ABSTRACT

The monitoring of electric vehicle (EV) batteries uses Internet of Things (IoT) technology which is proposed in this article. EVs rely on batteries as their energy source, but the amount of energy they receive decreases over time, leading to performance degradation, which is a major concern for battery production. The proposed IoT-based battery monitoring system includes an ESP 32 LCD and a voltage sensor, making monitoring possible in real time. With fuel prices on the rise, many vehicle manufacturers are seeking alternative fuel sources, including electrical ones that can reduce pollution and save energy. EVs typically use lithium-ion batteries, which are smaller and have a longer lifespan compared to lead-acid batteries. However, the limited range of EVs due to battery size and body structure, as well as safety concerns regarding current battery technology, remain major obstacles to their wider adoption.

The following project details the use of Internet-of-Things (IoT) technology for monitoring the efficiency of batteries in electric vehicles. As electric vehicles rely on batteries for power, the gradual decrease in energy supplied to the vehicle leads to reduced performance, which is a significant concern for battery manufacturers. To address this issue, this project suggests utilizing IoT techniques to monitor the vehicle's performance directly. The proposed monitoring system comprises ow primary components: a monitoring device and the user interface. Through experimentation, the system demonstrates the ability to identify and notify the user of degraded battery performance, prompting further action.

CHAPTER-1

INTRODUCTION

Nowadays, electric vehicles (EVs) are gaining popularity due to the rising cost of fuel. This has prompted many vehicle manufacturers to seek alternative energy sources to gasoline. The use of electric energy can have a positive impact on the environment as it produces less pollution. Furthermore, EVs offer significant benefits in terms of energy conservation and environmental protection. Rechargeable lithium-ion batteries are commonly used in most EVs due to their smaller size compared to lead-acid batteries, constant power, and longer lifespan of 6 to 10 times that of lead-acid batteries. However, the life cycle of lithium-ion batteries can be reduced by factors such as overcharging and deep discharges. One limitation of EVs is their limited range of travel due to battery size and body structure. Additionally, safety concerns related to existing battery technology are hindering the wider application of EVs. Overcharging a battery not only shortens its lifespan but also poses serious safety risks, such as fire. Therefore, a battery monitoring system that can notify users about the battery's condition is essential to prevent these problems. Previously proposed monitoring systems had been able to detect only the condition of the battery and alert the user through an indicator within the vehicle.

Nowadays, As fuel costs continue to rise, electric vehicles (EVs) are becoming increasingly popular. This has prompted various vehicle manufacturers to seek alternative fuel sources to gasoline. The use of electric fuel sources can benefit the environment by reducing pollution, and EVs offer significant advantages in terms of energy efficiency and environmental protection. Most EVs use lithium-ion batteries, which are safer and have a longer life cycle than lead-acid batteries. However, there are limitations to the range of EVs due to battery size and body structure, and the security of existing battery technology remains a major concern. To address this, a proposed system includes a voltage sensor to measure the voltage level of the battery, which is then processed by an esp32 microcontroller and sent to a battery monitoring UI on a computer via the cloud. The system also sends a notification email when the battery voltage level is low. The system not only measures battery voltage but also communicates with the battery monitoring structure to obtain battery capacity information. The system's detailed design is described in the following sections.

With advancements in notification system designs, the Internet of Things (IoT) technology can now be utilized to alert both manufacturers and users about battery statuses. This approach can be considered as a maintenance support measure that can be implemented by manufacturers. IoT technology allows for internet connectivity beyond traditional applications, which means that a wide range of devices and everyday objects can be connected to the internet, enabling easy access for users. This paper proposes the design and development of a battery monitoring system that uses IoT technology, as a solution to the problems. The project is organized into Sections where section 2 reviews the various wireless communication and battery monitoring systems for industries and EVs, section 3 presents the system design and implementation, section 4 describes the different tests that were performed, section 5 discusses the serious issues encountered, and section 6 provides the conclusions of the work.

IoT for EV Battery Monitoring

The Internet of Things (IoT) is the interconnection of daily use items via wireless networks using electronic identifiers, sensors, and two-dimensional codes. IoT allows for communication between humans and machines or machines and machines. It has three key features: considerable, intelligent, and internet connective. The International Telecommunication Union (ITU) proposed the concept in 2005, citing examples such as cars alerting drivers of errors and suitcases reminding owners of forgotten items. IoT-integrated Smart Grid has many benefits, including improved energy efficiency, reduced ecological impact, and increased reliability of electric supply. The integration of Smart Grid tools in utility networks will bring about significant transformation in grid management and electric power use. Energy storage devices are crucial for regulating load and balancing expenditure and production. This project proposes a wireless lightweight communication protocol based on the battery monitoring system in EVs that aims at prolonging the battery life. To reduce the impact of uncontrolled charging of EVs on the grid, an optimization model is formulated to maximize the EV aggregator's revenue.

Electric vehicle batteries are commonly used for energy storage and have played a significant role in the growth of the transportation industry. As the use of electric vehicles increases, the need for electric vehicle charging systems in parking and grid systems also grows. The Kyoto Treaty was signed to reduce CO2 emissions, which led to the discovery of new clean energy solutions, including electric vehicles. To reduce CO2 emissions, major automobile manufacturers are working on electric vehicles, and some are even producing vehicle-to-grid (V2G) projects. Previously the battery monitoring systems only alert the users about the battery's condition through the indicator which is present inside the vehicle. With the advancement of notification systems, IoT technology can now notify both the manufacturer and users of the battery's status. Cloud storage is used for data storage, and IoT technology creates a smart grid that amplifies connectivity with the help of infrastructures. This project focuses on the integration of IoT in V2G and G2V architecture.

The popularity of electric vehicles (EVs) is on the rise due to increasing fuel prices, which has led to vehicle manufacturers exploring alternative energy sources to gasoline. The use of electric energy sources can have a positive impact on the environment by reducing pollution, and EVs offer advantages in terms of energy-saving and environmental protection. Lithium-ion batteries, which have a longer life cycle than lead-acid batteries and are smaller in size, are commonly used in EVs. However, overcharging or deep discharges can shorten their lifespan. EVs also have a limited range due to the size of the battery and the body structure of the vehicle. Safety concerns with existing battery technology remain a significant limitation to the widespread use of EVs. To address this issue, a battery monitoring system that uses the Internet of Things (IoT) technology to notify the manufacturer and users of the battery's status is proposed. This is an improvement over previous battery monitoring systems, which only alerted the user via the battery indicator inside the vehicle. Section 2 reviews the various wireless communication technologies and battery monitoring systems for industries, while Section 3 presents the design and implementation of the system. The paper concludes by discussing the major issues faced and offering conclusions about the work.

Electric cars are gaining increasing influence in the field of transportation, as they do not produce polluting emissions. Consequently, the world is looking to electrify the transportation sector. With rising fuel prices, battery-powered vehicles are becoming more popular, and vehicle manufacturers are exploring alternative energy sources to gasoline. The use of electrical energy sources could potentially enhance environmental protection. Lithium-ion batteries are commonly used in rechargeable batteries for most electric vehicles.

The lithium-ion battery is smaller compared to a lead acid battery, but its lifespan can be reduced by overcharging and deep discharge. Electric vehicles have limited range due to their battery size and body structure, and safety concerns around existing battery technology are a significant limitation to their wider use. EV buyers often cite limited battery capacity and lack of charging infrastructure as concerns, leading to reluctance to drive long distances in battery-powered vehicles. These issues are important in terms of the cost of both the battery and the vehicle. Although new battery technologies are being developed for electric vehicles, various concerns continue to limit their use. One proposed solution is to develop an IoT-based battery monitoring system that displays important parameters such as battery voltage, temperature, and remaining charge on a mobile phone. This requires gathering a lot of sensory data and analyzing it at different levels. The aim is to promote green power and improve the intelligence of battery-powered vehicles. IoT technology can help connect a diverse range of devices and everyday objects via the internet, providing greater control and convenience to users. This project proposes to address the above issues by designing and developing an IoT-based battery monitoring system for electric vehicles.

1.3 GENERALINFORMATION

The modern way of life is centered around automation, and any process that is automated is often considered cutting-edge because it minimizes human intervention. Unfortunately, accidents caused by short circuits can make it dangerous for individuals to enter the affected area and prevent further damage. These types of incidents are on the rise due to a lack of awareness, safety precautions, and worker ignorance. To address this issue, this project proposes an intelligent security system that utilizes wireless techniques, making it highly beneficial for a range of industrial applications.

The system is designed to monitor various environmental factors within the industry, including temperature, humidity, and gases. The core of the prototype comprises a microcontroller that is connected to multiple modules. By utilizing a simple hardware circuit, this wireless industrial security system with temperature and humidity sensors can be easily used by anyone in an industrial setting. The project's objective is to create a Wi- Fi-based monitoring system that can be paired with an Android phone to provide real-time updates and notifications.

1.4 HARDWARE SPECIFICATIONS

An embedded system is a type of electronic system that utilizes a single-chip microcomputer, such as ARM or Cortex, programmed to perform a specific task. The software required for this application is programmed into the on-chip ROM, which is not user-accessible and only solves a limited range of problems. The microcomputer is hidden or embedded within the system, accepts inputs, performs computations, generates outputs, and operates in real-time.

In industries, the server room is the central data hub that houses computing equipment responsible for generating substantial heat. Cooling systems are essential to maintain lower temperatures and ensure the safety of machinery. The data center temperature and humidity must be within acceptable ranges (15°C to 30°C and 30% to 60%, respectively).

Python programming language and microcontroller development environments are used to program microcontroller boards. These projects may either stand-alone or communicate with software running on a computer. A wide range of microprocessors and microcontrollers are employed in the design of microcontroller boards. These boards feature sets of digital and analog input and output pins that can be interfaced with various expansion boards, breadboards, and other circuits. Serial communication interfaces, including USB on some models, are available on these boards, which are also used for loading programs or personal computers.

Google created the Android mobile operating system, which is based on a modified Linux kernel and other open-source applications. For touchscreen mobile devices like smartphones and tablets, it is primarily intended. The Android software development kit (SDK) is used to write applications that extend device functionality, often using the Java programming language. Upon booting, Android devices navigate to the home screen, the primary information and navigation hub, similar to the desktop found on a PC. Users can access all installed apps from the home screen list by dragging an app. Android has undergone several updates that have incrementally improved the operating system by adding new features and fixing bugs.

1.5 OBJECTIVE

The proposed system aims to utilize Internet of Things (IoT) technology to monitor the performance of electric vehicle batteries, which are critical to the operation of electric vehicles. Over time, the energy supply to the battery decreases, leading to a decline in vehicle performance. This degradation is a significant concern for battery manufacturers. Our system proposes the use of IoT techniques to monitor the performance of the battery in real-time, providing direct and accurate feedback. By calculating the battery's voltage, current, and remaining charge capacity, our system can detect degraded battery performance and send notification messages to the user, prompting further action.

We have developed a data acquisition system to monitor these battery parameters in real-time, utilizing a PIC-based system. Additionally, the data are displayed on an Android mobile device and stored in a server database. To create the final product for our proposed system, we have developed a realistic model.

CHAPTER 2
LITERATURE SURVEY

These chargers provide clean power to cars powered by electricity, which are themselves free of pollution and have certain beneficial effects on the environment. In this proposal, we envision a solar-controlled EV charging station in the parking lot of a vehicle-sharing organisation. The rental get and drop-off times for a car like this are predetermined. We propose a Direct Programming approach to handle charging EVs that increase the use of solar energy while maintaining comparable battery levels for all cars.

2.1. Technology Based on Wireless Communication is a type of data communication that is performed and delivered wirelessly. Using wireless communication technologies and devices, this general phrase refers to all processes and forms of establishing connections and exchanging information between two or more devices. As a result of earlier research, wireless battery monitoring systems have been developed that employ GSM, ZigBee, GPRS, Android, WIFI, and Bluetooth connection. A widely used kind of wireless communication is the GSM (Global System for Mobile communication). It operates in the 900MHz or 1800MHz frequency range. The GSM module has several advantages and downsides. GSM offers the benefit of not having any issues with international roaming. Additionally, it is simple to implement, and users and the carrier for the manufacturer of GSM handsets benefit from a significantly improved in-network effect. But keep in mind that the majority of the technology is protected by patents and requires a QUALCOMM Corp. licence. There is a wide range of literature on wireless communication-based battery monitoring and management. The Global Positioning System (GPS) makes use of GPS satellites to provide information to GPS receivers all around the world that includes position and time. It synchronises the process to emit these repeated signals at the same time. Due to the fact that some satellites are farther away than others, the signals, which are travelling at the speed of light, reach a GPS receiver at slightly different times. By measuring the time it takes for their signals to reach the receiver, one may calculate the distance to the GPS satellites. The receiver can determine its position in three dimensions when it determines the distance to at least four GPS satellites. The type of receiver used determines how accurately a position may be calculated using GPS. Accuracy for the majority of consumer GPS devices is around +/-10m. Differential GPS (DGPS) is a technique used by other types of receivers to achieve substantially better accuracy.

GSM/GPS technology was used to monitor and manage an EV battery. An ever-expanding range of devices, including wearable computing and in-car entertainment, may run the Android operating system, which is available for smartphones, tablets, and other mobile devices. Similar to Linux, Android is a Linux-based operating system that uses free and open-source technologies. Since it is open source and based on Linux, anyone can develop it. Your operating system may alert you to fresh notifications, SMS, emails, or even the most recent RSS reader articles. Unfortunately, in order for the device to be ready to go online to meet people's needs, there must always be an active internet connection present or at least a GPRS internet connection. Additionally, the operating system runs numerous processes in the background, wasting batteries.

Technology Using Wireless Battery Monitoring System For reasons of safety, dependable battery management is required. Battery failure can be caused by a variety of factors, including battery degradation and design flaws. Like a regular battery monitoring system, a manual battery monitoring system does not record the data in a database. But only display the data that was gathered in real-time. Therefore, it is crucial to use wireless technology to remotely monitor battery systems. Uninterruptible power supply (UPS), which is crucial to guarantee continuity of power supply for residential and commercial during power interruption, is one of the many battery monitoring systems employing wireless communication that have been created for the industry. When batteries are in critical condition and at room temperature, Suresh et al. presented a PLC-based battery health monitoring system for a UPS employing GSM modules and SCADA and provided alarm messages. A battery monitoring system for UPSs utilising GSM was also created by Sardar et al.

The battery's voltage, current, and temperature may all be monitored by the system. A battery monitoring system employing wireless communication for UPS was created by Hommalai et al. to identify dead battery cells. Several studies have also been conducted in relation to the creation of wireless communication-based battery monitoring systems for EVs. A GSM module was used by Dhotre et al. to create an autonomous battery charging and engine management system for EVs. When battery health drops below a certain level, an SMS is delivered to the user. The user can then react by SMS to cause the vehicle to start automatically and charge the battery. For electric vehicles (EVs), Mathew et al. suggested a wireless battery monitoring system employing a 2.4GHz radio transmission technique [10]. The transmit module, which keeps track of the batteries, and the controller module, which receives the condition of the batteries, make up the modular design. Additionally, Bacquet et al. created an EV battery management system that uses 2.4GHz radio transmission .

They showed that radio transmission for EV battery monitoring under challenging circumstances is feasible. A battery monitoring system based on GPRS communication was created by Luo et al. for electric vehicles (EVs). It consists of an online monitoring terminal to measure battery parameters (voltage and temperature) with a GPRS data transmitter unit and a user interface for battery monitoring [12]. Using ZigBee communication and point-to-point wireless architecture, Rahman et al. suggested a battery management system for electric vehicles (EVs) [13]. ZigBee was chosen because of its inexpensive cost, low power consumption, great reliability, and low data rates. They came to the conclusion that a wireless battery management system is crucial for electric vehicles (EVs) in order to balance the charge and prolong battery life, but it is ineffective at regulating battery temperature. A lithium-ion battery monitoring system for electric vehicles (EVs) that gathers and displays voltage, current, temperature, and other battery metrics on a smartphone was recently reported by Menghua et al. [14]. According to the previously mentioned studies, it is clear that there are no automatic monitoring methods accessible to inform the user of the battery's performance. In order to improve preventative maintenance, ensure the quality of the battery, and increase user safety, IoT technology may be integrated into the monitoring system

CHAPTER-3

SYSTEM DESCRIPTION

3.1 EXISTING SYSTEM

In 2007, Meng developed the architecture and prototype for an IoT system where every consumable device is treated as an object. In 2016, Yang created an algorithm for estimating air pollution sources using Mobile Sensor Networks. In industrial settings, workers often face hazardous situations, so monitoring and controlling the parameters that cause pollution is necessary. To address this, a wireless solution based on a GSM network was proposed for monitoring and controlling temperature and humidity in industries been conducted to monitor the pollution-causing parameters and create a smart environment in the area using various techniques and methods.

Wireless Sensor Network (WSN) plays a crucial role in Smart Environment Monitoring. In this work, the focus is mainly on making the city environment smart by deploying WSNs across the city and public and private transportation systems. Environmental behaviors are collected as a streaming database to identify environmental conditions by accessing all the dynamic global sensor networks. This methodology manages data from stationary nodes deployed in the city to mobile nodes on public and private transportation systems.

3.2 PROPOSED SYSTEM

The Internet of Things (IoT) technology offers enormous promise for enhancing and creating smart grids. The ambition to alter networks, the ageing of the current grid infrastructure, and the rise of distributed generators have all fueled interest in smart grids. As their prospective applications become more attractive, there is a rising demand for energy storage systems, especially electrical energy storage systems. Due to their superior electrical characteristics and adaptability, dynamic electrical energy storage systems like Electric Vehicles (EVs) are often employed; yet, their extensive usage has a substantial negative impact on the grid due to the potential for battery deterioration from deep draining or overcharging. To prevent battery damage, it's important to have an accurate estimation of the state of charge for EV batteries, both to increase their lifespan and to protect the equipment they power.

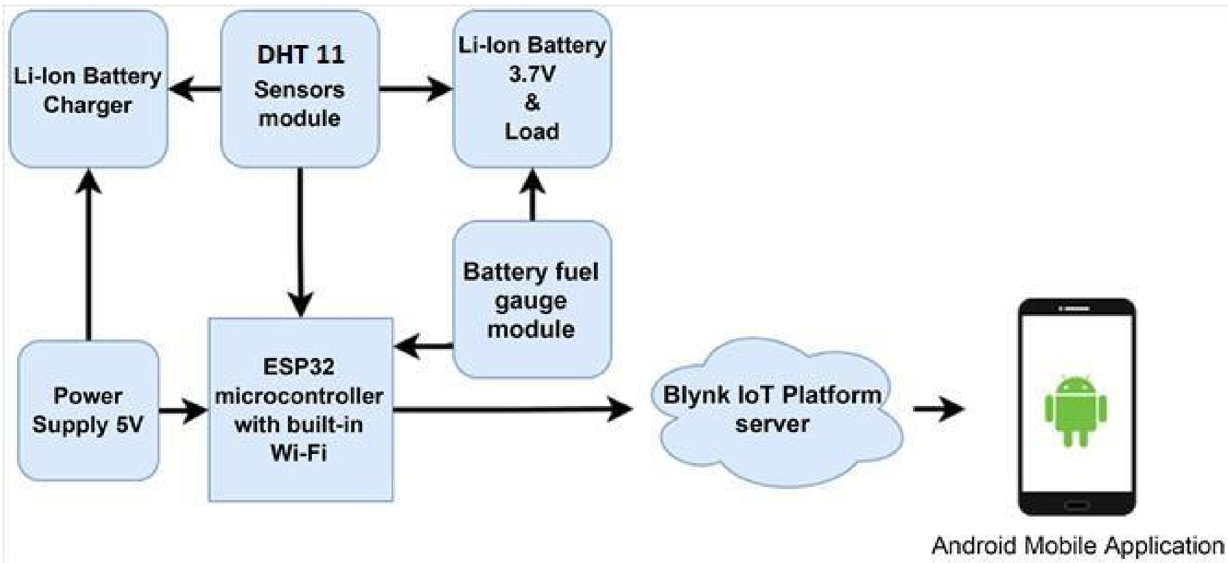


Fig 4.1 Proposed Block Diagram

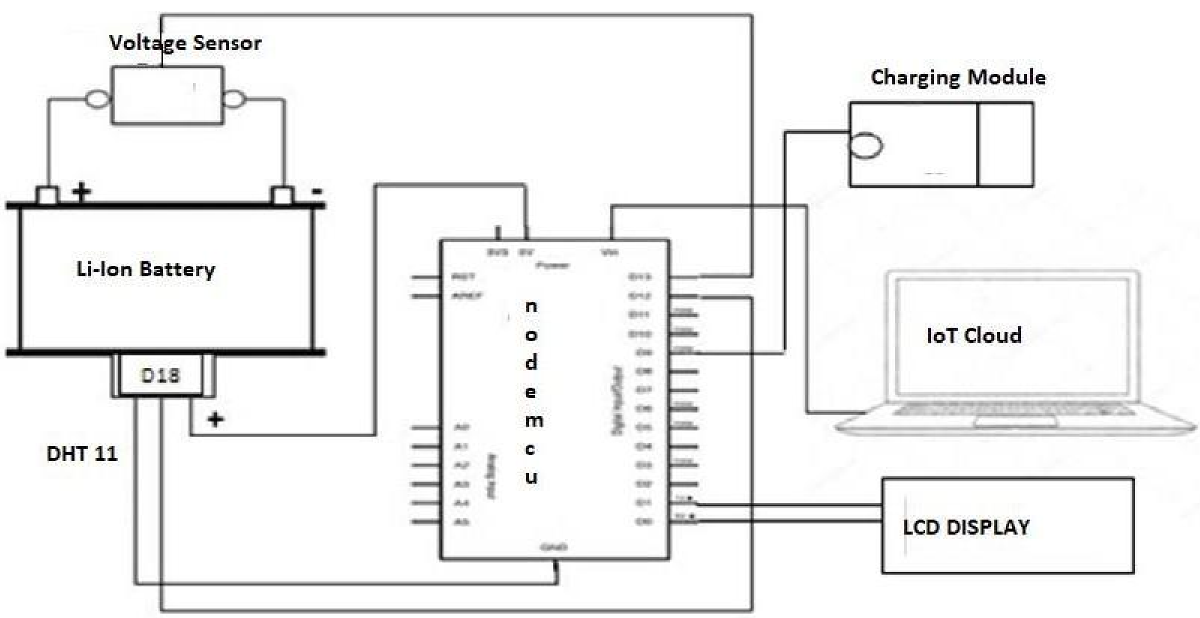


Fig 4.2 Figure Circuit Diagram

This project proposes a real-time Battery Monitoring System (BMS) using a coulomb counting method for State of Charge (SoC) estimation and messaging-based MQTT as the communication protocol. The BMS is implemented on a hardware platform using appropriate sensing technology, a central processor, interfacing devices, and the Node-RED environment. An optimization model is presented to maximize the trade revenue for Electric Vehicles (EVs) aggregators and enabling smart charging.

The main focus of this project is the application of the Internet of Things (IoT) in monitoring the performance of electric vehicle batteries. As the amount of energy supplied to the vehicle decreases gradually, performance degradation becomes a major concern for battery manufacturers. Therefore, this IoT-based battery monitoring system consists of two major parts: a monitoring device and a user interface. Based on experimental results, the system can detect degraded battery performance and send notification messages to the user for further action. This method is helpful for transportation systems and Vehicle-to-Grid (V2G) systems. By improving city planning and streamlining the V2G system with IoT, we can easily manage the whole system, which will save time and money.

This project aims to utilize IoT technology to monitor different parameters of the battery in electric vehicles. As the electric vehicle is solely dependent on the battery as its source of energy, monitoring the performance of the battery is essential. The proposed idea is to use IoT techniques for easy and direct monitoring. The main objective of this project is to promote the use of green power and enhance the efficiency of electric vehicles by monitoring important battery parameters such as voltage, temperature, current, and charge availability. Additionally, the recorded values will be displayed in the cloud, which aligns with the concept of IoT. The IoT-based battery monitoring system consists of two major parts: the monitoring device and the user interface. Based on the experimental results, the system can detect degraded battery performance and send warning messages to the user for further action. The integration of IoT will undoubtedly improve the display of EV charging and its impact. It will also contribute to city planning and simplify city life. IoT refers to the interconnectedness of everyday objects through a network-based interconnection. It is a self-setting, everything-connected system that links devices through electronic identifiers, sensors, and two-dimensional codes on items. The IoT technology enables communication between man and machine or machine to machine. The three key features of IoT are extensive, intelligent, and web-connected.

The Internet of Things (IoT) has four key features: data aggregation, bidirectional communication, management, and response control. When applied to the energy sector, IoT can enable smarter grid management, leading to improved energy efficiency, reduced environmental impact, enhanced security, lower vulnerability to external interference, and better electric supply reliability. An expanded deployment of energy storage devices in the distribution network can help achieve these benefits and improve system performance. While bulk energy storage has been traditionally used in the utility grid, the growing adoption of alternative energy sources and the increasing popularity of plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (EVs) create a need for more decentralized energy storage. This project aims to monitor the state of charge of EV batteries, with the data available through a mobile app. Additionally, the app helps users locate nearby charging stations and compare tariff rates for delivering power to or drawing power from the grid. By being informed of their car's battery status, users can make informed decisions regarding power management and optimize their energy consumption.

The power grid is equipped with bidirectional converters for transferring power, and some grids utilize solar energy as a source. The system block diagram is illustrated in Figure 1. One of the significant features of IoT is its ability to connect devices, use sensors, and small devices. IoT networks, a type of network that is not dependent on major providers, are emerging as new enabling technologies for networking [1]. IoT establishes both small and large networks between system devices, utilizing sensors to capture input, with sensors or controllers acting as the main working unit. Nowadays, controllers such as Arm Mbed and Arduino are gaining popularity in the IoT field [2,3]. Small devices, such as phones or tablets, are used to view the output or results, minimizing the effort required to obtain data.

The proposed methodology block diagram is presented in Figure 1. The proposed system comprises various sensors, including current, voltage, and temperature sensors for monitoring different battery conditions in the vehicle. The current sensor ACS712 monitors the current through the battery, while the voltage sensor provides real-time monitoring of the battery voltage. The voltage sensor is capable of monitoring up to 25V DC, while the current sensor can monitor the current of up to 5A. The temperature sensor monitors the temperature of the battery, which determines its performance. The outputs of the current, voltage, and temperature sensors are analog, and therefore we need to convert them into digital format using the inbuilt ADC of the controller, which is a 10-bit and 13-channel ADC. The microcontroller used in this system is the PIC18F4550 manufactured by Microchip Company. The information from the sensors is processed by the controller and displayed on an LCD. The information is also uploaded to the cloud via NodeMCU, which has inbuilt Wi-Fi, and accessed through an Android app. A read API key is used to read data from the cloud, while a write API key is used to write data on the cloud for monitoring purposes.

RESULTS

This study focuses on analyzing the improvement of battery performance in electric vehicles. An IoT-based battery monitoring system was designed and developed to monitor battery performance degradation online. The main objective of this project is to prove the feasibility of the idea. The system development process involved creating a battery monitoring hardware device and a web-based user interface for battery monitoring. Additional modifications can be made to enhance the system, such as incorporating GPS to detect location and displaying it on Google Maps. This feature allows the user to monitor their car battery's health, including its condition and time, through the internet. Based on the battery's health status, the car user can make an informed decision about whether to take power from the grid or sell power to it. Future work includes implementing the capability of handling multiple users, which will enable the comparison of different users' battery statuses.

Electric vehicles (EVs) have the potential to revolutionize transportation by replacing conventional vehicles. They are also more eco-friendly than traditional vehicles, as they emit fewer greenhouse gases and help combat global warming. This chapter provides an in-depth discussion of sensor-based technologies for various configurations of EVs, including sensors commonly used in automotive applications. Furthermore, this chapter reports on the emerging trend of micro-fabricated sensors developed through MEMS-based research that can be used for motion sensing, battery sensing, energy harvesting, and other applications. These miniaturized sensors can reduce costs, save space, and enhance sensing capabilities for future vehicles. To achieve a pollution-free environment, more research is needed in collaboration between laboratories and the automobile industry on EVs and their sensors.

In this context, a real-time monitoring system was proposed for Lithium-ion batteries using an onboard monitoring device connected to various sensors, as well as an Android smartphone with a web-based application that displays battery parameter values with and without load. The system can collect and display voltage, current, and temperature parameters of batteries via a phone. An actual prototype was designed and proven to be feasible. Future work will focus on precisely determining battery states through data analyses on a cloud server, which will enable remote repair and maintenance.

To showcase the gathered information, the previously mentioned architecture can be linked with mobile phones. By utilizing the Wi-Fi module, information can be transmitted to the Thingspeak platform, enabling remote regions to collect and view data. This prototype holds the potential to form a multi-battery monitoring system, as the fundamental battery parameters facilitate monitoring of the battery's status. Integrating cloud and IoT into the Battery Monitoring System can aid in data analysis. The system's functionality can be enhanced through alterations. The solution, operating on the Thingspeak platform, can be implemented on smartphones to assist users in monitoring their battery life, resulting in an efficient and user-friendly monitoring experience without any hassle of tracking it manually.

CHAPTER 4

HARDWARE DESCRIPTION

4.1 POWER SUPPLY UNIT

When working on electronic products or projects, it is often necessary to include a power supply that can convert mains AC voltage into a stable DC voltage. To create such a power supply, careful consideration must be given to the design of each component. In this discussion, I will focus on the design of a regulated 5V power supply.

Let's start with very basic things the choosing of component

Component List:

1. Step down transformer
2. Voltage regulator
3. Capacitors
4. Diodes

Voltage regulator:

As we require a 5V we need LM7805 Voltage Regulator IC.

7805 IC Rating :

- Input voltage range 7V- 35V
- Current rating $I_{c\,=}$ 1A
- Output voltage range $V_{Max=5.2V}$, $V_{Min=4.8V}$

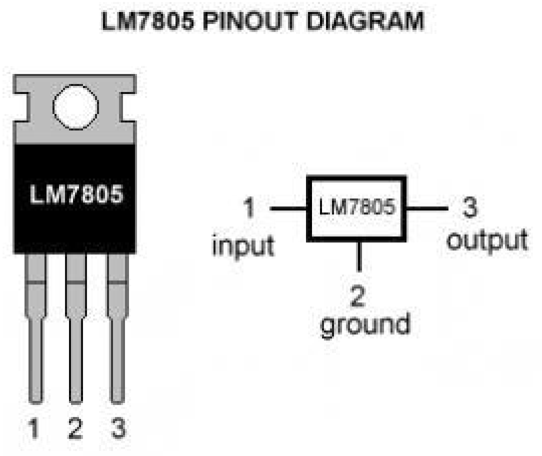


Fig 4.1 LM7805 – Pin Diagram

4.2 Operation of Regulated Power Supply

Step Down Transformer

The primary purpose of a step-down transformer is to reduce the voltage of the alternating mains to the desired voltage level. This is achieved by adjusting the turn ratio of the transformer to obtain the required voltage value. Once the voltage has been stepped down, the output of the transformer can be used as the input for the rectifier circuit

Rectification

An electrical circuit known as a rectifier uses diodes to transform alternating current or voltage into direct current Fig(4.2). A rectifier's output is a single-direction, pulsing direct current. A full-wave or bridge rectifier, which rectifies both half cycles of the alternating current source, is frequently used to produce full-wave rectification. In the diagram below, a bridge rectifier made up of four p-n junction diodes is depicted. The voltage induced across the secondary of the transformer (VMN) is positive during the positive half cycle of the supply. As a result, point E is positive in relation to point F, resulting in reverse bias in diodes D3 and D2 and forward bias in diodes D1 and D4. As seen in the first picture, the diodes D3 and D2 operate as open switches (with some voltage drop), while the diodes D1 and D4 operate as closed switches and begin to conduct, generating a rectified waveform at the rectifier output. A positive voltage appears at the filter input when the voltage generated in the secondary (VMN) is negative because this causes D3 and D2 to become forward biased and the other two diodes to become reverse biased .

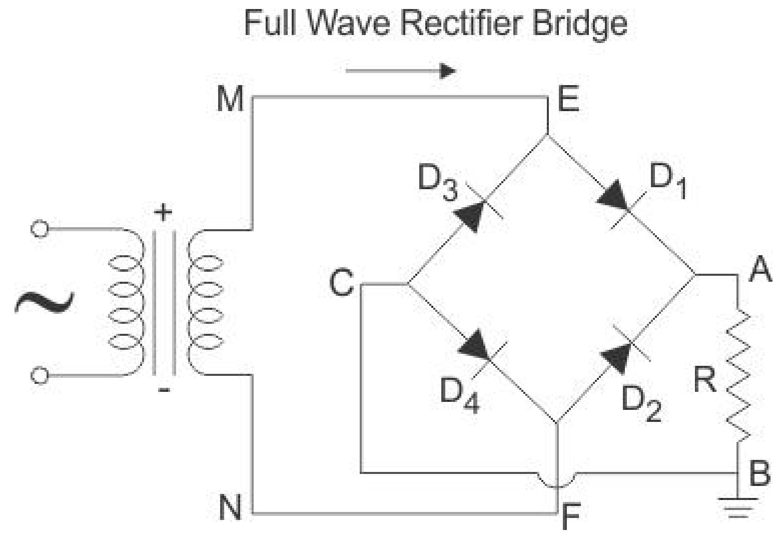


Figure 4.2 Full wave rectifier

DC Filtration

The rectified voltage from the rectifier is a pulsating dc voltage having a very high ripple content. But this is not what we want, we want a pure ripple-free dc waveform. Hence a filter is used. Different types of filters are used such as capacitor filter, LC filter, Choke input filter, π type filter. The figure below shows a capacitor filter connected along the output of the rectifier and the resultant output waveform.

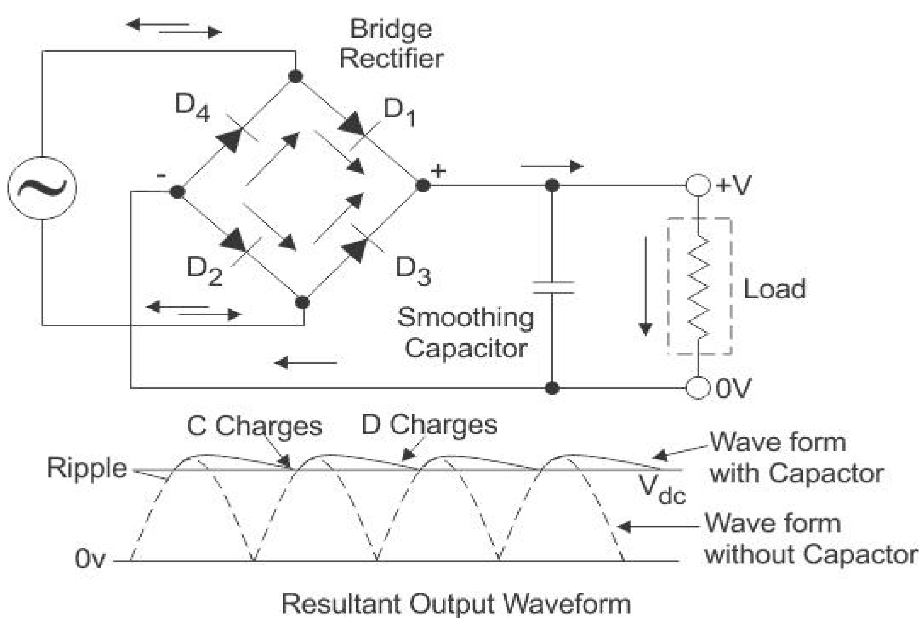


Figure 4.3 Bridge rectifier and resultant output waveform

The capacitor begins to charge as the instantaneous voltage rises, and it continues to charge until the waveform reaches its peak value. The capacitor begins slowly and exponentially discharging through the load (in this example, the input of the regulator), as soon as the instantaneous value starts to fall. As a result, a dc value that has nearly no ripple content is obtained.

Regulation

The final block in a regulated DC power supply is this one. When there is a change in the input from the ac mains owing to a change in load current at the output of the regulated power supply or due to other variables like temperature changes, the output voltage or current will vary or fluctuate. A regulator can be used to solve this issue. Even if the input varies or there are other changes, a regulator will keep the output constant. Depending on the applications, users can choose between using Zener diodes operated in the Zener region, fixed and variable IC regulators, or transistor series regulators. For the output voltages to have set values, ICs like the 78XX and 79XX are utilized . With ICs like LM 317 and 723 etc, The output voltage can be changed to a needed constant value. The LM317 voltage regulator is seen in the image below. The resistances R1 and R2's values can be changed to alter the output voltage. To handle input noise and output transients, coupling capacitors with values ranging from 0.01F to 10F must typically be linked at the output and input. The ideal output voltage is provided by

$$V_{OUT} = V_{REF}\left(1 + \frac{R_2}{R_1}\right)$$

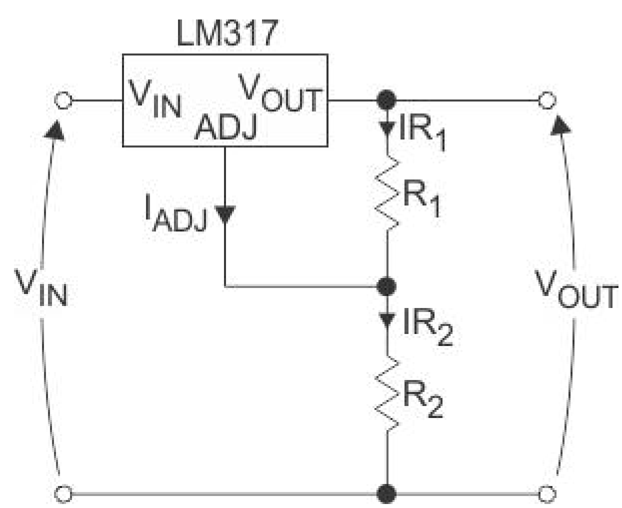


Figure 4.4 LM317 Voltage regulator

The Fig(4.4) shows the complete circuit of a regulated +5V DC power supply using a transformer, bridge rectifier, filter (smoothing), and a fixed +5 V voltage regulator. Here we can use IC 7803(for 3V),7809(for 9 V),7812(for 12V) etc.

Application of Regulated Power Supply

The regulated power supply Fig(4.5) is the main component of electrical, electronics, and as well as automation equipment. Mobile phone charger, oscillator, and amplifier are needed for the regulated power supply

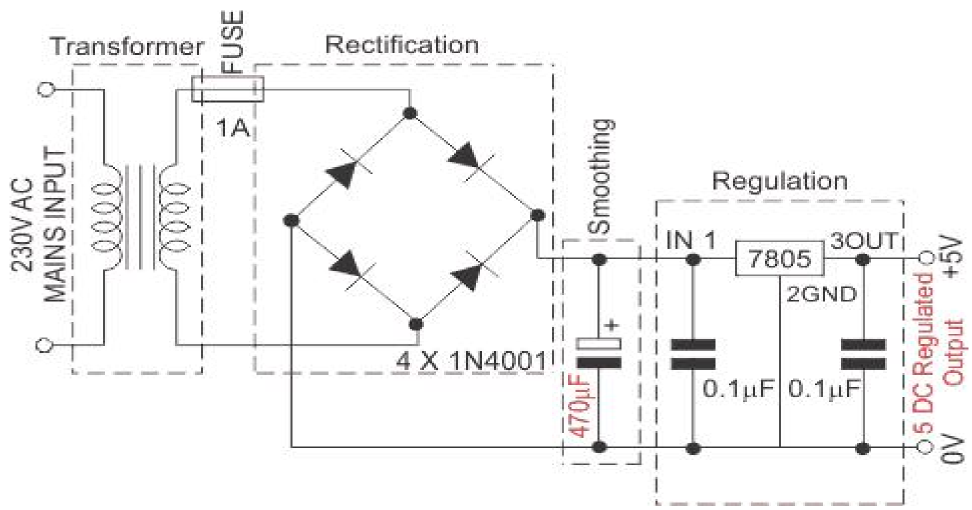


Figure 4.5 Regulated power supply

4.3 Understanding 7805 IC Voltage Regulator

Due to the semiconductor material used in many electronic devices having a set rate of current and voltage, a regulated power supply is absolutely necessary Fig(4.6). Any departure from the specified pace might result in harm to the equipment. This circuit converts the AC power source into steady DC. The uncontrolled output will be set to a constant voltage with the aid of a voltage regulator DC. The circuit consists of a bridge rectifier comprised of diodes, a linear voltage regulator (7805), capacitors, and resistors. The diodes and capacitors manage very efficient signal transmission in addition to providing a constant voltage supply and increasing assurance that output reaches the appliance uninterrupted.

A regulated power supply is a device that uses DC voltages and can keep its output exactly at a predetermined value even when the DC input voltage fluctuates substantially, as was previously stated.

The fundamental function of an IC regulator in a circuit is to maintain the precise voltage that the power supply follows. The input terminal and the output terminal of the IC regulator are typically linked in parallel when a regulator is used. Capacitors are utilised to test for significant changes in both the input and output filters. While the small period spikes on the input and output levels are monitored by bypass capacitors.

Bypass capacitors are mainly of small values that are used to bypass the small period pulses straightly into the Earth.

A circuit diagram having regulator IC and all the above-discussed components arrangement is revealed in the figure below.

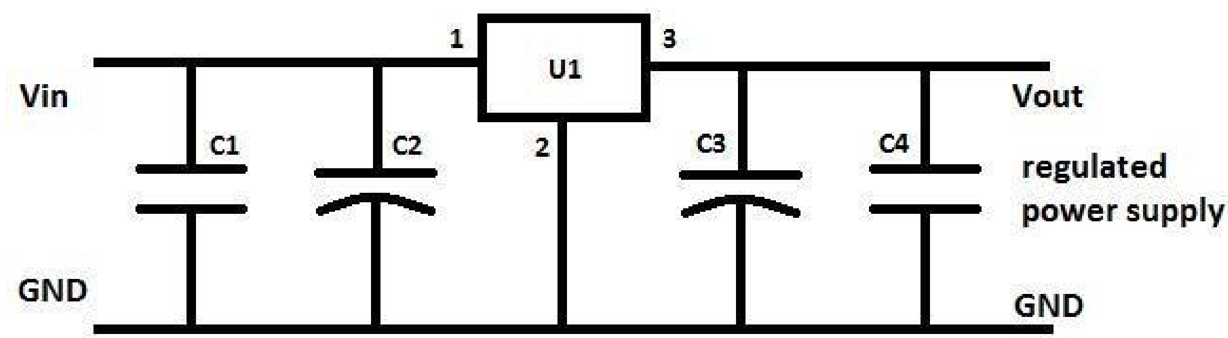


Figure 4.6 IC regulator

As we have made the whole circuit till now to be operated on the 5V DC supply, so we have to use an IC regulator for 5V DC. And the most generally used IC regulators Fig(4.6) get into the market for 5V DC regulation use is 7805. So we are connecting the similar IC in the circuit as U1. IC 7805 is a DC-regulated IC of 5V. This IC is very flexible and is widely employed in all types of circuits like a voltage regulator. It is a three-terminal device and is mainly called input, output, and ground. The pin diagram of the IC 7805 is shown in the diagram below.

4.4 RELAY:

An electrically controlled switch is a relay. Fig(4.7) Other working principles are also utilised, however electromagnets are frequently used in relays to mechanically activate a switching mechanism. Relays are employed when several circuits need to be controlled by a single signal or when a low-power signal is required to control a circuit with perfect electrical isolation between the control and controlled circuits. The earliest relays were employed in long-distance telegraph circuits to repeat and retransmit signals from one circuit to another. To carry out logical processes, relays were widely utilised in early computers and telephone

A contactor is a particular kind of relay that can manage the high power necessary to directly operate an electric motor or other loads. With no moving components and switching performed by a semiconductor chip, solid-state relays regulate power circuits. To safeguard electrical circuits from overload or defects, relays with calibrated operating characteristics and occasionally several working coils are employed. In contemporary electric power systems, digital instruments still go by the name "protective relays" to accomplish these tasks.

Figure 4.7 relay

Basic Design and Operation:

A basic electromagnetic relay Fig(4.8) consists of a coil of wire wound around a soft iron core, an iron yoke that offers a low resistance channel for magnetic flux, a moveable iron armature, and one or more sets of contacts (there are two in the relay shown). The armature is mechanically connected to one or more groups of moving contacts by a hinge that connects it to the yoke.

It is secured in place by a spring so that when the relay is de-energized, the magnetic circuit has an air gap. In this situation, one of the relay's two sets of contacts is closed while the other set is open. Based on how they are used, other relays might have more or fewer contact sets. A wire also connects the armature and yoke of the relay in the image. In doing so, the yoke, which is attached to the PCB, maintains circuit continuity between the moving contacts on the armature and the circuit track.

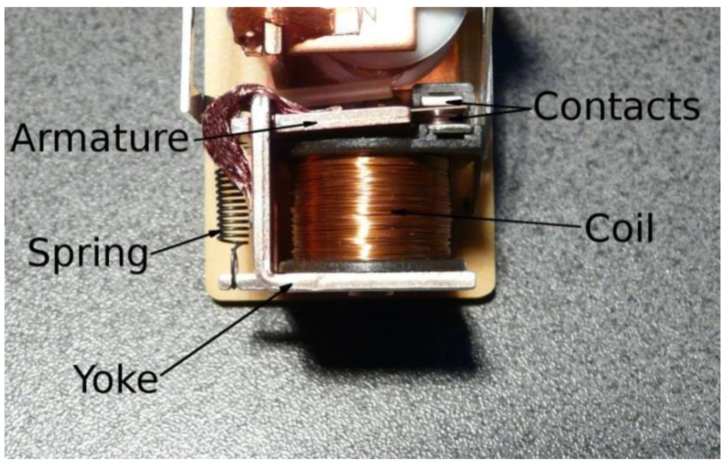


Figure 4.8 Electromagnetic relay

When an electric current or voltage is passed through the magnetic coil it generates a magnetic field that initiates to activate the armature, and the continuous movement of the adjustable contact either makes or breaks a connection with the circuit. If the number of contacts was closed when the relay was de-energized, this action opens the contact and breaks the connection and vice-versa. When the current passing to the coil is switched off, the armature is regained by a force, approximately half as strong as the electromagnetic force, to its original position. Usually, this force is provided by spring, but gravity is also needed commonly in industrial motor starters. Most relays are manufactured to operate fast. when the voltage application is less, noise is reduced; If the voltage or current application is high, arcing is reduced.

When the coil is again energized with direct current, a junction rectifier is often placed along the coil to dissipate the energy from the interchanging magnetic field at deactivating, which would also generate surges which is dangerous to semiconductor circuit components. Some automotive relays include a junction rectifier inside the relay case..

Conversely, a protection contact network consisting of an RC circuit in series may absorb the surge. If the coil is designed in such a way that it is to be energized with alternating current, a form of copper shading ring should be crimped to the end of the solenoid coil, creating a less amount of out-of-phase current which increases the number of pull on the armature during the alternative current cycle.[1]

A solid state switching device uses a thyristor or solid state relay, activated by the controlling system, to switch the controlled load, instead of a solenoid coil. An opto-isolator (an light-emitting diode coupled with a photo transistor) can be used to separate control and controlled circuits.

Types of Relay:

- Latching relay
- Read relay
- Mercury-wetted relay
- Mercury relay
- Polarized relay
- Machine tool relay
- Ratchet relay
- Coaxial relay
- Contactor
- Solid state relay
- Solid state contactor relay
- Overload protection relay
- Vacuum relay

Pole and Throw:

Since relay Fig(4.9) acts as switches, the terminology implied to the switches is also applied to relays; a relay switches one or more poles, each of those contacts can be thrown by energizing the coil in one of the three ways:

- Normally open (**NO**) junction connects the circuit when the relay is ON state; the circuit is disconnected when the relay is off. It is also called Form A junction or "make" contact. NO contact may also be differentiated as "early-make" or **NOEM**, which means that the contact closes before the button or switch is fully connected.
- Normally-closed (**NC**) junction disconnects the circuit when the relay is ON; the circuit is connected when the relay is in off condition. It is also called a **Form B** contact or "break" contact. NC contact may also be differentiated as "Late-break" or **NCLB**, which means that the contact may also stay closed until the button or switch is fully disengaged.
- Double throw(**DT**) or change-over(**CO**) contact takes control over the two circuits; one Normally-open junction and one normally closed junction contact with a common terminal. It is also called a **Form C** junction or "transfer" junction (break before make). If this type of contact utilizes a "make before break" functionality, then it is called a **Form D** junction.

The following designations are commonly encountered:

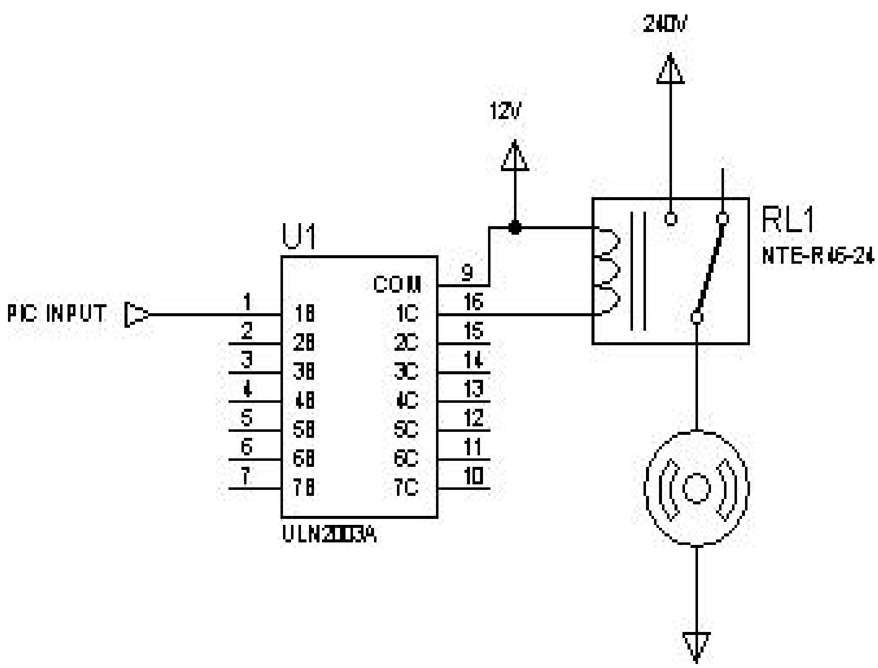
- **SPST** – Single Pole Single Throw. These two terminals can be joined or disjoined. Including two for the solenoid coil, such as the relay's four terminals in total. It is ambiguous whether the poles are normally closed. The terminology "**SPNO**" and "**SPNC**" is sometimes used to resolve the ambiguity
- **SPDT** – Single Pole Double Throw. A common terminal join either of two others. Including two for the solenoid coil, such as the relay has five terminals altogether.
- **DPST** – Double Pole Single Throw. These have two pairs of terminals. Equivalent to two SPST switches or relays actuated by a single solenoid coil. Including two for the coil, such a relay has six terminals altogether. The poles may be Form A or Form B or else

one of the coil.

- **DPDT** – Double Pole Double Throw. These have a pair of rows of change-over junctions. Equivalent to two **SPDT** switches or relays actuated by a single solenoid coil. such as a relay that has eight junctions, including the solenoid coil.

Relays are used for:

- Amplifying a signal in digital fields, switching a huge amount of power with a less amount of power. Some special cases are:
- A telegraph relay, repeating a poor signal received at the end of a long-distance controlling a high voltage circuit with a low voltage signal, as in some situations of modems or audio amplifier applications,
- Regulating a huge current circuit with a less current signal, as in the started solenoid of an automobile.



- Finding and isolating faults on transmission and distribution lines by opening and closing circuit-protecting relays, and switching to a standby power supply.

Figure 4.9 Relay pin diagram

4.5 TEMPERAURE SENSOR

A temperature sensor Fig(4.10) is an electrical device that collects data concerning the temperature from a source and converts that into a form that can be understood by the observer or another circuitry device. These temperature sensors come in many different forms and are widely used for a variety of purposes, from simple domestic use to extremely accurate and precise scientific use. These sensors play a very important role in almost every purpose that there are applied; knowing to help people to pick their clothing before they reach the closet just like it helps chemists to understand the data collected from a complex chemical reaction.

A very good known example is mercury which is present in glass thermometers. Mercury usually expands and contrasts depending upon the temperature changes; When these volume changes are notified, the temperature can be measured with a linear increase with the temperature of accuracy. The environment temperature is the source of the measurements and the position of the mercury in the glass tube is the visible quantification of temperature that can be clearly understood by observers. Typically, mercury in glass thermometers is only used for non-scientific purposes because they are not extremely accurate and precis

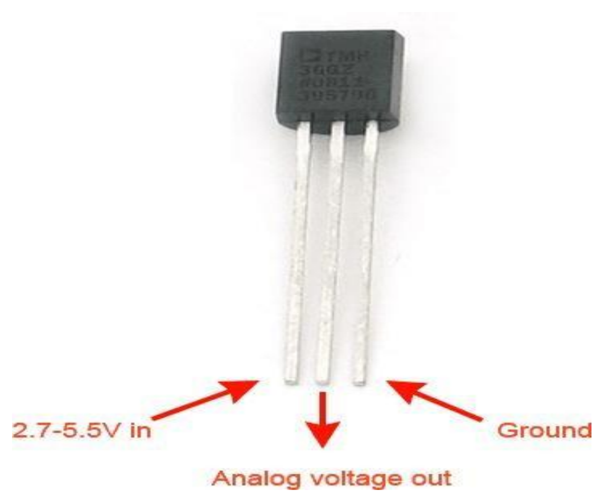


Fig 4.10 TemperatureSensor

A very complex temperature sensor will generally be computerized for more accurate and precise results. These are sometimes used in homes for non-scientific purposes, some people keep sensors outside that wirelessly send the environment's temperature to a digital display inside. In a lab, a digital temperature sensor will typically be calibrated to be very accurate and precise. These sensors take one of two forms: contact sensors measure their temperature after they have achieved thermal stability with the environment and non-contact sensors measure heat radiation from their environment within a specific area. All the temperature sensors tend to have some level of error in their output, as the temperature is quite difficult to measure accurately.

Temperature range: -40 degrees C to 150 degrees C /- 40 degrees F to 302 degrees F

Output range: 0.1 V (40 degrees C) to 2.0V (150 degrees C) but accuracy decreases after 125 degrees C

Power supply: 2.7V to 5.5V only, 0.05mA current draw.

4.6 GAS SENSOR

A gas detector Fig(4.11) is an electrical device that detects the presence of gases in an environment, it is often used as part of the safety system. This type of equipment is used to detect a gas leak and it is interfaced with a control system so that the process can be automatically shut down. A gas leakage detector can sound an alarm to operators in the areas where the leak is occurring, allowing them to leave. This type of device is important in many aspects because many gases can be harmful to organic life, such as human beings and animals..

Gas leakage detection can be used to detect combustible, flammable, and toxic gases and oxygen depletion. These types of gas sensors are widely used in industry and can be found in locations such as on oil rigs, to monitor manufacturing processes and emerging technologies such as photovoltaics. it can be also used in firefighting.

Gas leakage detection is a process of identifying the potential hazardous gases that are leaked by gaseous containers. These gas sensors usually employ an audible alarm to alert people when a dangerous gas leakage has been detected. Some common sensors include infrared point sensors, ultrasonic sensors, electrochemical gas sensors, and semiconductor sensors. In recent times, infrared imaging sensors have come into use. All of these sensors are used in a wide range of applications and can be found in industrial power plants, refineries, waste-water treatment facilities, vehicles, and homes..

DESCRIPTION

It is a very easy-to-use liquefied petroleum gas(LPG) sensor, Fig(4.11) which is suitable for sensing LPG's (composed of mostly propane and butane) rate of concentration in the air. The MQ-6 can detect gas concentrations anywhere from 200 to 1000 ppm. This sensor has a very high sensitivity and a very fast response time. The sensor's output is an analog resistance. The driver circuit is very simple; all you need to do is power the heater coil with 5 volts, add a load resistance, and connect the output to an Analog to Digital Convertor

.

Gas sensors are available in a wide range of specifications depending on the sensitivity levels, types of gas to be sensed, physical appearances, and numerous after factors. This Insight covers a

Fig 4.11 Gas Sensor

methane gas sensors Fig(4.11) that can sense gases such as ammonia which is the buy product of methane. When a gas interacts with this gas sensor, it is first ionized into its constituents and is then absorbed by the gas-sensing elements. This absorption can create a potential difference in the element which is conveyed to the microprocessor unit through the output pin informing of the current..

The effective resistance value of MQ-7 is different for various forms and various types of concentrations of gases. So, when using these components, sensitivity adjustments are very necessary. We can be recommended you calibrate the detector for 200 ppm. CO in the air and the value of the load resistance is about 10kΩ(5kΩ to 47kΩ). When accurate and precise measuring, the proper alarm point for the gas leakage detector should be determined after considering the environment temperature and humidity influence. The sensitivity adjustment program:

- Connect the sensor to the application circuit.
- Turn on the power; keep preheating through electricity for over 48 hours.
- Adjust the load resistance RL until you get a signal value that responds to a certain carbon monoxide concentration at the endpoint of 90 seconds.
- Adjust the other load resistance RL until you get a signal value that responds to a CO concentration at the endpoint of 60 seconds.
-

FEATURES

- It is highly sensitive to carbon monoxide
- It is Stable and long life

APPLICATION

- They are used in gas-detecting equipment for carbon monoxide (CO) in industry or cars.
- ARDUINO MICROCONTROLLER

Arduino Uno Fig(4.12) is a community-driven project that supplies open-source computer hardware and software. Arduino mainly focuses on developing single-boarded microcontrollers and kits that enable the user to creatively design digital devices and interactive objects capable of sensing and controlling the physical and digital environment. This company produces a license for both hardware and software under the GNU Lesser General Public License (LGPL) or the GNU General public license (GPL), allowing anyone to manufacture Arduino boards and supply their software. Arduino also offers pre-assembled boards and DIY kits in the market.

Many forms of microcontrollers and microprocessors are used in Arduino board designs. Many varieties of expansion boards, breadboards, and other circuits can be interfaced with the boards. It has a set of digital and analog input and output pins. The boards provide serial communications ports that can be used to load software from computers, including on certain phases, a universal serial bus (USB). Typically, a dialect of appearances from the programming languages such as C and C++ are used to program microcontrollers. The Arduino projects offer an integrated development environment (IDE) based on the processing languages project in addition to using conventional compiler toolbars.

The Arduino projects were launched in 2003 as a program for students at the Interaction Design Institute Ivrea, in Ivrea, with the goal of giving amateurs and expert a simple and affordable way to build gadgets that can use sensors to interact with their environment.

Simple robots, machinery, thermostats, and motion detectors are a few examples of such gadgets used again and again by hobbyists.

The hardware made with Arduino is open source. the hardware reference design is offered on the Arduino website and published under the attributes of a creative common share 2.5 license. There are in addition layout and production files are available for various hardware variants. The General public license, version 2, governs the publication of the integrated development environment source code. However, the Arduino staff has never published a formal Bill of materials for Arduino boards.

Even though the designs for the hardware and software are freely available under copyleft licenses, the creators have asked that the name Arduino only be used for the official product and not for derivative works without their consent. The project emphasizes that it is open to integrating work by others into the official product in the paper outlining the official policy for the usage of the Arduino name. Many Arduino-compatible products that were commercially released avoided using the project name by using different names that ended in -Duino.

The boot loader that comes pre-installed with Arduino microcontrollers makes it very easier to upload programs to the on-chip flash memory. The Opti boot loader is the default boot loader for the Arduino UNO Fig(4.12). Programming code is loaded onto boards using a serial link to another computer. A level shifter circuit is present on few serial Arduino boards to convert between Transistor-Transistor Logic (TTL) level signals and RS-232 logic levels. A USB-to-serial converter chip like the FTDI FT232 is used to implement the Universal Serial Bus (USB), which is the current programming language protocol for Arduino boards. Some boards, like later-model Uno boards, replace the FTDI chip with a different AVR chip that contains USB-to-serial languages and can be updated via its own ICSP header. Other variations, including the Arduino Mini and the unofficial Board uno, employ Bluetooth, a detachable USB-to-serial adapter board, or other techniques. Instead of using the Arduino Integrated Development Environment, ordinary AVR in-system programming (ISP) programming is employed when used with conventional microcontroller tools.

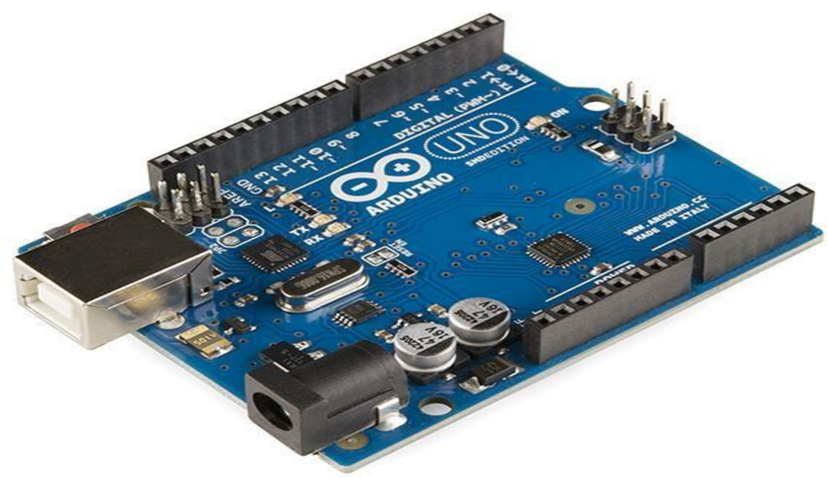


Figure 4.12 Arduino Board

An official Arduino Uno R2 Fig(4.12) with descriptions of the Input and output locations The Arduino board exposes most of the microcontroller's input and output pins for use by other circuits. They provide 14 digital input and output pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital input and output pins. These pins are on the top of the board, via female 0.1- inch (2.54 mm) headers. Several plug-in application shields are also commercially available. The Arduino Nano and Arduino-compatible Bare Bones Board and Board uno boards may provide male header pins on the underside of the board that can plug into solderless breadboards.

Many Arduino-compatible and Arduino-derived boards exist. Some are functionally equivalent to an Arduino and can be used interchangeable. Many enhance the basic Arduino by adding output drivers, often for use in school-level education, to simplify making buggies and small robots. Others are electrically equivalent but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use different processors, of varying compatibility. The Arduino Uno R3 is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an Alternative current-to-Direct Current adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to the ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near the AREF pin and two other new pins placed near the RESET pin, the IOREF that allow the shields to adapt to the voltage provided by the board. In the future, shields will be compatible both with the board that uses the AVR, which operate with 5V, and with the Arduino Due which operates with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB is used by the bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

4.7 LEVEL CONVERTER

A level shifter is also known as a logic-level shifter or voltage-level translator. It is a electronic circuit used in digital electronics to translate signals from one logic level or voltage domain to another, enabling compatibility between integrated circuits with various voltage requirements, including TTL and CMOS logic. Level shifters are used in contemporary systems to connect the domains of processors, logic, sensors, and other circuits. 1.8Volts, 3.3Volts, and 5Volts have been the most popular logic levels in recent years, while values above and below these voltages have also been employed.

All input pins are dedicated to one voltage domain, while all output pins are dedicated to the other in a unidirectional design. Dedicated ports that are bidirectional - The data direction of a pin does not vary, but each voltage domain includes input and output pins. Bi-directional with an external direction indicator: When the external signal is altered, inputs shift to outputs and vice versa. Bi-directional, auto-sensing - Without the requirement for a specific direction control pin, a pair of I/O spanning voltage domains can function as either inputs or outputs depending on environmental stimulation.

HARDWARE IMPLEMENTATION

Fixed function level shifter ICs - These ICs provide several different types of a level shift in fixed-function devices. Often lumped into 2-bit, 4-bit, or 8-bit level shift configurations offered with various VDD1 and VDD2 ranges, these devices translate logic levels without any additional integrated logic or timing adjustment. Configurable mixed-signal ICs (CMICs) – Level shifter circuitry can also be implemented in a CMIC. The no-code programmable nature of CMICs allows designers to implement fully customizable level shifters with the added option to integrate configurable logic or timing adjustments in the same device.

APPLICATIONS

Since level shifters are used to resolve the voltage incompatibility between various parts of a system, they have a wide range of applications as well. Level shifters are widely used in interfacing legacy devices and in SD cards, SIM cards, CF cards, audio codecs, and UARTs.

4.8 LCD (liquid crystal display:

LCD stands for liquid crystal display. They come in many sizes 8x1 , 8x2 , 10x2 , 16x1 , 16x2 , 16x4 , 20x2 , 20x4 ,24x2 , 30x2 , 32x2 , 40x2 etc. Many multinational companies like Philips Hitachi Panasonic make their special kind of LCDs to be used in their products. All the LCDs perform the same functions (display characters numbers special characters ASCII characters etc). Their programming is also the same and they all have the same 14 pins (0-13) or 16 pins (0 to 15). Eight (8) of them are data pins that take data from the external unit and display it on the screen. One VCC takes 5 volts to turn on the LCD and GND is ground and one is contrast (we use it to set the contract color of the alphabets (concerning LCD) that appears on the LCD).

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD is a very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi-segment LEDs. The reasons are: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations, and so on

Figure 4.13 LCD

A 16x2 LCD Fig(4.13) means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

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

4.8.1 PIN DIAGRAM:

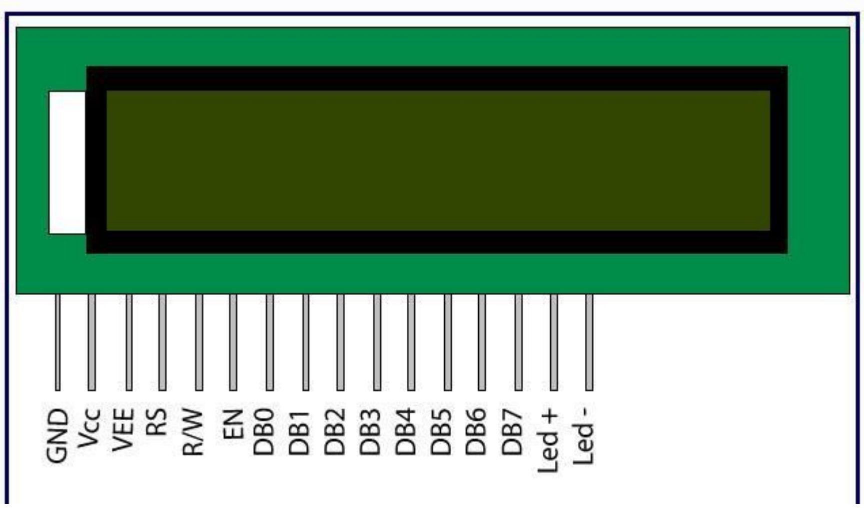


Figure 4.14 LCD pin diagram

4.8.2 CIRCUIT DIAGRAM:

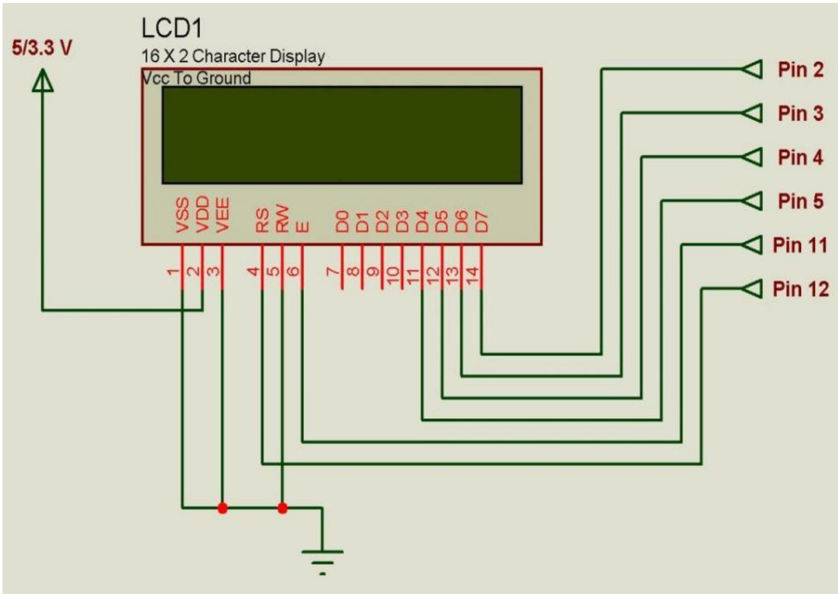


Figure 4.15 LCD Circuit Diagram

The renaming three are very important pins RS (register set), RW (read-write), and EN(enable signal).

RS (register set):

Is used to distinguish between commands and data. When it is 1 it means that some data is coming to LCD Fig(4.14) (by data I mean some characters or ASCII characters) and when it is 0 it means that some command is approaching LCD from an external unit (usually a microcontroller) by commands I mean that instruction for LCD is coming, for example, move cursor

RW (read-write):

This pin most often remains 0 because when it is 0 it means we are writing to the LCD module writing anything data or command. When it is 1 it means we are reading from LCD.

EN(Enable signal):

This enabled signal is very important. When it is 1 it provides an extra beam to LCD to display the character that the data pins are caring. After displaying the character, it then comes back to normal state 0. Two extra pins on some LCDs are for background display one pin represents the background display apply 5 volts to turn on the background display or 0 volts to turn off the background display.

The data which we send to our LCD can be any alphabet (small or big), digit, or ASCII character.

We cannot send integer, float, long, double type data to LCD because LCD is designed to display a character only. The 8 data pins on LCD carry only ASCII 8-bit code of the character to LCD. However, we can convert our data into a character-type array and send one by one our data to LCD. Data can be sent using 8-bit 0r 4-bit mode. If 4-bit mode is used, two nibbles of data (First high four bits and then low four bits with an E Clock pulse with each nibble) are sent to complete a full eight-bit transfer.8-bit mode is best used when speed is required in an application and at least ten I/O pins are available. The 4-bit mode requires a minimum of six bits. In 4-bit mode, only the top 4 data bits (DB4-7) are used.

LCD Commands:

The command 0x30 means we are setting 8-bit mode LCD having 1 line and we are initializing it to be a 5x7 character display. Now this 5x7 is something that everyone should know what it stands for. Usually, the characters are displayed on LCD in 5x8 matrices form. Where 5 is the total number of coulombs and is the number of rows. Thus, the above 0x30 command initializes the LCD to display characters in 5 coulombs and 7 rows the last row we usually leave for our cursor to move or blink etc.

- The command 0x20 means we are setting 4-bit mode LCD having 1 line and character shape between 5x7 matrixes.
- The command 0x28 means we are setting 4-bit mode LCD having 2 lines and character shape between 5x7 matrixes.
- The command 0x06 is entry mode it tells the LCD that we are going to use you.
- The command 0x08 displays the cursor off and display off but without clearing DDRAM contents.
- The command 0x0E displays the cursor on and display on.

- The command 0x0c display on cursor off (displays cursor off but the text will appear on LCD)
- The command 0x0F displays on cursor blink (text will appear on the screen and the cursor will blink).
- The command 0x18 shifts the entire display left (shift the whole of the text on the line to its left).
- The command 0x1C shifts the entire display right (shift the whole of the text on the line to its right).
- The command 0x10 Moves the cursor one step left or moves the cursor one step ahead to left whenever a new character is displayed on the screen.
- The command 0x14 Moves the cursor one step right or moves the cursor one step ahead to the right whenever a new character is displayed on the screen.
- The command 0x01 clears all the contents of the DRAM and clears the LCD and removes all the text from the screen.

The command 0x80 initializes the cursor to the first position means first line first matrix (start point) now if we add 1 in 0x80+1=0x81 the cursor moves to the second matrix for example 16x1 LCDs 16 characters only the first will appear on 0x80 second 0x81 third 0x82 and so on until last the 16 once on address 0xFF

4.9 ESP8266

Node MCU is an open-source firmware and development kit that helps you to prototype or build IoT products. It includes firmware that runs on the ESP8266 Wi-Fi firmware that uses the Lua scripting language. It is based on the eluate project, and built on the Express if Non-OS SDK for ESP8266. Node MCU is an open-source development board and firmware based on the widely used ESP8266 -12E Wi-Fi module. It allows you to program the ESP8266 Wi-Fi module with the simple and powerful LUA programming language or Arduino Integrated Development Environment. With just a few lines of code, you can establish a WIFI connection and define input/output pins according to your needs exactly like Arduino, turning your ESP8266 into a web server, and a lot more. It is the Wi-Fi equivalent of an ethernet module. Now you have the Internet of Things (IoT) real tool.

With its USB-TTL, the node MCU Dev board supports directly flashing from the USB port. It combines features of the WI-FI access point and station + microcontroller. These features make the Node MCU an extremely powerful tool for Wi-fi networking. It can be used as an access point and/or station, host a web server or connect to the internet to fetch or upload data.

Features

- A programable Wi-Fi module.
- Arduino-like (software-defined) hardware IO.
- Can be programmed with the simple and powerful Lua programming language or Arduino IDE.
- USB-TTL included plug & play.
- 10 GPIOs D0-D10, PWM functionality, IIC, and SPI communication, 1-Wire, and ADC A0, etc. all in one board.
- Wi-fi networking (can be used as an access point and/or station, host a web server), connect to the internet to fetch or upload data.
- Event-driven API for network applications.
- PCB antenna.

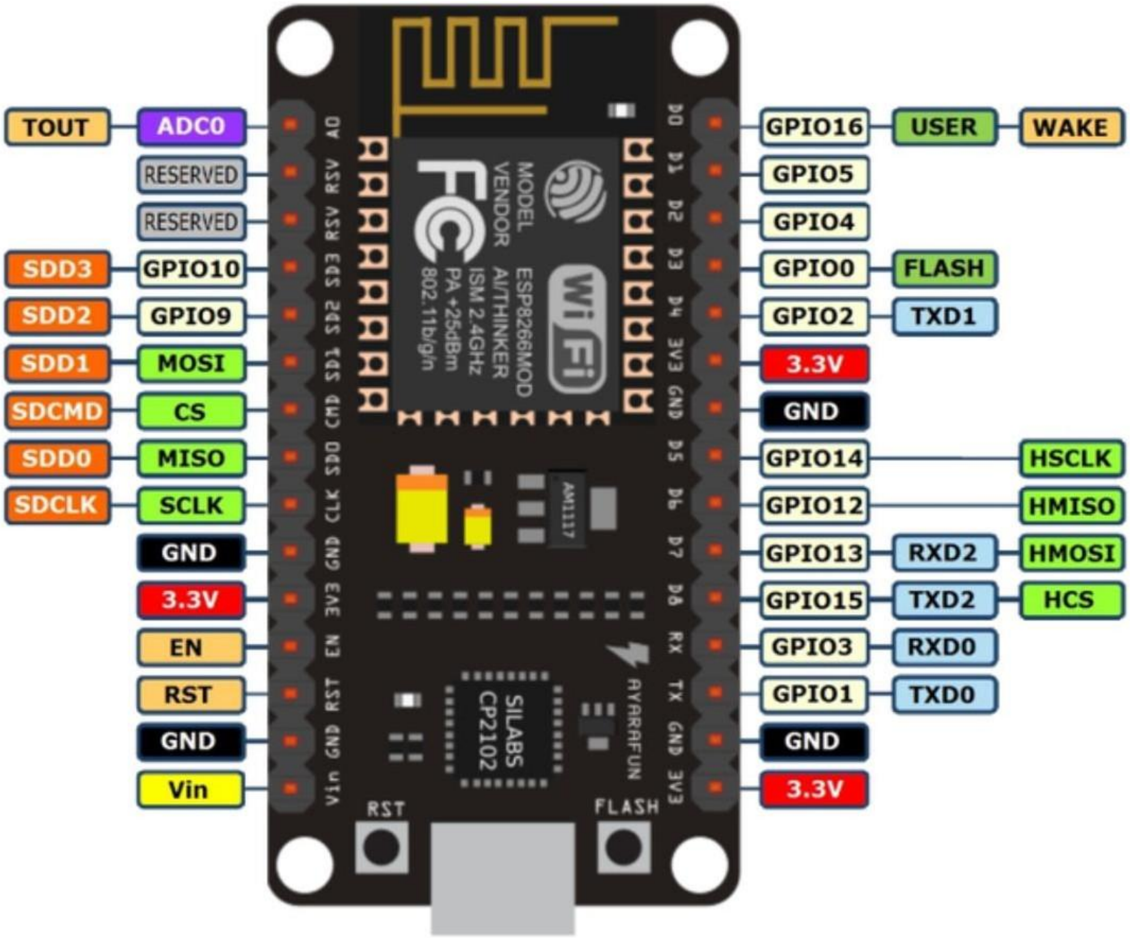


Figure 4.16 Node MCU

Node MCU is an open-source firmware for which open-source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (micro-controller unit).[8]. The term "Node MCU" strictly speaking refers to the firmware rather than the associated development kits

Peripherals and I/O

The ESP8266 Node MCU has a total of 17 GPIO pins are divided on to the pin headers on both sides of the development board. These pins can be assigned to all sorts of peripheral duties, including:

- ADC channel – A 10-bit ADC channel.
- UART interface – UART interface is used to load code serially

- PWM outputs – PWM pins for dimming LEDs or controlling motors.

The ESP8266 Node MCU features two buttons. One marked as **RST** located on the top left corner is the Reset button, used of course to reset the ESP8266 chip. The other **FLASH** button on the bottom left corner is the download button used while upgrading firmware.

GND is a ground pin of the ESP8266 Node MCU development board.

I2C Pins are used to hook up all sorts of I2C sensors and peripherals in the project. Both I2C Master and I2C Slave are supported perfectly for this application. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that the I2C clock frequency should be higher than the slowest clock frequency of the I2C slave device.

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

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

UART Pins ESP8266 Node MCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485) and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing logs.

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

- 4 timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO
- SDIO Pins ESP8266 features a Secure Digital Input/Output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

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

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

EN pin – The ESP8266 chip is enabled when the EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.

Advantages

• We can monitor the battery condition through the IOT using an Android phone.

• We can monitor the distance of kilometer cover by the vehicle.

• A BMS enhances the life span of the battery cell in EVs.

• It provides stability and reliability.

• This is an effective system to measure and control the batteries voltage.

• It monitors the battery constantly to avoid the occurrence of failure or explosion in between.

. • It forecasts the battery pack's capabilities shortly

CHAPTER 5

SOFTWARE DESCRIPTION

5.1 SOFTWARE REQUIREMENTS

- Arduino IDE

5.2 ARDUINO IDE

Arduino Integrated Development Environment (IDE) Fig(5.1) is an open-source software that is mainly used for writing and compiling code into the Arduino Module. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, and Linux which runs on the Java Platform that comes with inbuilt functions and commands that play a vital role in debugging, editing, and compiling the code in the environment.

A range of Arduino modules is available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro, and many more. Each of them contains a microcontroller on the board that is programmed and accepts the information in the form of code. The main code, also known as a sketch, created on the Integrated Development Environment (IDE) platform will ultimately generate a Hex File which is then transferred and uploaded to the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where the former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C++ languages.

The Arduino IDE is incredibly minimalistic, yet it provides a near-complete environment for most Arduino-based projects. The top menu bar has the standard options, including “File” (new, load save, etc.), “Edit” (font, copy, paste, etc.), “Sketch” (for compiling and programming), “Tools” (useful options for testing projects), and “Help”

The middle section of the IDE is a simple text editor where you can enter the program code. The bottom section of the IDE is dedicated to an output window that is used to see the status of the compilation, how much memory has been used, any errors that were found in the program, and various other useful messages.

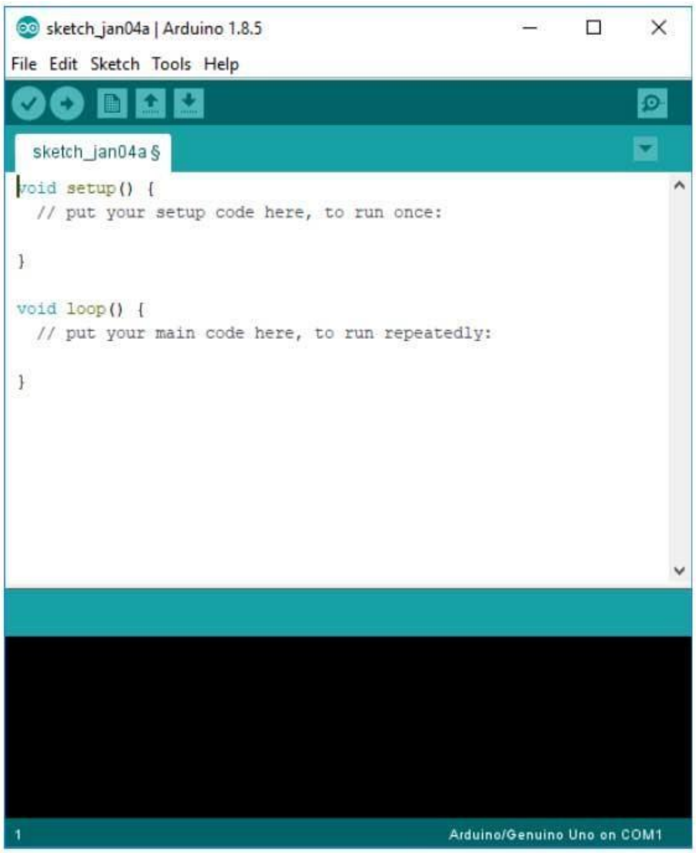


Fig 5.1 The Arduino in its default state

Projects made using Arduino are called sketches, and such sketches are usually written in a cut-down version of C++ (several C++ features are not included). Because programming a microcontroller is somewhat different from programming a computer, there are several devices-specific libraries (e.g., changing pin modes, output data on pins, reading analog values, and timers).

This sometimes confuses users who think Arduino is programmed in an "Arduino language." However, the Arduino is programmed in C++. It just uses unique libraries for the device. While more advanced projects will take advantage of the built-in tools in the IDE, most projects will rely on the six buttons found below the menu bar.

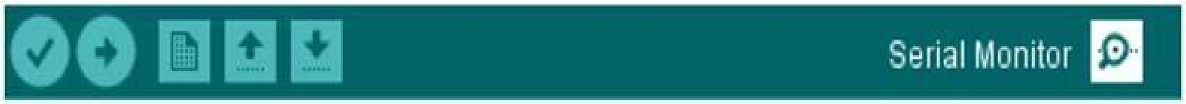


Fig 5.2 Button bar

- The checkmark is used to verify your code. Click this once you have written your code.
- The arrow uploads your code to the Arduino to run.
- The dotted paper will create a new file.
- The upward arrow is used to open an existing Arduino project.
- The downward arrow is used to save the current file.
- The far-right button is a serial monitor, Fig(5.2) which is useful for sending data from the Arduino to the PC for debugging purposes.

CHAPTER 6

RESULTS AND DISCUSSION

CODE

```
#include "MQ135.h"

#include <SoftwareSerial.h>

#define DEBUG true

SoftwareSerial esp8266(9,10); // This makes pin 9 of Arduino as RX pin and pin 10 of Arduino the
TX pin

const int sensorPin= 0; int

air_quality;

#include <LiquidCrystal.h>

LiquidCrystal LCD(12,11, 5, 4, 3, 2); void

setup() {

pinMode(8, OUTPUT);

lcd.begin(16,2);

LCD.setCursor (0,0);

lcd. print ("circuit digest ");

lcd.setCursor (0,1);

lcd. print ("Sensor Warming ");

delay(1000);
```

```
  esp8266.begin(115200); // your esp's baud rate might be different
 sendData("AT+RST\r\n",2000,DEBUG); // reset module
 sendData("AT+CWMODE=2\r\n",1000,DEBUG); // configure as access point
 sendData("AT+CIFSR\r\n",1000,DEBUG); // get ip address
 sendData("AT+CIPMUair_quality=1\r\n",1000,DEBUG); // configure for multiple connections
 sendData("AT+CIPSERVER=1,80\r\n",1000,DEBUG); // turn on server on port 80
pinMode(sensor in, INPUT);        //Gas sensor will be an input to the Arduino
lcd.clear();
}
void loop() {
MQ135 gasSensor = MQ135(A0);
float air_quality = gasSensor.getPPM();
if(esp8266.available()) // check if the esp is sending a message
 {
   if(esp8266.find("+IPD,"))
   {
    delay(1000);
    int connectionId = esp8266.read()-48; /* We are subtracting 48 from the output because the
read() function returns the ASCII decimal value and the first decimal number which is 0 starts at
48*/
    String webpage = "<h1>IOT Air Pollution Monitoring System</h1>";
```

```
      webpage += "<p><h2>";

      webpage+= " Air Quality is ";

      webpage+= air_quality;

      webpage+=" PPM";

      webpage += "<p>";

     if (air_quality<=1000)

{

  webpage+= "Fresh Air";

}

else if(air_quality<=2000 && air_quality>=1000)

{

  webpage+= "Poor Air";

}

else if (air_quality>=2000 )

{

webpage+= "Danger! Move to Fresh Air";

}

webpage += "</h2></p></body>";

     String cipSend = "AT+CIPSEND=";

     cipSend += connectionId;
```

```
    cipSend += ",";

    cipSend +=webpage.length();

    cipSend +="\r\n";


    sendData(cipSend,1000,DEBUG);

    sendData(webpage,1000,DEBUG);


    cipSend = "AT+CIPSEND=";

    cipSend += connectionId;

    cipSend += ",";

    cipSend +=webpage.length();

    cipSend +="\r\n";


    String closeCommand = "AT+CIPCLOSE=";

    closeCommand+=connectionId; // append connection id

    closeCommand+="\r\n";


    sendData(closeCommand,3000,DEBUG);

   }

 }
```

```
lcd.setCursor (0, 0);

lcd.print ("Air Quality is ");

lcd.print (air_quality);

lcd.print (" PPM ");

lcd.setCursor (0,1);

if (air_quality<=1000)

{

lcd.print("Fresh Air");

digitalWrite(8, LOW);

}

else if( air_quality>=1000 && air_quality<=2000 )

{

lcd.print("Poor Air, Open Windows");

digitalWrite(8, HIGH );

}

else if (air_quality>=2000 )

{

lcd.print("Danger! Move to Fresh Air");

digitalWrite(8, HIGH);   // turn the LED on

}
```

```
lcd.scrollDisplayLeft();

delay(1000);

}

String sendData(String command, const int timeout, boolean debug)

{

    String response = "";

    esp8266.print(command); // send the read character to the esp8266

    long int time = millis();

    while( (time+timeout) > millis())

    {

      while(esp8266.available())

      {

        // The esp has data so display its output to the serial window

        char c = esp8266.read(); // read the next character.

        response+=c;

      }

    }

    if(debug)

    {

      Serial.print(response);
```

```
    }

    return response;

}
```

CHAPTER-7

CONCLUSION

The main aim of the project is to design and develop an IoT-based battery monitoring system for electric vehicles (EV's). The purpose of this system is to monitor battery performance degradation online, and to prove that the concept can be realized. The system includes hardware for the battery monitoring device and a web-based user interface to display information such as location, battery condition, and time using GPS and Google Maps. Further modifications can be made to improve the system by adding more functionalities, such as smartphone applications for battery monitoring and degradation reminders, and using Ethernet for a better internet connection.

The Internet of Things (IoT) refers to the interconnection of everyday objects and has significant role in the development of the smart grid applications. As Smart Grid devices are implemented into the utility grid, there will be significant modifications in grid management and usage of electric power in the upcoming years. The integration of distributed generation requires the deployment of energy storage systems in which electric vehicles (EVs) are a promising option due to their superior electrical characteristics. However, there is a risk of damage to battery packs in cases of overcharging or deep discharging situations, which can severely impact grid functioning. To mitigate this risk, an accurate real-time capacity determination of a battery pack is desired to increase its lifespan and protect the components in power sources. This project implements the coulomb counting technique to estimate the State of Charge (SoC) in real-time and provide measured parameters to the user via messaging communication. In addition to that, an optimization model is presented for maximizing trade revenue for an aggregator of EVs, with the aim of facilitating smart charging to reduce the impact of increased penetration of EVs on the grid.

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