SAFETY ASSURANCE SYSTEM FOR AUTOMOBILES

PROJECT REPORT

Submitted by

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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I wish to thank the almighty for giving me such an opportunity. I express my sincere gratitude to my parents who steadfastly behind me in all my efforts to the successful completion of this project.

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ABSTRACT

The Safety Assurance System is a comprehensive project proposal that aims to significantly enhance the safety features of automobiles. With a focus on mitigating potential risks and ensuring driver and passenger safety, this innovative system incorporates advanced technologies and intelligent control mechanisms. One of the key features of the Safety Assurance System is the implementation of a battery drainage preventive system. By integrating an Arduino-based relay system, this feature effectively monitors the battery voltage and detects abnormal drainage patterns. This proactive approach helps prevent unexpected battery failure, ensuring that vehicles remain operational, and drivers are not stranded due to battery-related issues. Another crucial aspect of the system is the detection and response to headlight failures. Through the precise monitoring of the voltage and current levels and precise sensor mechanisms, the Safety Assurance System can promptly identify any malfunction in the vehicle's headlights. Upon detection, the system automatically activates an emergency headlight mode, providing an immediate and reliable alternative lighting solution to ensure visibility and driver safety in critical situations, along with a notification to the driver’s mobile phone through Bluetooth. Furthermore, the Safety Assurance System incorporates a comprehensive theft identification and alert system. By leveraging the capabilities of Arduino-based technologies, the system employs intelligent algorithms to detect unauthorised access and potential theft attempts. In such events, the system triggers an alert mechanism, notifying the vehicle owner and relevant authorities by sounding an alarm and providing a notification to the driver’s mobile phone through Bluetooth, thus increasing the chances of recovering the stolen vehicle and deterring future theft incidents.

The Safety Assurance System offers a multifaceted approach to addressing common safety concerns in the automotive industry. This proposal presents a robust and reliable solution. Through the proactive prevention of battery drainage, instant response to headlight failures, and efficient theft identification and alert mechanisms, the Safety Assurance System sets a new standard for automotive safety, significantly reducing the risk of accidents and ensuring the well-being of drivers and passengers. With its comprehensive features and commitment to enhancing safety, the Safety Assurance System represents a pioneering solution that aligns with the growing demands for improved vehicle safety in today's automotive landscape.

LIST OF FIGURES

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LIST OF ABBREVIATIONS

- ADAS: Advanced Driver Assistance Systems.
- NHTSA: National Highway Traffic Safety Administration.
- AAA: American Automobile Association.
- NCRB: National Crime Records Bureau.
- PWM: Pulse Width Modulations.
- IDE: Integrated Development Environment.
- CPU: Central Processing Unit
- I/O: Input/Output.
- USB: Universal Serial Bus.
- V: Voltage.
- GND: Ground.
- I: Current.
- A: Ampere.
- W: Wattage.
- AC: Alternating Currents.
- DC: Direct Currents.
- TWI: Two-Wire Interface.
- Rx: Receiver.
- Tx: Transmitter.
- IOREF: Input Output Voltage Reference.

- LED: Light Emitting Diode.
- LCD: Liquid Crystal Display.
- INA219: I2C Interface No drift Bi-directional Current / Power Supply Monitoring Module.
- IC: Integrated Circuit.
- ADC: Analog to Digital Converter.
- GPIO: General Purpose Input Output.
- UART: Universal Asynchronous Receiver and Transmitter.
- SPI: Serial Peripheral Interface.

CONTENTS

CHAPTER - 1

1.1 INTRODUCTION

The Safety Assurance System is an innovative project proposal that aims to revolutionise the safety features of automobiles by implementing advanced technologies and intelligent control mechanisms. This comprehensive system addresses common safety concerns encountered during everyday vehicle operation, with the primary objective of reducing the risk of accidents and enhancing overall safety for drivers and passengers. In today's fast-paced world, where road accidents and vehicle-related incidents pose significant threats to human life and property, it is crucial to develop robust safety measures that go beyond standard automobile features. The Safety Assurance System is designed to provide a proactive and reliable solution to mitigate potential risks and ensure optimal safety on the road.

The project focuses on several key areas of concern, including battery drainage prevention, headlight failure detection and response, emergency headlight activation, and theft identification and alert systems. By incorporating cutting-edge technologies, such as Arduino-based relay systems, isolated terminals, and intelligent algorithms, the Safety Assurance System sets itself apart as an innovative and effective safety enhancement for vehicles.

Battery drainage is a common issue that can lead to unexpected vehicle breakdowns and inconvenience for drivers. The project addresses this problem by implementing a battery drainage preventive system that constantly monitors the battery voltage and detects abnormal drainage patterns. Through real-time monitoring and proactive alerts, drivers can take timely action to prevent battery failure and ensure uninterrupted vehicle operation.

Headlight failures are another critical safety concern on the road, especially during nighttime driving. The Safety Assurance System employs sophisticated sensor mechanisms and isolated terminals to detect headlight malfunctions. When a failure is detected, the system automatically activates an emergency headlight mode, providing an immediate alternative lighting solution to ensure optimal visibility and driver safety in critical situations.

Vehicle theft is a prevalent issue, causing significant financial loss and emotional distress for owners. The Safety Assurance System incorporates an advanced theft identification and alert system that utilizes Arduino-based technologies and intelligent algorithms. Unauthorized access attempts trigger the system's alert mechanism, promptly notifying the vehicle owner and relevant authorities. This proactive approach enhances the chances of recovering stolen vehicles and acts as a deterrent against future theft incidents.

By combining these comprehensive safety features, the Safety Assurance System sets a new standard for automotive safety. It offers drivers and passengers peace of mind, knowing that their vehicles are equipped with advanced safety mechanisms that go beyond conventional features. With its focus on preventing battery drainage, responding to headlight failures, and identifying theft attempts, the system aims to significantly reduce the risk of accidents and enhance overall safety on the road.

1.2 PARASITIC BATTERY DRAINAGE

A car battery is a vital component of any vehicle, providing the electrical energy necessary to start the engine and power the various electrical components. However, several factors can cause a car battery to drain while the vehicle is off. The most common of these include leaving the headlights on while the vehicle is off, a parasitic draw, corroded battery terminals, extreme temperatures, a faulty alternator, or damaged battery cells.

One significant cause of a car battery drain is a parasitic draw, which is the constant electrical load on the battery from various electrical components in the car, even when the engine is not running. With the proliferation of electronics in vehicles, modern cars are equipped with more electronic components than ever before, including ADAS (Advanced Driver Assistance Systems), power trunk releases, and radios that can drain the battery even when the engine is off, reducing its longevity.

Another significant factor is leaving the headlights on while the vehicle is off. This is a common mistake that can quickly drain the battery, especially if the car is left parked for an extended period. Corroded battery terminals can also cause a car battery to drain while the vehicle is off, as it can prevent the battery from charging properly. Extreme temperatures, both hot and cold, can also cause a car battery to drain while the vehicle is off.

1.2.1 Solution

The proposed control circuit is designed with the primary aim of preventing power drainage from electronic components that are not essential when the engine is switched off. This is achieved through the Arduino system that switches OFF power draining and non-essential electronic components and significantly reduces the chances of parasitic draw from vehicle batteries. The proliferation of electronics in modern vehicles has led to an increase in the risk of battery drainage, which can be a major inconvenience to drivers and even pose safety hazards if the vehicle is unable to start when needed.

Therefore, implementing this control circuit would be an essential step towards addressing these issues and providing vehicle owners with greater peace of mind about the safety and reliability concerns of the vehicle.

By selectively switching off power-draining electronics, this control circuit helps to reduce the risk of battery drainage, ensuring that the battery is always ready to start the vehicle. This is particularly important in situations where the vehicle is parked for an extended period, such as at an airport or overnight, as it helps to prevent unnecessary battery drainage.

1.3 HEADLIGHTS FAILURE

The most common and frequently happening issue in most of the vehicles is head failure. When headlights stop working, it's usually an electrical problem or a physical issue with the bulbs themselves. In order to get to the bottom of the situation as quickly as possible, it's important to make note of exactly what type of failure you have experienced. Sometimes, vehicle users may not have an idea to change the headlight bulbs by themselves and they need some car mechanic's help to change the bulb. When this issue is happening in some remote area during night time, it is very difficult for the vehicle user to continue their journey further.

According to a study conducted by the National Highway Traffic Safety Administration (NHTSA) in the United States, headlight-related issues are a leading cause of vehicle recalls. The study found that between 2014 and 2016, there were over 40 headlight-related recalls affecting more than 6.8 million vehicles. The most common causes of these recalls were faulty wiring and defective headlight assemblies.

Another study conducted by the American Automobile Association (AAA) found that 50% of all vehicle crashes occur at night, despite only 25% of driving taking place during this time. The study also found that only 28% of vehicles had headlights that provided sufficient lighting for drivers to safely navigate roads at night.

These statistics highlight the importance of addressing headlight failure and ensuring that vehicles are equipped with reliable and effective lighting systems to improve safety on the roads, particularly at night.

1.3.1 Solution

The safety assurance system for automobiles includes a feature for detecting and alerting the driver and passengers when the primary headlights fail due to electrical or physical faults. The Arduino relay system is designed to detect when there is no load in the circuit, which indicates that the primary headlights have stopped functioning.

As a result, an alert is sent to the driver and passengers to notify them of the issue. To ensure safety during this situation, the Arduino system automatically enables the emergency secondary headlight units.

These secondary lights provide enough visible light for the driver to park the vehicle safely on the roadside or drive to a nearby mechanic for headlight replacement. The emergency lighting system consists of both low beam and high beam headlights, providing additional safety for the driver and passengers in the event of primary headlight failure.

1.4 THEFT IDENTIFICATION/ALERT SYSTEM

Vehicle theft is a major issue in India, with a significant number of cases being reported every year. According to the latest data from the National Crime Records Bureau (NCRB), there were 2,13,764 cases of motor vehicle theft reported in 2019, which is a slight decrease from the previous year. However, this still translates to an average of over 585 vehicles being stolen every day.

Despite the introduction of advanced security features in modern vehicles, thieves continue to find ways to bypass them. As per the NCRB data, only 22.8% of the stolen vehicles were recovered in 2019, highlighting the need for more effective theft alert and detection systems.

One of the most common ways that thieves are able to steal vehicles is by breaking into the locking system and short-circuiting the electrical wires going to the ignition unit. This allows them to start the vehicle without a key and without triggering the alarm.

1.4.1 Solution

To address this issue, our solution involves the use of isolated ‘+’ve and ‘-‘ve terminals that are designed to prevent thieves from short circuiting the wiring to start the vehicle. By rewiring the terminals and placing a key in a location known only to the owner, thieves will not be able to start the car under any circumstances.

In the event that thieves attempt to start the vehicle by short circuiting the fuse wire, our system will immediately trigger the buzzer unit, alerting the owner to the attempted theft. This provides an additional layer of security to prevent vehicle theft and ensures owners of the reliability and safety of the vehicle.

1.5 PROJECT BLOCK DIAGRAM

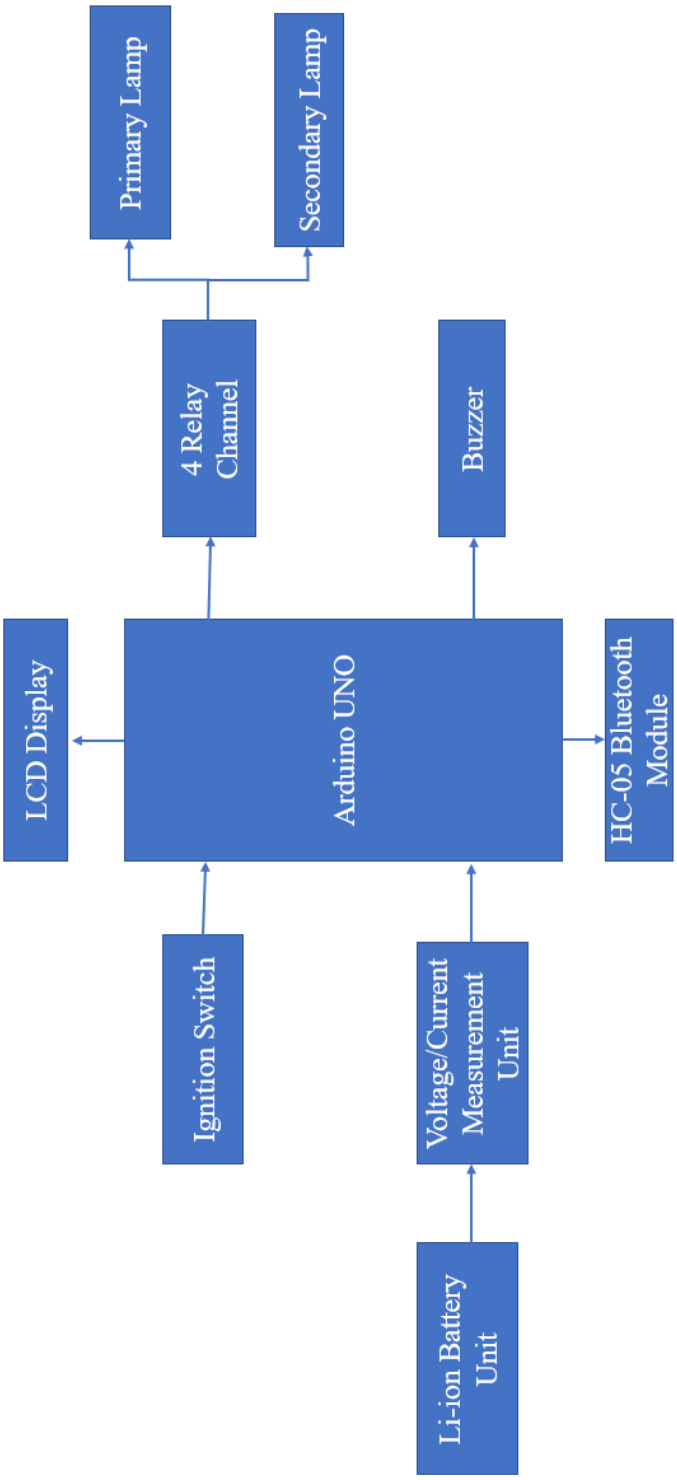


FIGURE (1.1) PROJECT BLOCK DIAGRAM

CHAPTER - 2

CIRCUIT COMPONENTS

2.1 ARDUINO

2.1.1 ARDUINO AT A GLANCE

Would you believe that each one of you is using at least 20 microcontrollers in your house? Well, that's a fact. There are more than two billion microcontrollers being produced every year. Almost everyone in developed as well as in developing nations cannot think of a day without using microcontrollers.

The microcontroller is an embedded computer chip that controls most of the electronic gadgets and appliances that people use on a daily basis, right from mobile phones, washing machines to anti-lock brakes in cars. The microcontroller was introduced in the electronics industry with the purpose of making our tasks easy that come with even a remote connection with automation in any way.

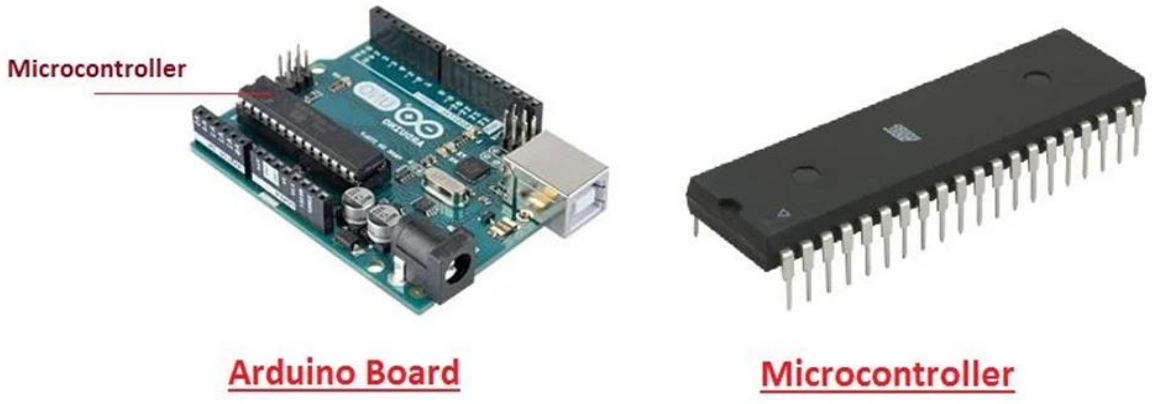


FIGURE (2.1) COMPARISON OF ARDUINO AND MICROCONTROLLER

Some people usually get confused between Microcontroller and an Arduino. Microcontroller is just an on-system 40 pin chip that comes with a built-in microprocessor and an Arduino is a board that comes with the microcontroller in the base of the board as shown in the above FIGURE 2.1. Arduino also comes with a boot loader and allows easy access to input-output pins and makes uploading or burning of the program very easy.

2.1.2 HISTORY

The name Arduino comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

When it comes to Arduino, there is not much technical knowledge required. However, people with a non-technical background can easily get hands-on experience with Arduino, but learning microcontroller requires some expertise and skills.

There are many versions of Arduino boards introduced in the market like Arduino Uno, Due, Leonardo, Mega, etc. However, the most common versions are Arduino Uno and Arduino Mega. So, what's this Uno actually?

Arduino Uno is a microcontroller board based on an 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists of other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

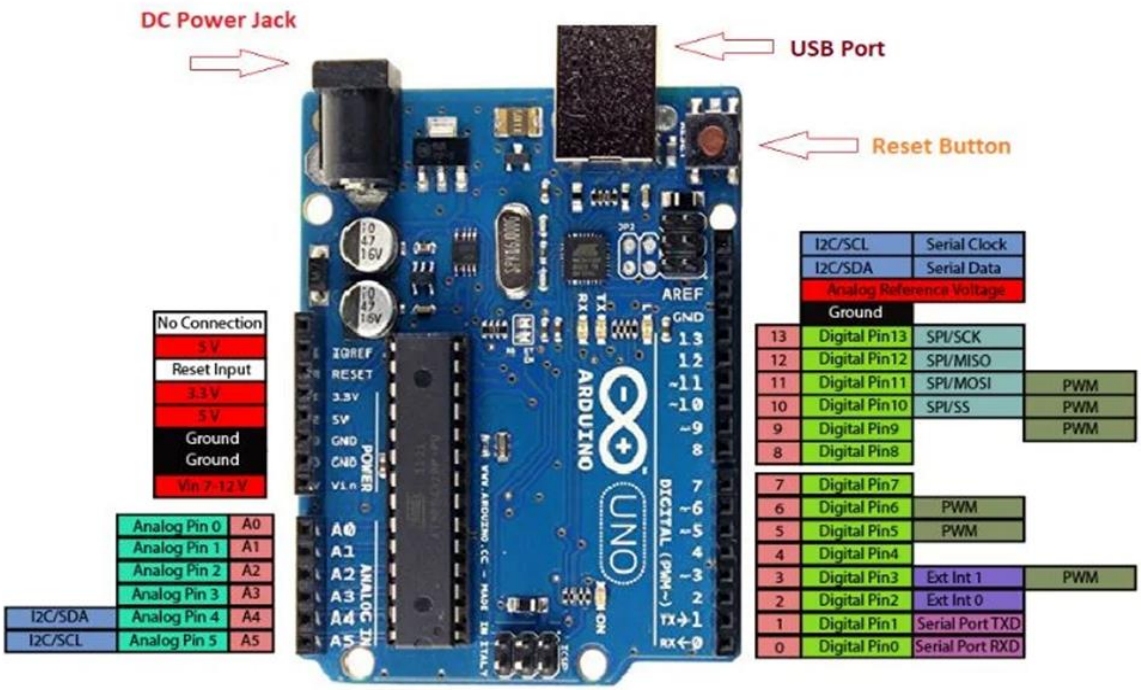


FIGURE (2.2) ARDUINO PIN DETAILS

2.1.3 ARDUINO UNO FEATURES

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. So, let's dive into the features of Arduino Uno.

More frequency and number of instructions per cycle: 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/cycle.

Built-in regulation: This board comes with a built-in regulation feature which keeps the voltage under control when the device is connected to the external device.

Flexibility & Ease of use: 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.

Configurable pins: The 6 analog pins are marked as A0 to A5 and come with a resolution of 10 bits. These pins measure from 0 to 5V, however, they can be configured to the high range using analogReference() function and AREF pin.

Quick Start: Reset pin is available in the board that reset the whole board and takes the running program in the initial stage. This pin is useful when the board hangs up in the middle of the running program; pushing this pin will clear everything up in the program and start the program right from the beginning.

Greater Flash Memory: 13KB of flash memory is used to store the number of instructions in the form of code.

Low Voltage Requirement: Only 5 V is required to turn the board on, which can be achieved directly using USB port or external adapter, however, it can support external power sources up to 12 V which can be regulated and limited to 5 V or 3.3 V based on the requirement of the project.

Plug & Play: There is no hard and fast interface required connecting 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.

USB interface: Arduino Uno comes with USB interface i.e. A USB port is added on the board to develop serial communication with the computer.

Power alternatives: Apart from USB, battery or AC to DC adapter can also be used to power the board.

More Storage: There is a provision of Micro SD cards to be used in the boards to make them store more information.

2.1.4 ARDUINO UNO PIN DESCRIPTION

There are several Arduino Uno pins, more specifically, I/O digital and analog pins placed on the board which operate at 5V. But, 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 resistors useless and damages the device.

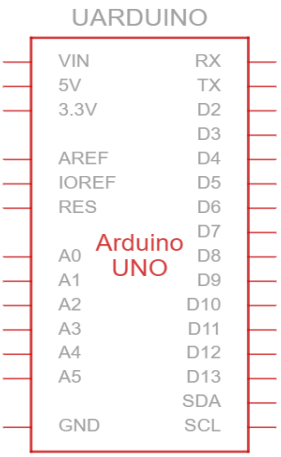


FIGURE (2.3) ARDUINO IC

LED - Arduino Uno comes with built-in LED which is connected through pin 13. Providing HIGH value to the pin will turn it ON. Providing LOW will turn it OFF.

VIN - It is the input voltage provided to the Arduino Board. This pin is used to supply voltage. It is different from 5 V supplied through a USB port. If a voltage is provided through the power jack, it can be accessed through this pin.

5V - This board comes with the ability to provide voltage regulation. A 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. USB supports voltage around 5V while Vin and Power Jack support a voltage range between 7V to 20V.

GND - These are ground pins. There are more than one ground pins provided on the board. They can be used as per requirement.

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.

IOREF -It is the abbreviation of Input Output Voltage Reference. 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 selects the proper power source.

PWM – Pulse Width Modulation is provided by 3, 5, 6, 9, 10, 11 pins. These pins are configured to provide 8-bit output PWM.

SPI - It is an abbreviation of Serial Peripheral Interface. Four pins 10(SS), 11(MOSI), 12(MISO), 13(SCK) provide SPI communication with the help of SPI library.

AREF - It is called Analog Reference. This pin is used for providing a reference voltage to the analog inputs.

TWI - It is called Two-Wire Interface. TWI communication is accessed through Wire Library. A4 and A5 pins are used for this purpose.

Serial Communication - Serial communication is carried out through two pins called Pin 0 (Rx) and Pin 1 (Tx).

Rx. & Tx. - Rx (Receiver) pin is used to receive data while Tx (Transmitter) pin is used to transmit data.

External Interrupts - Pin 2 and 3 are used for providing external interrupts. An interrupt is called by providing LOW or changing value.

Arduino Uno comes with an ability of interfacing with other Arduino boards, microcontrollers and computers. 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. A Serial monitor is provided on the IDE software which is used to send or receive text data from the board. If LEDs are placed on the Rx and Tx pins will flash, indicating the transmission of data. To understand how it does, you need to know the programming part of Arduino.

2.1.5 ARDUINO UNO PIN CONFIGURATION

Serial Pins 0 (Rx) and 1 (Tx): Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.

External Interrupt Pins 2 and 3: These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.

PWM Pins 3, 5, 6, 9 and 11: These pins provide an 8-bit PWM output by using analogWrite() function.

SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK): These pins are used for SPI communication.

In-built LED Pin 13: This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, it’s off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provides 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pins with analog Reference() function.

Analog pin 4 (SDA) and pin 5 (SCA) are also used for TWI communication using the Wire library.

Arduino Uno has a couple of other pins as explained below:

AREF: Used to provide reference voltage for analog inputs with analogReference() function.

Reset Pin: Making this pin LOW, resets the microcontroller.

2.1.6 COMMUNICATION SETUP FOR ARDUINO

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a.inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

2.1.7 AUTOMATIC (SOFTWARE) RESET

Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.

This setup has other implications. When the Uno is connected to a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the boot loader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened.

2.1.8 PROGRAMMING THE ARDUINO UNO

2.1.8.1 THE IDE SOFTWARE

The Integrated Development Environment (IDE) is a simple and easy to learn software for writing Arduino codes. The below image is a screenshot of Arduino IDE. Arduino has huge flexibility with which you can make almost anything you imagine. It can be easily connected to a variety of modules like fire sensors, obstacle sensors, presence detectors, GPS modules, GSM Modules, or anything with which you wish to give wings to your dream project.

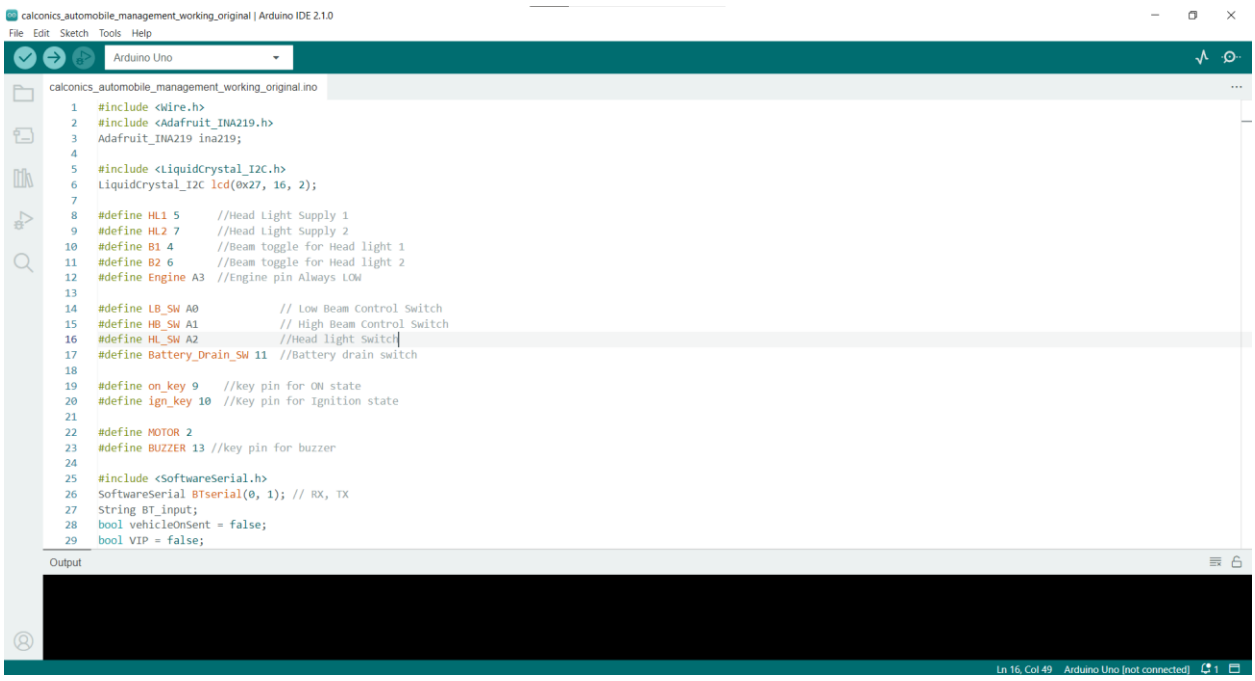


FIGURE (2.4) ARDUINO IDE

IDE is equally compatible with Windows, MAC or Linux Systems, however, Windows is preferable to use. It is an open-source platform where anyone can modify and optimise the board based on the number of instructions and tasks they want to achieve.

2.1.8.2 INTERFACING ARDUINO WITH COMPUTER

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.

Once the Arduino IDE is installed on the computer, connect the board with the computer using a USB cable. Now open the arduino IDE and choose the correct board by selecting Tools>Boards>Arduino/Genuino Uno, and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring. To get it started with Arduino Uno board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking. Below is the example code for blinking:

```
// the setup function runs once when you press reset or power the board

void setup() {

  // initialise digital pin LED_BUILTIN as an output.

  pinMode(LED_BUILTIN, OUTPUT);

 }

// the loop function runs over and over again forever

void loop() {

  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)

  delay(1000);                       // wait for a second

digitalWrite(LED_BUILTIN, LOW);// turn the LED off by making the voltage LOW

  delay(1000);                       // wait for a second

}
```

2.1.9 APPLICATIONS

- Prototyping of Electronics Products and Systems
- Various DIY Projects.
- Easy to use for beginner level DIYers and makers.
- Projects requiring Multiple I/O interfaces and communications.

2.2 3S BMS UNIT

This is a protection module for 3-serial-cell lithium-ion / lithium polymer rechargeable batteries and includes a high-accuracy voltage detector and delay circuit. Automatically cancel protection after fault conditions are removed. With Protection function of overcharge, over-discharge, short circuit and overcurrent protection. Suitable for lithium battery pack of 11.1V, 12V & 12.6V.

2.2.1 FEATURES

- Overcharge Voltage Detection: 3.9~4.35V ± 0.05V.
- Over discharge voltage Detection: 2.3~3.0V ± 0.05V.
- Maximum operating current: 6~8A.
- Quiescent current: ＜ 30uA.
- Internal resistance: ＜ 100mΩ.
- Charging voltage: 12.6V ~ 13V.
- Working temperature: -40~+50℃
- Short circuit protection: Yes, delayed self-recovery.
- Dimensions: (50 x 16 x 1) mm

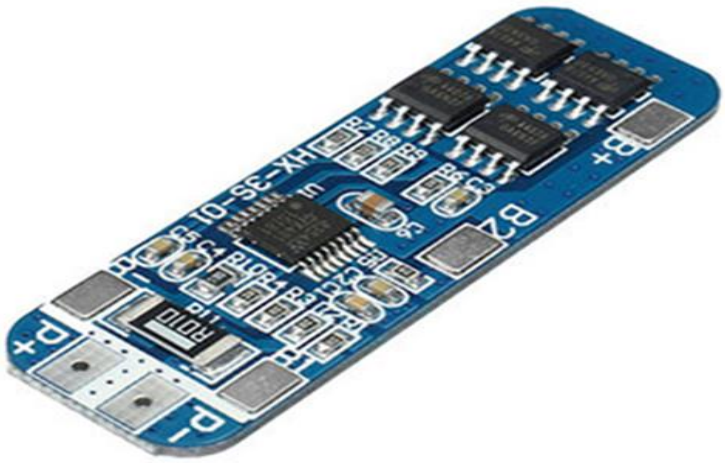


FIGURE (2.5) ACTUAL 3S BMS UNIT

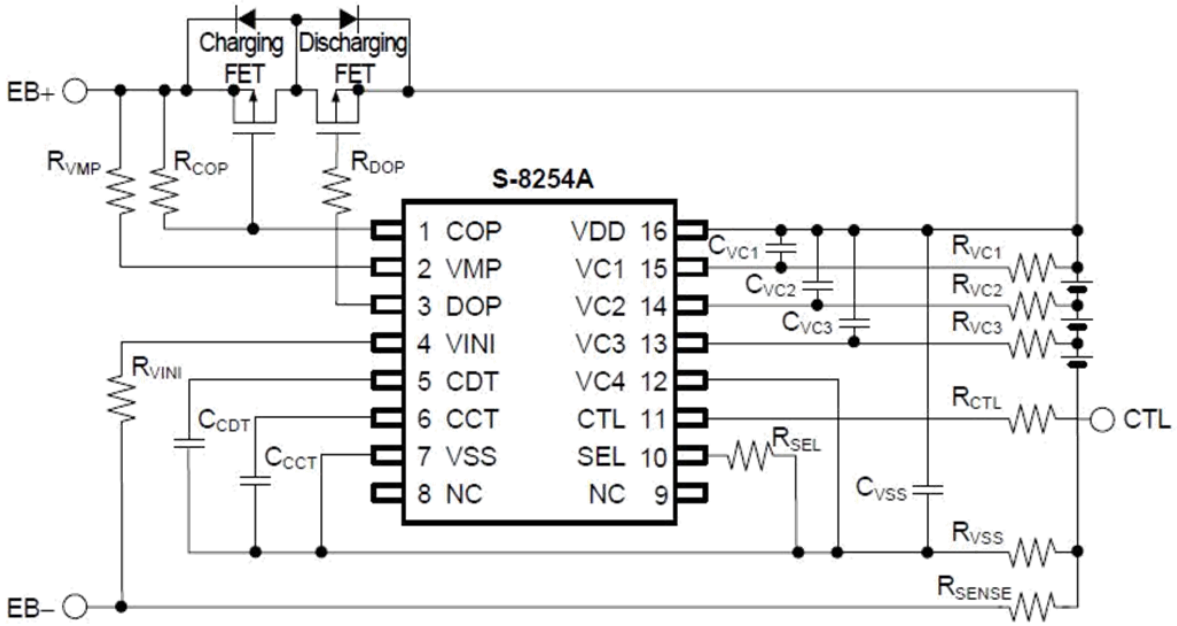


FIGURE (2.6) SCHEMATIC DIAGRAM OF 3S BMS UNIT

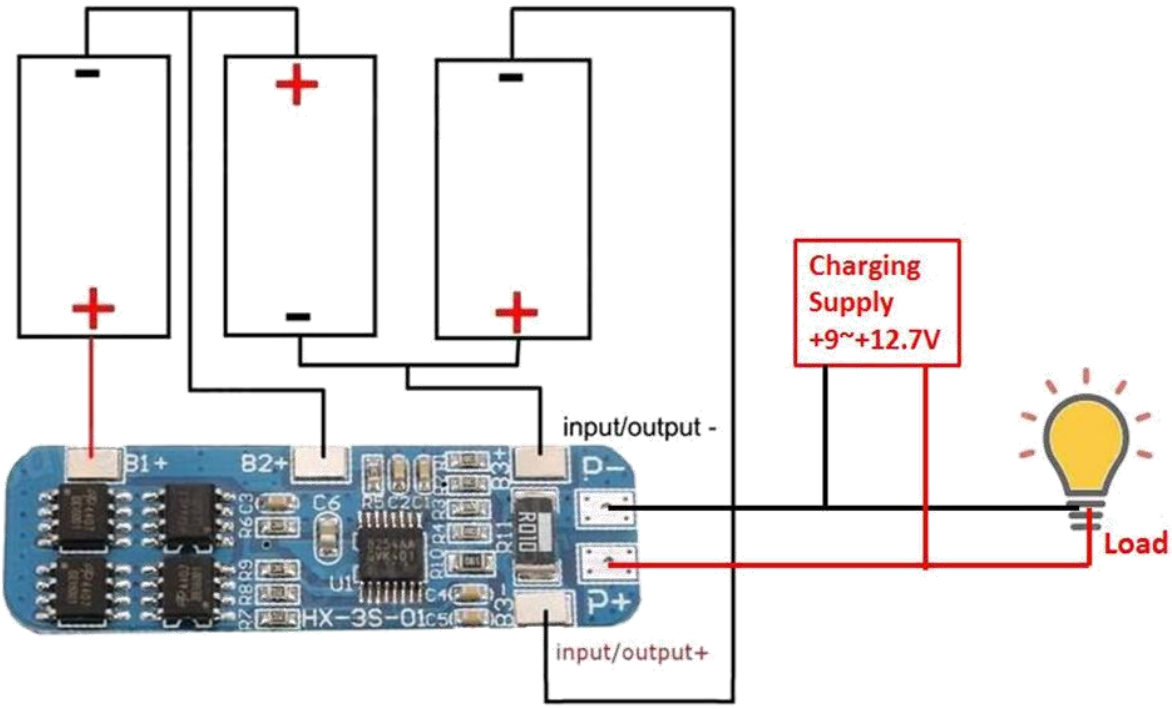


FIGURE (2.7) BASIC CONNECTION DIAGRAM OF 3S BMS UNIT

2.3 BATTERY

A battery is a device in which chemical energy is directly converted to electrical energy. It consists of one or more voltaic cells, each of which is composed of two half cells connected in series by the conductive electrolyte. consists of one or more voltaic cells in series.

Each cell has a positive terminal, shown by a long horizontal line, and a negative terminal, shown by the shorter horizontal line. These do not touch each other but are immersed in a solid or liquid electrolyte. The electrolyte is a conductor which connects the half-cells together.

FIGURE (2.8) 12V Li-ION BATTERY PACK

It also contains ions which can react with chemicals of the electrodes. Chemical energy is converted into electrical energy by chemical reactions that transfer charge between the electrode and the electrolyte at their interface.

Such reactions are called *faradaic*, and are responsible for current flow through the cell. Ordinary, non-charge-transferring (*non-faradaic*) reactions also occur at the electrode-electrolyte interfaces. Non-faradaic reactions are one reason that voltaic cells (particularly the lead-acid cell of ordinary car batteries) "run down" when sitting unused.

2.3.1 LI-ION BATTERY

Nowadays, Lithium-ion batteries are incredibly popular. You can find them in laptops, PDAs, cell phones and iPods. They are so popular because they are the most energetic rechargeable batteries. Lithium-ion batteries power the lives of millions of people each day. In this blog, we are learning about the working of Lithium-ion batteries.

2.3.2 LITHIUM-ION BATTERY WORKING

The rechargeable lithium-ion battery is made of one or more power-generating compartments called cells. Each cell has essentially three components. - positive electrode, negative electrode and electrolyte.

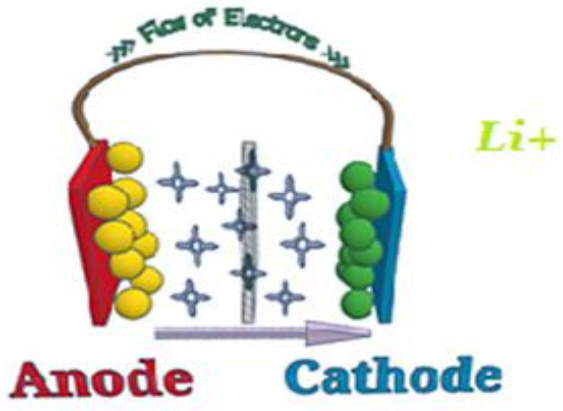


FIGURE (2.9) WORKING DIAGRAM OF Li-ION BATTERY

A positive electrode connects to the battery's positive or + terminal. A negative electrode connects to the negative or − terminal. And a chemical called an electrolyte in between them.

The positive electrode is typically made from a chemical compound called lithium-cobalt oxide (LiCoO2) or lithium iron phosphate (LiFePO4). The negative electrode is generally made from carbon (graphite). The electrolyte varies from one type of battery to another.

The electrolyte carries positively charged lithium ions from the anode to the cathode. The movement of the lithium ions creates free electrons in the anode which creates a charge at the positive current collector.

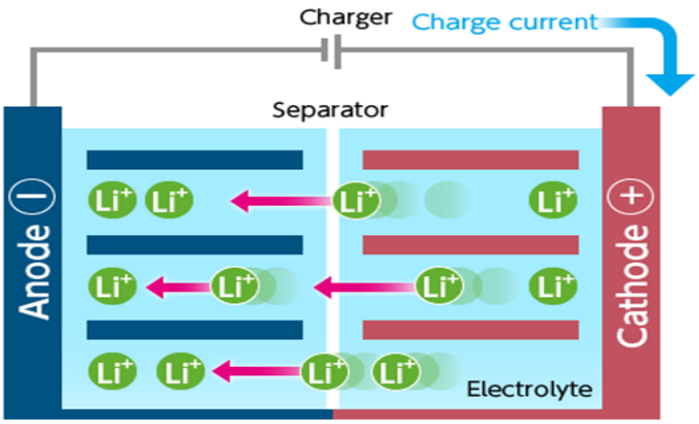


FIGURE (2.10) CHARGING OPERATION OF Li-ION BATTERY

The electrical current then flows from the current collector through a device being powered (cell phone, computer, etc.) to the negative current collector. The separator blocks the flow of electrons inside the battery.

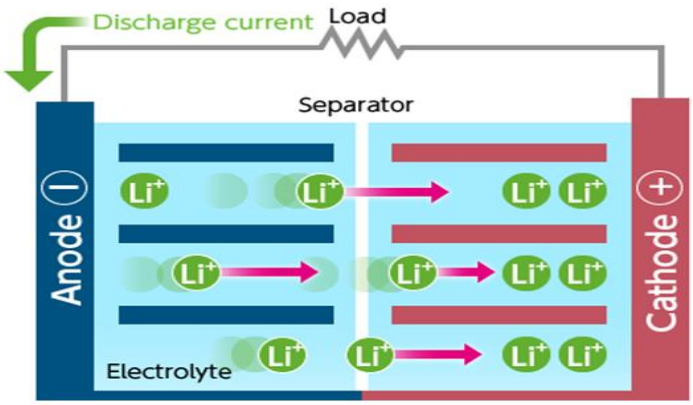


FIGURE (2.11) LOAD OPERATION OF Li-ION BATTERY

While the battery is discharging and providing an electric current, the anode releases lithium ions to the cathode, generating a flow of electrons from one side to the other.

When plugging in the device, the opposite reaction happens, the cathode releases lithium ions and anode receives them. This is how the Lithium-ion battery works.

In this battery, the energy density and power density are the most common things of the battery. Generally, the energy density measures in watt-hours per kilogram (wh/kg) and is the amount of energy the battery can store with respect to its mass. Power density measures in watts per kilogram (W/kg) and is the amount of power of a battery with respect to its mass.

2.3.3 ADVANTAGES OF LITHIUM-ION BATTERY

Now days Lithium-ion batteries are popular because they have a number of important advantages over competing technologies:

- Generally, they are much lighter than other types of rechargeable batteries of the same size.
- They hold their charge. A lithium-ion battery pack loses only about 5 percent of its charge per month.
- High specific energy and high load capabilities with Power Cells
- Long cycle and extend shelf-life; maintenance-free. They can handle hundreds of charge/discharge cycles.
- High capacity, low internal resistance, good coulombic efficiency.
- Simple charge algorithm and reasonably short charge times.
- Low self-discharge (less than half that of NiCd and NiMH).

2.3.4 LIMITATIONS OF LITHIUM-ION BATTERY

- Requires protection circuit to prevent thermal runaway if stressed
- Degrades at high temperature and when stored at high voltage
- No rapid charge possible at freezing temperatures (<0°C, <32°F)
- Transportation regulations required when shipping in larger quantities
- They are extremely sensitive to high temperatures. Heat causes lithium-ion battery packs to degrade much faster than they normally would.

2.3.5 APPLICATIONS OF LITHIUM-ION BATTERY

Lithium batteries have a long list of real-world applications beyond running the apps on your phone. From life-saving medical equipment to luxury yachts, lithium batteries keep both the essentials and the comforts of modern life running with safety and reliability.

2.4 BUCK CONVERTER

DC-DC Buck Converter Step down Module LM2596 Power Supply is a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.

The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

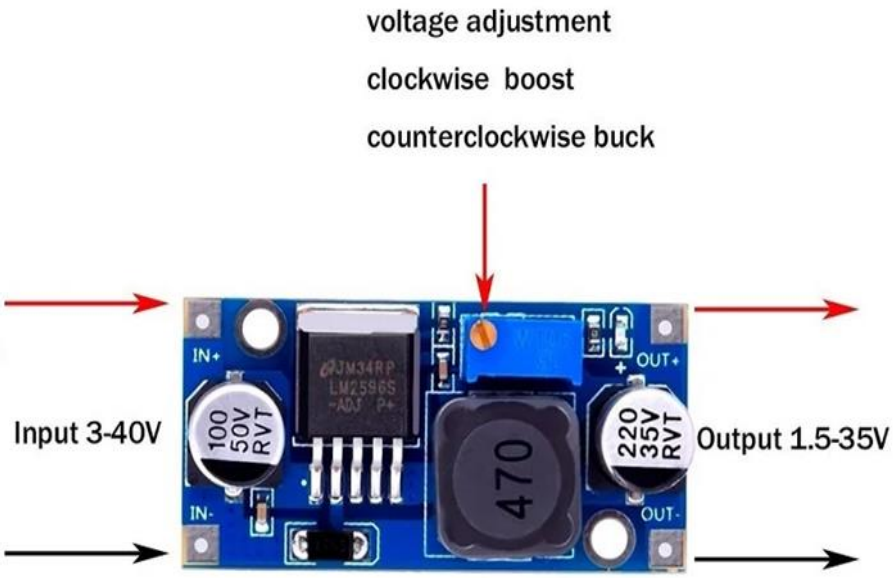


FIGURE (2.12) ACTUAL BUCK CONVERTER

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.

Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed frequency oscillator. The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators. Available in a standard 7-pin TO-220 package with several different lead bend options, and a 7-pin TO-263 surface mount package.

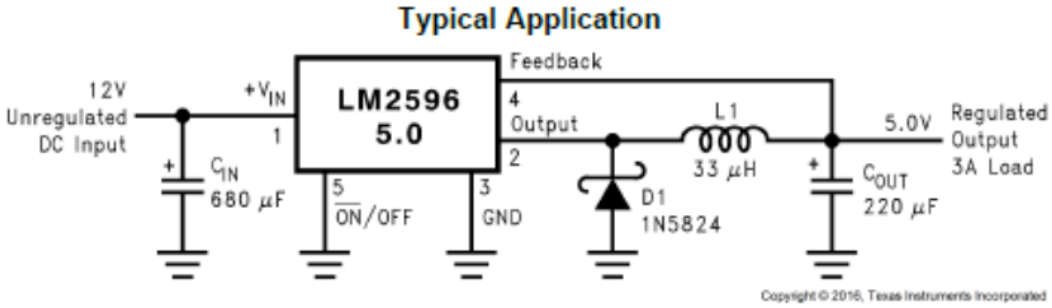


FIGURE (2.13) SCHEMATIC DIAGRAM OF BUCK CONVERTER

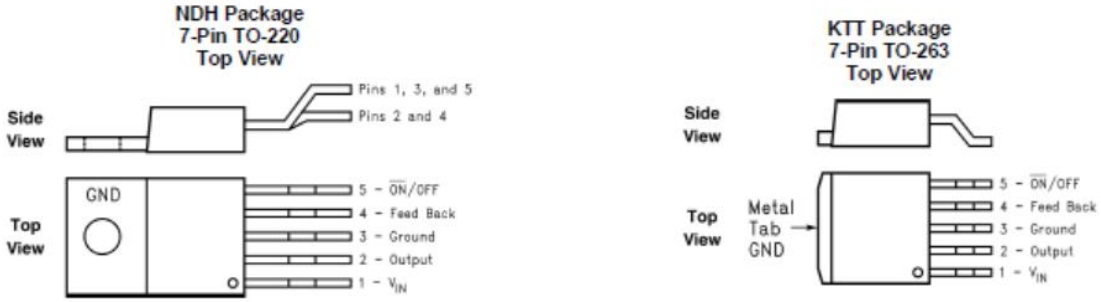


FIGURE (2.14) PIN DESCRIPTION OF BUCK CONVERTER

2.4.1 APPLICATIONS

- Simple High-Efficiency Step-Down (Buck) Regulator.
- On-Card Switching Regulators.
- Positive to Negative Converter.

2.5 INA219

This New CJMCU-219 INA219 I2C Interface No drift Bi-directional Current / Power Supply Monitoring Module. Get yours today at the Best Price from the official reseller INDIA only at Robu, the CJMCU-219 INA219 I2C Interface No drift Bi-directional Current / Power Supply Monitoring Module includes all you need to hook up.

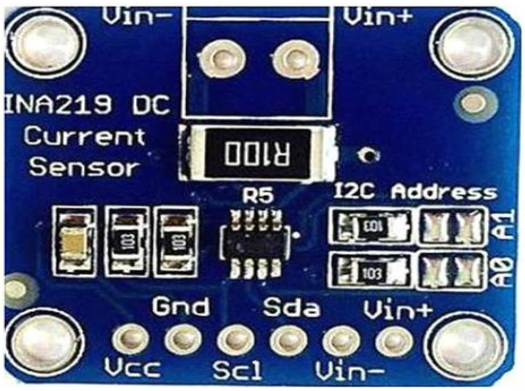


FIGURE (2.15) ACTUAL INA219

CJMCU-219 is a module with the I2C interface of zero drift and bi-directional current/power monitoring and control integrated circuit (IC). INA219 has the industry's highest precision and the small size, not only can monitor the pressure drop on the shunt resistor, sensing shunt power supply voltage, at the same time also can calculate the power.

This breakout board will solve all your power-monitoring problems. Instead of struggling with two multimeters, you can just use the handy INA219 chip on this breakout to measure both the high side voltage and DC current draw over I2C with 1% precision.

The device adopts the SOT23 packaging, but for the server, notebook computer, power supply, battery management, and digital electric vehicle and telecommunication equipment measuring flu provide a small low-cost solution.

A precision amplifier measures the voltage across the 0.1, 1% sense resistor. Since the amplifier's maximum input difference is ±320mV this means it can measure up to ±3.2 Amps. With the internal 12 bit ADC, the resolution at ±3.2A range is 0.8mA. With the internal gain set at the minimum of div8, the max current is ±400mA and the resolution is 0.1mA. Advanced hackers can remove the 0.1-ohm current sense resistor and replace it with their own to change the range (say a 0.01 ohm to measure up to 32 Amps with a resolution of 8mA)

INA219-40 c to + 85 Degree Celsius temperature range and can realise the maximum error of 1% accuracy, a maximum offset of 100μV. The advantage of the high precision of the product in combination with 12 resolutions, can help clients as much as possible, reduce the pressure drop on the shunt resistor, which can minimise the power loss and power consumption, and save board space. The device epic of 26 bus voltage range of 0 V to + V.

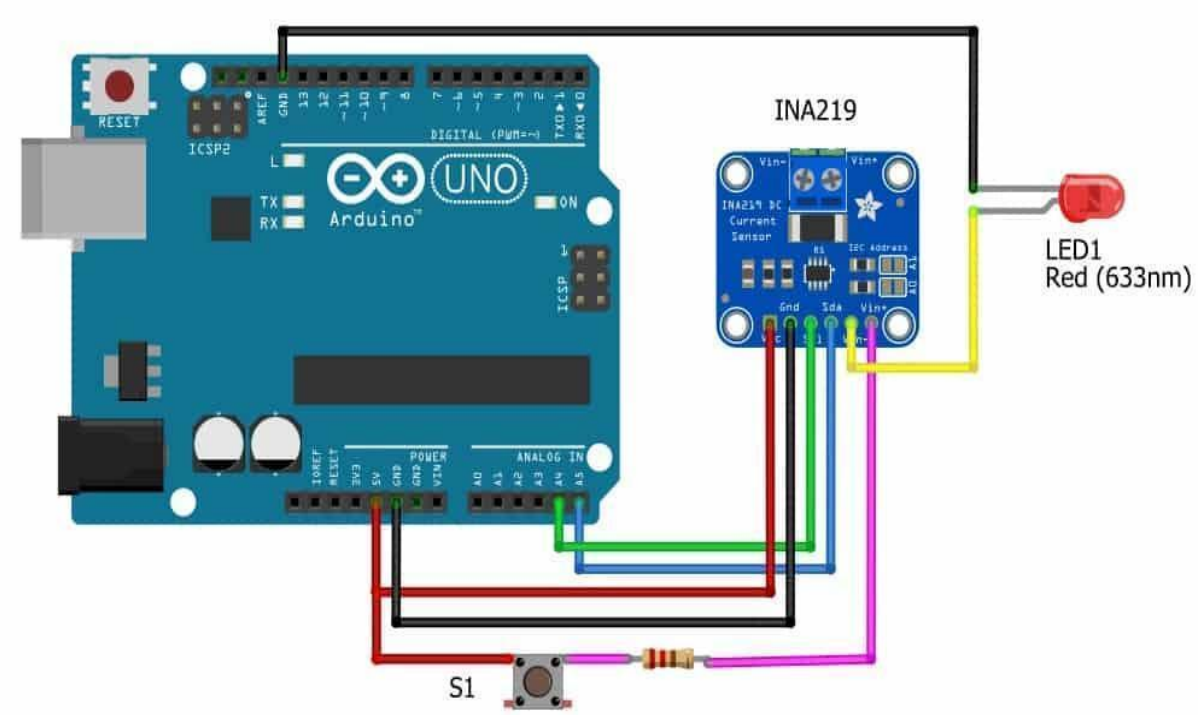


FIGURE (2.16) INTERFACING INA219 AND ARDUINO

2.5.1 CURRENT SENSING RESISTOR

The module has a shunt resistor to measure current, voltage, and power by measuring the voltage drop across it. It can be altered as per requirement.

2.5.2 INA219 CHIP

The integrated Circuit is responsible for all the signal and data processing. I2C Interface: The I2C bus consists of SDA and SCL and serves the purpose of communicating data between the module and the microcontroller.

2.5.3 INA219 OTHER IMPORTANT FEATURES

- Calibration programmable registers can directly read its unit of measure is the ampere current, and power in watts per reading.
- For as many as 128 samplings averaging, in order to realise filters in the noise environment.
- The I2C interface has a timeout, not only can avoid the bus lock, but also can provide high-speed mode, meeting the communication requirements of up to 3.4 MHz.
- All features are supported software programmable INA219.
- Using a single power supply, the working voltage is between + 3.0 to + 5.5V

2.5.4 INA219 PINOUT

The following diagram shows the pinout of the INA219 Current Sensor Module:

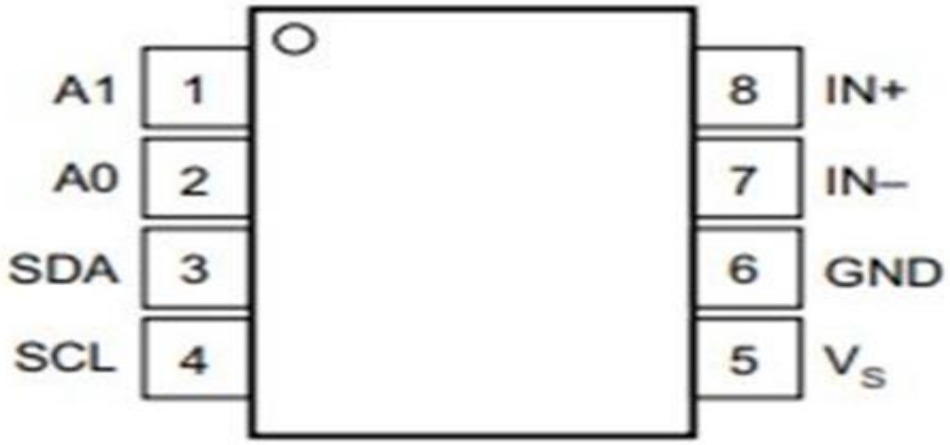


FIGURE (2.17) INA219 PINOUT

2.5.5 INA219 ALTERNATIVE OPTIONS

- ACS712 Current Sensor Module – 20A

2.5.6 APPLICATION

Voltage and current sensor units are commonly used in a variety of applications, including power electronics, renewable energy systems, and electric vehicles. In power electronics, voltage and current sensors are used to control the output of power supplies and inverters.

In renewable energy systems, they are used to monitor the output of solar panels and wind turbines, and to control the charging rate of batteries. In electric vehicles, they are used to monitor the state of charge of the battery and to control the power output of the motor.

2.5.7 ADVANTAGES

Some of the advantages of voltage and current sensor units include high accuracy, fast response time, and low power consumption. They are also compact and lightweight, making them easy to integrate into various electronic systems. In addition, they provide a reliable way to monitor and control the voltage and current levels in electrical circuits, helping to prevent damage to components and ensuring optimal performance.

2.5.8 DISADVANTAGES

One of the main disadvantages of voltage and current sensor units is that they can be expensive, especially for high-precision applications. In addition, they require additional circuitry and calibration to operate properly, which can increase the complexity and cost of electronic systems. Finally, they may be subject to noise and interference from other components in the circuit, which can affect their accuracy and reliability.

2.6 LCD (LIQUID CRYSTAL DISPLAY)

2.6.1 INTRODUCTION

LCD stands for liquid crystal; this is an output device with a limited viewing angle. The choice of LCD as an output device was Because of its cost of use and is better with alphabets when compared with a 7-segment LED display.

We have so many kinds of LCD today and our application requires a LCD with 2 lines and 16 characters per line, this gets data from the microcontroller and displays the same. It has 8 data lines, 3 control lines, a supply voltage Vcc (+5v and a GND).

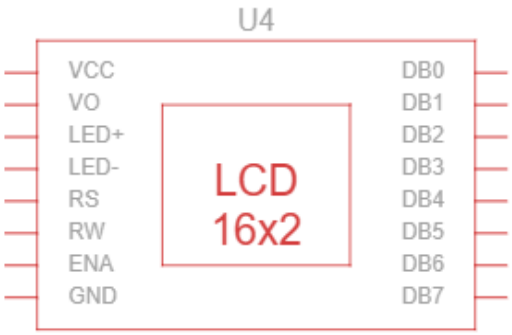


FIGURE (2.18) IC OF 16x2 LCD

This makes the whole device user friendly by showing the balance left in the card. This also shows the card that is currently being used. In recent years the LCD is finding widespread use replacing LEDs. This is due to the following reasons:

1. The declining prices of LCD's.

2. The ability to display numbers, characters and graphics. This is in contrast to LED's, which are limited to numbers and few characters.

3. Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD . In contrast, the Led must be refreshed by the CPU to keep displaying the data.

4. Ease of programming for characters and graphics.

2.6.2 LCD PIN DESCRIPTIONS

VCC, VSS and VEE

While VCC and VSS provide +5v and ground respectively, VEE is used for controlling LCD contrast.

RS, REGISTER SELECT

There are two very important registers inside the LCD. The RS pin used for their selection is as follows. If RS=0, the instruction command code register is selected, allowing the user to send a command such as clear display, cursor at home ,etc. .IF RS=1 the data register is selected, allowing the user to send data to be displayed on the LCD.

R/W READ/WRITE

R/W input allows the user to write information to LCD or read information from it.

R/W=1 when reading; R/W=0 when writing.

E, ENABLE

The enable pin is used by the LCD to latch information present to its data pins. When data is supplied to data pins, a high to low pulse must be applied to this pin in order for the LCD to latch in the data present at the data pins. This pulse must be a minimum of 450ns wide.

D0-D7

The 8-bit data pins, D0-D7, are used to send information to LCD or read the contents of the LCD’s internal registers. To display letters and numbers, we send ASCII codes for the letters A-Z, a-z, and numbers 0-9 to these pins while making RS=1.

There are also instruction command codes that can be sent to the LCD to clear the display or force the cursor to the home position or blink the cursor. We also use RS=0 to check the busy flag bit to see if the LCD is ready to receive information.

The busy flag is D7 and can be read when R/W=1 and RS=0, as follows, if R/W=1 ,RS=0. When D7=1, The LCD is busy taking care of internal operations and will not accept any new information. When D7=0, the LCD is ready to receive new information.

2.6.3 LCD COMMAND CODES

1	Clear display screen
2	Return home
4	Decrement cursor
6	Increment cursor
5	Shift display right
7	Shift display left
8	Display off, cursor off
A	Display off, cursor on
C	Display on, cursor off
E	Display on, cursor blinking
F	Display on, cursor blinking
10	Shift cursor position to left
14	Shift cursor position to right
18	Shift the entire display to the left
1C	Shift the entire display to the right
80	Force cursor to beginning of the 1st line
C0	Force cursor to beginning of the 2nd line
38	2 lines and 2*7 matrix

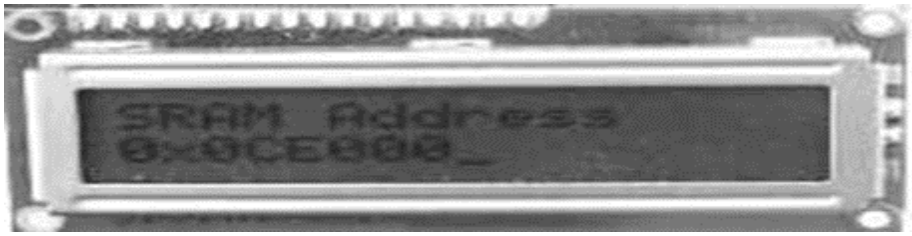


FIGURE (2.19) ACTUAL LCD

2.6.4 16x2 LIQUID CRYSTAL DISPLAY OPERATION FLOWCHART

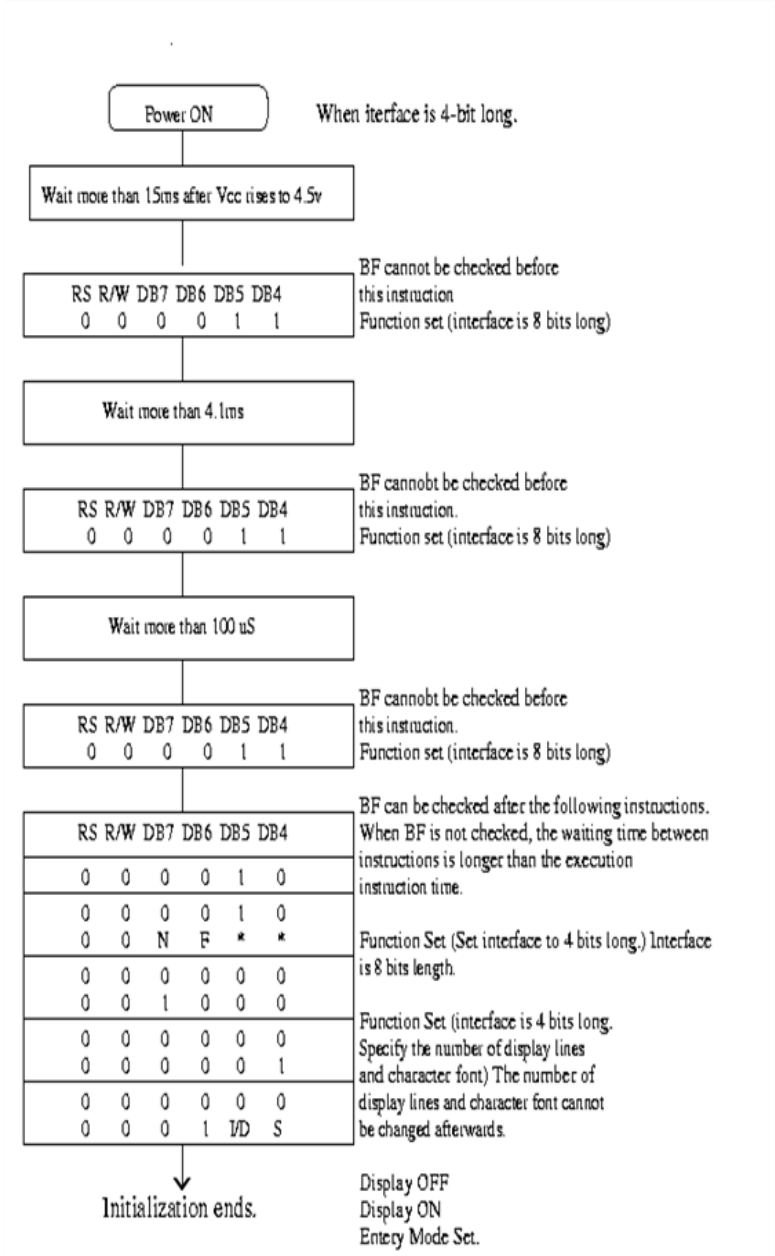


FIGURE (2.20) 16x2 LCD OPERATION FLOWCHART

2.6.5 8-BIT INTERFACE

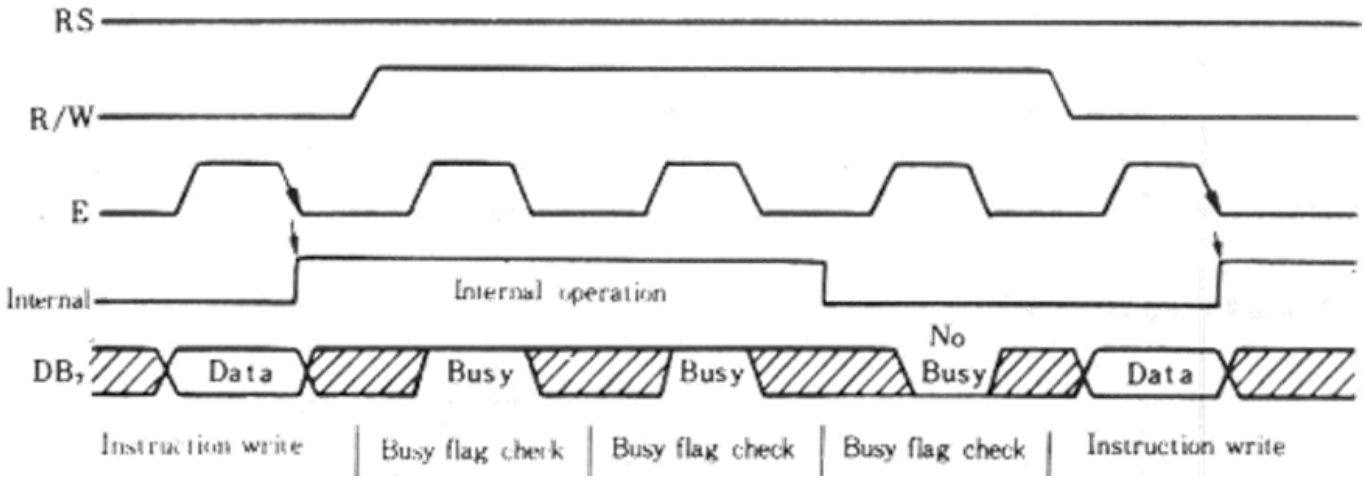


FIGURE (2.21) 8-BIT INTERFACE

2.6.6 4-BIT INTERFACE

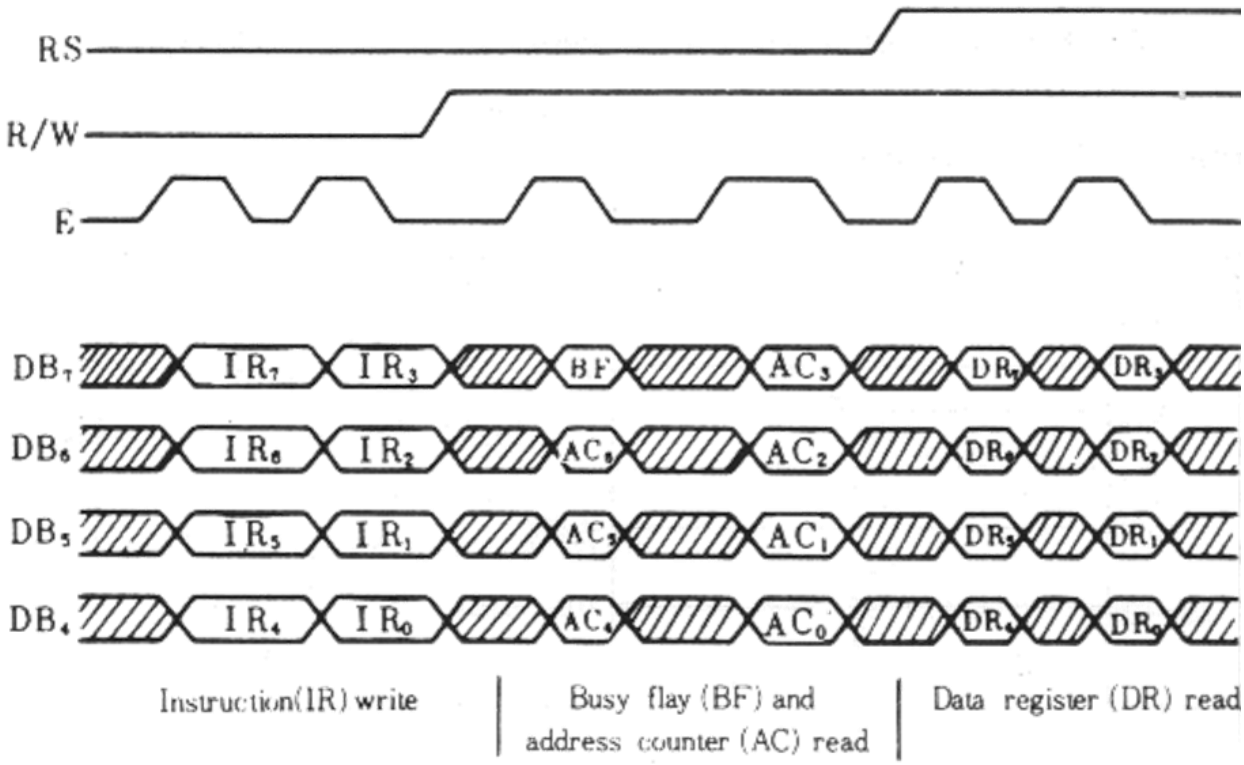


FIGURE (2.22) 4-BIT INTERFACE

The LCD requires either 8 or 11 I/O lines to communicate with. For the sake of this tutorial, we are going to use an 8-bit data bus--so we'll be using 11 of the 8051's I/O pins to interface with the LCD. The EN line is used to tell the LCD that you are ready for it to execute an instruction that you've prepared on the data bus and on the other control lines.

Note that the EN line must be raised/lowered before/after each instruction sent to the LCD regardless of whether that instruction is read or write text or instruction. In short, you must always manipulate EN when communicating with the LCD. EN is the LCD's way of knowing that you are talking to it. If you don't raise/lower EN, the LCD doesn't know you're talking to it on the other lines.

2.6.7 CHARACTER SET

FIGURE (2.23) CHARACTER SET OF LCD

2.6.8 PROGRAMMING THE LCD

Before you may really use the LCD, you must initialise and configure it. This is accomplished by sending a number of initialization instructions to the LCD. The first instruction we send must tell the LCD whether we'll be communicating with it with an 8-bit or 4-bit data bus. We also select a 5x8 dot character font.

These two options are selected by sending the command 38h to the LCD as a command. As you will recall from the last section, we mentioned that the RS line must be low if we are sending a command to the LCD. The second byte of the initialization sequence is the instruction 0Eh. Thus we must repeat the initialization code from above, but now with the instruction. Thus the next code segment is:

The last byte we need to send is used to configure additional operational parameters of the LCD. We must send the value 06h.

Thus, the first character in the upper left-hand corner is at address 00h. The following character position (character #2 on the first line) is address 01h, etc. This continues until we reach the 16th character of the first line which is at address 0Fh.

However, the first character of line 2, as shown in the memory map, is at address 40h. This means if we write a character to the last position of the first line and then write a second character, the second character will not appear on the second line. That is because the second character will effectively be written to address 10h--but the second line begins at address 40h.

Thus we need to send a command to the LCD that tells it to position the cursor on the second line. The "Set Cursor Position" instruction is 80h. To this we must add the address of the location where we wish to position the cursor.

2.6.9 I2C LCD Interfacing

The character LCD is ideal for displaying text and numbers and special characters. LCDs incorporate a small add-on circuit (backpack) mounted on the back of the LCD module. The module features a controller chip handling I2C communications and an adjustable potentiometer for changing the intensity of the LED backlight. An I2C LCD advantage is that wiring is straightforward, requiring only two data pins to control the LCD.

A standard LCD requires over ten connections, which can be a problem if your Arduino does not have many GPIO pins available. If you happen to have an LCD without an I2C interface incorporated into the design, these can be easily acquired separately.

The LCD displays each character through a matrix grid of 5×8 pixels. These pixels can display standard text, numbers, or special characters and can also be programmed to display custom characters easily.

The I2C LCD interface is compatible across much of the Arduino family. The pin functions remain the same, but the labelling of those pins might be different.

This chart will assist in identifying the pins on your Arduino model to the SDA and SCL functions.

The Arduino R3 also extends the Data Line (SDA) and Clock Line (SCL) to the header pin beside the AREF header.

2.6.10 CONTRAST ADJUST – A NECESSARY FIRST STEP

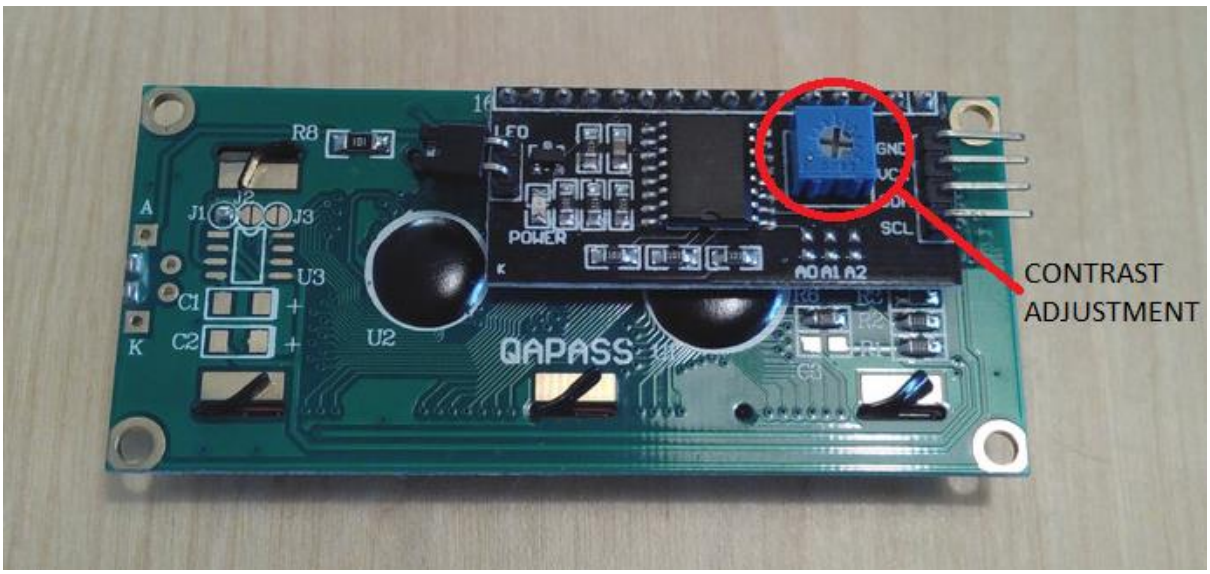


FIGURE (2.24) CONTRAST ADJUSTMENT IN LCD

Once you have the four connections to your LCD made, you can power your Arduino, which will provide power to the LCD. The LCD has an adjustment on it which needs to be approximately set to allow you to see characters on the display. You must now adjust that contrast setting.

Located on the back of the LCD screen is the I2C interface board, and on the interface is an adjustable potentiometer. This adjustment is made with a small screwdriver. You will adjust the potentiometer until a series of rectangles appear – this will allow you to see your programming results.

After you have your first program loaded, and you can see the output on the LCD, you can go back and adjust the contrast control for optimal viewing.

2.6.11 INSTALLING THE LCD LIBRARY

The Arduino module and editor do not know how to communicate with the I2C interface on the LCD. The parameters to enable the Arduino to send commands to the LCD are in separately downloaded **LiquidCrystal_I2C library**.

LiquidCrystal_I2C is available from **GitHub**. When visiting the GitHub page, select the **Code** button and from the drop-down menu, choose the Download **ZIP** option to save the file to a convenient location on your workstation.

We also have the **LiquidCrystal_I2C** library available for download directly on our site should the master GitHub repository ever disappear.

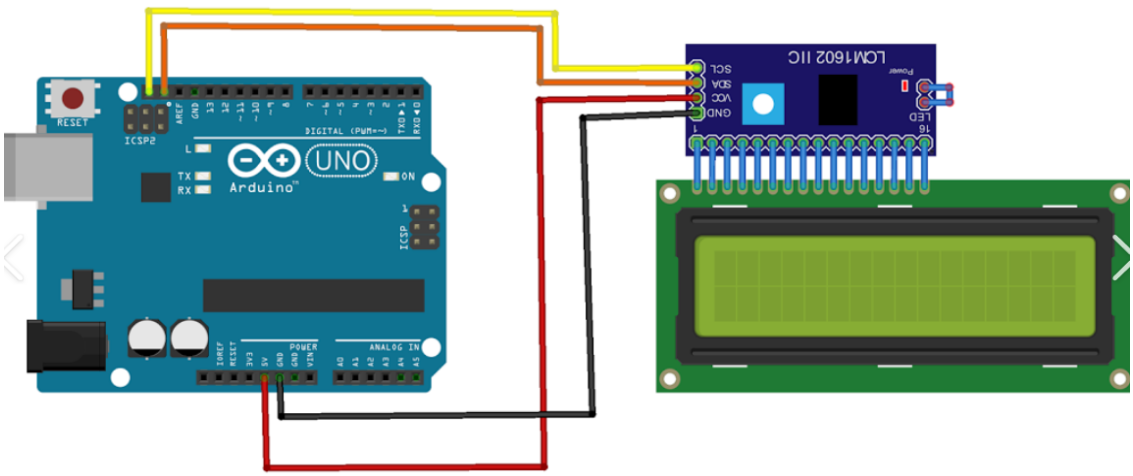


FIGURE (2.25) INTERFACING ARDUINO AND LCD

2.7 RELAY

Relays are switching devices. It is the heart of the industrial electronic system. Every industrial electronic system required some type of switching device (or) relay. For the simplest photo-electric relay to the most advanced.

Depending up on the basic force available for relay contact closing and opening there are several types of relays. Some of them are listed below:

- Electromagnetic or electrodynamics relays
- Gas or compressed air operated pneumatic relays
- Heat sensitive bimetallic

Electronic relays made of vacuum tubes, gas tubes, solid state devices and saturable core reactions.

Electromagnetic relays are forms of electromagnets in which the coil current produces a magnetic effect to pull or push flat soft iron armatures of strips carrying relay contacts. Several relay contacts can be operated to get several possible ON/OFF combinations.

Relays may be classified in many ways, but there are two large groups defined by their use. One is a general purpose relay and the other is a special purpose relay designed for specific applications demanding high sensitivity, high speed, large current carrying capacity etc.

General purpose relays or telephone relays of read type relays from the largest group of electromagnetic switching devices. They are usually DC operated. Basic electromagnetic relay principle is illustrated in figure. Constructional details of a telephone type relay are shown in the figure.

2.7.1 WORKING

Relays are nothing but the electro mechanical device that can be used as a switch. The circuit and the operation of the relay is explained below. A relay is a switch worked by an electromagnet. It is useful if we want a small current in one circuit to control another circuit containing a device such as a lamp or electric motor which requires a large current, or if we wish several different switch contacts to be operated simultaneously.

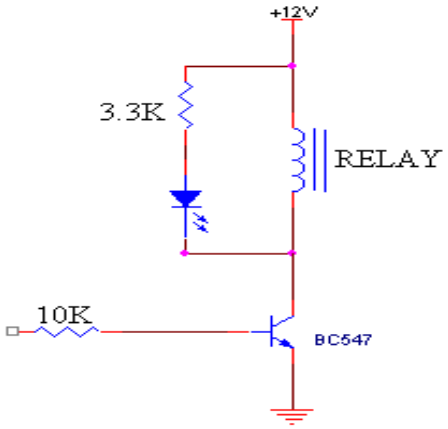


FIGURE (2.26) RELAY CIRCUIT DIAGRAM

When the controlling current flows through the coil, the soft iron core is magnetised and attracts the L-shaped soft iron armature. This rocks on its pivot and opens, closes or changes over, the electrical contacts in the circuit being controlled it closes the contact the current needed to operate a relay is called the pull-in current and the dropout current in the coil when the relay just stops working. If the coil resistance R of a relay is 185W and its operating voltage V is 12V, the pull in current I is given by

$$I = \frac{V}{R} = \frac{12}{185} = 0.065A = 65mA$$

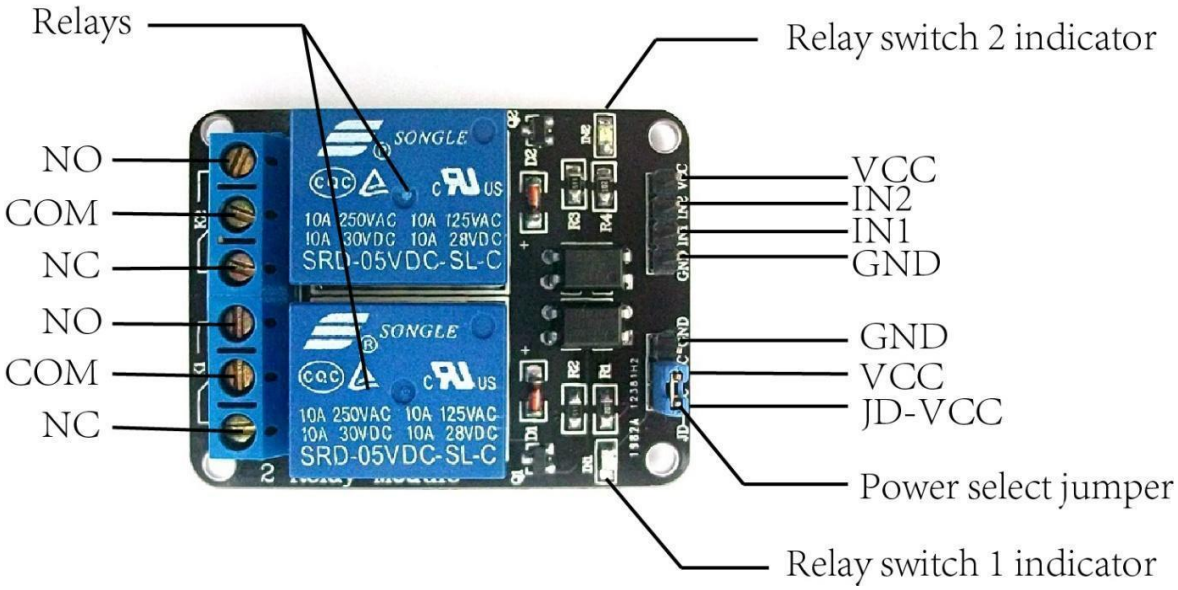


FIGURE (2.27) ACTUAL RELAY

2.7.2 REED SWITCHES

Relays operate comparatively slowly and for fast switching of a signal circuit, e.g. in a telephone exchange, reed switches are used. The reeds are thin strips of easily magnetised and demagnetizable material. They are sealed in a glass tube containing an inert gas such as nitrogen to reduce corrosion of the contacts.

The switch is operated either by bringing a magnet near or by passing a current through a coil surrounding it. In both cases reeds become magnetised, attract each other and on touching they complete the circuit connected to the terminals. They separate when the magnet is removed or the current stops flowing in the coil. When the changeover reed switch operates, the reed is attracted from the non-magnetic contact to the magnetic one.

2.7.3 PROTECTION OF RELAYS AND REED SWITCHES

When the current in the coil of a reed switch falls to zero, a large voltage is induced in the coil due to its inductance. This voltage could damage any transistor used to control the current in the coil. However if a diode is connected in reverse bias for the supply voltage it offers an easy path to the induced voltage and stops it building up to a high value.

2.7.4 RELAY CONTACTS

The heart of the relay is the junction of the contact points. The relay contact points may be flat, spherical, pointed and combination of these. Some of the contact types are shown in the figure

- Flat contacts require more pressure for perfect contact closing. Half round (spherical) contacts are better because the surface contamination will be minimal.
- But it has one disadvantage that is due to fault current this type of contacts closed or opened even if there is no supply.
- The twin contacts give more reliable operation. Relay contacts are made of silver and silver alloys in small power applications. For larger relays, contacts are made up of copper.
- Certain relays use silver – palladium – ruthenium alloys for contacts. The special types mentioned above give long life, carry moderate currents and keep shape for a long time.

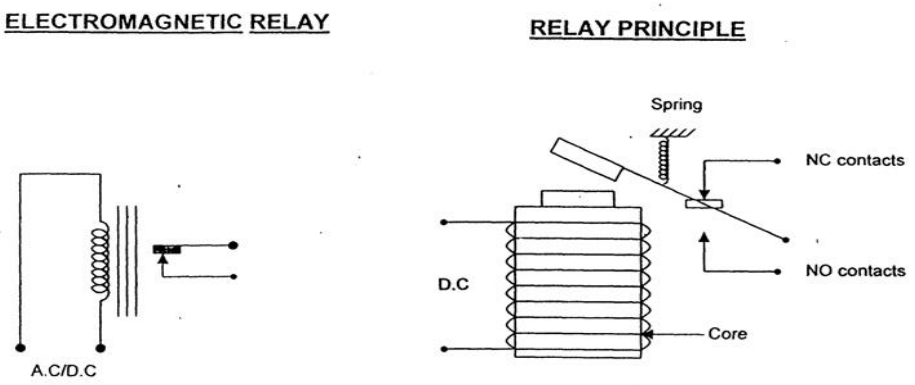


FIGURE (2.28) RELAY PRINCIPLE OF OPERATION

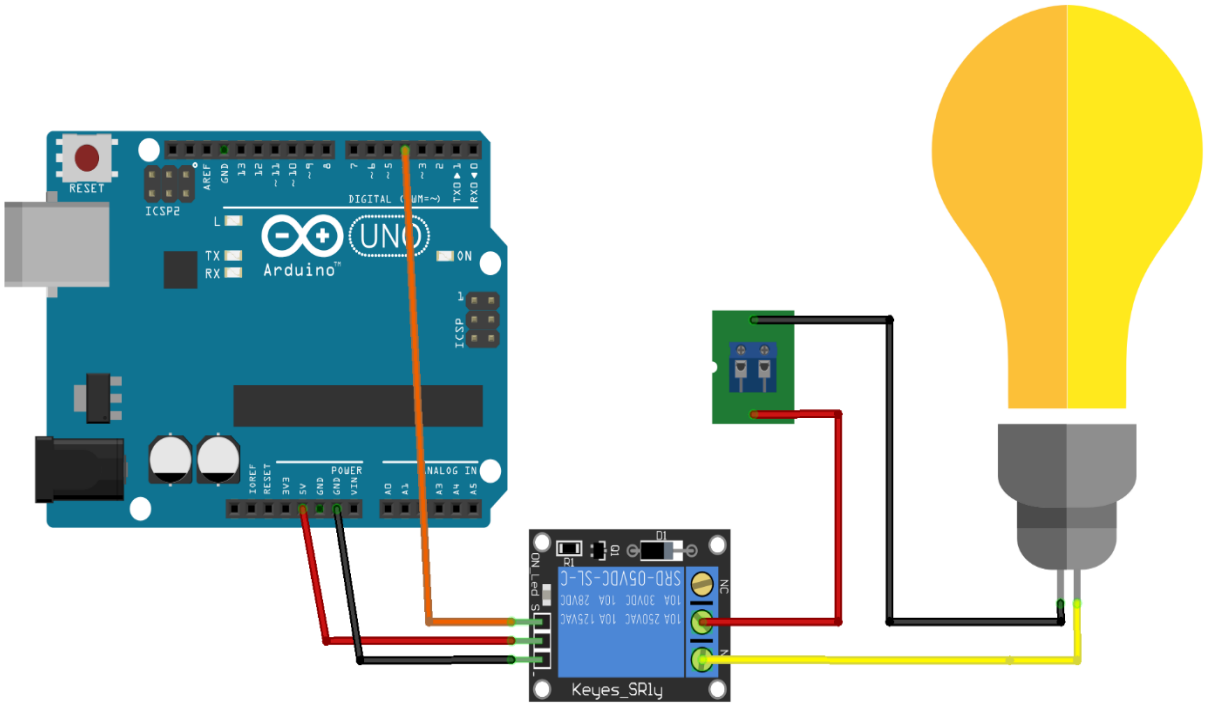


FIGURE (2.29) INTERFACING ARDUINO AND RELAY

2.8 LEDs (LIGHT EMITTING DIODE)

LEDs, or Light Emitting Diodes, are semiconductor devices that emit light when an electric current flows through them. They are used for a wide range of applications, including lighting, displays, and indicators.

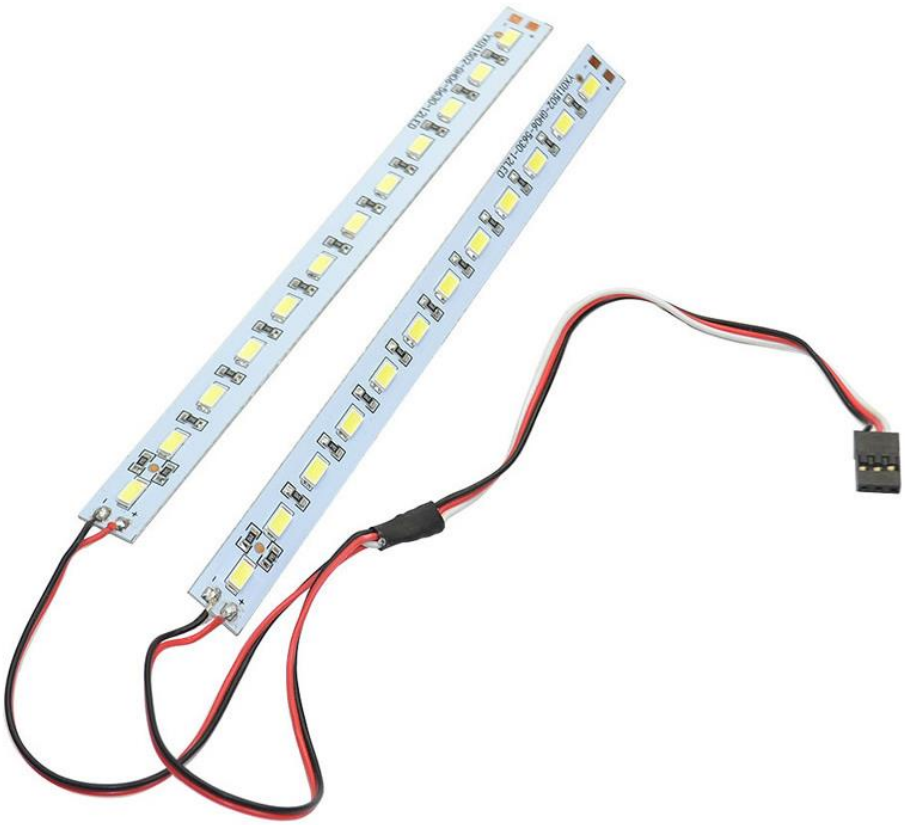


FIGURE (2.30) ACTUAL LED STRIP

2.8.1 CONSTRUCTION

LEDs are made up of several layers of materials, including a semiconductor material such as gallium arsenide, and a conductor material such as aluminium or gold.

The layers are arranged in a way that creates a junction, which allows current to flow through the device. The junction emits light when an electric current is applied, with the colour of the light depending on the materials used in the construction of the LED.

2.8.2 WORKING

When an electric current is applied to an LED, electrons move from the negative side of the device (called the anode) to the positive side (called the cathode).

As the electrons move through the semiconductor material, they combine with holes in the material, releasing energy in the form of photons (light).

2.8.3 APPLICATIONS

LEDs are used in a wide range of applications, including lighting (both residential and commercial), automotive lighting, electronic displays, traffic signals, and indicators. They are also used in devices such as remote controls and infrared cameras.

2.8.4 ADVANTAGES

LEDs offer several advantages over traditional lighting technologies such as incandescent bulbs and fluorescent tubes. They are more energy efficient, using up to 80% less energy than traditional lighting technologies.

They also have a longer lifespan, lasting up to 50,000 hours compared to the 1,000-2,000 hours of incandescent bulbs. LEDs are also more durable, with no fragile filament or tube to break, and are generally smaller and more compact.

2.8.5 DISADVANTAGES

One of the main disadvantages of LEDs is their higher initial cost compared to traditional lighting technologies. They also emit directional light, which can be a disadvantage for some applications where a wider spread of light is needed.

Additionally, LED colour can vary between devices, which can be problematic for applications where colour accuracy is important.

Overall, the construction and working of LEDs make them a highly versatile and efficient lighting solution, with many advantages over traditional lighting technologies.

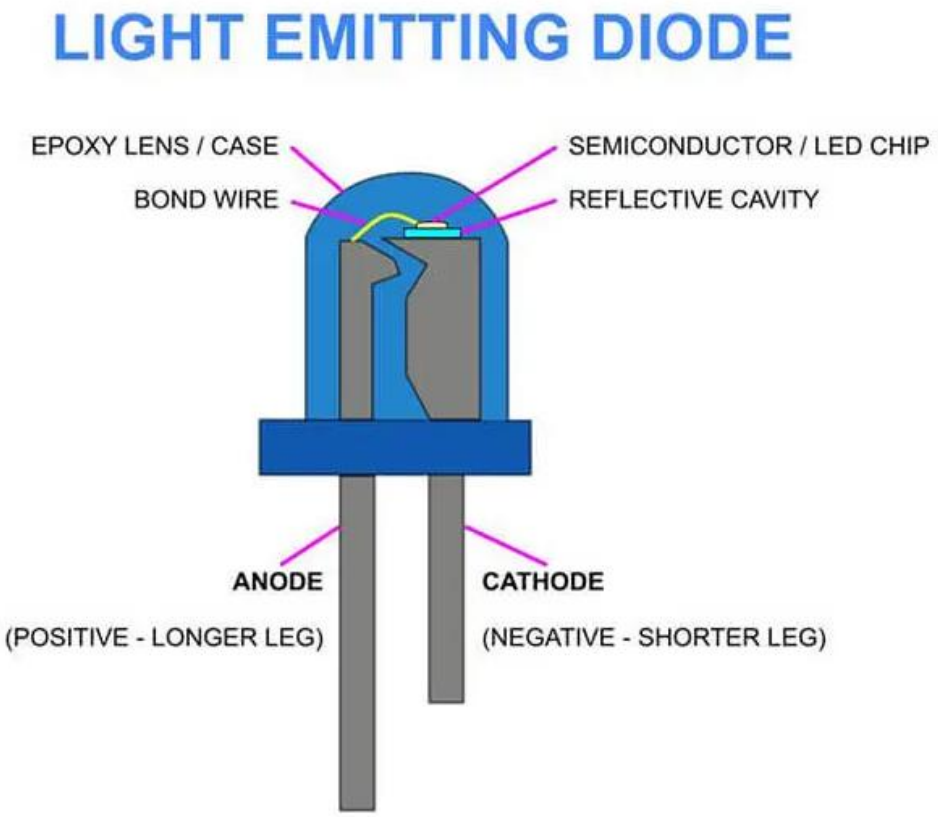


FIGURE (2.31) LED CONSTRUCTION

2.9 IGNITION SWITCH

FIGURE (2.32) 4-POINT IGNITION SWITCH WITH KEYS

2.9.1 CONSTRUCTION

The ignition switch is a part of the vehicle's electrical system that controls the flow of electricity to the engine. It is typically located on the dashboard, steering column, or console of the vehicle. The switch consists of several parts, including the key cylinder, switch housing, wiring harness, and electrical contacts. The key cylinder is inserted into the switch housing and is turned by the driver using the ignition key. This rotates the electrical contacts inside the switch, which allows electricity to flow to the engine.

2.9.2 WORKING

The ignition switch works by controlling the flow of electrical current to the engine. When the key is inserted into the key cylinder and turned, it rotates a series of electrical contacts inside the switch. This movement allows electricity to flow from the battery to the starter motor, which in turn starts the engine. The ignition switch also controls the other electrical components of the vehicle, such as the lights and radio, by sending electricity to those systems when the key is turned to the appropriate position.

2.9.3 APPLICATION

The ignition switch is used in all types of vehicles, from cars and trucks to motorcycles and boats. It is an essential part of the vehicle's electrical system and is required to start the engine and control the other electrical systems of the vehicle.

2.9.4 ADVANTAGES

- The ignition switch is a simple and reliable way to start the engine of a vehicle.
- It is a widely used technology and is familiar to most drivers.
- The switch is typically durable and long-lasting, requiring minimal maintenance.

2.9.5 DISADVANTAGES

- The ignition switch can be vulnerable to wear and tear over time, particularly if it is used frequently.
- If the switch is damaged or malfunctions, it can prevent the engine from starting and may require repair or replacement.
- In some cases, the ignition switch can be a target for theft or tampering, particularly in older or less secure vehicles.

2.10 TOGGLE SWITCH

Toggle switch, also known as a "rocker switch" or "on-off switch," is a mechanical switch that is used to control the flow of electricity in a circuit. It consists of a lever, or "toggle," that can be moved back and forth to open or close the circuit.

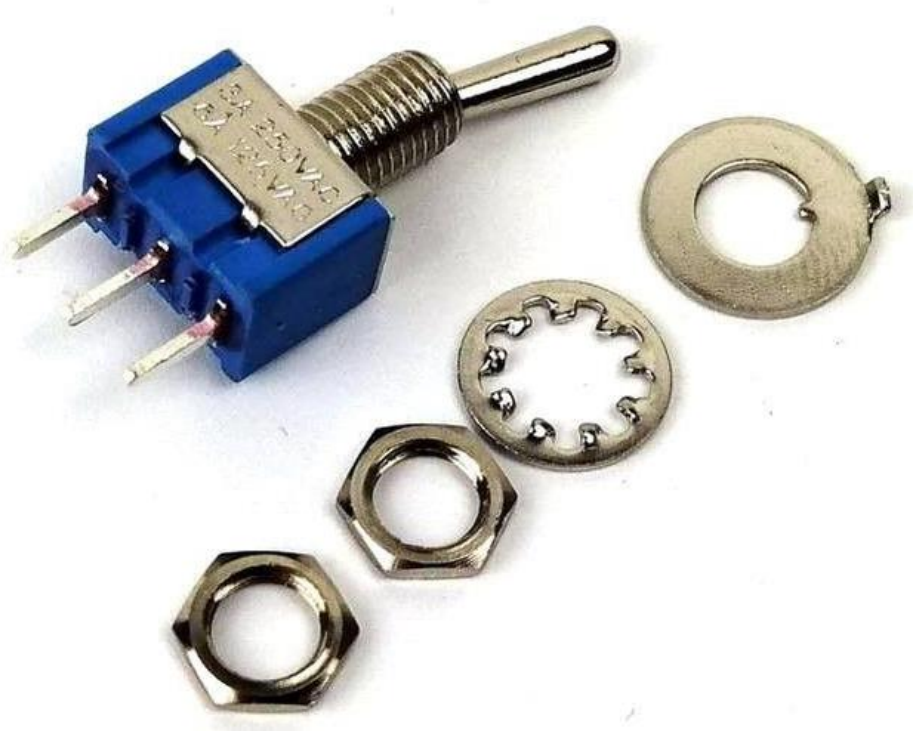


FIGURE (2.33) ACTUAL TOGGLE SWITCH

2.10.1 CONSTRUCTION

Toggle switches can have various construction designs, but they typically consist of a metal or plastic housing that holds the internal components. Inside the housing, there is a spring-loaded lever that is attached to a metal contact mechanism.

The contact mechanism is typically composed of two metal plates that can be pushed together or pulled apart by the lever. The switch housing also includes electrical terminals that allow the switch to be connected to an electrical circuit.

2.10.2 WORKING

When the toggle lever is in the "ON" position, the metal plates inside the switch housing are pushed together, creating a closed circuit that allows electricity to flow through the switch. When the lever is in the "OFF" position, the metal plates are pulled apart, breaking the circuit and stopping the flow of electricity.

2.10.3 APPLICATIONS

- Lighting control: Toggle switches can be used to turn lights on and off, either individually or in groups.
- Motor control: Toggle switches can be used to control the operation of motors, such as those used in fans, pumps, and other machinery.
- Audio equipment: Toggle switches can be used to control the power, volume, and other functions of audio equipment, such as amplifiers and mixers.
- Automotive applications: Toggle switches are used in vehicles to control various functions, such as headlights, turn signals, and windshield wipers.

2.10.4 ADVANTAGES

- Simple and easy to use: Toggle switches are easy to operate and require minimal training or expertise to use.
- Durability: Toggle switches are designed to be durable and can withstand repeated use and abuse.
- Compact size: Toggle switches are relatively small and can be mounted in tight spaces or in locations where other types of switches may not fit.

2.10.5 DISADVANTAGES

- Limited functionality: Toggle switches can only be used to turn circuits on or off, making them less versatile than other types of switches.
- Limited precision: Because toggle switches are binary in nature (either on or off), they may not be precise enough for some applications that require fine control over the flow of electricity.

- Limited visual indication: Toggle switches do not typically provide a clear visual indication of whether they are on or off, which may be a disadvantage in some applications where it is important to know the switch position at a glance.

2.11 WIRE WOUND CERAMIC CEMENT RESISTOR

Wound Ceramic Cement Resistors, also known as WWCC resistors, are passive electronic components used to restrict the flow of current in a circuit.

These resistors are designed by wrapping a metal wire, typically made of nichrome or other high-resistance materials, around a ceramic core and then encapsulating the assembly in cement. The wire-wound construction provides precise and stable resistance values that are ideal for high-power applications.

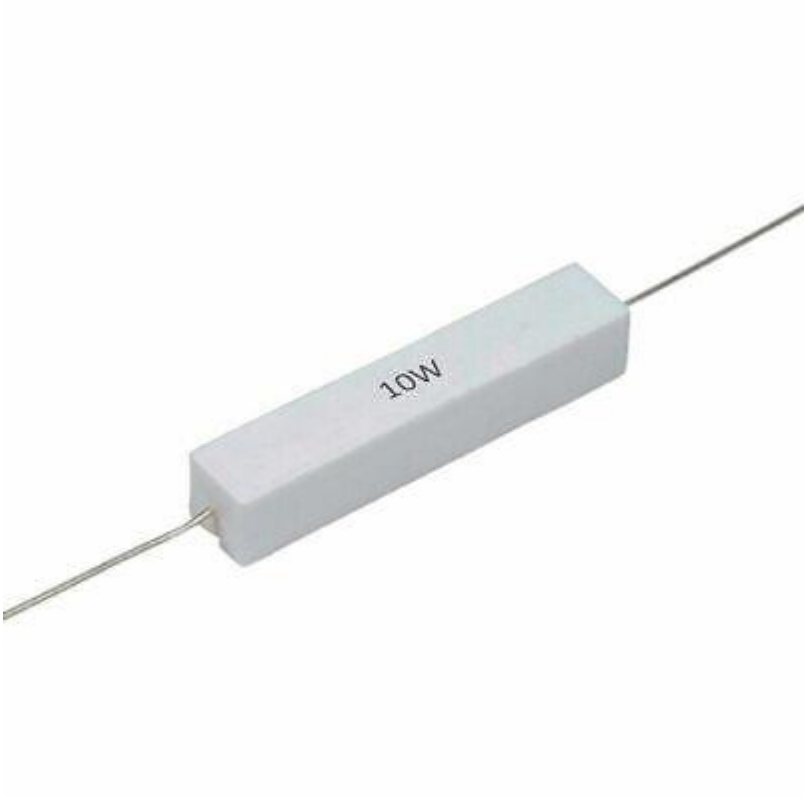


FIGURE (2.34) ACTUAL WIRE WOUND CERAMIC CEMENT RESISTOR

2.11.1 CONSTRUCTION

The ceramic core is used as a mechanical support for the winding and helps in providing excellent thermal stability. The wire is usually wrapped tightly around the core to produce the desired resistance value.

After winding the wire, the assembly is then coated with a ceramic cement to protect the resistor from the environment and improve heat dissipation. The resistor's leads are then attached to either end, allowing it to be connected to a circuit.

2.11.2 WORKING

The wire-wound ceramic cement resistor works by converting electrical energy into heat energy. When current flows through the resistor, the wire's resistance causes a voltage drop, and power is dissipated in the form of heat. The resistor's resistance value determines the amount of current that flows through the resistor, which is calculated using Ohm's law.

2.11.3 APPLICATIONS

Wire Wound Ceramic Cement Resistors are used in a variety of applications, including power supplies, motor controllers, audio amplifiers, and electronic circuit protection.

They are also used in high-frequency applications where their high stability, low noise, and low inductance properties are beneficial. They are commonly used in circuits that require high power, high voltage, and high reliability.

2.11.4 ADVANTAGES

- Precise and stable resistance values
- High power handling capabilities
- Low noise and low inductance
- High thermal stability
- Resistance to environmental conditions such as humidity and temperature changes

2.11.5 DISADVANTAGES

- Generally larger in size compared to other types of resistors
- Wire-wound construction can lead to inductive effects, which can impact circuit performance in high-frequency applications
- Higher cost compared to other types of resistors

2.12 BUZZAR UNIT

Buzzer units are commonly used in electronic circuits to produce a buzzing or beeping sound. They are a type of transducer that converts an electrical signal into an audible sound. In this response, we will provide a detailed explanation of buzzer unit construction, working, application, advantages, and disadvantages.

2.12.1 CONSTRUCTION

Buzzer units consist of a piezoelectric element or an electromechanical component, which produces sound when an electric current is passed through it. The piezoelectric element is made up of a ceramic material that vibrates when an electric current is applied to it. The electromechanical component is made up of a magnetic coil and a diaphragm, which moves back and forth to produce sound.

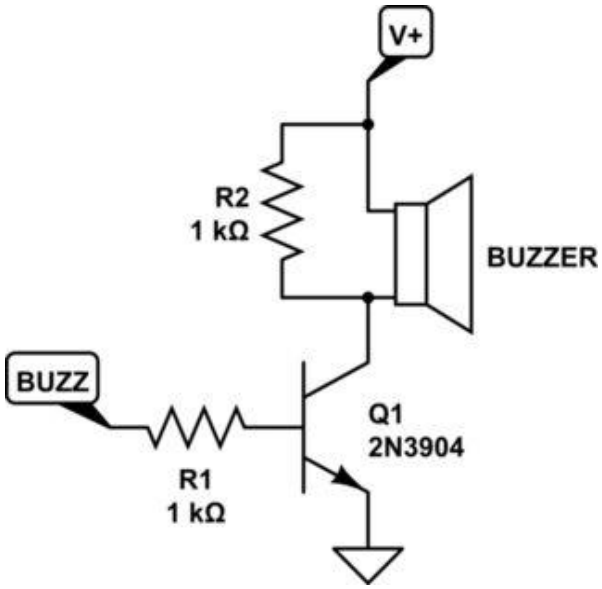


FIGURE (2.35) CIRCUIT DIAGRAM OF BUZZER UNIT

2.12.2 WORKING

Buzzer units work on the principle of the piezoelectric effect or the electromagnetic effect. When an electric current is applied to the piezoelectric element, it vibrates and produces sound. In the case of an electromechanical component, the electric current flows through the magnetic coil, which creates a magnetic field. This field then moves the diaphragm back and forth, producing sound.

2.12.3 APPLICATION

Buzzer units are commonly used in a wide range of electronic devices and equipment, including alarms, timers, security systems, and appliances. They are also used in industrial applications, such as machinery and production lines, where they can provide audible feedback to operators.

2.12.4 ADVANTAGES

Buzzer units are relatively simple and inexpensive to produce, and they are highly reliable and durable. They can produce a range of different sounds, including beeps, buzzes, and alarms, and they can be easily integrated into a wide range of electronic circuits and systems.

2.12.5 DISADVANTAGES

One disadvantage of buzzer units is that they can produce a limited range of sounds compared to other types of audio devices, such as speakers. They can also be relatively loud and obtrusive, which can be a disadvantage in certain applications where a more subtle or quiet sound is required. Finally, buzzer units typically consume more power than other types of audio devices, which can be a disadvantage in battery-powered applications.

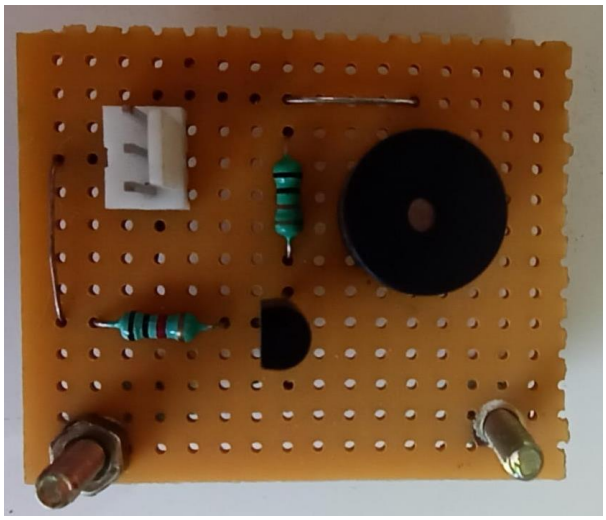


FIGURE (2.36) BUZZER UNIT ON PCB BOARD

2.13 HC-05 BLUETOOTH MODULE

The HC-05 Bluetooth module is a popular and widely used Bluetooth module that provides a simple and reliable wireless communication link between devices. It is a compact and cost-effective solution for wireless communication applications that require low-power consumption and low-cost.

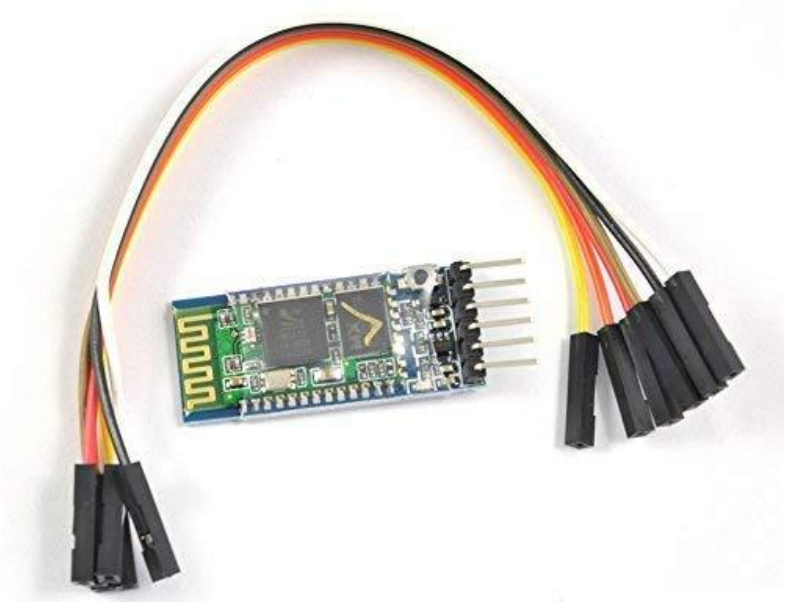


FIGURE (2.37) ACTUAL HC-05 BLUETOOTH MODULE

2.13.1 CONSTRUCTION

The HC-05 module is a small and compact Bluetooth module that consists of a Bluetooth chip, an antenna, and a voltage regulator. It operates on a 3.3V power supply and communicates with a host device using a UART interface.

2.13.2 WORKING

The HC-05 module works by establishing a wireless Bluetooth connection between two devices. It operates in two modes: master and slave. In master mode, the module initiates the connection with another Bluetooth device, while in slave mode, it waits for a connection from a master device. Once the connection is established, data can be transferred between the two devices wirelessly.

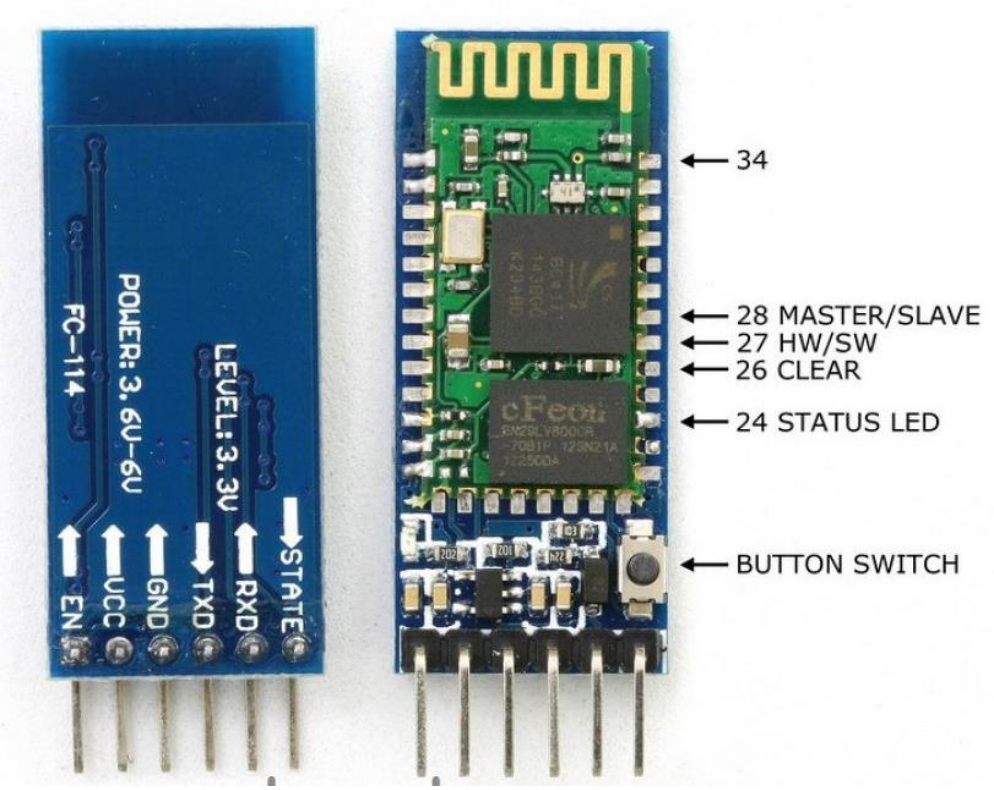


FIGURE (2.38) PIN DESCRIPTION OF HC-05 BLUETOOTH MODULE

2.13.3 APPLICATION

The HC-05 Bluetooth module is widely used in various applications, such as wireless communication between microcontrollers, wireless data transfer between smartphones and other devices, and wireless remote control of electronic devices.

2.13.4 FEATURES

1. Low power consumption: The HC-05 module consumes very low power, making it suitable for battery-powered applications.

2. Low-cost solution: It is a cost-effective solution for wireless communication applications.

3. Easy to use: The module is easy to use and requires minimal setup to establish a wireless connection.

4. Reliable: The module provides a reliable wireless communication link between devices.

5. Compatibility: It is compatible with most Bluetooth-enabled devices.

2.13.5 DISADVANTAGES

1. Limited range: The HC-05 module has a limited range of approximately 10 metres, making it unsuitable for long-range communication applications.

2. Interference: The wireless communication link may be affected by interference from other Bluetooth devices or wireless signals in the environment.

3. Data rate: The data transfer rate of the HC-05 module is limited, making it unsuitable for applications that require high-speed data transfer.

Overall, the HC-05 Bluetooth module is a popular and widely used Bluetooth module due to its low power consumption, low-cost solution, and easy-to-use interface. However, it has some limitations, such as limited range and data transfer rate, that need to be considered when selecting it for a particular application.

2.13.6 INTERFACING HC-05 BLUETOOTH MODULE WITH ARDUINO

The HC-05 Bluetooth module can be easily connected to the Arduino Uno to establish wireless communication between the Arduino and other devices such as smartphones, tablets, and laptops. The HC-05 module can be used as either a master or a slave device, but in this case, we will be using it as a slave device.

Here are the steps to connect the HC-05 Bluetooth module to the Arduino Uno:

1. Connect the HC-05 module to the Arduino Uno using the following connections:

- VCC to 5V
- GND to GND
- TXD to RXD (pin 0)
- RXD to TXD (pin 1)

2. Connect a push button switch between the digital pin 2 and the ground.

3. Open the Arduino IDE and create a new sketch.

4. Import the SoftwareSerial library by adding the following line at the beginning of the sketch:

`#include <SoftwareSerial.h>`

5. Create two instances of the SoftwareSerial class to establish serial communication between the Arduino and the HC-05 module. The following code snippet shows how to create two instances:

```
SoftwareSerial BTSerial(0, 1);  // RX, TX
SoftwareSerial mySerial(2, 3); // RX, TX
```

In this example, the BTSerial instance is used to communicate with the HC-05 module, while the mySerial instance is used to communicate with other devices.

6. In the `setup()` function, initialise the two SoftwareSerial instances by setting the baud rate to 9600:

```
void setup() {
  // initialise serial communication
  BTSerial.begin(9600);
  mySerial.begin(9600);

  // set pin 2 as input with pull-up resistor
  pinMode(2, INPUT_PULLUP);
}
```

7. In the `loop()` function, read the status of the push button and send the data to the HC-05 module:

```
void loop() {
  // read the status of the push button
  int buttonState = digitalRead(2);

  // send the data to the HC-05 module
  BTSerial.write(buttonState);

  // delay for 100 milliseconds
  delay(100);
}
```

In this example, the status of the push button is sent to the HC-05 module every 100 milliseconds.

8. Upload the sketch to the Arduino Uno and power it up.

9. Pair the HC-05 module with your smartphone or other device using the default password "1234".

10. Open a serial terminal app on your smartphone or other device and connect to the HC-05 module.

11. You should see the status of the push button being displayed on the serial terminal app.

The above steps illustrate the basic process of connecting the HC-05 Bluetooth module to the Arduino Uno. The HC-05 module can be used in various other projects where wireless communication is required, such as home automation, robotics, and remote control applications. Its low cost, easy availability, and simple connectivity make it a popular choice for hobbyists and makers.

2.14 6V MINI MOTOR - 1.5 to 12VDC

FIGURE (2.39) 6V DC MINI MOTOR

2.14.1 CONSTRUCTION

The DC 6V mini motor is a small electric motor designed to operate on a DC (direct current) power supply. It typically consists of a cylindrical body with a rotating shaft at one end. Inside the motor, there are permanent magnets, an armature (coil of wire), brushes, and a commutator. The permanent magnets create a magnetic field, and the armature, connected to the rotating shaft, interacts with this magnetic field to generate rotational motion.

2.14.2 WORKING PRINCIPLE

When a DC voltage is applied to the motor, the current flows through the armature coil. The interaction between the magnetic field created by the permanent magnets and the magnetic field generated by the current in the armature coil causes a force that creates rotational motion. The brushes and commutator ensure that the direction of the current in the armature coil changes at the right time, allowing the motor to continue rotating.

2.14.3 APPLICATIONS

DC 6V mini motors have a wide range of applications due to their small size and versatile performance. Some common applications include:

- Toys and Hobby Projects: Mini motors are commonly used in toys, remote-controlled cars, model trains, and other hobby projects that require small-scale motion.

- Electronics and Robotics: These motors can be used in various electronic devices, such as robots, drones, and small appliances, to provide motion and functionality.
- Automotive Accessories: Mini motors find application in automotive accessories like power windows, windshield wipers, door locks, and seat adjustments.
- Medical Devices: They can be used in small medical devices, such as portable pumps, robotic surgical tools, and laboratory equipment.
- Printers and Scanners: Mini motors are used in the paper feeding mechanism of printers and scanners to control the movement of paper and scanning elements.

2.14.4 ADVANTAGES

1. Compact Size: DC 6V mini motors are small in size, making them suitable for applications where space is limited.
2. Versatility: They can operate over a wide range of voltages, typically ranging from 1.5V to 12V, allowing flexibility in various projects.
3. Ease of Use: These motors are relatively easy to integrate into circuits and can be controlled using simple electronic components.

2.14.5 DISADVANTAGES

1. Limited Power: Due to their small size, mini motors have limited power output, making them unsuitable for heavy-duty applications that require high torque.
2. Wear and Tear: The brushes and commutator in the motor can wear out over time, requiring periodic maintenance or replacement.
3. Voltage Sensitivity: Mini motors are sensitive to voltage fluctuations, and excessive voltage can lead to overheating and damage.

Overall, DC 6V mini motors are widely used for small-scale motion control in a variety of applications. Their compact size, versatility, and ease of use make them popular choices in the electronics, robotics, automotive, and toy industries. However, their limited power output and sensitivity to voltage fluctuations should be considered when selecting and using them in specific projects.

CHAPTER - 3

3.1 WORK PLAN

The work plan to complete the proposed project work is detailed below:

Week 1 and 2: Design of auto cut-off power circuit for vehicle headlights

Week 3 & 4: Design and development of Theft identification/Alert System

Week 5 & 6: Design of emergency vehicle lighting unit under headlight failure condition.

Week 7: Assembling of all units verification of system performance

Week 8, 9 & 10: Project report preparation

3.2 PROGRAMMING THE ARDUINO

1. Install the necessary libraries: You'll need the Wire library for I2C communication, the Adafruit_INA219 library for interfacing with the INA219 sensor, the LiquidCrystal_I2C library for controlling the LCD display, and the SoftwareSerial library for communication with Bluetooth.

2. Define pin assignments: Assign pin numbers for various components such as the headlight supplies (HL1 and HL2), beam toggles (B1 and B2), engine pin (Engine), control switches (LB_SW, HB_SW, HL_SW, and Battery_Drain_SW), key pins for ON and Ignition states (on_key and ign_key), motor pin (motor), and the buzzer pin (BUZZER).

3. Initialize variables: Declare variables to store data related to the headlight, system state, menu, motor control, etc.

4. Setup function: In the setup function, perform the following tasks:

- Initialize serial communication at a baud rate of 9600.

- Configure pin modes for input and output pins.

- Initialize digital outputs for headlight supplies and beam toggles.

- Configure input pull-up resistors for control switches.

- Initialize the LCD display and clear it.

- Check if the INA219 sensor is connected and functioning properly.

5. Loop function: In the loop function, implement the main logic for your project. Here's a breakdown of the main sections:

- Read sensor data: Use the Adafruit_INA219 library to read voltage, current, and power data from the INA219 sensor.

- Check for incoming data: Check if there is any data available from the serial monitor or the Bluetooth module. If data is available, read and process it.

- Check system state: Monitor the ON and Ignition key pins to determine the current state of the system. Update the state variables accordingly.

- Handle system states: Based on the system state, perform the necessary actions. For example:

- When the system is turned ON (on_key is LOW), update the state variables and display a message on the LCD.

- When the Ignition key is LOW and the Engine pin is LOW, start the motor. You can control the motor using a motor driver module or by directly connecting it to an external power supply through a transistor.

- When the Ignition key is LOW and the Engine pin is HIGH, display a theft detected message on the LCD and activate the buzzer.

- Display information on the LCD: Depending on the menu variable, display relevant information such as voltage, current, power, etc., on the LCD.

- Handle various switches and controls: Monitor the state of control switches (LB_SW, HB_SW, HL_SW, and Battery_Drain_SW) to control the headlight supplies, beam toggles, and handle battery drain detection.

- Implement power-saving mode: If the headlight is ON but the system is idle for a certain period (count variable), turn off the headlight to conserve power.

6. Delay and repeat: Add appropriate delay periods in the loop to control the frequency of sensor readings, display updates, and other actions. The loop function will repeat indefinitely, continuously checking and updating the system state and performing the necessary actions.

7. Make the appropriate connection: According to the defined pin schematic in the arduino program connect the wires to the circuit components using circuit accessories such as heat seal, hot glue, wires, etc.

8. Testing the kit: Once the appropriate connections are made with the arduino, test all the functions and conditions of the kit. If there seems to be any error or malfunctions correct it accordingly in the arduino IDE.

3.3 DRILLING

Drilling is a common woodworking process used to create holes in a variety of materials, including plywood. Plywood is a type of engineered wood made up of thin layers of wood veneer that are glued together to form a sheet.

The drilling process for plywood involves the use of a drill bit to cut through the layers of wood veneer. To ensure the best results and prevent damage to the plywood, there are several necessary precautions to be taken:

1. Choose the right drill bit
2. Clamp the plywood
3. Mark the hole location
4. Drill slowly and steadily
5. Use a backer board
6. Wear protective gear

3.4 SOLDERING

Soldering is the process of joining two or more pieces of metal together by melting and flowing a filler metal (known as solder) into the joint. Soldering is widely used in electronics, plumbing, and metalworking, among other industries. A soldering iron is the primary tool used in this process.

3.4.1 WORKING

The soldering process involves heating the two pieces of metal that are to be joined with a soldering iron, and then applying a small amount of solder to the joint. The solder melts and flows into the joint, forming a strong and permanent bond. The key to successful soldering is getting the metal hot enough to melt the solder, without overheating it and causing damage.

3.5 WIRE MANAGEMENT

Wire management refers to the proper organisation and routing of wires and cables within a project kit. It involves arranging wires in a way that minimises the risk of damage, prevents interference, and improves the overall appearance of the project. Proper wire management is necessary for several reasons:

Safety: Unmanaged wires can pose a safety hazard by increasing the risk of electric shock, short circuits, or fires.

Functionality: Organised wiring makes it easier to troubleshoot and repair a project if something goes wrong. It also reduces the risk of misconnections and improves the overall functionality of the project.

Durability: Properly managed wires are less likely to become damaged or break over time, which can extend the life of the project.

Aesthetics: A well-managed project with neatly organised wires looks more professional and visually appealing.

To ensure proper wire management in a project kit, some essential precautions should be taken:

1. Plan ahead
2. Label wires
3. Use cable ties
4. Use proper tools
5. Avoid sharp edges

CHAPTER - 4

RESULT AND DISCUSSION

The implementation of the Safety Assurance System project has successfully enhanced the safety features of automobiles by addressing common issues that may arise during everyday vehicle operation. The system incorporates various safety features such as a battery drainage preventive system, headlight failure detection, emergency headlight activation, and theft identification and alert system.

The battery drainage preventive system effectively detects instances of battery drain and alerts the driver, reducing the risk of unexpected vehicle breakdowns. The system monitors the battery drain switch and notifies the driver through the LCD display and Bluetooth communication.

The headlight failure detection feature ensures that the headlights are functioning properly at all times. It detects headlight switch positions and sends alerts if any failure is detected. The LCD display provides real-time status updates, allowing the driver to take necessary actions promptly.

In emergency situations where the primary headlights fail, the system activates the emergency headlight mode. This mode automatically switches on the secondary headlights to ensure visibility and safety on the road. The driver is notified through the LCD display and Bluetooth communication about the activation of the emergency headlight mode.

Furthermore, the theft identification and alert system provide an additional layer of security. If unauthorized access is detected or the engine is turned off without proper ignition, the system triggers an alarm and sends theft alerts to the driver. The alarm is accompanied by the activation of a buzzer and notifications on the LCD display.

The implemented Arduino-based relay systems and isolated terminals ensure reliable and efficient operation of the Safety Assurance System. The integration of the Adafruit INA219 module enables accurate monitoring of battery voltage, current, and power consumption, providing valuable insights into the vehicle's electrical system.

Overall, the Safety Assurance System demonstrates the potential of incorporating advanced technologies into automotive safety systems. The Arduino platform, along with additional modules and sensors, offers flexibility and scalability for future enhancements and customization based on specific vehicle requirements.

Further improvements could include integration with GPS technology for real-time tracking and remote monitoring capabilities. Additionally, implementing a user-friendly mobile application could provide drivers with convenient access to system status, alerts, and control functions.

The Safety Assurance System project serves as a valuable contribution to enhancing automotive safety, promoting accident prevention, and providing peace of mind for drivers and passengers alike.

CHAPTER - 5

SOURCE CODE

```
#include <Wire.h>
#include <Adafruit_INA219.h>
Adafruit_INA219 ina219;

#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);

#define HL1 5      //Head Light Supply 1
#define HL2 7      //Head Light Supply 2
#define B1 4       //Beam toggle for Head light 1
#define B2 6       //Beam toggle for Head light 2
#define Engine A3  //Engine pin Always LOW

#define LB_SW A0            // Low Beam Control Switch
#define HB_SW A1            // High Beam Control Switch
#define HL_SW A2            //Head light Switch
#define Battery_Drain_SW 11  //Battery drain switch

#define on_key 9    //key pin for ON state
#define ign_key 10  //Key pin for Ignition state

#define MOTOR 2
#define BUZZER 13 //key pin for buzzer

#include <SoftwareSerial.h>
SoftwareSerial BTserial(0, 1); // RX, TX
String BT_input;
bool vehicleOnSent = false;
bool VIP = false;
bool BATTERYDRAINOFF = false;
```

```
bool MON = false;

float shuntvoltage = 0, busvoltage = 0, current = 0, loadvoltage = 0, power = 0;
int Head_Light, on, menu, start;
int HL_state, count, HL_disp;

void setup() {
  // put your setup code here, to run once:

  Serial.begin(9600);
  BTserial.begin(9600);

  pinMode(MOTOR, OUTPUT);

  pinMode(HL1, OUTPUT);
  pinMode(HL2, OUTPUT);
  pinMode(B1, OUTPUT);
  pinMode(B2, OUTPUT);

  digitalWrite(Engine, 0);

  digitalWrite(HL1, 1);
  digitalWrite(HL2, 1);
  digitalWrite(B1, 1);
  digitalWrite(B2, 1);


  pinMode(LB_SW, INPUT_PULLUP);
  pinMode(HB_SW, INPUT_PULLUP);
  pinMode(HL_SW, INPUT_PULLUP);
  pinMode(Battery_Drain_SW, INPUT_PULLUP);
  pinMode(Engine, INPUT_PULLUP);

  pinMode(on_key, INPUT_PULLUP);
```

```
  pinMode(ign_key, INPUT_PULLUP);



  lcd.begin();
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("SAFETY ASSURANCE");
  lcd.setCursor(0, 1);
  lcd.print("     SYSTEM     ");
  Serial.println("SAFETY ASSURANCE SYSTEM");
  delay(2000);
  lcd.clear();

  if (!ina219.begin()) {
    Serial.println("Failed to find INA219 chip");
    while (1) { delay(10); }
  }
  delay(200);
}

void loop() {
  // put your main code here, to run repeatedly:
  busvoltage = ina219.getBusVoltage_V();
  current = ina219.getCurrent_mA() * 0.001;
  power = ina219.getPower_mW() * 0.001;

  // send from serial monitor to the Bluetooth device connected the HC05.
  if (Serial.available()) {
      BT_input = Serial.readString();   // read input string from bluetooth
      BTserial.write(Serial.read());
  }

  // print incoming data from the Bluetooth device connected the HC05
  // to the serial monitor
```

```
 if (BTserial.available()) {
    Serial.print(char(BTserial.read()));
}


 if (digitalRead(on_key) == LOW) {
  on = 1;
 } else {
  on = 0;
  menu = 0;
  start = 0;
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Put Key to ");
  lcd.setCursor(0, 1);
  lcd.print("START ... ");
  delay(50);
 }

 if (on == 1 and start == 0) {
  menu = 1;
 }

 if (digitalRead(ign_key) == LOW and digitalRead(Engine) == LOW) {
  start = 1;
  count = 0;
  menu = 2;
  HL_state = 0;
  delay(50);
 }
 if (digitalRead(ign_key) == LOW and digitalRead(Engine) == LOW && !MON) {
  digitalWrite(MOTOR, HIGH); // Turn on the motor
  delay(8000);
  digitalWrite(MOTOR, LOW);
```

```
  MON = true;
}
if (digitalRead(ign_key) == LOW and digitalRead(Engine) == HIGH) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Theft detected");
  Serial.println(BT_input);
  Serial.println("THEFT DETECTED");
  lcd.setCursor(0, 1);
  lcd.print("Engine OFF");
  digitalWrite(BUZZER, HIGH); // Turn on the buzzer
  delay(5000);
  digitalWrite(BUZZER, LOW); // Turn off the buzzer
  lcd.clear();
}

if (menu == 1) {
  lcd.setCursor(0, 0);
  lcd.print("   VEHICLE ON   ");
  lcd.setCursor(0, 1);
  lcd.print("                ");
  delay(100);
}

if (menu == 1 && !vehicleOnSent) {
  Serial.println(BT_input);
  Serial.println("VEHICLE ON");
  vehicleOnSent = true;
}

if (menu == 2) {
  lcd.setCursor(0, 0);
  lcd.print("V:       I:     ");
  lcd.setCursor(0, 1);
```

```
  lcd.print("Power:          ");

  lcd.setCursor(2, 0);
  lcd.print(busvoltage, 1);
  lcd.print(" V");
  lcd.setCursor(11, 0);
  lcd.print(current, 1);
  lcd.print(" A");

  lcd.setCursor(6, 1);
  lcd.print(power, 1);
  lcd.print(" W");
  delay(150);
}

if (menu == 2 && !VIP) {
  Serial.println(BT_input);

  Serial.print("V:       I:     ");
  Serial.print("Power:          ");

  Serial.print(busvoltage, 1);
  Serial.print(" V");
  Serial.print(current, 1);
  Serial.print(" A");

  Serial.print(power, 1);
  Serial.print(" W");
  VIP = true;
}

//-----------------For Battery Drain

if (digitalRead(Battery_Drain_SW) == LOW and on == 1) {
```

```
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Battery Drain");
  lcd.setCursor(0, 1);
  lcd.print("Detected");
  Serial.println(BT_input);
  Serial.println("BATTERY DRAINAGE DETECTED");
  delay(2000);
  lcd.clear();
 }

//--------------------For HeadLight Supply On/off switch

if (digitalRead(HL_SW) == LOW) {
  Head_Light = 1;
  HL_disp = 1;
  if (HL_state == 0) {
    HL_state = 1;
    digitalWrite(HL1, LOW);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Head Light - 1");
    lcd.setCursor(0, 1);
    lcd.print("ON");
    Serial.println(BT_input);
    Serial.println("PRIMARY HEADLIGHT - ON");
    delay(2000);
    power = ina219.getPower_mW() * 0.001;
    delay(100);
    lcd.clear();
  }
  if (HL_state == 1 and power <= 2.5) {
    HL_state = 2;
    lcd.clear();
```

```
    lcd.setCursor(0, 0);
    lcd.print("Head Light - 2");
    lcd.setCursor(0, 1);
    lcd.print("ON");
    Serial.println(BT_input);
    Serial.println("EMERGENCY HEADLIGHT - ON");
    delay(2000);
    lcd.clear();
    digitalWrite(HL2, LOW);
    digitalWrite(HL1, HIGH);
   }
 }
 if (digitalRead(HL_SW) == HIGH and Head_Light == 1) {
   Head_Light = 0;
   HL_state = 0;
   count = 0;

   digitalWrite(HL1, HIGH);
   digitalWrite(HL2, HIGH);

   if (HL_disp == 1) {
    HL_disp = 0;
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Head Light");
    lcd.setCursor(0, 1);
    lcd.print("OFF");
    Serial.println(BT_input);
    Serial.println("HEADLIGHT - OFF");
    delay(2000);
    lcd.clear();
   }
 }
```

```
//--------------------For Low Beam , High Beam Control

if (digitalRead(LB_SW) == LOW and Head_Light == 1) {
  digitalWrite(B1, HIGH);
  digitalWrite(B2, HIGH);
} else if (digitalRead(HB_SW) == LOW and Head_Light == 1) {
  digitalWrite(B1, LOW);
  digitalWrite(B2, LOW);
} else {
  digitalWrite(B1, HIGH);
  digitalWrite(B2, HIGH);
}

//--------------------For Head Light Power Efficient Mode

if (Head_Light == 1 and on == 0 and start == 0) {
  count++;

  if (count >= 30) {
    digitalWrite(HL1, HIGH);
    digitalWrite(HL2, HIGH);

    if (HL_disp == 1 && !BATTERYDRAINOFF) {
      HL_disp = 0;
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Head Light");
      lcd.setCursor(0, 1);
      lcd.print("OFF");
      Serial.println(BT_input);
      Serial.println("HEADLIGHT - OFF");
      BATTERYDRAINOFF = true;
      delay(2000);
      lcd.clear();
```

```
      }

    }
  }
  delay(350);
}
```

CHAPTER - 6

ADVANTAGES AND APPLICATIONS

6.1 ADVANTAGES OF THE PROJECT

1.Enhanced Safety: The project provides enhanced safety features for vehicles, including automatic headlight control, battery drain detection, and theft detection. These features contribute to a safer driving experience and reduce the risk of accidents and theft.

2.Real-time Monitoring: The integration of the INA219 module allows for real-time monitoring of voltage, current, and power consumption. This provides users with valuable insights into the health and performance of the vehicle's electrical system.

3.Customizability: The Arduino platform used in the project offers a high level of customizability, allowing users to adapt and modify the system according to their specific requirements. Additional sensors and functionalities can be easily integrated, making it a versatile solution.

4.Mobile Control and Monitoring: The inclusion of a Bluetooth module enables users to control and monitor the system using a mobile device. This provides convenience and flexibility in managing the vehicle's safety and security features.

6.2 APPLICATIONS OF THE PROJECT

1.Automotive Industry: The project finds application in the automotive industry, where safety and security features are of utmost importance. The system can be integrated into vehicles to enhance their safety capabilities and provide additional security measures.

2.DIY Vehicle Projects: Enthusiasts involved in do-it-yourself (DIY) vehicle projects can benefit from this project. It provides a foundation for building customised safety and security systems for their vehicles, incorporating features such as automatic headlight control and theft detection.

3.Research and Development: The project serves as a valuable resource for researchers and developers working on vehicle safety and security systems. It showcases the capabilities of Arduino-based solutions and can be used as a reference for further advancements in the field.

4.Education and Learning: The project can be utilized as an educational tool to introduce students and enthusiasts to the concepts of embedded systems, sensor integration, and Arduino programming. It offers hands-on experience in building a practical project with real-world applications.

5.Fleet Management: The project's features can be applied in fleet management systems to monitor and control the safety and security aspects of a fleet of vehicles. This can help improve overall operational efficiency and ensure the well-being of drivers and assets.

6.3 FUTURE SCOPE OF THE PROJECT

1.Enhanced Safety Features: The current project focuses on basic safety features such as battery monitoring and headlight control. In the future, additional safety features can be incorporated, such as integrating sensors for detecting obstacles, implementing an anti-lock braking system (ABS), or integrating a GPS-based theft tracking system.

2.Smart Connectivity: Explore the possibility of adding smart connectivity features to the project. This could involve integrating wireless communication modules like Bluetooth or Wi-Fi, allowing the user to remotely monitor the vehicle's status, receive notifications, or control certain functions through a mobile application or web interface.

3.Data Logging and Analysis: Implement a data logging mechanism to collect and analyze various parameters such as battery voltage, current, and motor performance over time. This data can provide valuable insights into the vehicle's operation, energy efficiency, and potential areas for improvement.

4.User Interface Enhancements: Improve the user interface by incorporating a graphical display or touchscreen interface. This would enable a more intuitive and user-friendly interaction, providing real-time information about the vehicle's status, battery levels, and other important metrics.

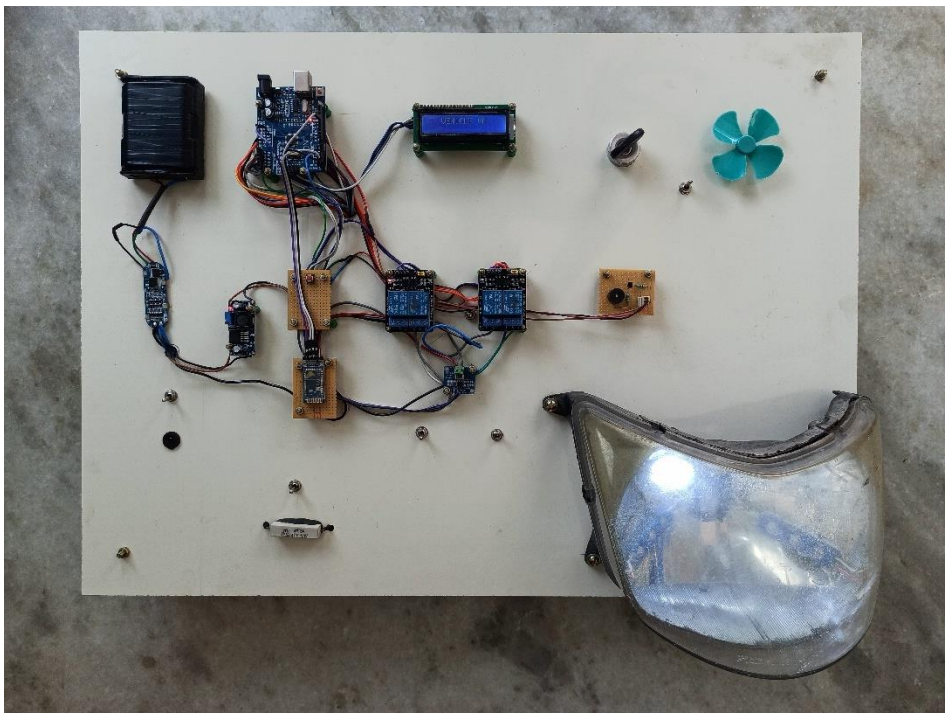
5.Power Management Optimization: Focus on optimizing power management to maximize the vehicle's efficiency and battery life. This can involve incorporating energy recovery systems, regenerative braking, or intelligent power management algorithms to optimize the use of electrical power.

6.Expandability and Customizability: Design the project with expandability and customizability in mind. Allow users to add or modify features according to their specific requirements, such as integrating additional sensors, implementing different control mechanisms, or supporting different types of vehicles.

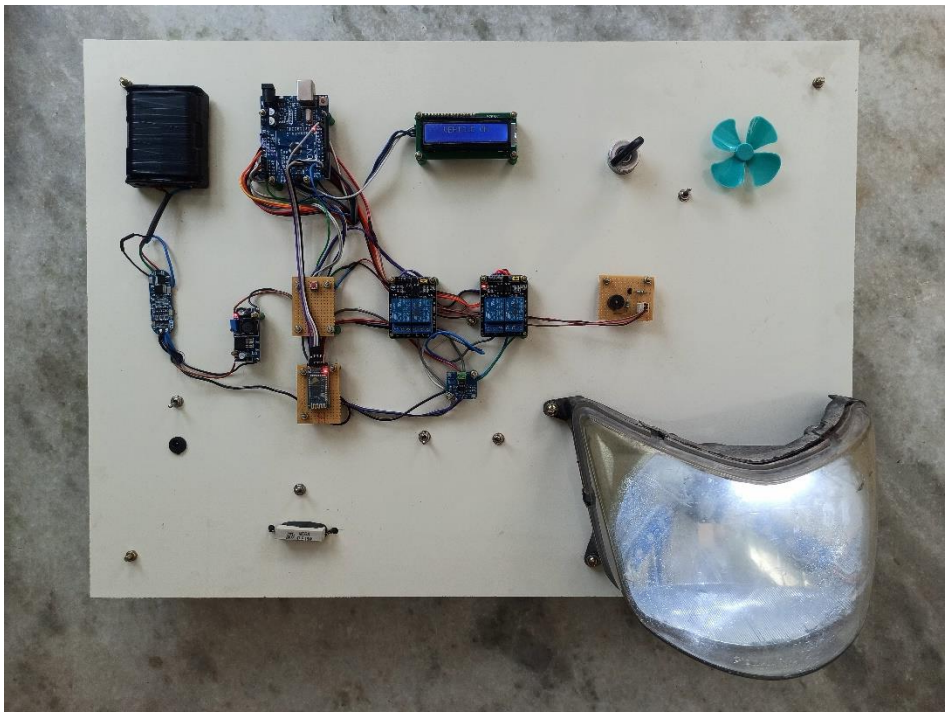
7.Integration with IoT and Cloud Services: Explore the integration of Internet of Things (IoT) technology and cloud services. This could enable advanced functionalities such as remote vehicle monitoring, over-the-air updates, predictive maintenance, and integration with smart home systems or third-party services.

CHAPTER - 7

SCREEN SHOT

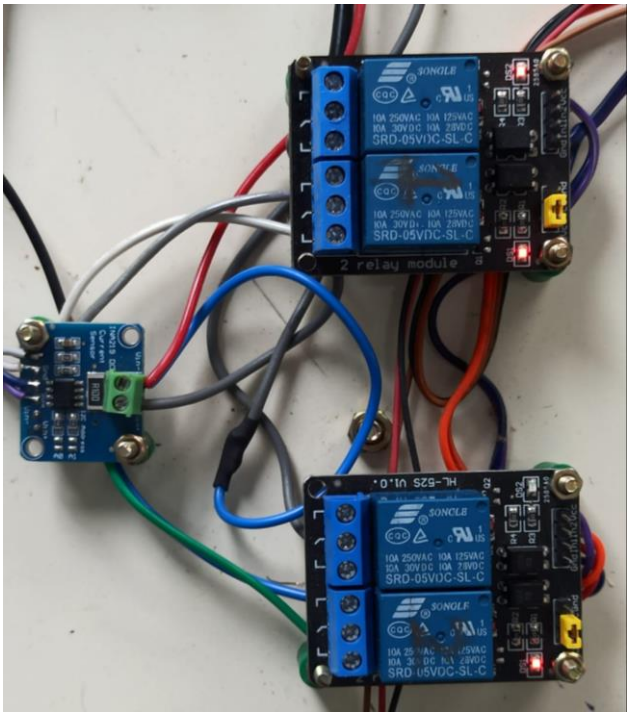


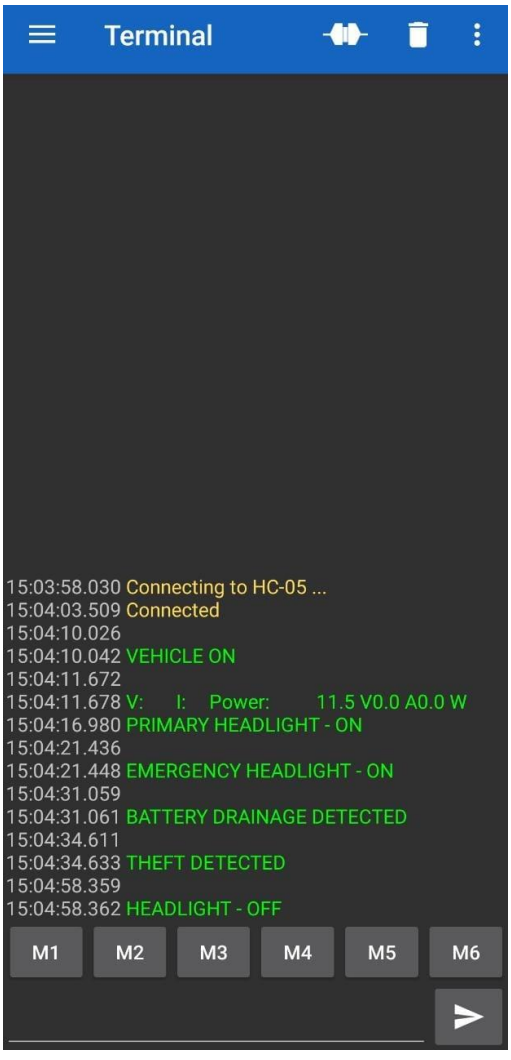

Head Light - 2
ON




V:11.3 V I:0.0 A
Power:0.0 W


Theft detected
Engine OFF


SONGLE
SRD-05VDC-SL-C
2 relay module


Terminal
15:03:58.030 Connecting to HC-05 ...
15:04:03.509 Connected
15:04:10.026
15:04:10.042 VEHICLE ON
15:04:11.672
15:04:11.678 V: I: Power: 11.5 V0.0 A0.0 W
15:04:16.980 PRIMARY HEADLIGHT - ON
15:04:21.436
15:04:21.448 EMERGENCY HEADLIGHT - ON
15:04:31.059
15:04:31.061 BATTERY DRAINAGE DETECTED
15:04:34.611
15:04:34.633 THEFT DETECTED
15:04:58.359
15:04:58.362 HEADLIGHT - OFF
M1
M2
M3
M4
M5
M6

CHAPTER - 8

CONCLUSION

In conclusion, the implementation of the Arduino-based vehicle safety and security system has been successfully achieved. The system integrates various components and functionalities to enhance the overall safety and security of the vehicle. Through the use of sensors, the system is capable of detecting and alerting the user about potential risks such as battery drain, unauthorised engine ignition, and theft.

The inclusion of a Bluetooth module enables convenient monitoring of the system via a mobile device. The system effectively controls the vehicle's headlight functionality, allowing for the automatic switching between low and high beams and providing power-efficient modes. This enhances visibility and contributes to safer driving conditions.

The integration of an INA219 module provides real-time monitoring of voltage, current and power consumption, allowing users to monitor the electrical system's health and take appropriate actions if necessary.

Throughout the project, the Arduino platform proved to be highly versatile and customizable, allowing for seamless integration of various components and sensors.

Overall, the developed vehicle safety and security system demonstrates the potential of Arduino-based solutions in enhancing the safety and security features of vehicles. The system offers reliable and effective functionality, contributing to a safer and more secure driving experience.

Further improvements and enhancements can be explored, such as integrating additional sensors or implementing advanced algorithms for more sophisticated risk detection and prevention. The project serves as a foundation for future developments in the field of vehicle safety and security systems, with potential applications in the automotive industry and beyond.

CHAPTER – 9

REFERENCES

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6. "Arduino-Based Vehicle Accident Detection and Tracking System" by R. Kumar, A. Kumar, and M. S. Saini | Web Site: https://ieeexplore.ieee.org/document/8685113
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