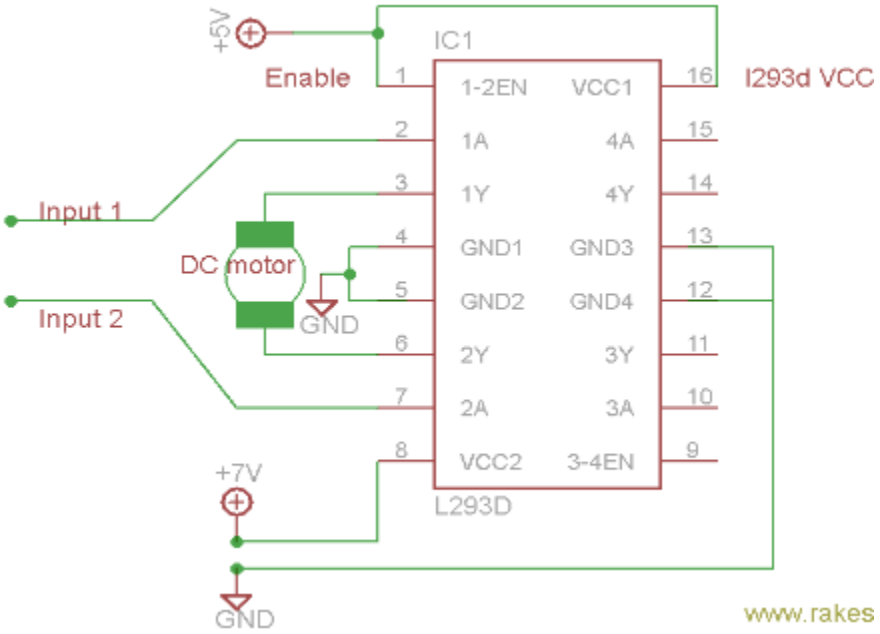

Fig 4.10 motor driver circuit diagram

Voltage Specification :

VCC is the voltage that it needs for its own internal operation 5v; L293D will not use this voltage for driving the motor. For driving the motors it has a separate provision to provide motor supply VSS (V supply). L293d will use this to drive the motor. It means if you want to operate a motor at 9V then you need to provide a Supply of 9V across VSS Motor supply. The maximum voltage for VSS motor supply is 36V. It can supply a max current of 600mA per channel. Since it can drive motors Up to 36v hence you can drive pretty big motors with this l293d. VCC pin 16 is the voltage for its own internal Operation. The maximum voltage ranges from 5v and up to 36v.A direct current (DC) motor is a type of electric machine that converts electrical energy into mechanical energy. DC motors take electrical power through direct current, and convert this energy into mechanical rotation. DC motors use magnetic fields that occur from the electrical currents generated, which powers the movement of a rotor fixed within the output shaft. The output torque and speed depends upon both the electrical input and the design of the motor.

How DC motors work The term 'DC motor' is used to refer to any rotary electrical machine that converts direct current electrical energy into mechanical energy. DC motors can vary in size and power from small motors in toys and appliances to large mechanisms that power vehicles, pull elevators and hoists, and drive steel rolling mills. What is a DC Motor?A direct current (DC) motor is a type of electric machine that converts electrical energy into mechanical energy. DC motors take electrical power through direct current, and convert this energy into mechanical rotation.DC motors use magnetic fields that occur from the electrical currents generated, which powers the movement of a rotor fixed within the output shaft. The output torque and speed depends upon both the electrical input and the design of the motor.

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DC motors include two key components: a **stator** and an **armature**. The stator is the stationary part of a motor, while the armature rotates. In a DC motor, the stator provides a rotating magnetic field that drives the armature to rotate. A simple DC motor uses a stationary set of magnets in the stator, and a coil of wire with a current running through it to generate an electromagnetic field aligned with the centre of the coil. One or more windings of insulated wire are wrapped around the core of the motor to concentrate the magnetic field. The windings of insulated wire are connected to a commutator (a rotary electrical switch), that applies an electrical current to the windings. The commutator allows each armature coil to be energised in turn, creating a steady rotating force (known as torque). This amazing piece of electrical equipment has revolutionised our lives in many ways, but who invented the DC motor? As with all major innovations, there are many people who had a role to play through the development of similar mechanisms. In the US, Thomas Davenport is widely celebrated as the inventor of the first electric motor, and undoubtedly he was the first to patent a useable electric motor in 1837. Davenport, however, was not the first person to build an electric motor, with various inventors in Europe having already developed more powerful versions by the time Davenport filed his patent. The commutator allows each armature coil to be energised in turn, creating a steady rotating force. This amazing piece of electrical equipment has revolutionised our lives in many ways, but who invented the DC motor? As with all major innovations, there are many people who had a role to play through the development of similar mechanisms. In the US, Thomas Davenport is widely celebrated as the inventor of the first electric motor, and undoubtedly he was the first to patent a useable electric motor in 1837. Davenport, however, was not the first person to build an electric motor, with various inventors in Europe having already developed more powerful versions by the time Davenport filed his patent. Davenport, however, was not the first person to build an electric motor, with various inventors in Europe having already developed more powerful versions by the time Davenport filed his patent. Davenport, however, was not the first person to build an electric motor, with various inventors in Europe having already developed more powerful versions by the time Davenport filed his patent. electric motor, with various inventors in Europe having already developed.

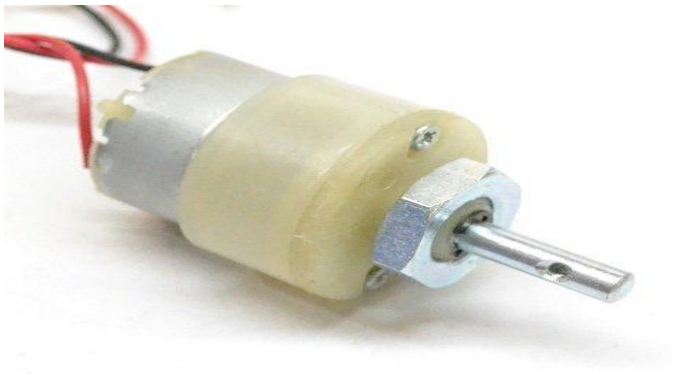


Fig 4.11 DC MOTOR

The first practical DC motor was invented some years later in 1886 by Frank Julian Sprague, whose invention lead to the first motor powered trolley system in 1887, and the first electric elevator in 1892. Sprague's DC motor was a hugely significant development, leading to a variety of applications which would reshape the face of industry and manufacturing.Types of DC Motors.

Inventor of the first electric motor, and undoubtedly he was the first to patent a useable electric motor in 1837. Davenport, however, was not the first person to build an electric motor, with various inventors in Europe having already developed more powerful versions by the time Davenport filed his patent. Davenport, however, was not the first person to build an electric motor, with various inventors in Europe having already developed more powerful versions by the time Davenport filed his patent. Davenport, however, was not the first person to build an electric motor, with various inventors in Europe having already developed more powerful versions by the time Davenport filed his patent. electric motor, with various inventors in Europe having already developed. electric elevator in 1892. Sprague's DC motor was a hugely significant development, leading to a variety of applications which would reshape the face of industry and manufacturing.Types of DC Motors. electric elevator in 1892. Sprague's DC motor was a hugely significant development, leading to a variety of applications which would reshape the face of industry and manufacturing.Types of DC Motors. variety of applications which would reshape however, was not the first person to build an electric motor.

4.8 Buzzer:

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. Buzzer is an integrated structure of electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys, automotive electronic equipment, telephones, timers and other electronic products for sound devices. Active buzzer 5V Rated power can be directly connected to a continuous sound, this section dedicated sensor expansion module and the board in combination.

Fig 4.12 BUZZER

Buzzer Pin Configuration

Pin Number	Pin Name	Description
1	Positive	Identified by (+) symbol or longer terminal lead. Can be powered by 5V DC
2	Negative	Identified by short terminal lead. Typically connected to the ground of the circuit

Table 4.6 Buzzer pin configuration

Buzzer Features and Specifications

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

How to use a Buzzer

A **buzzer** is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

There are two types are buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But, the one shown here is most widely used because it can be customized with help of other circuits to fit easily in our application.

This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

Applications of Buzzer

- Alarming Circuits, where the user has to be alarmed about something
- Communication equipment's
- Automobile electronics
- Portable equipment's, due to its compact size

4.9 CPU fan:

A CPU fan, also known as a heatsink fan or cooler fan, is an essential component in a computer's cooling system. Its primary function is to dissipate heat generated by the central processing unit (CPU) during operation. Here are some key points about CPU fans:

1. Heat Dissipation: The CPU is one of the most heat-intensive components in a computer. It generates heat as it processes data and performs calculations. Without proper cooling, the CPU can overheat, leading to reduced performance, instability, or even permanent damage.

2. Types of CPU Fans:

Air Cooling: Most desktop computers use air cooling solutions. These consist of a heatsink and a fan. The heatsink is a metal block with fins that help dissipate heat, and the fan blows air across the heatsink to cool it down.

Liquid Cooling: High-performance systems, including gaming PCs and workstations, often use liquid cooling systems. These systems use a liquid coolant to transfer heat away from the CPU to a radiator, where fans dissipate the heat. Liquid cooling can be more efficient but is also more complex and expensive.

3. CPU Fan Placement: CPU fans are typically mounted directly on top of the CPU. The fan's airflow helps dissipate heat from the CPU and keeps its temperature within safe limits.

4. Speed Control: Most CPU fans are designed to run at variable speeds based on the CPU's temperature. This is known as PWM (Pulse Width Modulation) control. When the CPU is under heavy load, the fan speeds up to cool the CPU more effectively.

5. Maintenance: Over time, dust and debris can accumulate on the CPU fan and heatsink, reducing its cooling efficiency. Regular cleaning is essential to maintain optimal cooling performance.

6. Cooling Efficiency: The cooling efficiency of a CPU fan is measured in terms of its thermal dissipation capacity and noise level. High-performance fans can cool the CPU more effectively but may produce more noise.

7. Aftermarket Cooling: CPU cooling is especially critical for users who overclock their CPUs, as overclocking increases heat generation. Specialized cooling solutions are often required to handle the additional heat produced by overclocking.

8. Overclocking: CPU cooling is especially critical for users who overclock their CPUs, as overclocking increases heat generation. Specialized cooling solutions are often required to handle the additional heat produced by overclocking.

In summary, a CPU fan is a critical component in a computer's cooling system, ensuring that the CPU operates within safe temperature limits. Proper cooling is essential for maintaining system stability and performance, and it can also extend the lifespan of the CPU. Depending on your computer's usage and performance requirements, you may consider upgrading or maintaining your CPU cooling solution to ensure efficient heat dissipation.

Fig 4.13 CPU FAN

CPU cooling is especially critical for users who overclock their CPUs, as overclocking increases heat generation. Specialized cooling solutions are often required to handle the additional heat produced by overclocking. CPU cooling is especially critical for users who overclock their CPUs, as overclocking increases heat generation. Specialized cooling solutions are often required to handle the additional heat produced by overclocking. Most CPU fans are designed to run at variable speeds based on the CPU's temperature. This is known as PWM (Pulse Width Modulation) control. When the CPU is under heavy load, the fan speeds up to cool the CPU more effectively.

4.10 Relay:

What is a relay?

A relay is an electromagnetic switch that is used to turn on and turn off a circuit by a low power signal, or where several circuits must be controlled by one signal. Most of the high end industrial application devices have relays for their effective working. Relays are simple switches which are operated both electrically and mechanically. Relays consist of an electromagnet and also out with the help of the electromagnet. There are also other operating principles for its working. But they differ according to their applications. Most of the devices have the application of relays.

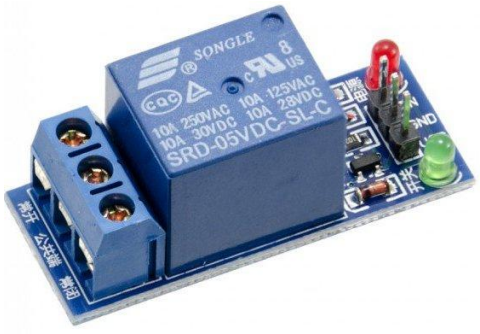


Fig 4.14 Relay

Pin Diagram:

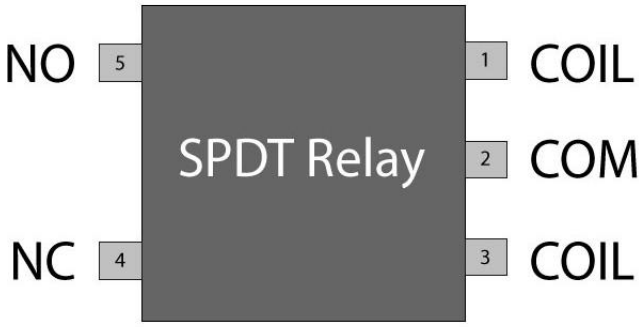


Fig 4.15 Relay Pin Diagram

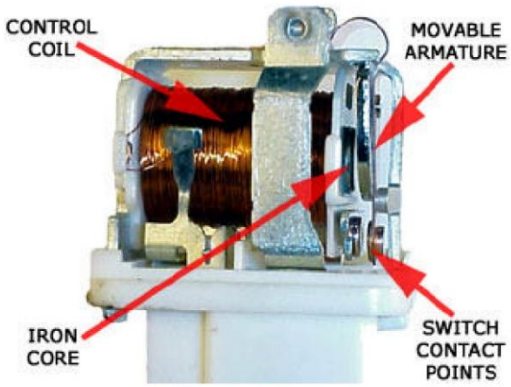
Why is a relay used?

The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits. The application of relays started during the invention of telephones. They played an important role in switching calls in telephone exchanges. They were also used in long distance telegraphy. They were used to switch the signal coming from one source to another destination. After the invention of computers they were also used to perform Boolean and other logical operations. The high end applications of relays require high power to be driven by electric motors and so on. Such relays are called contactors.

Relay Design

- There are only four main parts in a relay. They are
- Electromagnet
- Movable Armature
- Switch point contacts
- Spring

The figures given below show the actual design of a simple relay.



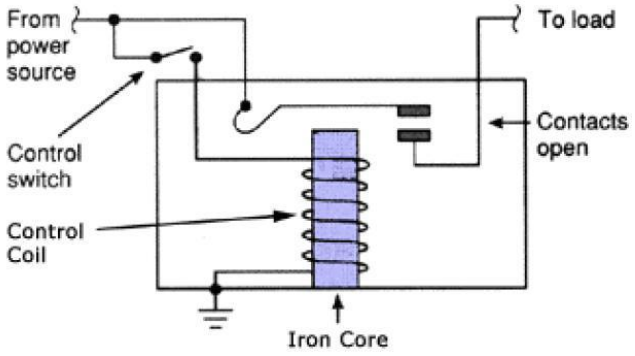
Relay Construction

Fig 4.16 Relay Construction

It is an electro-magnetic relay with a wire coil, surrounded by an iron core. A path of very low reluctance for the magnetic flux is provided for the movable armature and also the switch point contacts. The movable armature is connected to the yoke which is mechanically connected to the switch point contacts. These parts are safely held with the help of a spring. The spring is used so as to produce an air gap in the circuit when the relay becomes de-energized.

How relay works?

The relay function can be better understood by explaining the following diagram given below.



Relay Design

Fig 4.17 Relay Design

The diagram shows an inner section diagram of a relay. An iron core is surrounded by a control coil. As shown, the power source is given to the electromagnet through a control switch and through contacts to the load. When current starts flowing through the control coil, the electromagnet starts energizing and thus intensifies the magnetic field. Thus the upper contact arm starts to be attracted to the lower fixed arm and thus closes the contacts causing a short circuit for the power to the load. On the other hand, if the relay was already de-energized when the contacts were closed, then the contact move oppositely and make an open circuit. As soon as the coil current is off, the movable armature will be returned by a force back to its initial position. This force will be almost equal to half the strength of the magnetic force. This force is mainly provided by two factors. They are the spring and also gravity.

Relays are mainly made for two basic operations. One is low voltage application and the other is high voltage. For low voltage applications, more preference will be given to reduce the noise of the whole circuit. For high voltage applications, they are mainly designed to reduce a phenomenon called arcing.

Relay Basics

The basics for all the relays are the same. Take a look at a 4 pin relay shown below. There are two colors shown. The green color represents the control circuit and the red color represents the load circuit. A small control coil is connected onto the control circuit. A switch is connected to the load. This switch is controlled by the coil in the control circuit. Now let us take the different steps that occur in a relay.

- **Energized Relay (ON)**

As shown in the circuit, the current flowing through the coils represented by pins 1 and 3 causes a magnetic field to be aroused. This magnetic field causes the closing of the pins 2 and 4. Thus the switch plays an important role in the relay working. As it is a part of the load circuit, it is used to control an electrical circuit that is connected to it. Thus, when the electrical relay in energized the current flow will be through the pins 2 and 4.

- **De – Energized Relay (OFF)**

As soon as the current flow stops through pins 1 and 3, the relay switch opens and thus the open circuit prevents the current flow through pins 2 and 4. Thus the relay becomes de-energized and thus in off position. In simple, when a voltage is applied to pin 1, the electromagnet activates, causing a magnetic field to be developed, which goes on to close the pins 2 and 4 causing a closed circuit. When there is no voltage on pin 1, there will be no electromagnetic force and thus no magnetic field. Thus the switches remain open.

Pole and Throw

Relays have the exact working of a switch. So, the same concept is also applied. A relay is said to switch one or more poles. Each pole has contacts that can be thrown in mainly three ways. They are

- **Normally Open Contact (NO):** NO contact is also called a make contact. It closes the circuit when the relay is activated. It disconnects the circuit when the relay is inactive.
- **Normally Closed Contact (NC):** NC contact is also known as break contact. This is opposite to the NO contact. When the relay is activated, the circuit disconnects. When the relay is deactivated, the circuit connects.
- **Change-over (CO) / Double-throw (DT) Contacts:** This type of contacts are used to control two types of circuits. They are used to control a NO contact and also a NC contact with a common terminal. According to their type they are called by the names **break before make** and **make before break** contacts.

Relays can be used to control several circuits by just one signal. A relay switches one or more poles, each of whose contacts can be thrown by energizing the coil.

Relays are also named with designations like

- **Single Pole Single Throw (SPST)**: The SPST relay has a total of four terminals. Out of these two terminals can be connected or disconnected. The other two terminals are needed for the coil to be connected.
- **Single Pole Double Throw (SPDT):** The SPDT relay has a total of five terminals. Out of these two are the coil terminals. A common terminal is also included which connects to either of two others.
- **Double Pole Single Throw (DPST):** The DPST relay has a total of six terminals. These terminals are further divided into two pairs. Thus they can act as two SPST which are actuated by a single coil. Out of the six terminals two of them are coil terminals.

- **Double Pole Double Throw (DPDT)**: The DPDT relay is the biggest of all. It has mainly eight relay terminals. Out of these two rows are designed to be change over terminals. They are designed to act as two SPDT relays which are actuated by a single coil.

Relay Applications

- A relay circuit is used to realize logic functions. They play a very important role in providing safety critical logic.
- Relays are used to provide time delay functions. They are used to time the delay open and delay close of contacts.
- Relays are used to control high voltage circuits with the help of low voltage signals. Similarly they are used to control high current circuits with the help of low current signals.
- They are also used as protective relays. By this function all the faults during transmission and reception can be detected and isolated.

Another type of overload motor is the electronic type which continuously watches the motor current, whereas the thermal overload relay shuts off the motor depending on the rise of temperature/heat of the strip. All overload relays available to buy comes in different specifications, the most important of them being the current ranges and response time. Most of them are designed to automatically reset to work after the motor is turned back on.

4.10 Light Emitting Diodes (LEDs)

The Light emitting diode is a two-lead semiconductor light source. In 1962, Nick Holonyak has come up with an idea of light emitting diode, and he was working for the general electric company. The LED is a special type of diode and they have similar electrical characteristics of a PN junction diode. Hence the LED allows the flow of current in the forward direction and blocks the current in the reverse direction. The LED occupies the small area which is less than the **1 mm^2**. Applications of led's used to make various electrical and electronic projects. In this article, we will discuss the working principle of the LED and its applications.

What is a Light Emitting Diode?

The lighting emitting diode It is a specially doped diode and made up of a special type of semiconductors. When the light emits in the forward biased, then it is called as a light emitting diode.

Fig 4.18 LED

How does the Light Emitting Diode work?

The light emitting diode simply, we know as a diode. When the diode is forward biased, then the electrons & holes are moving fast across the junction and they are combining constantly, removing one another out. Soon after the electrons are moving from the n-type to the p-type silicon, it combines with the holes, then it disappears. Hence it makes the complete atom & more stable and it gives the little burst of energy in the form of a tiny packet or photon of light.

Schematic:

- A Light emitting diode (LED) is essentially a pn junction diode. When carriers are injected across a forward-biased junction, it emits incoherent light.
- Most of the commercial LEDs are realized using a highly doped n and a p Junction.

LED Materials:

A critical class of business LEDs that cover the unmistakable range. Ternary composites in view of alloying GaAs and GaP which are signified by GaAs1-yPy. InGaAlP is a case of a quarternary (four component) III-V compound with an immediate band crevice. The LEDs

acknowledged utilizing two diversely doped semiconductors that are the same material is known as a homojunction. When they are acknowledged utilizing diverse bandgap materials they are known as a heterostructure gadget heterostructure LED is brighter than a homoJunction LED.

LED Structure:

The LED structure assumes a vital part in radiating light from the LED surface. The LEDs are organized to guarantee the majority of the recombinations happens at first glance by the accompanying two ways. • By expanding the doping grouping of the substrate, so that extra free minority charge transporters electrons move to the top, recombine and emanate light at the surface. • By expanding the dissemination length $L = \sqrt{D\tau}$, where D is the dispersion coefficient and τ is the bearer life time. In any case, when expanded past a basic length there is a possibility of re-retention of the photons into the gadget. The LED must be organized so that the photons produced from the gadget are transmitted without being reabsorbed. One arrangement is to make the p layer on the top, sufficiently flimsy to make an exhaustion layer. Taking after picture demonstrates the layered structure. There are diverse approaches to structure the vault for proficient transmitting. LEDs are normally based on a n-sort substrate, with a terminal joined to the p-sort layer saved on its surface. P-sort substrates, while less basic, happen too. Numerous business LEDs, particularly GaN/InGaN, likewise utilize sapphire substrate. Driven productivity: A vital metric of a LED is the outside quantum proficiency next. It measures the efficiency of the transformation of electrical vitality into transmitted optical vitality. It is characterized as the light yield isolated by the electrical information power. It is likewise characterized as the result of Internal radiative proficiency and Extraction productivity. ηext = Pout(optical)/IV For backhanded band gap semiconductors ηext is for the most part under 1%, where concerning an immediate band hole material it could be generous. ηint = rate of radiation recombination/Total recombination The interior effectiveness is an element of the nature of the material and the structure and arrangement of the layer.

Applications:

LED have a lot of applications. Following are few examples.

• Devices, medical applications, clothing, toys

• Remote Controls (TVs, VCRs)

• Lighting

• Indicators and signs

• Optoisolators and optocouplers

• Swimming pool lighting

Advantages of using LEDs

• LEDs deliver more light per watt than radiant knobs; this is valuable in battery fueled or vitality sparing gadgets.

• LEDs can radiate light of a planned shading without the utilization of shading channels that customary lighting techniques require. This is more effective and can bring down introductory expenses.

• The strong bundle of the LED can be intended to center its light. Glowing and fluorescent sources frequently require an outside reflector to gather light and direct it in a usable way.

• When utilized as a part of utilizations where darkening is required, LEDs don't change their shading tint as the present going through them is brought down, not at all like radiant lights, which turn yellow.

• LEDs are perfect for use in applications that are liable to visit on-off cycling, not at all like fluorescent lights that copy out all the more immediately when cycled much of the time, or High Intensity Discharge (HID) lights that require quite a while before restarting.

• LEDs, being strong state segments, are hard to harm with outer stun. Fluorescent and radiant globules are effectively broken if dropped on the ground.

CHAPTER-5

SOFTWARE DESCRIPTION

Software Requirements

- Embedded C
- Arduino IDE

5.1 Embedded C

Implanted C makes use of KEIL IDE programming. The framework program written in implanted C can be placed away in Microcontroller. The accompanying is a portion of the actual motives behind composing applications in C as opposed to get collectively. It is much less disturbing and much less tedious to write down in C then amassing. C is less traumatic to trade and refresh. You can utilize code available in capacity libraries.

C code is compact to different microcontrollers with subsequent to 0 alteration. Genuine, installed C programming need nonstandard expansions to the C driver with a view to bolster charming components, as an example, settled point range catching, numerous unmistakable reminiscence banks, and fundamental I/O operations. In 2008, the C Standards Committee prolonged the C data to deal with these problems via giving a normal well known to all executions to purchaser to contains numerous additives not handy in standard C, for example, settled factor wide variety catching, named address spaces, and vital I/O equipment tending to Installed C utilize the greater part of the grammar and semantics of wellknown C, e.G., number one() paintings, variable definition, facts type statement, contingent proclamations (if, switch. Case), circles (even as, for), capacities, exhibits and strings, structures and union, piece operations, macros, unions, and so on. Installed

•Embedded gadgets have asset limitations (restricted ROM, constrained RAM, constrained stack space, less handling power)

•Components utilized as a part of installed framework and PCs are distinctive; implanted frameworks ordinarily utilizes littler, less power devouring segments. Inserted frameworks are more fixing to the equipment.

Two remarkable components of Embedded Programming are code speed and code estimate. Code speed is represented by the handling power, timing requirements, while code size is administered by accessible program memory and utilization of programming dialect. Objective of implanted framework writing computer programs is to get greatest elements in least space and least time.

Implanted frameworks are modified utilizing distinctive sort of dialects:

•Machine Code

•Low level dialect, i.e., get together

•High level dialect like C, C++, and Java and so on.

•Application level dialect like Visual Basic, scripts, Access, and so on..,

Components utilized as a part of installed framework and PCs are distinctive; implanted frameworks ordinarily utilizes littler, less power devouring segments. Inserted frameworks are more fixing to the equipment.

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5.2 Arduino IDE:

The Arduino IDE software is a open source software, where we can have the example codes for the beginners. In the Present world there are lot of version in the Arduino IDE in which present usage is Version1.0.5. It is very easy to connect the PC with Arduino Board.

First we have to install the Arduino IDE software according to the below instructions:

- ✓ Insert the CD-ROM or PENDRIVE which Contains the software and then Copy the Setup File to your desired location.
- ✓ After Copying, now click on the setup you will see an window shown below
- ✓ Click On NO, not this time. Then after NEXT
- ✓ Another Window opens –select Install from a list of specific location and NEXT

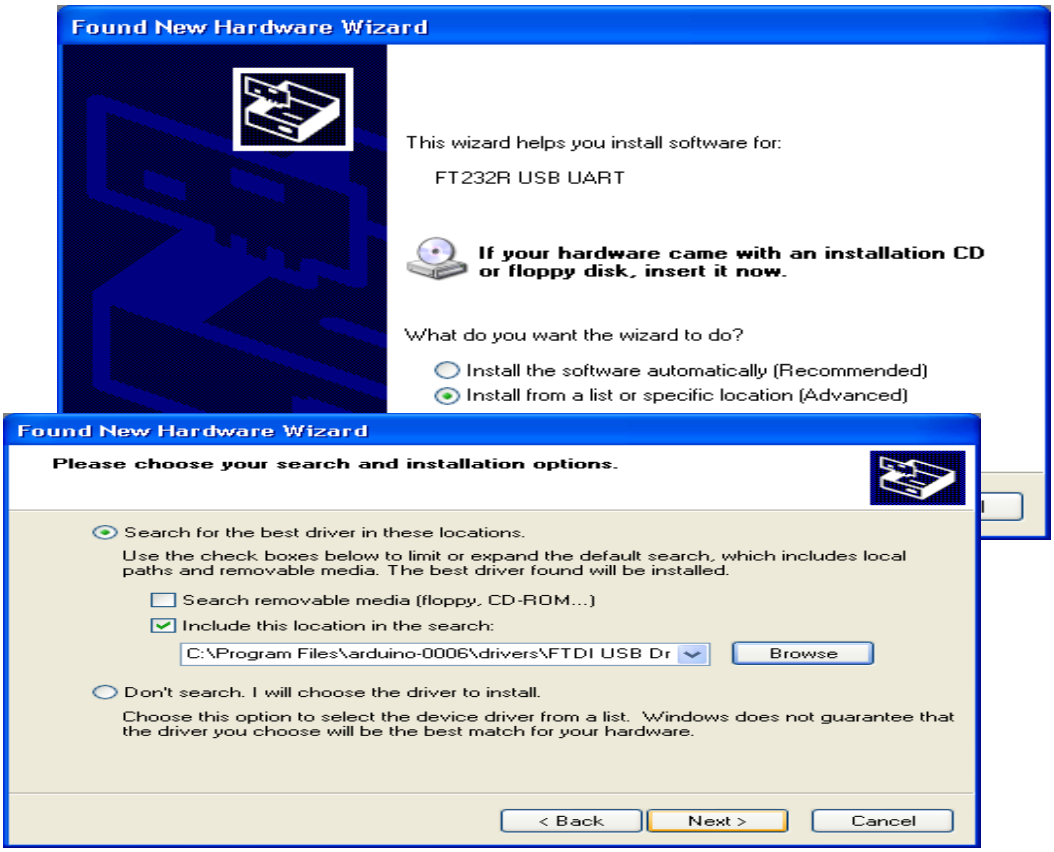


Fig 5.1 Arduino IDE Setup

Select “include this location in the search” and then click Browse option available in it

✓ Now it will Automatically check the USB driver and the software is installed click Finish

Fig 5.2 Arduino IDE installation

✓ Now click Finish, the Software will be downloaded.

✓ Now click on the Arduino IDE icon present on your Desktop. A window will appear like this.

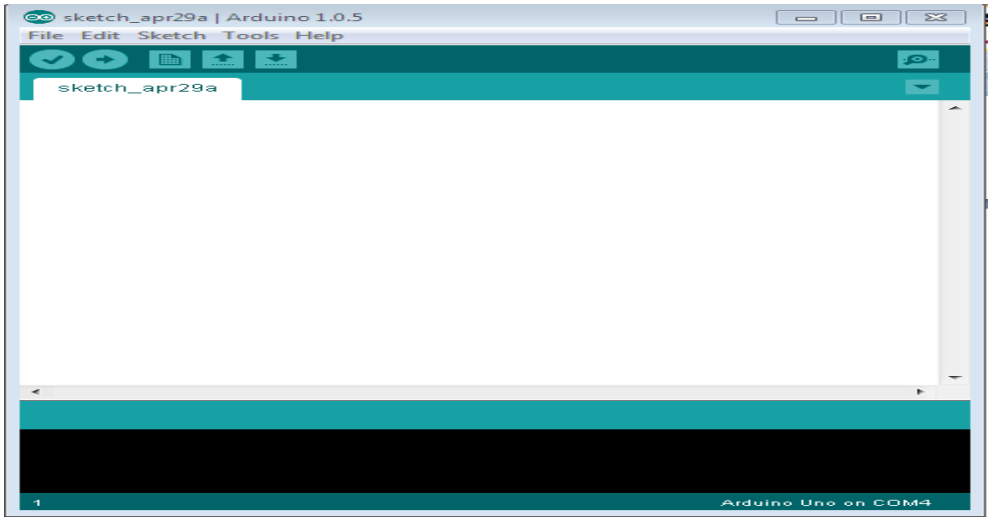


Fig 5.3 Arduino IDE(Click File)

✓ For any sample programs, select FILE option→Examples.

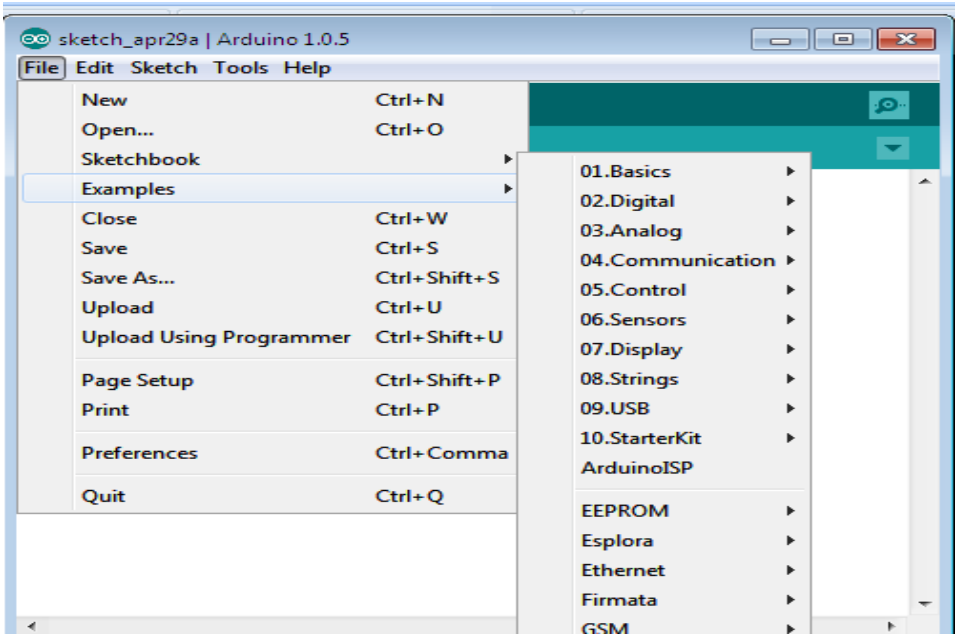


Fig 5.4 opening blink example

✓ After Entering the Sample Code in the file, it would look like this

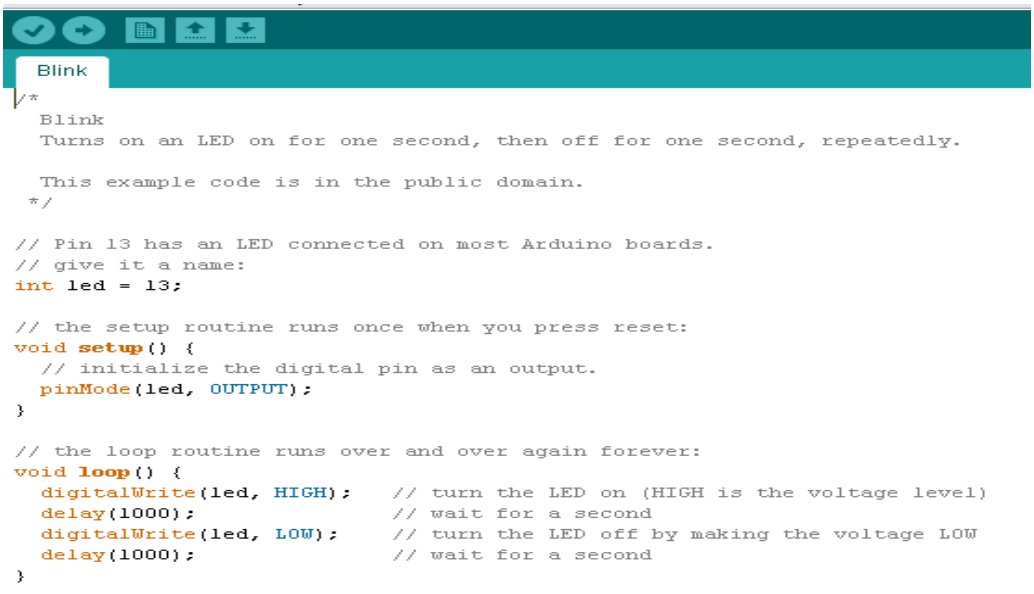


Fig 5.5 Source code written in arduino

✓ Before Connecting we have to select which Board is used by the user, Basically UNO. By selecting TOOLS→Board→ARDUINO UNO

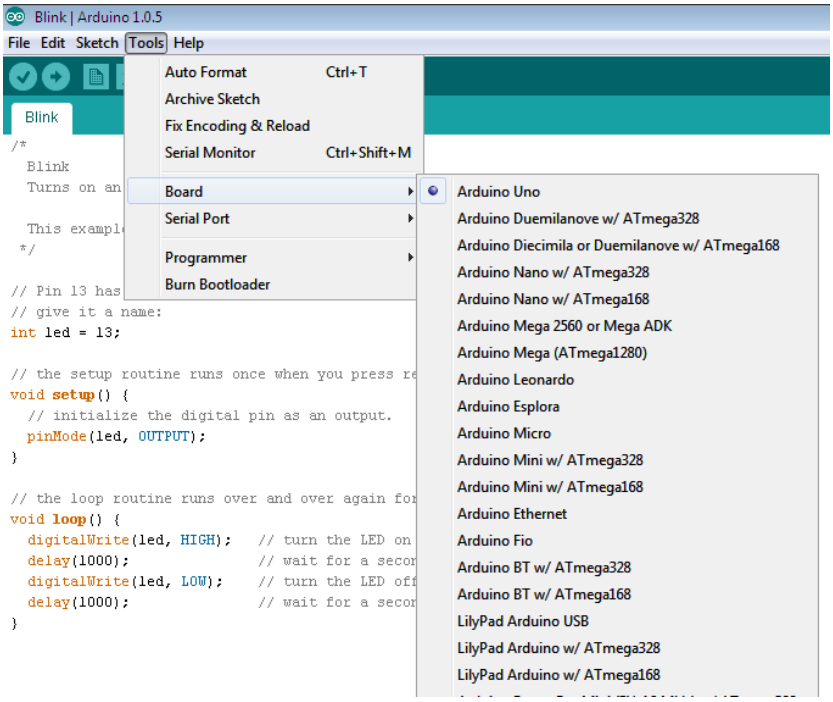


Fig 5.6 Selecting an Arduino Uno

✓ Now to dump the in the board Connect the Arduino to the PC through the USB port available in it. Like this TOOLS→SERIAL PORT→COMM4,COMM8 etc;

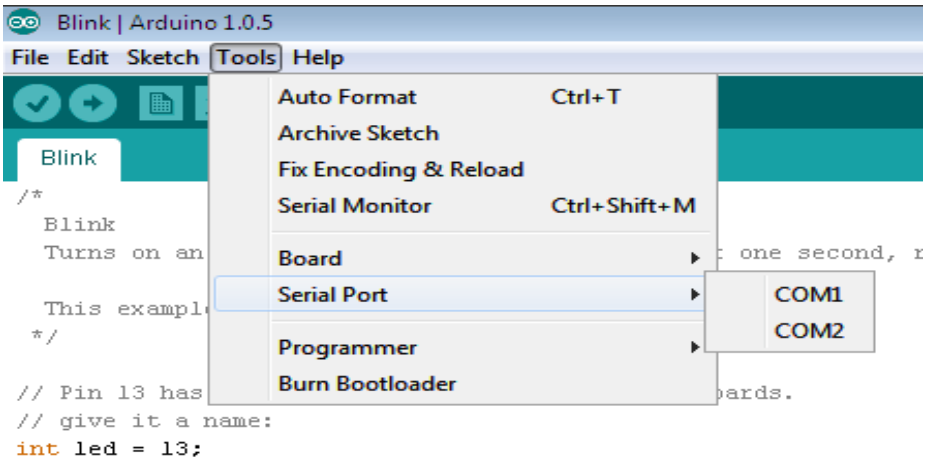


Fig 5.7 Compilation under process

- ✓ To verify the written Program select COMPILE option available in the software (√).
- ✓ Now Connect the Board and select the COMM port and then UPLOAD the file in ARDUINO(→)
- ✓ To OPEN the Previous ARDUINO FILE selects (↑) option.
- ✓ To enter new files select NEW option.
- ✓ To Save the Existing File, Click on the(↓).
- ✓ To Send the Data Through Serial Monitor, Click on the (Q).

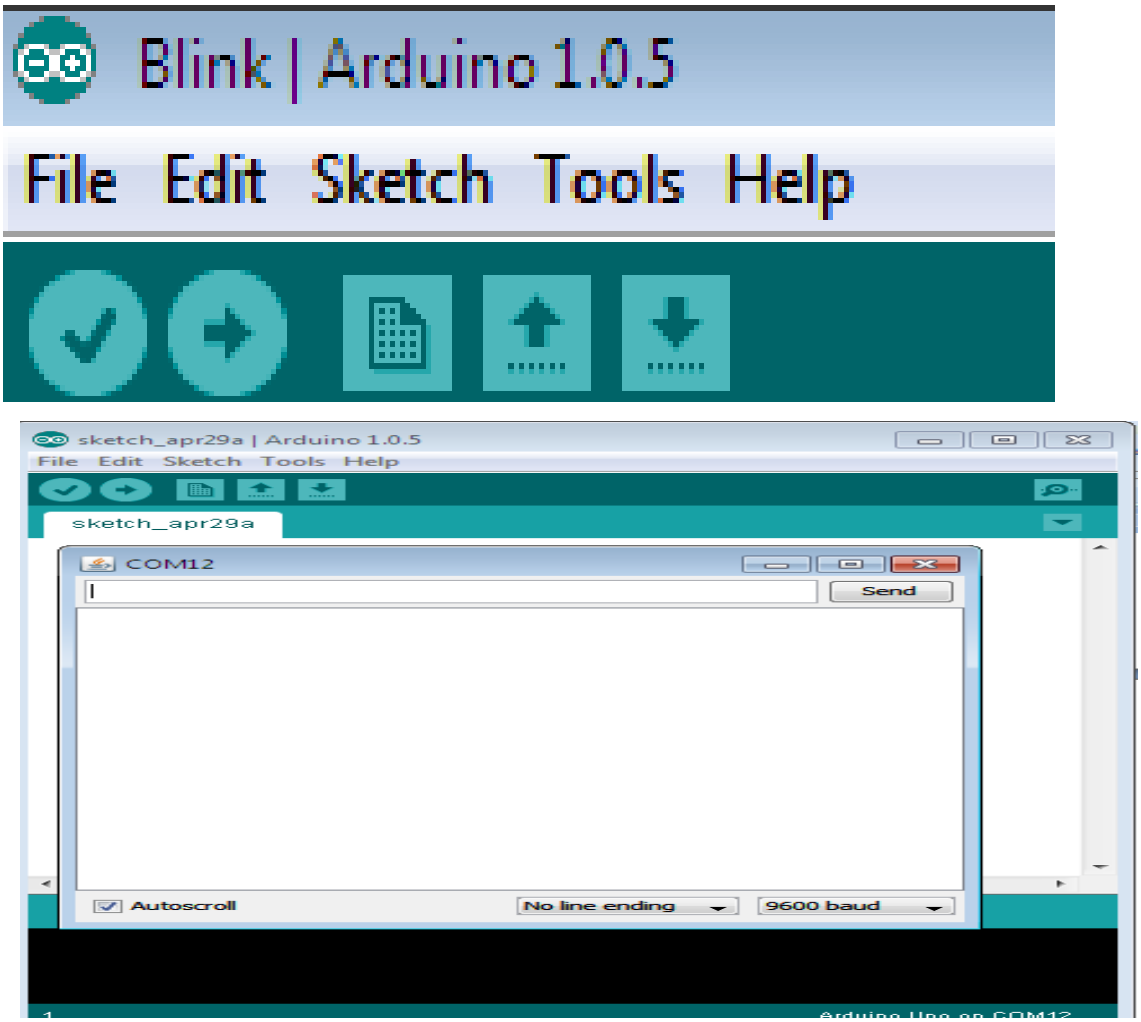


Fig 5.8 Arduino IDE compilation Done

CHAPTER-6

APPLICATIONS AND ADVANTAGES

Applications:

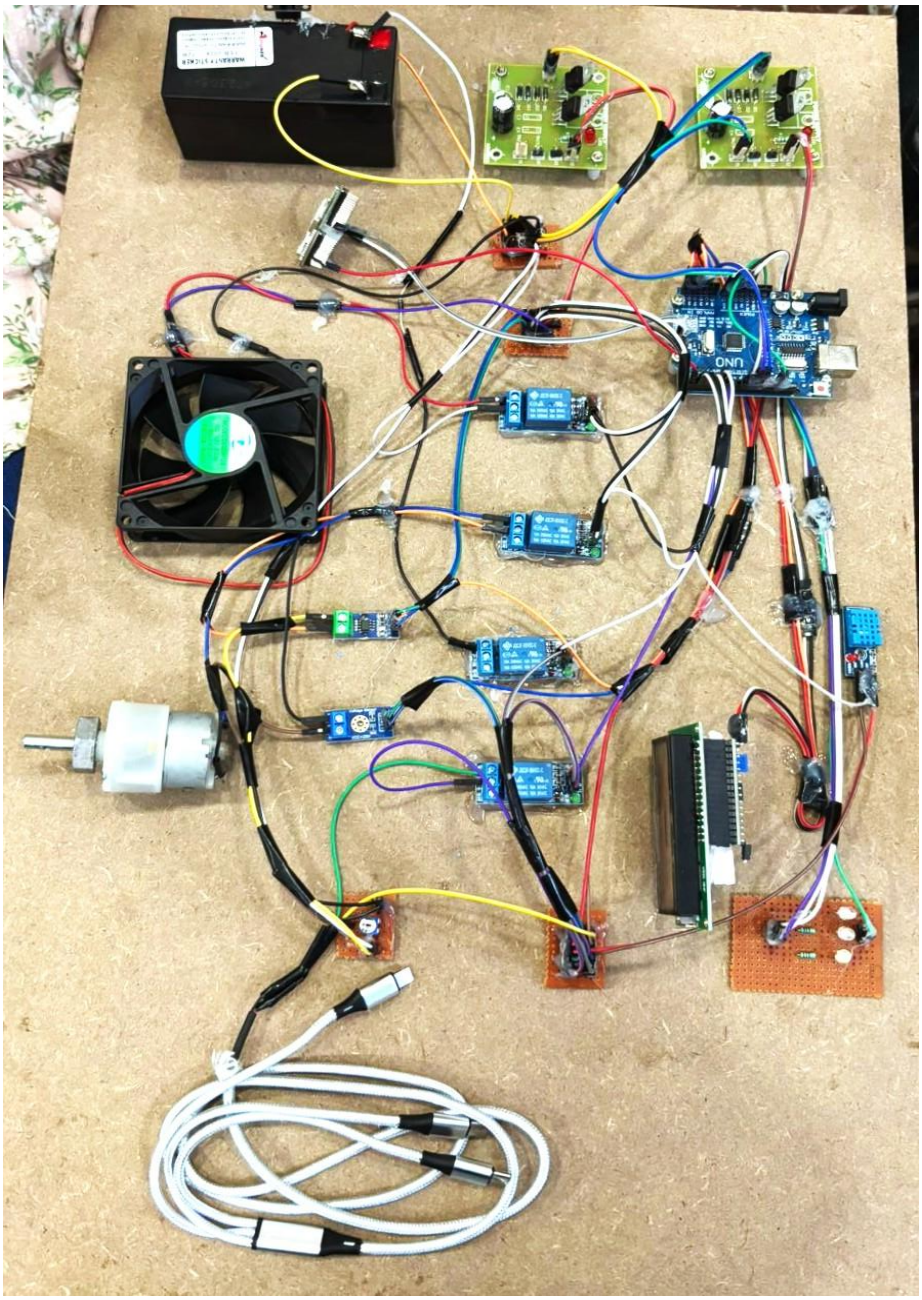
- Charging
- Safety
- Monitoring
- Management
- Detection
- Automation
- Protection
- Notification

Advantages:

- Efficiency
- Safety
- Automation
- Monitoring
- Protection
- Real-time
- Reliability
- Control

CHAPTER -7

EXPERIMENTAL RESULTS:



CHAPTER -8

CONCLUSION AND FUTURE SCOPE

8.1 CONCLUSION

In conclusion, the "Microcontroller based battery charge estimation and Fire Protection" represents a significant step forward in the realm of electric vehicle technology. By combining effective monitoring of battery performance with proactive safety measures, this system is poised to enhance the operational efficiency of electric vehicles while mitigating risks associated with battery malfunctions.

The integration of IoT technology facilitates real-time data access, enabling both users and manufacturers to make informed decisions regarding battery health and maintenance. As electric vehicles continue to gain popularity, systems like this will play a pivotal role in ensuring their safe and efficient operation. By combining effective monitoring of battery performance with proactive safety measures, this system is poised to enhance the operational efficiency of electric vehicles while mitigating risks associated with battery malfunctions. The integration of IoT technology facilitates real-time data access, enabling both users and manufacturers to make informed decisions regarding battery health and maintenance. As electric vehicles continue to gain popularity, systems like this will play a pivotal role in ensuring their safe and efficient operation.

8.2 FUTURE SCOPE

1. Improves Battery Efficiency
2. Protects the battery from fire protection
3. Cost efficiency
4. Improves human safety
5. Lesser pollution
6. Protection of environment
7. Protection of human health.

REFERENCES

1. **Pavithra, S. et al.** "Smart Battery Management System for Electric Vehicles Using IoT." *Journal of Electrical Engineering and Automation*, vol. 4, no. 2, 2024, pp. 45-56.
2. **Bai, X. et al.** "A Review of Battery Management Systems for Electric Vehicles." *Energy Reports*, vol. 6, 2023, pp. 69-82.
3. **Rahman, M. et al.** "IoT-Based Smart Battery Management System for Electric Vehicles." *International Journal of Electrical and Computer Engineering*, vol. 10, no. 4, 2023, pp. 4012-4020.
4. **Ghosh, A. et al.** "Temperature Management in Electric Vehicle Batteries: An Overview." *IEEE Transactions on Industrial Electronics*, vol. 67, no. 9, 2023, pp. 7981-7990.
5. Ayman S. Elwer , Samy M. Ghania , Nagat M. K. A. Gawad ," Battery Management Systems For Electric Vehicle Applications" 2023
6. Aniket Rameshwar Gade," The New Battery Management System in Electric Vehicle" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV10IS070210 www.ijert.org Vol. 10 Issue 07, July-2022
7. Nitin Saxena , Anant Singh , Aniket Dharme , "Iot Based Battery Management System Inelectric Vehicle".
8. Rui Hu University of Windsor." Battery Management System For Electric Vehicle Applications"2021
9. A.Sowmiya , P.Aileen Sonia Dhas , L.Aquiline Lydia , M.Aravindan , K.Rajsaran," Design of Battery
10. Monitoring System for Electric Vehicle" IARJSET International Advanced Research Journal in Science, Engineering and Technology Vol. 8, Issue 11, November 2021
11. AswinthRaj,"Battery Management System(BMS)forElectricVehicles" December 5, 2018
12. Anjali Vekhande, Ashish Maske," Iot-Based Battery Parameter Monitoring System For Electric Vehicle "© 2020 IJCRT | Volume 8, Issue 7 July 2020 | ISSN: 2320-2882
13. A. Hariprasad , I. Priyanka , R. Sandeep , V. Ravi, O. Shekar," Battery Management System in Electric Vehicles" IJERTV9IS050458,Volume 09, Issue 05 (May 2020)