VISVESVARAYA TECHNOLOGICAL UNIVERSITY

BEL AGAVI - 590018

**A Major Project Report On**

# "RFID BASED EV CHARGING SYSTEM"

**Dissertation submitted in partial fulfillment of the requirement for the award of degree of**

BACHELOR OF ENGINEERING IN

**ELECTRONICS AND COMMUNICATION ENGINEERING**


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**2023-202**

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## CERTIFICATE

This is to certify that the Project Work entitled is **"RFID BASED EV CHARGING SYSTEM"** is a Bonafide work carried out by Chetan M R(2SR21EC016), Ganesh S (2SR21EC022), Karthik A Divan(2SR21EC027), Maruthi A H(2SR21EC032) in partial fulfillment for the award of degree of Bachelor of Engineering in Electronics and Communication Engineering of the **Visvesvaraya Technological University**, Belgaum during the year 2024-25. It is certified that all corrections/suggestions indicated for the internal assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of work prescribed for the Bachelor of Engineering Degree.

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# ABSTRACT

The increasing adoption of Electric Vehicles (EVs) has led to a surge in the demand for efficient and user-friendly EV charging infrastructure. An RFID-based EV charging system offers an innovative solution to streamline the process of vehicle identification, authentication, and billing, thereby enhancing the overall charging experience. This system utilizes Radio Frequency Identification (RFID) technology to enable seamless and automated interaction between the EV and the charging station.

The RFID-based system comprises RFID tags embedded in the vehicle, which communicate with the RFID reader at the charging station. Upon detecting a vehicle, the system authenticates the user via a unique RFID ID, thereby ensuring that only authorized users can access the charging service. The charging station then adjusts the power output according to the vehicle's requirements, and the energy consumption is monitored in real-time.

The system also integrates a centralized server that manages user accounts, payment processing, and usage tracking. This allows users to conveniently make payments through various methods such as prepaid accounts, credit cards, or mobile apps.

This RFID-based approach improves efficiency by reducing the need for manual intervention, enhancing security, and providing a transparent, automated charging process. By implementing such a system, EV owners benefit from a hassle-free, streamlined experience, while charging operators can optimize operations and reduce maintenance costs.

# TABEL CONTENTS

# CHAPTER 1

## 1.1 INTRODUCTION

Radio Frequency Identification (RFID) technology has been increasingly used in various applications, including electric vehicle (EV) charging systems. An RFID-based EV charging system provides a secure, efficient, and convenient way to manage EV charging.

As the number of EVs on the road's increases, charging stations in both parking structures and private garages will become more prevalent. These stations will be responsible for meeting the requirements of the distribution grid, EV owners, and parking structure operators. For security and financial reasons, among the many functions these charging stations will perform are user authorization, authentication, and billing. Other commercial charging stations, such as Coulomb and Blink require a short-range RFID card for the same purpose. For vehicle authorization. identification and charging The Internet of Things, also called things linked internet, it refers to a kind of network that adopts RFID (radio frequency identification) and to enable the linkage between any articles and the internet, to enable the exchange and communication of information.

In both cases, extra steps on the part of the user must be taken to authorize charging. The authors in propose using conventional RFID tags inside EVs and RFID readers on parking garage access gates together with middleware and an aggregate charging controller to authorize, assign, and enable charging. However, this system still requires action from the user and is not as flexible as may be desired.

The proposed improvements allow charging authorization to take place seamlessly at multiple charging stations in a single geographic location without any action on the part of the user. Vehicle Monitoring/Identification Modules (VMMs), located in EVs, act as RFID tags.

This paper aims to discuss the application of RFID technology in the battery charging stations, and analysis the technical advantages of RFID technology in the electric vehicle identification as well as the unified management of the battery charging compartment. Here for the output power supply SMPS (switching mode power supply) is used.

## 1.2 PROBLEM STATEMENT

Conventional EV charging systems face several challenges, such as:

1. Manual user authentication, leading to delays and security risks.
2. Lack of automated billing, causing inefficiencies in payment processes.
3. Difficulty in tracking and managing energy usage for both users and operators.
4. Damaging in charger, EV Points, Vehicles.
5. The charging station could have issue like faulty components.

## 1.3 OBJECTIVES

1 To design a system that enables secure and automated user authentication using RFID cards.

2 To develop a process for monitoring energy consumption during charging sessions.

3 To automate billing and payment systems for enhanced user convenience.

4 To provide a scalable solution for future EV charging networks.

5 To use as a credential to gain access to a gated vehicle entrance.

# CHAPTER 2

## 2.1 LITERATURE SURVEY

- **[1] C. Y. Chung, A. Shepelev, C. Qiu, C. C. Chu, Rajit Gadh, "Design of RFID Mesh Network for Electric Vehicle Smart Charging Infrastructure", 2013 IEEE International Conference on RFID Technologies and Applications, In press**
- This paper aims to discuss the application of RFID technology in the battery charging stations, and analyse the technical advantages of RFID technology in the electric vehicle identification as well as the unified management of the battery charging compartment. Here for the output power supply SMPS (switching mode power supply) is used. The Internet of Things, also called things linked internet, it refers to a kind of network that adopts RFID (radio frequency identification) and to enable the linkage between any articles and the internet, to enable the exchange and communication of information. The UCLA Smart-Grid Energy Research Center (SMERC) has been developing the WIN Smart EVTM [5-8] research platform to solve the inherent problems with the current approach to PEV charging. In order to address the inability of current systems to respond to grid-imposed constraints, WIN Smart EVTM consists of a centrally controlled network of charging stations.
- **[2] S.Banu Prathap, R.Priyanka, G.Guna, Dr.Sujatha, " Coin Based Cell Phone Charger", International Journal of Engineering Research & Technology (IJERT) , ISSN: 2278-0181, Vol. 2 Issue 3, PP.1-4, March – 2013.**
- The user has to plug the phone into one of the adapters and insert the coin for the charging at constant current for a definite time period. Coin detecting mechanism is used to detect the coin. When the user inserts the coin, this will detect the coin and send a corresponding signal to the signal conditioning unit in which the incoming signal is converted into square pulse and then given to microcontroller. The microcontroller used is Atmel, which is a type of reprogrammable microcontroller. The microcontroller is already programmed when the user inserts the coin, in the coin detecting mechanism detects the coin, and it generates the pulse to the microcontroller through signal

conditioning unit. The microcontroller activates the driver circuit for particular time period as per coin inserted in the machine. Driver circuit consists of transistor, it just acts as switch to turn ON, turn OFF MOSFET. The MOSFET output is directly connected to charging circuit. The different cell phone charging socket is connected in the charging circuit. Such as Nokia, Motorola, Samsung, LG, Sony, Apple, Tab, Etc. By using this paper we can charge the cell phone as per coin inserted in the machine.

- **[3] T. Chandrashekhar, G. swaminadu Ch. babu Rao, “Coin based mobile charger using Solar tracking system”, ISSN: 2278-909X, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Volume 2, Issue 9, PP 741-745, September 2013.**

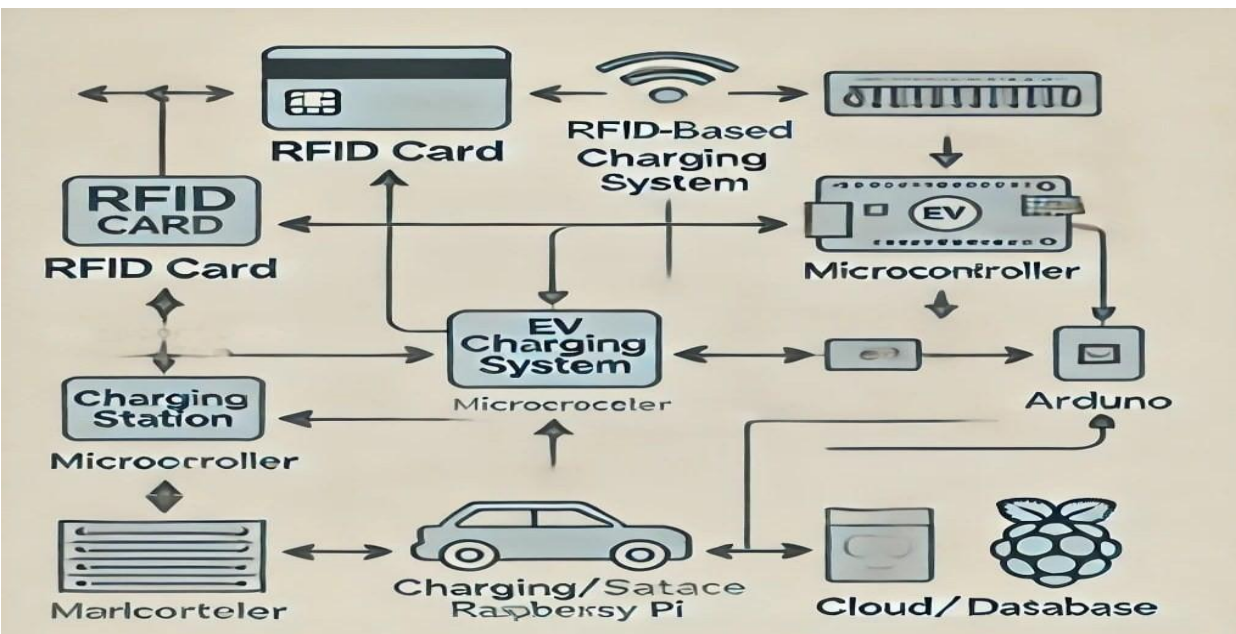
- The mobile phones are play’s vital role in the present communication. The coin-based mobile battery charger developed in this paper for providing a unique service to the rural public where grid power is not available for partial/full daytime and a source of revenue for site providers. This can be quickly and easily installed outside any business premises. This type of charger will be very useful for the public people; many times the battery becomes flat in the middle of the conversation in particularly at inconvenient times when access to a standard charger isn’t possible. The power supply for the charger is determined from solar power and current supply. When we put a coin, the coin detector detects the coin and the input is given to the controller. MOSFET acts as the switch in the circuit. This circuit can be placed in public places such as Bus stands, Railway stations.

# CHAPTER 3

## 3.1 METHODOLOGY

The implementation of an RFID-based Electric Vehicle (EV) Charging System involves several key steps, integrating RFID technology with an EV charging setup for seamless user authentication and payment. Below is a detailed methodology to design and implement such a system.

The RFID-based EV Charging System provides secure, automated access to EV chargers. The system allows users to authenticate themselves by scanning their RFID cards or tags at the charging station, which triggers the activation of the charging process. The system is integrated with a backend server for managing payments and monitoring the charging progress.




The RFID-based EV charging system methodology involves the integration of RFID technology to streamline user authentication and charging management. Users register their RFID cards or tags, which are linked to their accounts for easy identification. Upon arrival at a charging station, users scan their RFID tags, allowing the system to authenticate them and grant access to available charging slots. The charging process is then initiated, with real-time monitoring of energy consumption and session data. Once charging is complete, the system calculates the total cost based on the energy used and facilitates secure payment via an integrated payment gateway. The entire process is automated, enhancing convenience, security, and efficiency for both users and operators. The system also records session data for future analysis and billing purposes, offering scalability and ease of management for multiple charging stations.

## System Design and Architecture

Hardware Setup The system is built around RFID-enabled charging stations, where each station is equipped with an RFID reader, communication interface, and power management system. Each Electric Vehicle (EV) is assigned a unique RFID tag or card.

## User Registration

Users register for the service by creating an account with their personal details and payment information, linked to an RFID tag (card or key fob).

## Charging Process Management

Upon authentication, the microcontroller activates the charging relay. Sensors track power usage (kWh), voltage, and current.

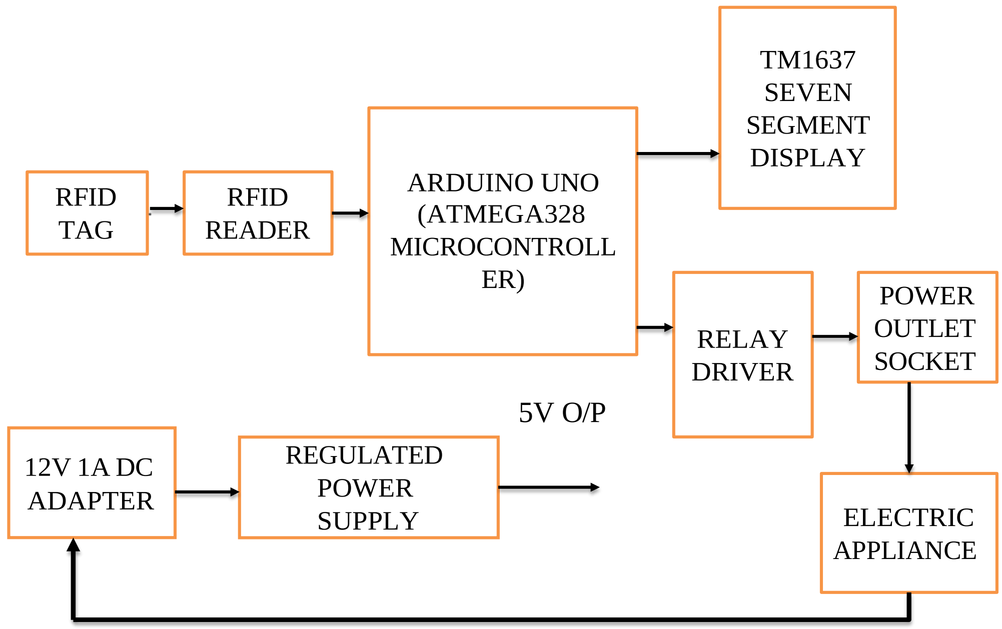
## Data Logging and Analytics

Log each session's data User ID, charging duration, energy consumed, cost, and timestamp.

To develop a smart vehicle charging station. we are using AVR microcontroller for this project as a controller.

RFID tag is on powered and when it comes in a contact with RF ID radar, which is powered it send. The unique ID to the microcontroller, then micro controller, check the code and identify the user.

## 3.2 BLOCK DIAGRAM WITH DESCRIPTION




A smart Electric vehicle charging infrastructure is composed of electric vehicle, electric vehicle supply equipment (EVSE), connectors connecting vehicle to EVSE and secure network connecting EVSE to the IoT cloud service to transmit data using secured wireless technology. The IoT cloud service offers applications that receive, analysis and manage data in real-time to assist EV users in making real time decision that would enhance the quality of EV charging. Here while tapping the RFID tag into the RFID reader then the signal is given to the Arduino controller board. Next step the user can select the output port because of in this smart charging system has the three level of output ranges like 60V output, 48V output and 12V output ranges. The Smart EV charging station is an innovative product developed for the growth of both two-wheeler and four-wheeler.

## MICROCONTROLLER

A microcontroller is a compact integrated circuit designed to perform a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input / output (I/O) peripherals on a single chip. A microcontroller is embedded inside of a system to control a specific function in a device. It does this by interpreting data it receives from its I/O peripherals using its central processor. The temporary information that the microcontroller receives is stored in its data memory, where the processor accesses it and uses instructions stored in its program memory to perform different actions.

The core elements of a microcontroller are:

**Central Processing Unit (CPU)** -- A processor can be thought of as the brain of the device. It processes and responds to various instructions that direct the microcontroller's function. This involves performing basic arithmetic, logic and I/O operations. It also performs data transfer operations, which communicate commands to other components in the larger embedded system.

**Memory** -- A microcontroller's memory is used to store the data that the processor receives and uses to respond to instructions that it's been programmed to carry out. A microcontroller has two main memory types:

Program memory, which stores long-term information about the instructions that the CPU carries out. Program memory is non-volatile memory, meaning it holds information over time without needing a power source.

Data memory, which is required for temporary data storage while the instructions are being executed. Data memory is volatile, meaning the data it holds is temporary and is only maintained if the device is connected to a power source.

**I/O peripherals** -- The input and output devices are the interface for the processor to the outside world. The input ports receive information and send it to the processor in the form of binary data. The processor receives that data and sends the necessary instructions to output devices that execute tasks external to the microcontroller.

While the processor, memory and I/O peripherals are the defining elements of the microprocessor, there are other elements that are frequently included. The term I/O peripherals itself simply refers to supporting components that interface with the memory and processor. There are many supporting components that can be considered as peripherals.

**Arduino**-- Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It is a single board microcontroller, descendant of the open-source wiring platform designed to make the process of using electronics in multidisciplinary projects. The hardware consists of a simple open hardware design for the Arduino board with an on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the board. Arduino hardware is programmed using a Wiring-based language (syntax and libraries), similar to C++ with some slight simplifications and modifications, and a Processing-based integrated development environment.

**Arduino Hardware:** Arduino Uno board is based on the ATmega328 microcontroller. Current Arduino boards are programmed via USB, implemented using USB-to-serial adapter chips such as the FTDI FT232.

The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. Arduino Uno provides 14 digital I/O pins, 6 of which can produce pulse-width modulated (PWM) signals. It has 6 analog channel inputs.

**Technical Features of Arduino Uno Board**

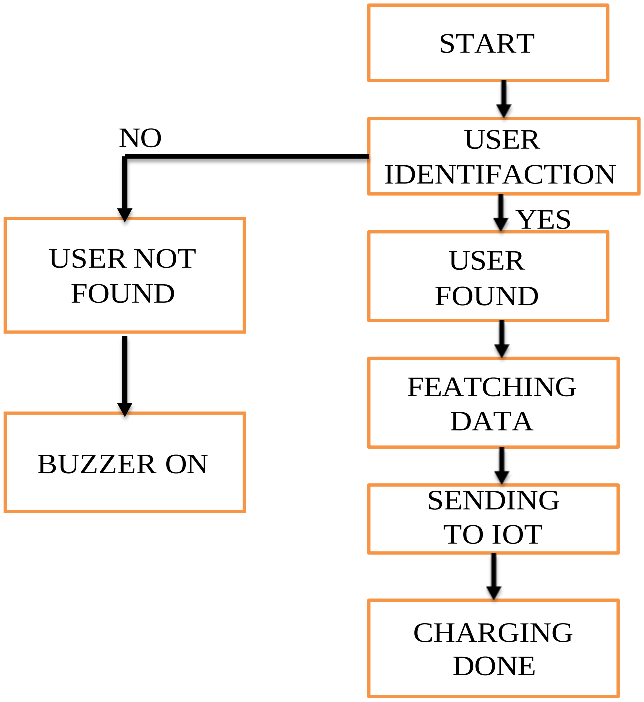
- ATmega328 microcontroller
- Input voltage - 7-12V
- 14 Digital I/O Pins (6 PWM outputs)
- 6 Analog Inputs
- 32k Flash Memory
- 16Mhz Clock Speed
- The maximum values that Arduino can handle:
- Max frequency: 16MHz
- Max Voltage: 5V

- Max Current: 50mA


**Pin Description**

- Arduino can be powered using power jack, USB port. Apart from this it can also be powered by using a external battery or AC to DC adaptor through pin Vin.
- 5V, 3.3V: there is a inbuilt regulator on the board. Through this regulator a constant DC supply of 5V, 3.3V is provided.
- Reset: This pin enables to reset the micro controller.
- IOREF: This pin acts as reference to the inputs given to the arduino board.
- There are 6 pins A0 – A5 through which analog input can be given to the arduino board.
- There are 14 digital pins 0-13. Among these (3,5,6,9,10,11) are PWM pins(pulse width modulation) from which analog output can be taken from the arduino board.
- There is a inbuilt LED on pin 13.
- AREF- This pin acts as reference to the analog inputs.
- Rx,Tx are used for receiving and transmitting serial data.
- ICSP- (In circuit serial programming)- These pins enable the user to programme the chips on the circuit.

## 3.3 Flow Chart



# CHAPTER 4

## 4.1 IMPLEMENTATION

### 4.1.1 System Design

Step 1: RFID Registration & User Authentication

- RFID Tag Registration: Users must first register their RFID cards/tags at the charging station or via a mobile app. Registration includes associating the RFID tag with a unique user account that holds payment and personal information.
- RFID Tag Scanning: When a user approaches the charging station, they scan their RFID tag against the RFID reader.

Step 2: RFID Reader Interaction

- RFID Scan: The RFID reader scans the RFID tag to extract the unique ID associated with the user.
- Authentication: The reader sends the unique RFID ID to the server for verification. If the user is valid and registered, the server responds with an authentication confirmation.

Step 3: Charging Session Initiation

- Charging Slot Availability: Once authenticated, the system checks if the charging station is available. If so, it allows the user to initiate charging.
- Charge Start: The charging station is activated, and the EV starts charging. The UI provides real-time updates on the charging process, such as energy consumption, current voltage, and estimated time to full charge.

Step 4: Energy Consumption Monitoring

- Monitoring: The system continuously monitors the energy consumed during the charging session. Data such as kilowatt-hours (kWh) used, time spent, and charging rate are recorded.

- Charge Completion: Once the vehicle is fully charged or the user decides to stop, the system ends the session and calculates the total cost.

Step 5: Payment Processing

- Cost Calculation: The total cost of charging is calculated based on the energy consumed (kWh), the rate per kWh, and any other applicable fees.
- Payment Gateway: The user is prompted to pay for the service. The system integrates with a payment gateway, either via a mobile app or credit/debit card, to process the payment securely.
- Payment Confirmation: Once the payment is processed, the charging session is logged, and the user receives a confirmation receipt via the app or email.

Step 6: Session End and Data Storage

- Session Termination: After the payment is completed, the charging station is turned off, and the user is notified that the charging process is complete.
- Data Logging: All session data, including the energy consumed, payment, and duration, is logged into the system for future reference or analysis.

### 4.1.2 IMPLEMENTATION STEPS

A. HARDWARE SETUP

1. Install RFID Reader: Mount the RFID reader at the entry point of the EV charging station.
2. Connect Charging Station: Set up the EV charging unit and ensure it is connected to a power source.
3. Integrate User Interface: Install the user interface (UI) system to display real-time information.

4. Connect Backend: Set up a server or cloud infrastructure to manage user data, session data, and payment processing.

B. SOFTWARE DEVELOPMENT

1. Backend Server: Develop the server to manage user authentication, charging session management, energy monitoring, and payment processing.
2. Mobile App/Website: Create a user-friendly app or web portal where users can register, check charging station availability, view historical data, and make payments.
3. Payment Gateway Integration: Integrate payment systems like credit card processing or mobile wallet systems.
4. Data Analysis: Implement a data logging and analytics system to track energy consumption, revenue, and user behavior.

C. TESTING

1. RFID Tag Scanning: Test the RFID reader for reliable scanning and user identification.
2. Charging Functionality: Ensure that the charging process works smoothly and the system accurately tracks energy consumption.
3. Payment Flow: Verify the end-to-end payment flow, including cost calculation, payment gateway integration, and receipt generation.
4. User Experience: Test the mobile app or UI for ease of use and responsiveness.

# 4.2 COMPONENTS REQUIREMENT

## 4.2.1 HARDWARE REQUIREMENT

- RFID TAGS
- RC522 RFID READER
- ARDUINO UNO BOARD (Atmega 328 microcontroller)
- TM1637 SEVEN SEGMENT DISPLAY

- RELAY
- POWER OUTLET SOCKET
- REGULATED POWER SUPPLY
- 12V 1A DC ADAPTER
- RFID READER

1. RFID Tags: These are small devices that hold information and communicate with the RFID reader.

2. RC522 RFID Reader: A device to read data from RFID tags.

3. Arduino Uno Board: A microcontroller board used to control the project.

4. TM1637 Seven Segment Display: A digital display for showing numbers or messages.

5. Relay: An electronic switch to control high-power devices like the power outlet.

6. Power Outlet Socket: A socket to connect electrical devices.

7. Regulated Power Supply: Ensures a stable power output for the components.

8. 12V 1A DC Adapter: A power adapter providing 12 volts and 1 amp of current to the system.

**Hardware Components Description:**

**Voltage Regulator**

This is the most common voltage regulator that is still used in embedded designs. LM7805 voltage regulator is a linear regulator. With proper heat sink these LM78xx types can handle even more than 1A current. They also have Thermal overload protection, Short circuit protection. This will connect at the output of rectifier to get constant dc supply instead of ripple voltages. It mainly consists of three pins:

1. Input voltage

2. Ground

3. Output voltage

**Regulated Power Supply Board**

Power supply regulation is the ability of a power supply to maintain an output voltage constant inspite of changing conditions of input voltage and/or load. We can use 7805,7806,7809,7912 ICs for voltage regulation purpose. Picture below shows regulated power supply board with 7812 IC and 7805 IC.


**Single Channel Relay Module**


Relay is basically an electromagnetic switch. We are using an electric appliance which is connected to high voltage. Relay used here works on 5V dc power supply and it simply acts as a switch. The necessary control signal is applied to relay module using microcontroller I/O Pin. This is active low signal operated relay module so we need to provide logic LOW in order to make relay active.

**RFID Reader**

**Introduction to RC522 RFID Reader**

The RC522 RFID Reader/Writer Module (Transceiver) is based on a highly integrated reader/writer IC MFRC522 from NXP Company. It is used for contactless Multi-communication at 13.56 MHz. The RFID stands for Radio Frequency Identification. This module uses electromagnetic waves in radio frequency to transfer data (read/write). It can read/write all types of Transponders (RFID card tags and key fob tags) which having 1KB memory and compatible with 13.56 MHz frequency. This is a low-voltage, low-cost, small-sized module and It comes with SPI protocol which enables it to easily interface with almost any microcontroller like ATTiny, Arduino, ESP8266, Raspberry Pi, and other more advanced development boards.

**Hardware Overview**

In the market or online the RC522 RFID module comes as a kit set, which consists of the RC522 RFID Reader Module (transceiver), RFID Card Tag, Key Fob Tag, and 8 pin male headers.

Hardware Overview of RC522 RFID Reader Module


**RC522 RFID Reader Module**

The RC522 RFID Reader Module or Transceiver is a reader/writer device that is capable of reading/writing data from/to an RFID transponder. It consists of 3 key components, these are the MFRC522 IC, a 27.12 MHz Crystal Oscillator, and Antenna.


Reader Module (Transceiver)

**Working Principle of RFID RC522 Module**

The RFID reader module or Transceiver uses electromagnetic waves in radio frequency to transfer data. The control unit and an antenna coil of the reader module generate a high-frequency electromagnetic field. When an RFID tag or Transponder comes in the range of the electromagnetic field (detection range) of an RFID reader module (Transceiver). Due to mutual induction, a voltage is generated in the antenna coil of the tag, and this voltage work as a power supply for the microchip. Now, the tag starts transmitting data serially and the reader read the tag information.

**Arduino Uno Interfacing with RC522 RFID Reader**

### RC522 RFID Reader Connections with Arduino Uno Board

| RC522 RFID Reader | Arduino UNO / Nano |
|---|---|
| RST | 9 |
| SS | 10 |
| MOSI | 11 |
| MISO | 12 |
| SCK | 13 |

### TM1637 Display

We are using TM1637 module which basically uses seven segment displays. We can display numeric information and it is used here as a count down timer.

### 4.2.2 SOFTWARE REQUIRMENT

- AUDUINO UNO
- EMBEDDED CPP CODE

1. Embedded CPP Code: Programming code written in C++ to control the components.

2. Arduino IDE: Software used to write, compile, and upload the code to the Arduino board.

**Arduino Software:**

The Arduino IDE is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click.

The Arduino IDE comes with a C/C++ library called "Wiring" (from the project of the same name), which makes many common input/output operations much easier. Arduino ide programs are written in C/C++, although users only need define two functions to make a program:

**1.VOID SETUP(): Setup ()** is called when a sketch starts. It is used to initialize variables, pin modes, start using libraries etc. The **setup ()** will only run once, after each power up or reset of the Arduino board.

**Syntax:**

```
Void setup ()

{

Statement(s);

}
```

**2. Void loop ():**

After creating a **setup ()** function which initializes and sets the initial values, the **loop ()** function does precisely what its name suggests, and loops consecutively, allowing your program to change and respond. It is used to actively control the Arduino board.

**Syntax:**

```
Void loop ()

{

Statement(s);

}
```

# CHAPTER 5

## 5.1 RESULTS AND DISCUSSIONS

Here in this system we have to provide three level of outputs. In normal EV charging points there is a single output port only available but here in this system provide up to three output ports like 60V, 48V, 12V Output ports. While tapping the RFID Tag into the RFID reader then the reader reads the specific value in the tag after that the signal passes through the Arduino controller then the controller switches the particular relay coil. Finally, the EV system is get charged for particular predetermined time duration. Wi-Fi module is connected with the Arduino controller while tapping the RFID tag the information has send to the owner and the total time of charging is stored in the cloud storage. This type of charging process reduce the complexity of payment method and reduce the components of EV chargers because the single system provide three outputs. Then the total consumption of power and charging period of time all the information's are stored in the cloud platform so the owner can easily access the date from the cloud.

# CONCLUSION

In future the demand of EV system is necessary to control the air pollution as well as the global warming. Internet of Things (IoT) based smart charger has been developed to monitor status of batteries in EV systems. The IoT which is developed here uses a cloud platform and Android Apps for communication purposes. The car user can easily check the usage of his charging process. The data stored in the Adafruit IO lasts for 30 days. For future work, handling of multiple users could be implemented so as to compare the status of different users. The RFID-based EV charging system offers a seamless, efficient, and secure solution for electric vehicle owners and charging station operators. By automating authentication, payment, and monitoring, it enhances user experience and reduces manual intervention. The system provides real-time data, ensuring efficient resource management and scalability as EV adoption grows. With secure payment processing and easy integration, this system supports the widespread expansion of charging infrastructure. As the demand for electric vehicles increases, RFID-based systems will play a crucial role in supporting sustainable, smart mobility solutions for the future.

## ADVANTAGES

- Convenience and Ease of Use
- High Security and Access Control
- Efficient Energy Management
- Enhanced User Experience
- Reduced Operational Costs
- Improved Infrastructure Management

## DISADVANTAGES

- Limited Range and Compatibility
- Limited Innovation
- Limited User Options

# REFERENCES

**[1]** S.Banu Prathap, R.Priyanka, G.Guna, Dr.Sujatha, " Coin Based Cell Phone Charger", International Journal of Engineering Research & Technology (IJERT) , ISSN: 2278-0181, Vol. 2 Issue 3, PP.1-4, March – 2013.

**[2]** C. Y. Chung, A. Shepelev, C. Qiu, C. C. Chu, Rajit Gadh, "Design of RFID Mesh Network for Electric Vehicle Smart Charging Infrastructure", 2013 IEEE International Conference on RFID Technologies and Applications.

**[3]** T. Chandrashekhar, G. swaminadu Ch. babu Rao, "Coin based mobile charger using Solar tracking system", ISSN: 2278-909X, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Volume 2, Issue 9, PP 741-745, September 2013.

**[4]** IEEE Xplore Digital Library – https://ieeexplore.ieee.org/. A reliable source for research papers, technical articles, and journals about RFID and electric vehicle charging systems.