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EV Charging Station with Solar Base (RFID)

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Abstract: *Electric vehicle is a new and upcoming technology in the transportation and energy sector that has many advantages in terms of economic and environmental aspects. This study presents a comprehensive review and evaluation of specialized battery chargers and charging stations for various types of electric vehicles and their associated equipment. Commercial and prototype electric vehicles are compared in terms of electric range, battery size, charger power and charging time. Diffrentrent types of charging stations and standards used for charging electric vehicles are outlined and the impact of electric vehicle charging on utility distribution systems is also discussed.*

Keywords: Battery charger, charging station, electric vehicle, standards

I. INTRODUCTION

Background

An electric vehicle charging station is a device that connects an electric vehicle (EV) to a power source to recharge electric cars, hybrid electric vehicles, and plug-in hybrids. Some charging stations have advanced features such as smart metering, cellular capabilities and network connectivity, while others are more basic. Charging stations are also called electric vehicles equipment supply companies (EVSE) are supplied by utility companies in urban parking lots or by private companies in shopping malls. These stations provide special connectors that conform to electric charging connector standards. EVSE usage charges vary from monthly or annual flat rates to per-kWh to hourly rates. Charging stations can be free and are usually subsidized by local governments. Different types of EVSE offer different charging speeds. Level 1 charging stations use a 120 volt (V), alternating-current (AC) plug and require a dedicated circuit, offering about 5 miles of range for each hour of charging. Level 2 stations charge via a 240V, AC plug and require home charging or public charging equipment to be installed. Level 2 stations provide a range of 10 to 20 miles per hour of charging. Level 2 chargers are the most common and charge at the same rate as a home system. Level 3 chargers are also known as DC fast chargers. Level 3 uses a 480V, direct-current (DC) plug. They bypass the onboard charger and supply DC power to the battery through a special charging port. DC fast chargers offer a range of up to 40 miles per 10 minute charge but are not compatible with all vehicles. In addition, some proprietary charging stations, such as the Tesla Supercharger, are designed for significantly higher-speed charging. As the demand for more publicly accessible charging stations increases, there is a greater need for devices that support fast charging at higher voltages and currents not currently available from residential ESVEs. Globally, an increasing number of electric vehicle networks provide systems of publicly accessible charging stations for EV recharging. Governments, automakers and charging infrastructure providers have forged agreements to build these networks.

Theme

Energy in the form of electricity plays a very important role in our daily life. Electricity is one of the great wonders of science. Next to man, it is the most important and revolutionary creation in our world. The slow but rampant use of electricity has led to remarkable changes in industry. Computers as calculators perform sums and other calculations with great precision. Newspapers and books are printed in millions overnight. There is no phase of human life which is not indebted to the advancement of electricity. That is why the modern age has truly been called the "age of electricity". The infrastructure component that provides the critical link with a depleted battery in an electric vehicle (EV) and the electrical source that recharges those batteries is the Electric Vehicle Supply Equipment, or EVSE.

Problem Statement

The aim of the RFID based EV charging station is that the system takes advantage of the opportunities of connectivity with the computational capabilities of big data (as we are using Google Sheets to store information). First, source data to support defining use cases that represent driving patterns and functionality. Second, the connection to big data and computing capabilities in the cloud enables optimization of EV energy leading to new functionalities such as reliable range estimation, eco-driving, eco-routing as well as smart fast charging and assured charging.

II. LITERATURE REVIEW

In recent years, electric vehicles (EV) have received considerable attention as an environmentally-sustainable and cost-effective alternative to vehicles with internal combustion engines (ICE) to address fossil fuel dependence and save greenhouse gas emissions. To define them, organizations consider safety, reliability, durability, rated power and cost of different charging methods. Charging equipment for EVs plays an important role in their development, grid integration and daily use: charging stations usually include charge cords, charge stands, attachment plugs and power outlets, and vehicle connectors and protection systems. The configuration of charging stations can vary from country to country based on frequency, voltage, electrical grid connection and standards. In any case, the charging time and lifetime of the battery of an EV is linked to the characteristics of the charger which must first guarantee a proper charge of the battery. Then a good charger should be efficient and reliable, high power density, low cost and low noise and weight. After an in-depth overview of different types of EV charging stations and a comparison between the relevant European and American standards, the paper includes a summary of the possible types of Energy Storage Systems (ESSs) and possible layouts of charging stations with them. ESSs can become fundamental for the integration of last-generation EV fast charging stations into smart grids: in this case storage can have peak shaving and power quality functions, and also to reduce charge times. From this brief analysis, it is possible to conclude that a good ESS for coupling fast EV charging stations can be considered as a system with batteries and ultra-capacitors: the former are suitable for their high energy density and the latter for their high energy density. Regarding the integration of ESSs, another important issue investigated is the way of integration in terms of energy planning. Two possibilities are found in the literature based on AC-bus configuration and DC-bus configuration. The AC-bus scheme is generally preferred, as the standards for AC components are well defined and AC technology and products are already available in the market. However, DC-bus based systems provide a more convenient way to integrate renewable energy sources and also provide higher energy efficiency thanks to the lower number of conversion stages.[1]

In paper [2], fast charging of electronic vehicle is explained. The versatile converter topology is based on the concept of a power electronic transformer. For direct transformer-less coupling to the medium-voltage grid, a cascaded h-bridge (CHB) converter is used. At the level of each sub module, integrated split battery energy storage elements play the role of a power buffer, thus reducing the impact of charging stations on the distribution grid. The power interface between the stationary split storage stage and the EV batteries is performed through the use of a parallel-connected dual-half-bridge dc/dc converter, shifting the isolation requirement to the medium-frequency range. By choosing several different sub-module configurations for parallel connection, a multiport output concept is achieved, which means the ability to charge multiple EVs simultaneously without using additional high-power chargers.

A four-stage intelligent optimization and control algorithm for an electric vehicle (EV) bidirectional charging station equipped with photovoltaic generation and fixed battery energy storage is proposed in this paper. The proposed algorithm aims to minimize customer satisfaction-related operational costs by considering possible uncertainties, and balance real-time supply and demand by adjusting optimally scheduled charging/discharging of EV mobile/local battery storage, grid supply, and deferrable loads. . . [3] Paper [4] discusses the power electronics aspects of EV charging stations. Paper [5] discusses a charging station model for fast DC charging. DC bus is realized using grid connection through AC/DC converter. The converter is designed to achieve close to unity power factor operation and minimum line current. Harmonics are removed. Better performance is observed with changes in load. The results show the correct dynamic behavior of DC bus voltage, battery voltage and battery current. Line current harmonics are greatly reduced by using the proposed control technique. Electric vehicles (EVs) have been considered a key technology for reducing greenhouse gas emissions from the transportation sector and are expected to alleviate the problem of fossil fuel depletion. Thanks to

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policies and plans to promote EVs in regions and countries around the world (e.g., in the US, sales of EVs including PHEVs will reach 50% of total sales of mobile vehicles by 2030, and Europe has a similar target), amounting to EVs expected to reach a large market share in the next decade. .[6]

III. METHODOLOGY

1. Introduction

Energy in the form of electricity plays a very important role in our daily life. Electricity is one of the great wonders of science. Next to man, it is the most important and revolutionary creation in our world. The slow but rampant use of electricity has led to remarkable changes in industry. Computers as calculators perform sums and other calculations with great precision. Newspapers and books are printed in millions overnight. There is no phase of human life that is not indebted to the advancement of electricity. That is why the modern age has truly been called the “age of electricity”. The critical link infrastructure between an electric vehicle (EV) and the electrical source that recharges those batteries is the electric vehicle supply equipment, or EVSE.

System Architecture

Solar Panel

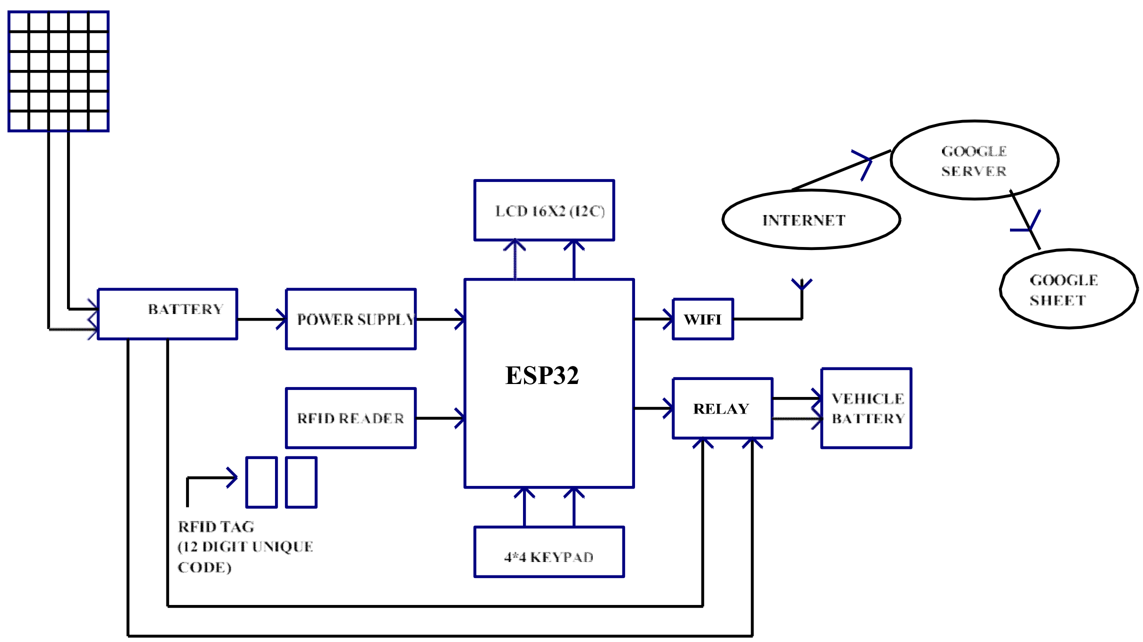

Figure 1: Block Diagram

Working

A prototype EV charging station is proposed that uses renewable energy (solar energy). An electrical vehicle battery recharging system composed of photovoltaic solar panels connected to the electrical power grid. Energy will be stored in batteries with the help of solar panels. Here we are giving each customer an RFID card through which the customer can get petrol at the charging station. Before using this card we have to recharge it like a prepaid card. Whenever we want to charge the vehicle battery, we have to insert the required amount and place the RFID card near the RFID reader. Then the microcontroller reads the data from the RFID reader and acts accordingly customer. This system provides security for vehicle battery charging at EV charging stations by avoiding human intervention for customers, so charge batteries on hourly basis every time and as needed to avoid risk of cash flow. All data is displayed on the OLED and saved in Google Sheets. While the vehicle is parked at the charging station, the vehicle battery will be charged by charging the station battery.

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System Design

Overall system design involves following steps:

- Power Supply Design
- Interfacing various modules to micro-controller
- PCB designing

Let's focus on the steps one by one

Power Supply

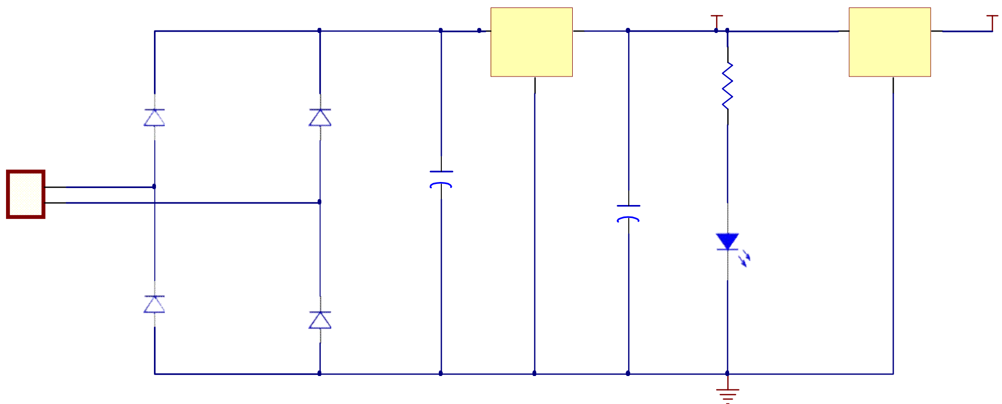

Figure 2: Power Supply

The following information must be available to the designer of the transformer.

- Power output.
- Operating voltage.
- Frequency range.
- Efficiency and regulation

Size of core is one of the first consideration in regard of weight and volume of a transformer. This depends on type of core and winding configuration used. Generally following formula is used to find Area or Size of the Core.

Ai = √ Wp / 0.87

Where Ai = Area of cross section in square cm.Wp = Primary Wattage.

For our project we require +5V output, so transformer secondary winding rating is 9V, 500mA. So secondary power wattage is,

P2 = 9 * 500mA

= 4.5Watt

So, Ai = √ 4.5 / 0.87 = 2.43

Generally 10% of area should be added to the core.

So, Ai = 2.673

per volt:- Turns per volt of transformer are given by relation. Turns per volt = 100000 / 4.44 f * Bm * AiWhere, F = Frequency in Hz.

Bm = Density in Wb / Square meter.Ai = Net area of the crosssection.

Following table gives the value of turns per volt for 50 Hz frequency.

Flux density 0.76 Wb /sq m	1.14	1.01	0.91	0.83
Turns per Volt 45 / Ai	40 / Ai	45 / Ai	50 / Ai	55 / Ai

Generally lower the flux density better the quality of transformer. For our project we have taken the turns per volt is 0.91 Wb / sq.m from above table. Turns per volt = 50 / Ai
= 50 / 2.673
= 18.7055
Thus the turns for the primary winding is, 230 * 18.7055 = 4302.265And for secondary winding,
9 * 18.7055 =168.3495

Wire Size :- As stated above the size is depends upon the current to be carried out by winding which depends upon current density. For our transformer one tie can safely use current density of 3.1 Amp / sq.mm.
for less copper loss 1.6Amp/sq.mm or 2.4sq.mm may be used generally even size gauge of wire are used.
R.M.S secondary voltage at secondary to transformer is 9V. so maximum voltage Vm(Vp) across secondary is VP = Vrms x√2
Vrms =VP / √2
= 9 / 1.141
= 7.88
D.C output voltage Vm across secondary is, Vdc = 2 * 7.88/pi
= 2 * 7.88/3.14
= 5.02 V
P.I.V rating of each diode is PIV = 2Vdc
= 2 * 5.02
= 10.04 V
Maximum forward current, which flow from each diode is 500 mA. So from above parameter, we select diode 1N4007 from the diode selection manual.

B) Design of Filter Capacitor
Formula for calculating filter capacitor is C = ¼ √ 3 r * F * R1
Where, r = ripple present at output of rectifier, which is maximum 0.1 for full wave rectifier.F = frequency of AC main.
R1 = input impedance of voltage regulator IC C = 1/(4 *(√ 3 * 0.1 * 50 * 28))
= 1030 µf
= 1000 uF
Voltage rating of filter capacitor should be greater than the i/p Vdc i.e. rectifier output which is 5.02 V so we choose 1000µf / 25V filter capacitor.

PCB Design
Printed circuit boards can be included in two topics; Technology and Design. Printed circuit boards are abbreviated as PCB. A printed circuit consists of a conductive circuit pattern applied to one or both sides of an insulation base, depending on whether it is called a single-sided PCB or a double-sided PCB (SSB and DSB). Conductor materials such as silver, brass, aluminum and copper are widely used. The thickness of the conductive material depends on the current carrying capacity of the circuit. Thus a thicker copper layer has a higher current carrying capacity.
A printed circuit board usually performs three different functions:

- It provides mechanical support for the components mounted on it.
- It provides necessary electrical interconnections.
- It acts as a heat sink that is it provides a conduction path leading to removal of most of the heat generated in the circuit.

Manufacturing process of printed circuit board:
The conductor pattern which is on the master film is transferred on copper clad laminate by two methods:

- Photo resist printing
- Screen printing.

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Photo Resist Printing

A photopolymer resist is a light sensitive organic material such as KPR (Kodak Photo Resist) that is applied to the board as a thin film. Photo hardens or polymerizes when exposed to ultraviolet light. Once it is polymerized, it becomes insoluble to certain chemical solvents known as developers

Developer dissolves masked or unexposed areas. Thus the pattern printed on the PCB is removed by a photographic process. This is transferred to the master film at a 1:1 scale. Miniaturization is possible as it can be reduced to any smaller size. The sample is transferred to the mask. This mask is placed on the PCB. The entire process is known as image transfer.

The polymerized or masked area is washed in developer and the copper pattern placed on the KPR board or photo resist is removed. Photo Resist Requirements:

- It should have good resolution and light sensitivity.
- It should be resistant to developers which are used to remove unwanted copper.
- It should have possibility to strip after unwanted copper is removed.
- Its cost must be less.

Photo resist is normally applied by:

- Flow coating OR
- Roller coating OR
- Dip coating OR
- Spraying

Screen Printing

This technique is similar to that used in the printing industry. Copper foil is covered with printing ink where the conducting paths will be. The screen used for the pattern is stainless steel or polymer mesh that is dimensionally accurate and fine mesh. The opening of the screen corresponds to the lattice pattern.

The PCB is placed under the screen. Printing ink is placed at one end of the screen and pushed through the opening with a rubber squeegee. The printed circuit board is then removed to dry. After drying the board is washed in ferric chloride which acts as an etchant. Etching is a chemical process by which unwanted copper is removed. The ink covered area is not removed, the pattern remains. The ink is then extracted with trichloroethylene.

Protection of Copper Tracks

Long exposure to the environment tarnishes copper and causes problems with soldering. Tracks can be protected by applying lacquer or varnish depending on the thickness of the track. Copper is also protected by plating. There are three methods of plating.

- Immersion plating
- Electro less plating
- Electroplating

Immersion plating uses tin and its alloys and gold. This coating material is chemically modified from a salt solution. This method is simple and less expensive. Electroless copper coating does not use electric current. Instead, a chemical reducing agent is used that supplies electrons for the reaction in which copper is reduced from its ionic state. In electroplating, a DC current is passed through the two electrodes and a thin coating is deposited on the cathode when immersed in the electrolyte.

Etching:

The removal of unwanted copper to give the final copper pattern is called etching. Solutions used in etching are known as etchants.

- Ferric chloride
- Cupric chloride

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- Chromic acid
- Alkaline ammonia

Among these chemicals, ferric chloride is widely used because of its shorter etching time and longer shelf life. Rinsing follows etching.

Solders and Soldering Techniques

Solders are special alloys used to obtain mechanically strong joints or electrical joints with low contact resistance. Solder has a lower melting point than the metals to be joined. So when the solder is heated, the molten solder wets the metal, the spread and the joints. Any contamination on the surface of the metal to be joined acts as a bond and hinders the wet process. Solders are divided into two groups, soft and hard. Soft solder has a low melting point and low tensile strength. Soft solders are mainly tin lead alloys and silver based compositions. Flux is an auxiliary material used in soldering.

- They dissolve and remove oxides and contaminants from surface of metals to be soldered
- They protect the metal surface and molten solder from oxidation.
- They reduce the surface tension of molten solder.
- They improve the ability of solder to wet the metal.

Active or acid fluxes: They are prepared on the basis of active substances such as hydrochloric acid, chlorides and fluorides of metals. This flux strongly dissolves the oxide films on the metal surface and allows the solder to adhere better to the base. After soldering, metal, residue must be completely removed. No active current is used in soldering circuit wires of radio equipment.

Acid-free fluxes: These are rosin and rosin base materials in addition to heavy substances such as alcohol and glycerin.

Active fluxes: These include rosin base fluxes containing active ingredients such as hydrochlorides and phosphates of aniline, salicylic acid and hydrochlorides of diethyl amine. The high activity of some of these streams makes primary removal of oxides unnecessary.

Software Requirements

Sr. No	Software Name	Description
1	Arduino IDE	For programming on ESP-32 Microcontroller
2	OrCAD	To designing purpose
3	Altiun	For PCB designing
4	Proteus	For simulation purpose

Table 3: Software Requirements

Arduino IDE

The open source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board. For microcontroller ESP32 we will use Arduino IDE with embedded C programming language.

OrCAD 9.1

This software is primarily used by electronic design engineers and electronic technicians to create electronic schematics, mixed-signal simulations, and electronic prints for creating printed circuit boards. We will use OrCAD for development of software schematics and simulations.

Altium 6.0

Ultium Designer is a PCB and electronic design automation software package for printed circuit boards. It is developed by Australian software company Ultium Limited. We will be using Altium for PCB designing.

Proteus

LabCenter Electronics' Proteus Design Suite, leading EDA software including schematic capture, advanced simulation, PCB autorouting, MCAD integration. Power supply design is done in Proteus and various signals are captured before actual system development.

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Hardware Requirements

Sr. No	Hardware Name	Description
1	ESP -32 Microcontroller	It will use as microcontroller
2	RFID Tags	It will store the information along with tags
3	Solar Panel	It will store the energy of Solar
4	RFID Reader	To read the information provided by RFID Tags
5	LCD with I2C module	To display the result
6	Keypad	For enrolling the new person with the system

Table 4: Hardware Requirements

ESP 32 micro-controller

This is the latest generation of ESP32 IoT development modules. This development board breaks all the ESP32 module pins into a 0.1" header and provides a 3.3 volt power regulator, reset and programming buttons, and an onboard CP2102 USB to TTL converter for direct programming via the USB port. At the heart of this module is the ESP32 chip, which is designed to be scalable and adaptable. The ESP32 integrates a rich set of peripherals, from capacitive touch sensors, Hall sensors, low-noise sense amplifiers; SD card interface, Ethernet, high-speed SDIO/SPI, UART, and I²C. Using Bluetooth, users can connect to their phone or transmit low energy beacons for its detection. The use of Wi-Fi enables greater physical range, as well as a direct connection to the Internet through a Wi-Fi router. Perfect for wearable electronic or battery-powered applications, the ESP32 chip consumes less than 5µA.

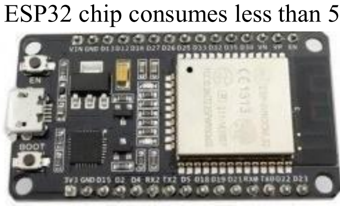

Figure 5: NodeMCU

RFID Tags

This basic RFID tag operates in the 125 kHz RF range and comes with a unique 32-bit ID. It is not reprogrammable. This blank, smooth and mildly flexible RFID tag is ready for your logo.

Figure 6:RFID Tag

Features of RFID:

- EM4001 ISO based RFID IC
- 125kHz Carrier
- 2kbps ASK
- Manchester encoding
- 32-bit unique ID
- 64-bit data stream [Header+ID+Data+Parity]

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Solar Panel

Figure 7: Solar Panel

Features of Solar Panel:

- Voltage : 12 Volts
- Current : 0.4167 Amp
- Power : 5 Watt
- Size : 29 cm x 18.5 cm x 1.7 cm

RFID Reader

RC522-AN module uses Philips MFRC522 original chip design circuit card reader, easy to use, low cost, suitable for equipment development, development of advanced applications reader users, essential for RF card terminal design / production users. This module can be loaded directly into various reader molds. The module uses a voltage of 3.3V, a simple few lines are directly connected to the CPU board with any user through the SPI interface, the communication module can guarantee stable and reliable work, reader distance.

Figure 8: RFID Reader

Specification of RF522 Mifare Reader/Writer

- Module Name : MFRC522-ED
- Working current : 13—26mA/ DC 3.3V
- Standby current : 10-13mA/DC 3.3V
- sleeping current : <80uA
- peak current : <30mA
- Working frequency : 13.56MHz
- Card reading distance : 0～60mm（mifare1 card）
- Protocol : SPI
- data communication speed : Maximum 10Mbit/s Card types supported: mifare1 S50、mifare1 S70、mifare Ultra Light, mifare Pro, mifare Desfire
- Dimension : 40mm×60mm
- Working temperature : -20—80 degree
- Storage temperature : -40—85 degree
- Humidity : relevant humidity 5%—95%
- Max SPI speed : 10Mbit/s

LCD Display with I2C Module

This board has a PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. By default the I2C address is 0x3F, but it can be changed via the 3 solder jumpers provided on the board. It allows controlling up to 3 LCD displays (each with its own address) via a single I2C bus.

Figure 9: LCD Display with I2C Module

Features of I2C Module for 16X2 LCD:

- 5V power supply
- Serial I2C control of LCD display using PCF8574
- Back-light can be enabled or disabled via a jumper on the board
- Contrast control via a potentiometer
- Can have 8 modules on a single I2C bus (change address via solder jumpers) address, allowing
- Size : 41.6mm x 19.2mm

Keypad

Figure 10 : Keypad

Features of keypad:

- This is a Low cost 4X3 Matrix Keypad with 12 Membrane Switches
- 4 x 3 Matrix Membrane Keypad
- 7 pin connector
- Adhesive mounting (sticker on the back side)
- Operation Temperature: 0 to +60 centigrade
- Humidity: 40 centigrade, 90%-95%, 240 hours
- Fexible Circuit Length: Approx. 3.3 inch / 83 mm

An RFID reader will read the RFID tag to identify a specific person. The signal goes to the ESP32 microcontroller and the LCD display will display the code assigned to the 16 X 2 RFID tag. These programs are logged into GoogleSheets via Wi-Fi connectivity of the ESP32 microcontroller. For the prototype we paid Rs. 1/- has been reduced

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Flowchart

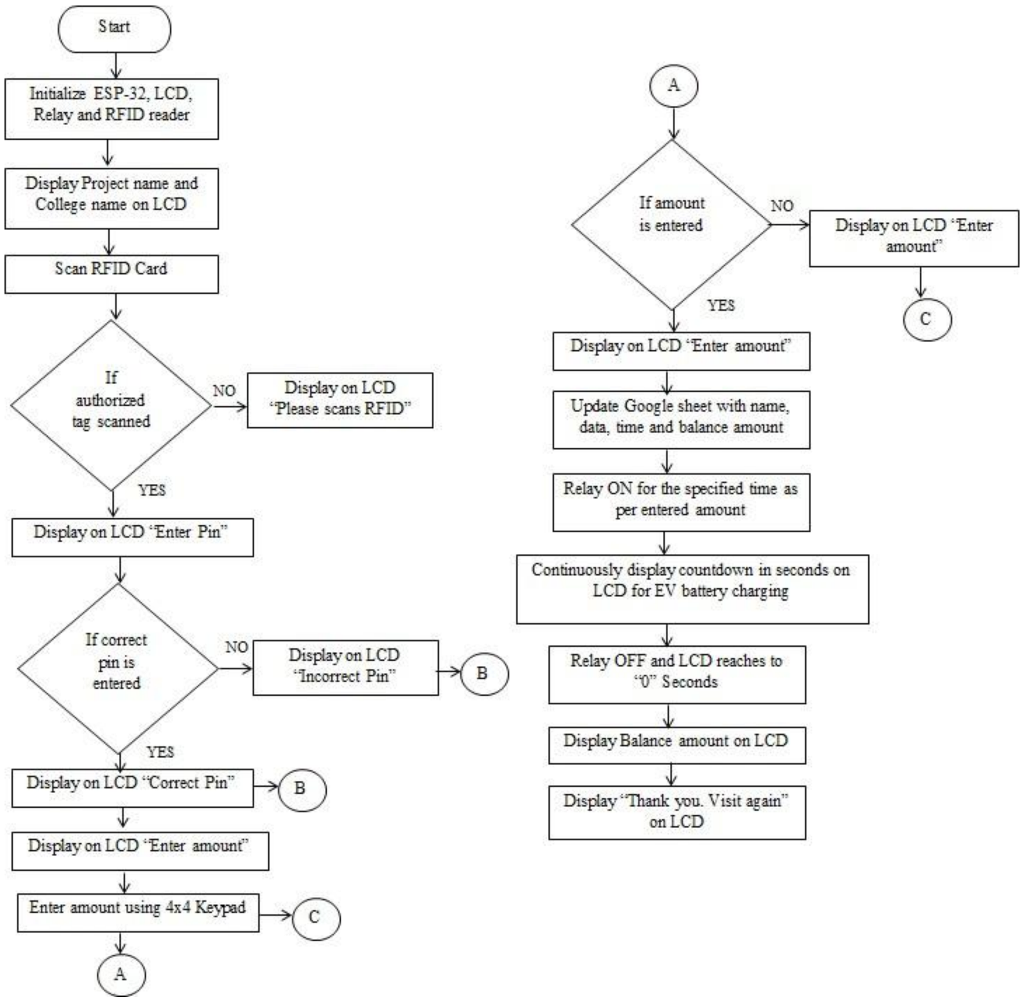

Figure 11: Flowchart

IV. EXPERIMENTAL ANALYSIS

Empirical analysis is based on charging infrastructure, it provides an overview of optimization metrics such as: minimization of various nuisance infrastructure cost types, minimization of total travel time, minimization of travel failures, maximum flow capture, maximization of covered demand, Increasing annoying post usage, reducing numbers Charging stations and grid management. The main objectives are to maximize the utilization of distress points and minimize the number of charging points while meeting maximum demand.

Charging stations with energy storage have some notable synergies with benefits to both the charger user and operator.

Energy storage can buffer and localize solar energy. A charging system with intelligent energy management can localize power electricity for energy vehicle charging and remove demand for energy vehicle charging power from the grid and shift battery recharging to off-peak periods if necessary. Power consumption, energy vehicle charging load, power consumption of the grid and power delivered to the grid are combined to evaluate the energy in the system and utility grid.

Estimation or prediction of energy vehicle charging load is very important for economical operation and optimal control of solar powered battery buffered energy charging stations. The battery target solar based charging station is optimized on the estimated electricity and energy vehicle charging load. Separate other battery buffer charging stations, in which the battery is fully charged during off-peak hours; The battery in the current system is recharged only when the solar

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power battery is less than the optimal target solar power at night. This approach will optimize the use of energy storage and reduce energy exchange with the grid.

An intelligent energy management strategy is best suited for charging station systems with large energy storage batteries and multiple charging outlets.

V. CONCLUSION

A prototype EV charging station with a renewable energy source has been successfully commissioned. The project shows how we can have an accounting facility for EV charging stations with Google Sheets. Using microcontroller with RFID module helps in smooth running of accounting process. Microcontroller programming, power supply design and PCB design are part of the project. The operation of the opto-coupler in isolation of high and low voltage can be easily understood by this procedure. So using regular components, this project implements a prototype EV charging station.

VI. FUTURE SCOPE

- Prototype can be converted into real project with 12th solar panel and 5 watt high configuration solar panel.
- More sophisticated microcontrollers and human machine interface (HMI) options can be used for the control process of EV charging stations.
- RFID modules can be replaced by Wi-Fi card technology used in ATMs or credit cards.

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