Electric Vehicle Charging Station for E-Bike

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Chapter 1

Introduction

1.1 Overview

An electric vehicle, also called an EV, uses one or more electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off vehicle sources, or may be self-contained with a battery, solar panels or an electric generator to convert fuel to electricity. EVs include, but are not limited to, road and rail vehicles, surface and underwater vessels, electric aircraft and electric spacecraft. EVs first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion.

Commonly, the term EV is used to refer to an electric car. In the 21st century, EVs saw a resurgence due to technological developments, and an increased focus on renewable energy. A great deal of demand for electric vehicles developed and a small core of do-it-yourself (DIY) engineers began sharing technical details for doing electric vehicle conversions. Government incentives to increase adoptions were introduced, including in the United States and the European Union. Electric vehicles are expected to increase from 2% of global share in 2016 to 22% in 2030.

During the last few decades, environmental impact of the petroleum-based transportation infrastructure, along with the fear of peak oil, has led to renewed interest in an electric transportation infrastructure. EVs differ from fossil fuel-powered vehicles in that the electricity they consume can be generated from a wide range of sources, including fossil fuels, nuclear power, and renewable sources such as tidal power, solar power, hydropower, and wind power or any combination of those. The carbon footprint and other emissions of electric vehicles varies depending on the fuel and technology used for electricity generation

1.2 Objective

- To enable faster adoption of electric vehicles in India by ensuring safe reliable, accessible and affordable charging infrastructure and eco-system.
- To promote affordable tariff chargeable from EV owners and charging station operators/owners.
- To generate employment/income opportunities for small entrepreneurs.
- To proactively support creation of EV charging infrastructure in the initial phase and eventually create a market for EV charging business.
- To encourage preparedness of electrical distribution system to adopt EV charging infrastructure . Ease of charging.
- To Develop the infrastructure for charging station to cope up with EVs demands.
- To make EV mobility pollution free (power generation using renewable resources)
- Government initiative on EV policy 2030.
- Time to move towards electric vehicle.
- Increase overall awareness and education regarding EV's.
- Encourage off-peak charging. Reduce dependence on foreign oil. Reduce greenhouse gases.

1.3 Aim of Project

1. To control the pollution and make a better Environment (Eco-friendly).
2. To implement charging station on each and every Fuel pump (Malls .etc.)
3. To Attract the people towards Electric Vehicle.
4. To increase the production of electric vehicle in the market.
5. To increase the Employability.

Chapter 2

Literature Review

2.1 Literature Survey

[1] Trends In Electric Vehicle (EV) Charging and Key Technology Developments IJERT,2020

Mr. Navpreet Hans, Mrs. Shikha Gupta

Starting from different charger types used in the various regions of the world to working on wireless and battery swap technology.

[2] International Journal of Research in Mechanical Engineering & Technology, IJRMET 2017

Mr. Kunjan Shinde

Electric bike is a modification of the existing cycle by using electric energy and also solar energy if solar panels are provided, that would sum up to increase in energy production.

[3] Electric Vehicle Charging Station, JETIR April 2020

Avinash Shrivastav, Rahul Gupta

Smart Charging , Fast Charging , Easy To install anywhere & eco friendly.

In over research we find some places where we established the charging station & as well as EV charging Stations to allow EV driving anywhere in the country to provide EV charging station at all petrol stations and malls etc.

[4] Sustainable E-bike Charging Station . MDPI 2020

Gautam Ramchandra Mouli, Ajay Jamodkar

The DC charging system uses current-mode controlled flyback converters to charge 24–48V e-bike batteries from the 48 V DC nano-grid.

[5] Comprehensive Review on Developments in Electric Vehicle Charging Station Infrastructureand Present Scenario of India, Sustainability 2021

Shubham Mishra , Shrey Varma, Ambar Gaur

Adoption of new technologies like V2G, Smart Grid, Smart charging technique, etc., for EV chargingwill be very helpful in maintaining the energy balance of the power system and effective utilization ofavailable renewable energy. It will also help in meeting customer satisfaction and economic charging rates

[6] Review paper on optimal location of Electric Vehicle charging station, IJRES 2021

Deepashri .D. Devakate , Vaiju N Kalkhambkar

Electric vehicles offers negligible emissions providing sustainable and cleaner environmental solution. The work mainly focus to present a review on optimal location of EVCS problem

2.2 Problem Identification

• The Increasing Use Of Fossil Fuels In The World Is Causing A Deleterious Effect On The Planet Increasing Population Has Caused Increased Use Of Vehicles Running On Petroleum, CNG, Diesel (Crude Oil /Liquid Fuel) . Co2 Emissions (Metric Tons Per Capital) In India.

• The issues about inadequate charging infrastructure is also a major impediment in this sector.

• If there are few charging stations then it will affect on productivity scales of electric bike on this basis we can install more charging stations at minimum distance so that it can be helpful for consumer.

• Recently, the government-owned Energy Efficiency Services Ltd (EESL) could not procure enough electric bikes because of the lack of charging stations across the country.

• Fuel vehicles can be filled with fuel at fuel station wherever they want. But due to less availability of charging station electric vehicles cannot be charged again and again while travelling.

Chapter 3

Methodology

3.1 Proposed Methodology

- Electric Vehicle Charging- There are three levels commonly used to describe the charging power of EVSE: Level 1, Level 2 and DC Fast Charging. The amount of range provided for each of these is shown in Figure 1. Below with additional details in the following sections.

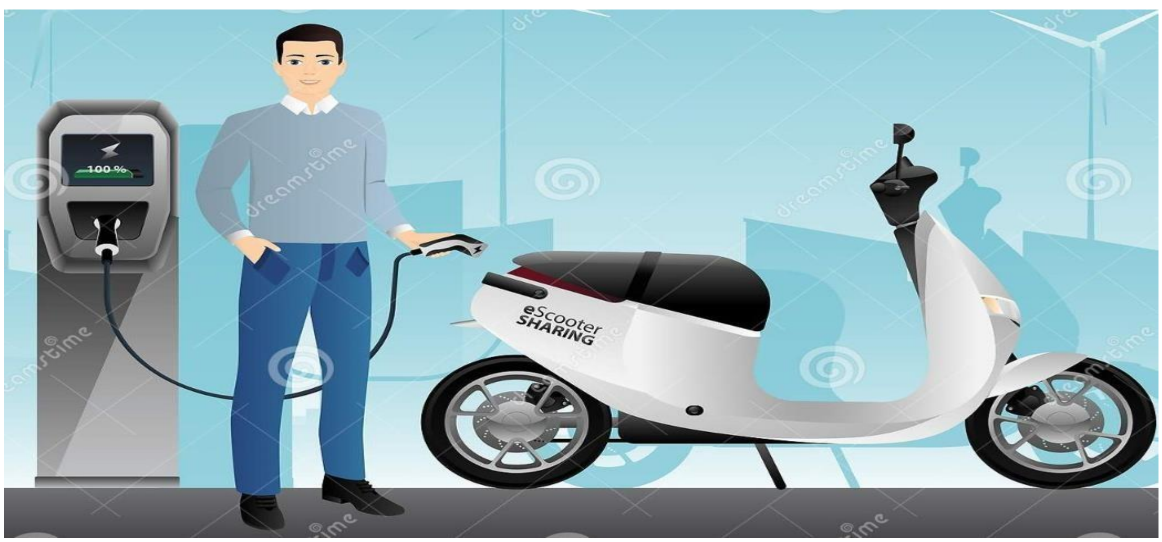

Fig 3.1- EV Charging Station

- Level 1- 120 Volt Charging- This simplest form of charging uses a 120V AC connection to a standard residential/commercial electrical outlet capable of supplying 15-20 amps of current, for a power draw usually around 1.4 kW when charging. EVs come equipped from the manufacturers with portable Level 1 chargers. AEVs with 60-80 miles of range will require 10-14 hours for a full charge using Level 1 EVSE.

- Level 2- 208/240 Volt Charging- Level 2 charging requires a 208/240V AC power connection and significantly reduces charging time. Home users commonly use 240 V power for electric clothes dryer appliances and many commercial customers have 3 phase electric service with 208 V power

Fig 3.2- EV Battery Charging Model

- Either voltage works well for "Level 2" charging. The J1772 standard connector used by most EVs can theoretically provide up to 80 amps of current (19.2 kW), although most vehicles presently available only use up to 30 amps for 3.3 to 6.6 kW6 charging.
- AEVs with 60-80 miles of range will usually require 3-7 hours for a full charge using Level 2 equipment, depending on the capacity of the EVSE and the vehicle charging system. EVs with smaller batteries, such as a PHEV with 10 miles of range (e.g. Toyota Prius Plug-in) may require less than an hour to reach a full charge.
- Although the rechargeable electric vehicles and equipment can be recharged from a domestic wall socket, a charging station is usually accessible to multiple electric vehicles and has additional current or connection sensing mechanisms to disconnect the power when the EV is not charging.

Fig 3.3 Electric Vehicle 3D Model

3.2 Block Diagram

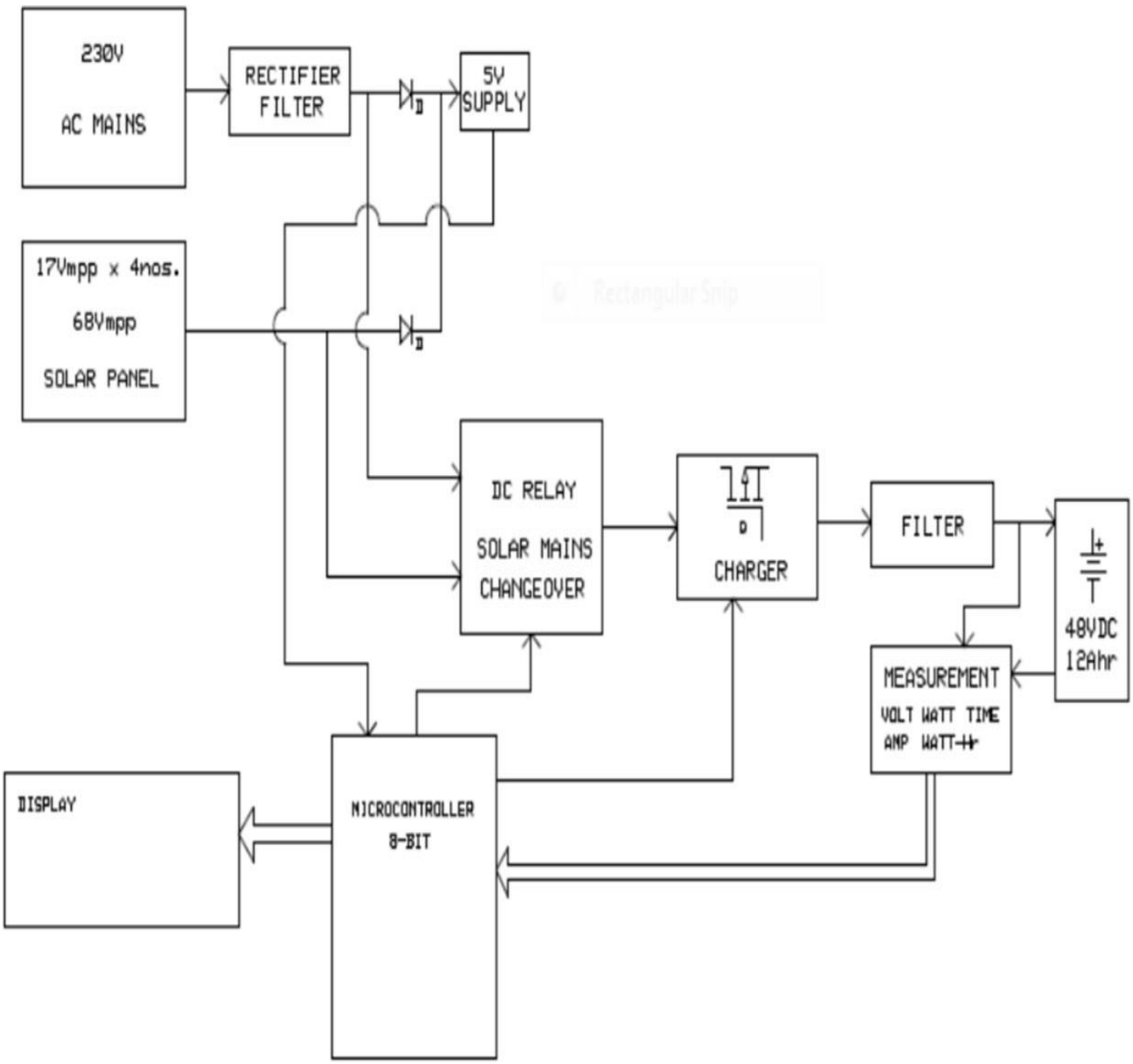

Fig 3.4 – Block Diagram

3.3 Circuit Diagram

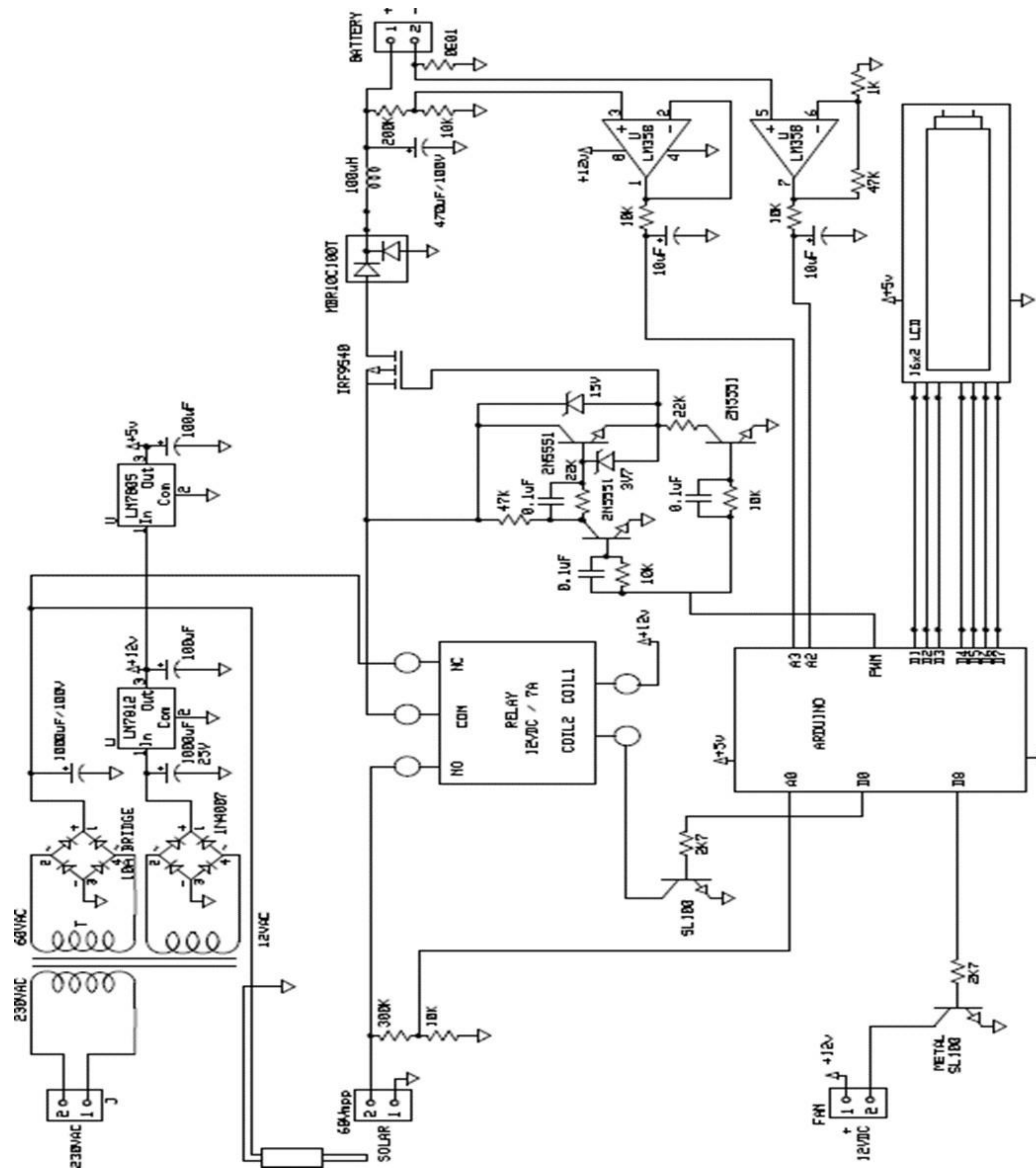

Fig 3.5- Circuit Diagram

3.4 Working Of EV Charging Station

Step By Step Work Done For Making Prototype Model:

STEP 1: Planning

Planning (Also Called Forethought) is the process of thinking about and organizing the activities required to achieve a desired goal. It involves the creation and maintenance of plan, such as psychological aspect that require conceptual skills. We have plan the basic model/ structure of prototype and also planned the basic flow or steps of our project.

STEP 2: Purchase of Materials

The material which are planned at basic stage were brought which includes, Arduino, led, soldering iron machine, electric wire tap, nuts & bolts, resistors, capacitors, centre-tap transformer,PCB and so on.

STEP 3: Sort of Study and Tests on Prototype Model

As we were totally unaware about the ratings and exact functionality of the elements involved in our project, we had to perform certain tests and calculations along with it we also suffered with damage of some equipment's. In initial stages the main problem was to calculate the maximum voltage at different points on the circuit along with the devices that would be required. Before installing the devices on the board we did their respective tests such as for transformer we had to check whether it is transferring enough power to the regulators by doing no load tests on it

Similarly we had to select a proper rating of the switch that is nothing but the MOSFET (p-channel Enhancement), it has been used because it is normally off unless a negative gate voltage is applied to it. The Arduino microcontroller can be considered as the heart of our system since it performs all the controlling tasks through programs. We had to write the programs ourselves and execute it many times as its syntax and logic posed a big problem to us. We used C programming language as it was easy to learn and understand.

The measurement device that is both the operational amplifiers were selected depending upon the maximum amount of current that our system may face while in use (10Amp). Depending on this we chose the wire size of 2.5 sq mm. The LCD display shows various important parameters one of them being the rate (Rs/unit).The display got damaged twice and thus display showed garbage values of the Arduino's memory. The part of level shifter had no problems as the requirements met with its standard circuit.

We performed the test of the entire project on four batteries (completely discharged) of 12V/10AH each. It successfully charged the batteries to 100% within 3hours and 30mins.

STEP4: The Outer Body Design of the Model

The outer body of model was decides to make by using steel sheet and cut in suitable shape to look like a charging station. After cutting it in appropriate shape we painted it in black colour .

STEP5: Assembling the Prototype Model

The various parts devices viz. Outer body (steel sheet), PCB mounted with whole circuit, mounting of LCD display, led, switch, socket on outer body, different connection also included in this step.

3.5 Prototype Model

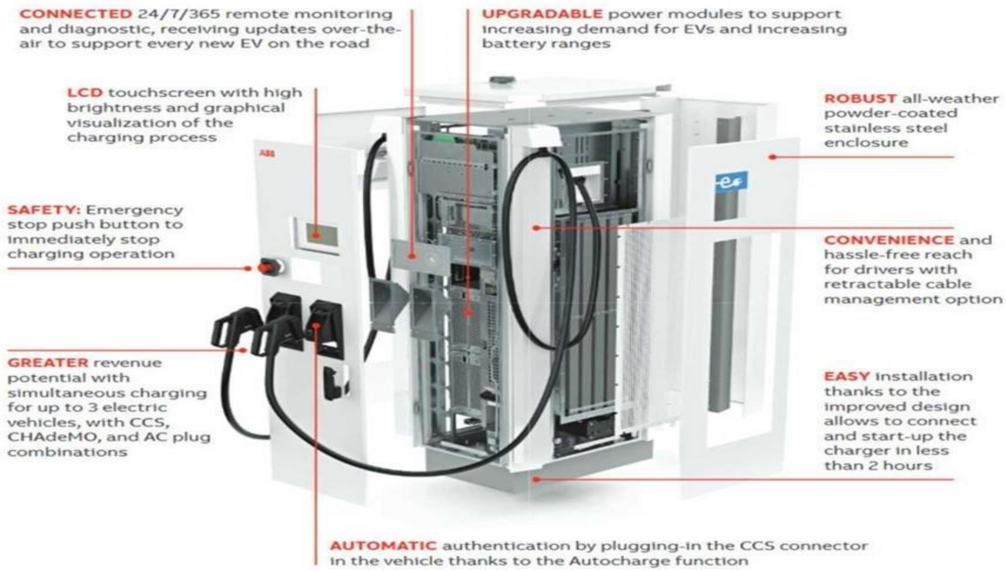

Fig 3.6- Prototype Model

3.6 Project Visualization

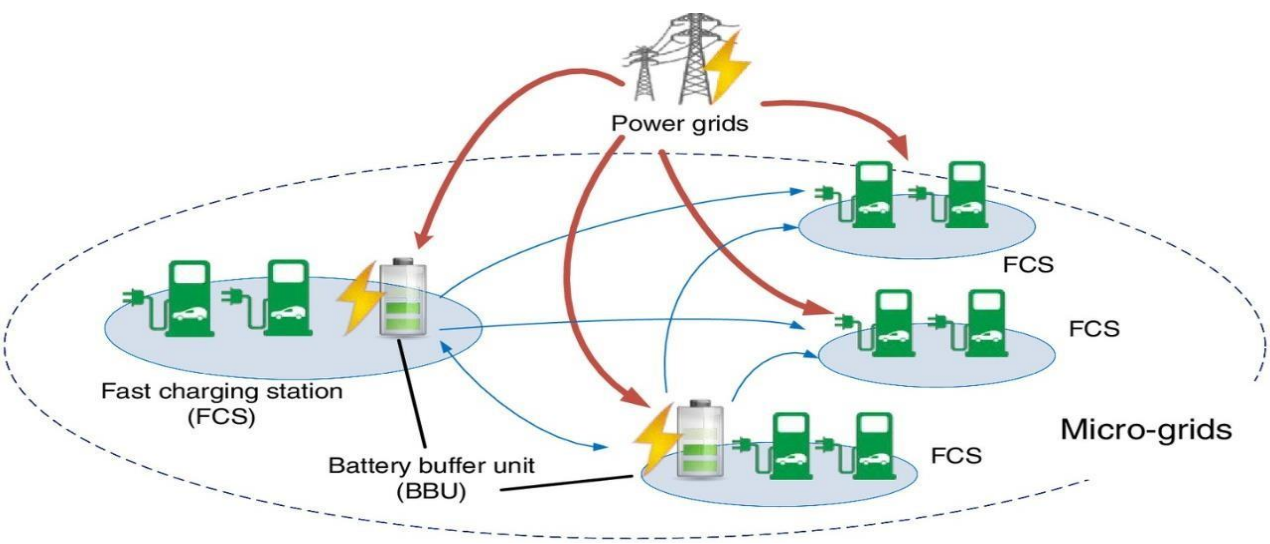

Fig 3.7- Project Visualization

3.7 Specification of Components

3.7.1 Centre tap transformer

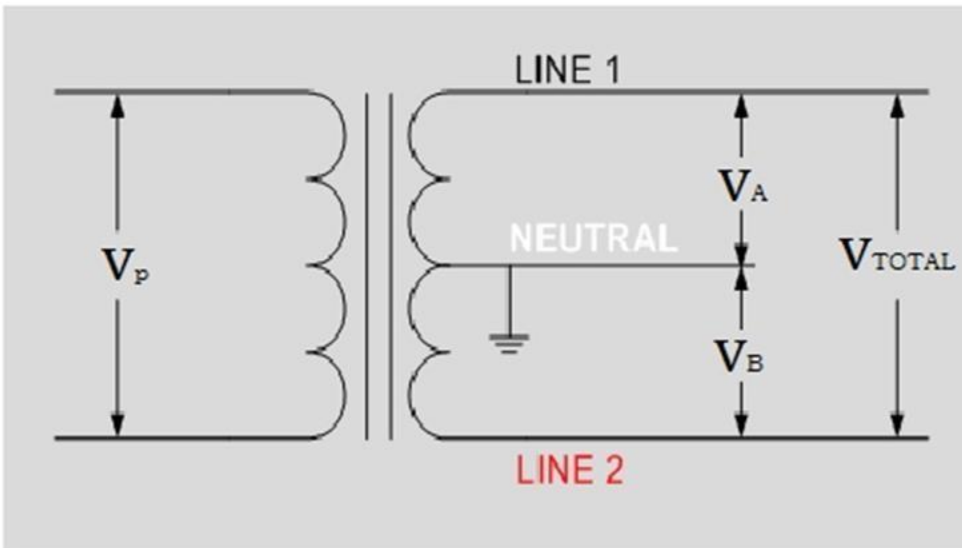

Fig 3.8- Center Tap Transformer

Working Principle of a Centre Tapped Transformer

A Centre Tapped transformer works in more or less the same way as a usual transformer. The difference lies in just the fact that its secondary winding is divided into two parts, so two individual voltages can be acquired across the two line ends.

The internal process is the same, which is when an alternating current is supplied to the primary winding of the transformer it creates a magnetic flux in the core, and when the secondary winding is brought near, an alternating magnetic flux is also induced in the secondary winding as the flux flows through the ferromagnetic iron core and changes its direction with each and every cycle of the alternating current. In this way an alternating current also flows through the two halves of the secondary winding of the transformer and flows to the external circuit.

Construction

When an additional wire is connected across the exact middle point of the secondary winding of a transformer, it is called a center tapped transformer. The wire is adjusted such that it falls in the exact middle point of the secondary winding and is thus at zero volts, forming the neutral point for the winding. This is called the “center tap” and this thing allows the transformer to provide two separate output voltages which are equal in magnitude, but opposite in polarity to each other. In this way, we can also use a number of turn ratios from such a transformer.

3.7.2 Diode

The most common function of a diode is to allow an electric current to pass in one direction (called the diode's forward direction), while blocking it in the opposite direction (the reverse direction)

1.1N4007 is a rectifier diode, designed specifically for circuits that need to convert alternating current to direct current. It can pass currents of up to 1 A, and have peak inverse voltage (PIV) rating of 1,000 V.

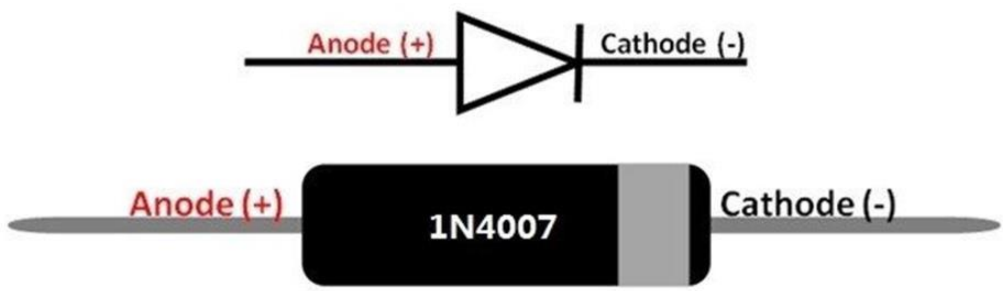

Fig 3.9- IN4007 Diode

2. FR 607 – It is a Fast Recovery Diode is a semiconductor device which possesses short reverse recovery time for rectification purpose at high frequency.

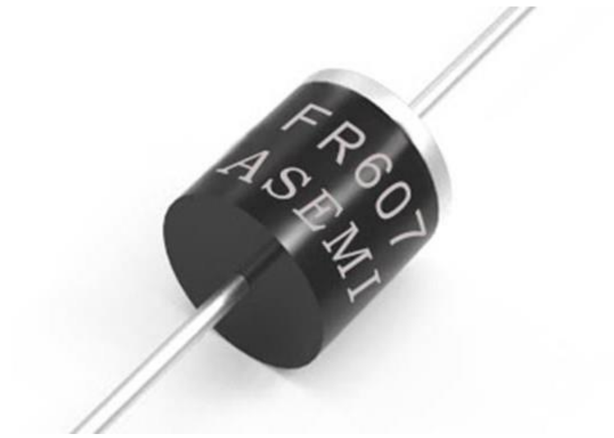

Fig 3.10- FR 607 Diode

3. MIC6A4 - The 6A4 diode has a cathode (-) and anode (+). In the schematic symbol, the tip of the triangle with the line on top of it is the cathode. The cathode is marked on the body of a diode by a band.

3.7.3 Resistor

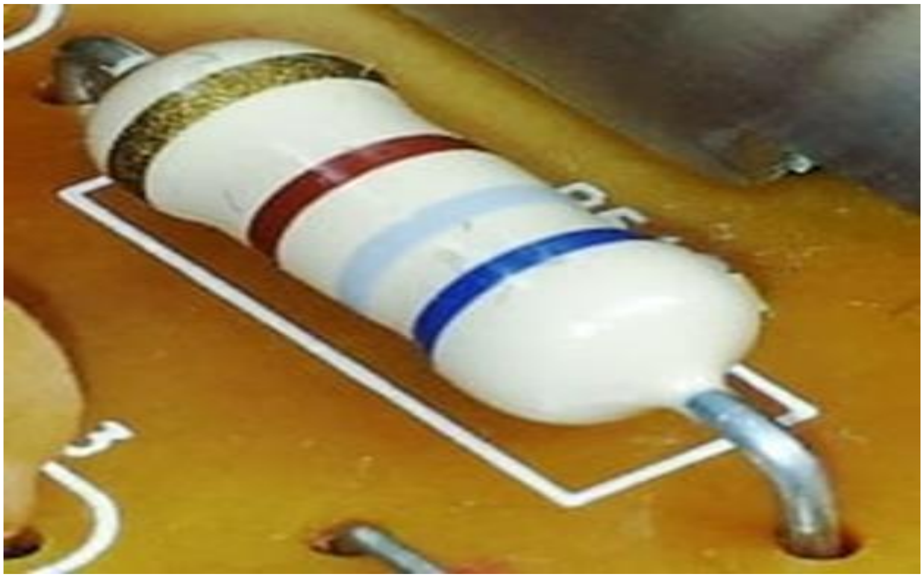

Fig 3.11- Resistor

The resistor is a passive electrical component that creates resistance in the flow of electric current. In almost all electrical networks and electronic circuits they can be found. The resistance is measured in ohms (Ω). An ohm is the resistance that occurs when a current of one ampere (A) passes through a resistor with a one volt (V) drop across its terminals. The current is proportional to the voltage across the terminal ends. This ratio is represented by ohms law.

3.7.4 Relay

Fig 3.12- Relay

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). You can think of a relay as a kind of electric lever: switch it on with a tiny current and it switches on ("leverages") another appliance using a much bigger current.

As the name suggests, many sensors are incredibly sensitive pieces of electronic equipment and produce only small electric currents. But often we need them to drive bigger pieces of apparatus that use bigger currents. Relays bridge the gap, making it possible for small currents to activate larger ones. That means relays can work either as switches (turning things on and off) or as amplifiers (converting small currents into larger ones).

3.7.5 Arduino Nano

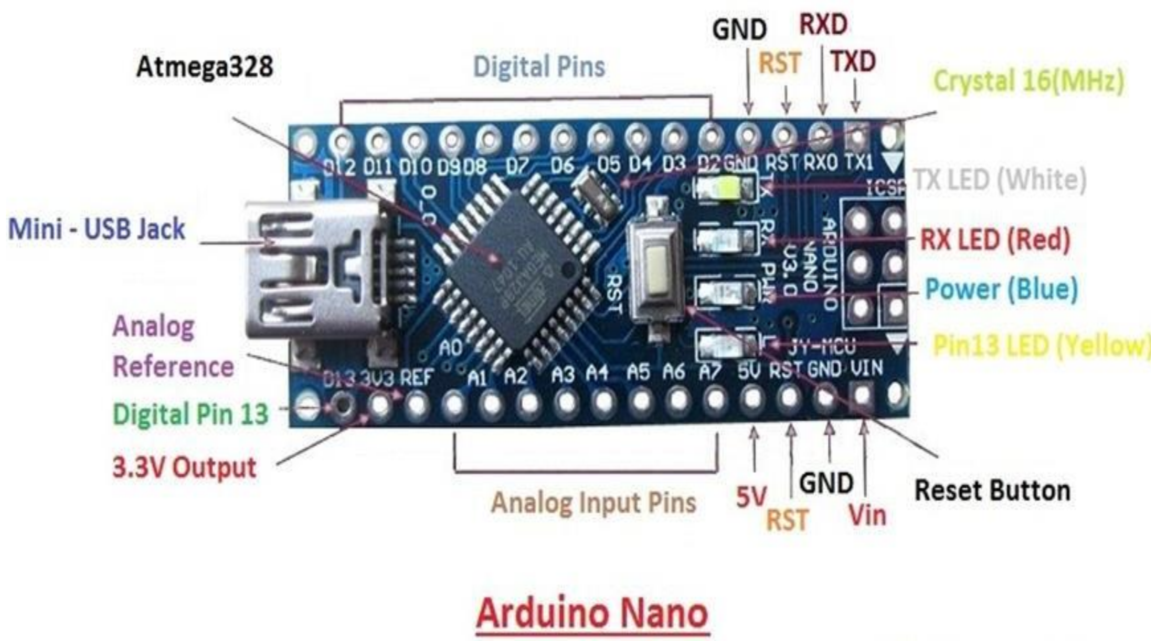

Fig 3.13- Ardunio Nano

The Arduino board is designed in such a way that it is very easy for beginners to get started with microcontrollers. This board especially is breadboard friendly is very easy to handle the connections. Let's start with powering the Board**.**

Powering Arduino Nano: There are totally three ways by which you can power your Nano.

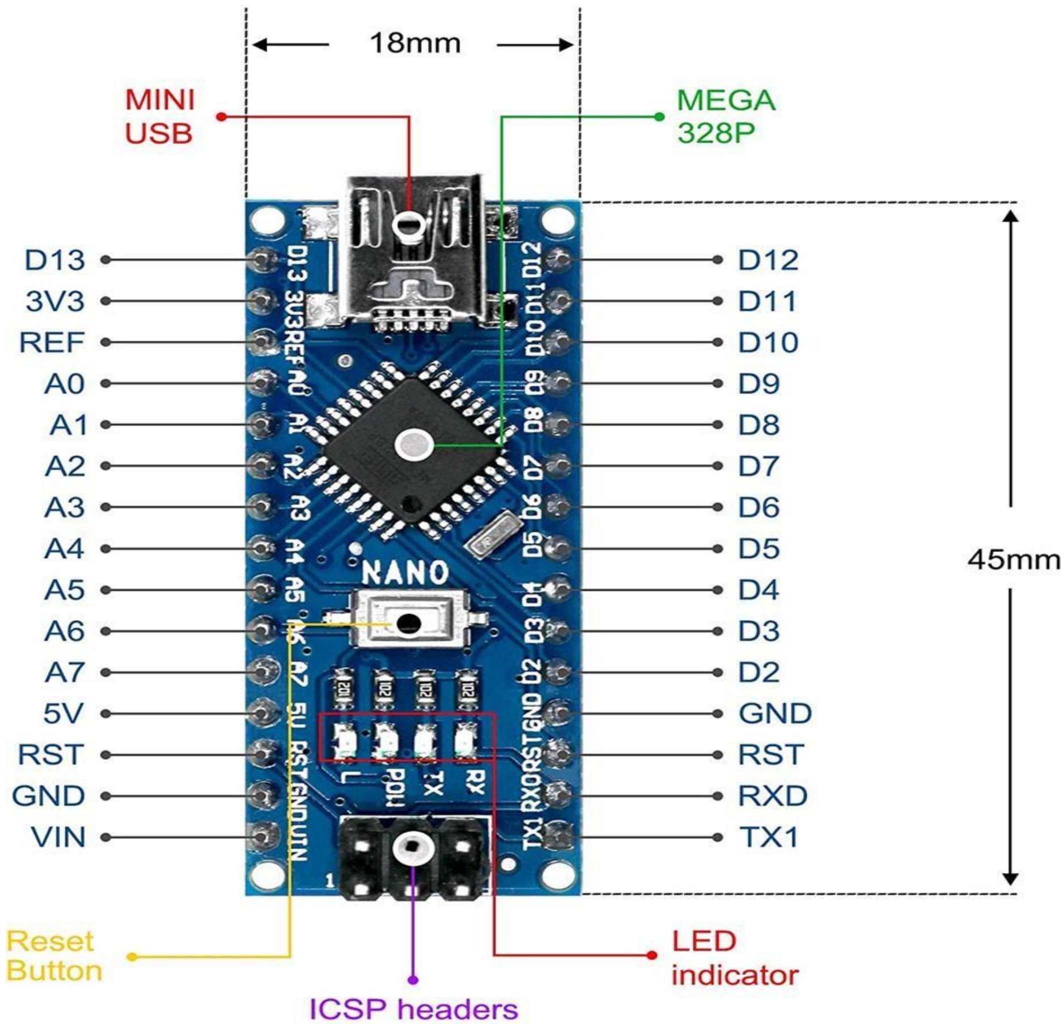

Fig 3.14- Pin Diagram

USB Jack: Connect the mini .USB jack to a phone charger or computer through a cable and it will draw power required for the board to function.

Vin Pin: The Vin pin can be supplied with a unregulated 6-12V to power the board. The on-board voltage regulator regulates it to +5V

+5V Pin: If you have a regulated +5V supply then you can directly provide this o the +5V pin of the ardunio.

3.7.5 LCD Display

A liquid crystal display or LCD draws its definition from its name itself. It is combination of two states of matter, the solid and the liquid. LCD uses a liquid crystal to produce a visible image. Liquid crystal displays are super-thin technology display screen that are generally used in laptop computer screen, TVs, cell phones and portable video games. LCD’s technologies allow displays to be much thinner when compared to cathode ray tube (CRT) technology. Liquid crystal display is composed of several layers which include two polarized panel filters and electrodes. LCD technology is used for displaying the image in notebook or some other electronic devices like mini computers. Light is projected from a lens on a layer of liquid crystal.

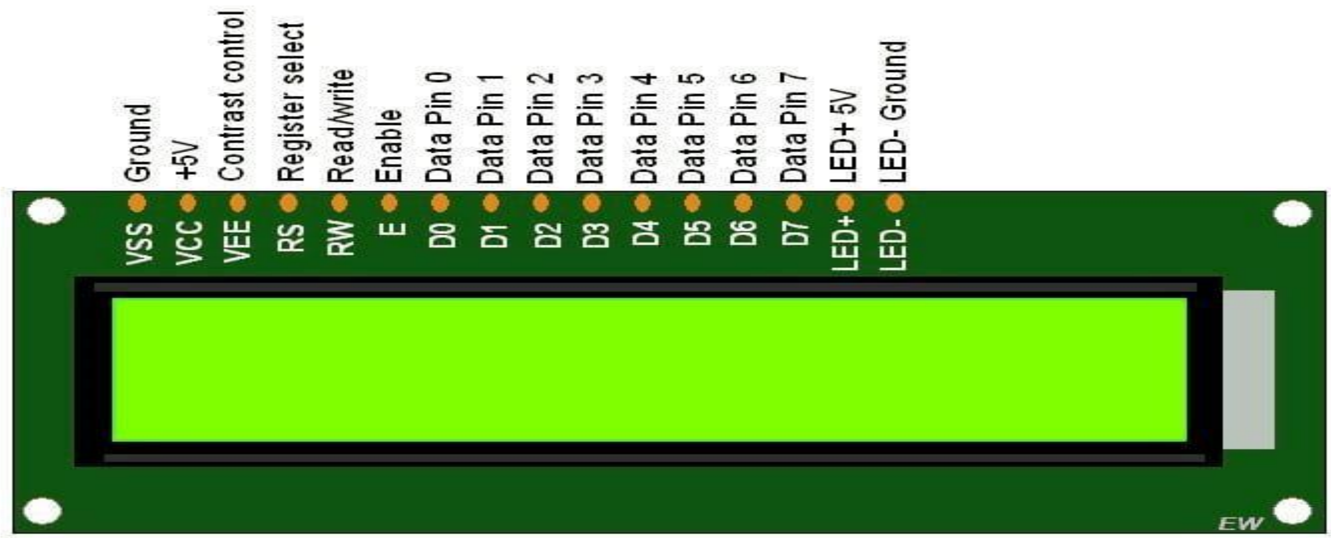

Fig 3.15- LCD Display

This combination of colour light with the grayscale image of the crystal (formed as electric current flows through the crystal) forms the colour image. This image is then displayed on the screen. An LCDis either made up of an active matrix display grid or a passive display grid. Most of the Smartphone’s with LCD display technology uses active matrix display, but some of the older displays still make use of the passive display grid designs. Most of the electronic devices mainly depend on liquid crystal display technology for their display. The liquid has a unique advantage of having low power consumption than the LED or cathode ray tube. Liquid crystal display screen works on the principle ofblocking light rather than emitting light.

3.7.6 MOSFET(IRF3710)

MOSFET (metal-oxide semiconductor field-effect transistor is a special type of field-effect transistor (FET) that works by electronically varying the width of a channel along which charge carriers (electron s or hole s) flow. The wider the channel, the better the device conducts. The charge carriers enter the channel at the source, and exit via the drain. The width of the channel is controlled by the voltage on an electrode called the gate, which is located physically between the source and the drain and is insulated from the channel by an extremely thin layer of metal oxide

Fig 3.16- MOSFET (IRF3710)

DATA SHEET:

3.7.6.1 Type Designator: IRF3710

3.7.6.2 Type of Transistor: MOSFET

3.7.6.3 Type of Control Channel: N -Channel

3.7.6.4 Maximum Power Dissipation (Pd): 200 W

3.7.6.5 Maximum Drain-Source Voltage |Vds|: 100 V

3.7.6.6 Maximum Gate-Source Voltage |Vgs|: 10 V

3.7.6.7 Maximum Drain Current |Id|: 57 A

3.7.6.8 Maximum Junction Temperature (Tj): 150 °C

3.7.6.9 Maximum Drain-Source On-State Resistance (Rds): 0.025 Ohm.

3.8 Advantages

1. Attract customers.

2. Put your business on the map.

3. Offer something your competitors aren’t.

4. Increase customer connections.

5. Support a green business initiative by reducing your carbon footprint.

6. Back-up your brand values and CSR commitments.

7. Attract and retain customers and employees.

8. Change is coming and it pays to get ahead.

9. One of the best advantages of using the EV is it saves the environment to be polluted from the fossil fuels.

10.With the increase in the population and their desires which is causing global warming can be reduced with the EV.

• More quiet

• Cheaper and easy to charge.

• Best speed experience

3.9 Limitations

1. Recharge Points
2. The Initial Investment is Steep
3. Electricity isn't Free
4. Short Driving Range and Speed
5. Longer Recharge Time
6. Silence as a Disadvantage
7. Battery Replacement
8. Not Suitable for Cities, Facing Shortage of Power
9. Lower Amount of Choices
10. Minimal Amount of Pollution

Chapter 4

Mathematical Modelling

Input given to battery

Consider voltage V2= 5V is available at pin A2 of Arduino and corresponding circuit diagram is shown in fig.

$V1 = I_B X0.01$ ....(1)

$V2= V1 (1+47/1) = V1 (48)$

$V2= I_B X 0.01 X 48$

$V2 = 0.48 I_B$ ....(2)

As we know that Arduino operates at 5V

$5= 0.48 I$

$I_B =10.4167$

The range 0-1023 comes from the A/D Converter built in Arduino. It takes voltage reading andcompare it to analog reference voltage (i.e.5 volt, it can be changed). It converts that reading tobinary number. The maximum number we can represent with 10 binary bit is 1023. Therefore,a reading of 0V is converted to number 0; a reading of 5V is converted to number 1024 .

I/p Voltage,

XV = (5/1024) X Hex bit .... (3)

I/p Current,

XA = (10.4167/1024) X Hex bit .... (4)

Battery %

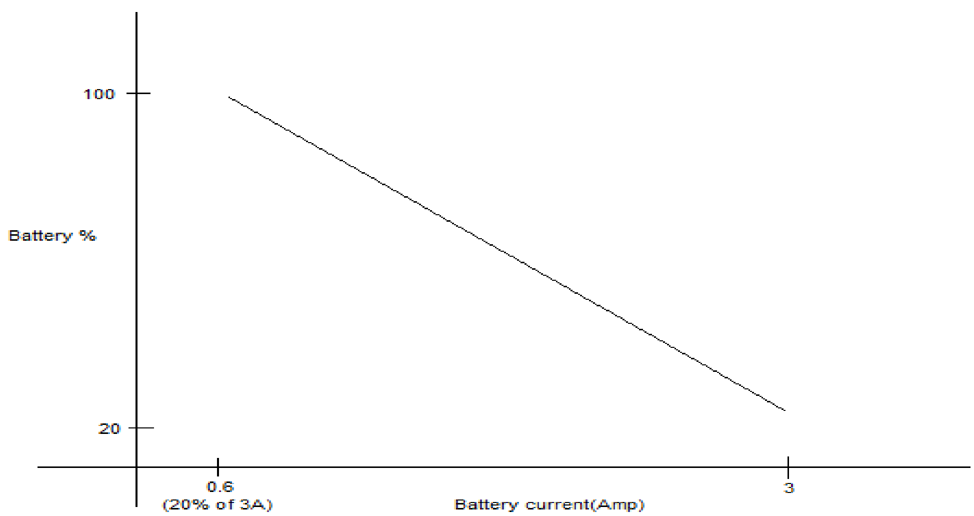

Fig 4.1- Battery Percentage

Equation of straight line on graph,

$$y = mx + c$$

Let, y be the battery % and x is Battery current, slop m is given by,

$m = (y_2 - y_1 / x_2 - x_1) = (100-20/ 0.6 -3) = 80/-2.4$

$m = -100/3$

Let, x = 0.6

$y = mx + c$

$100 = (-100/3) \times 0.6 + c$

$c = 100 + 20$

$c = 120$

Battery % = [(-100/3) X battery current] + 120 ....(5)

Charging Time (t)

Charging Time (t) = Battery Capacity (Amp-hr) / Charging current (Amp)

= 7Amp-hr / 3 Amps

= 2.33 hrs

If Battery is fully discharged then charging time is equal to 2.33hr = 60min X 2.33 = 140 min will be required to charge full battery.

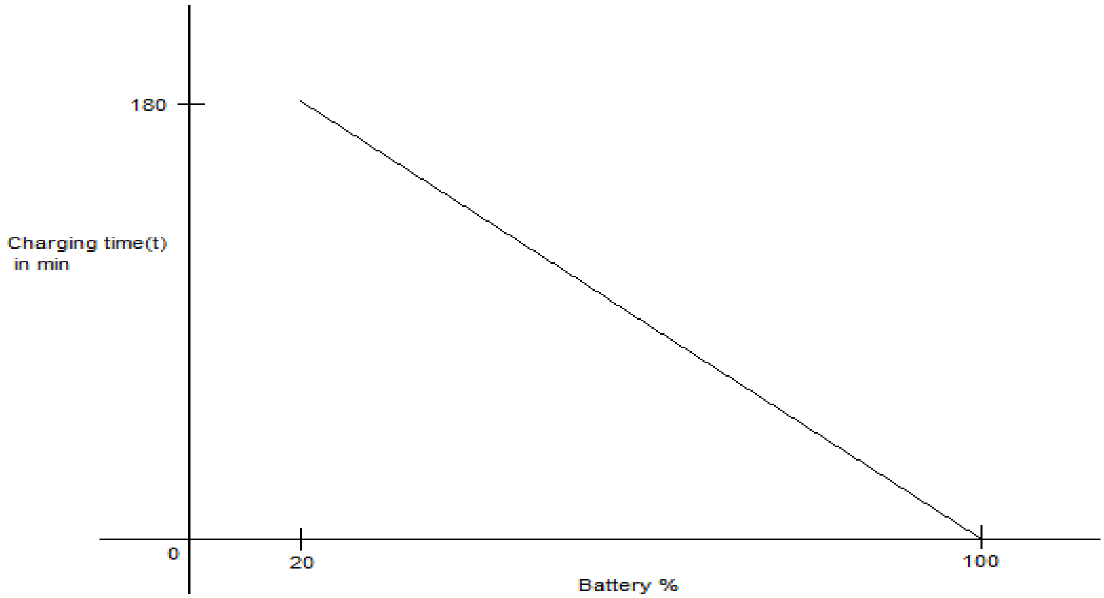

Fig 4.2- Charging Time

Equation of straight line on graph,

$y = mx + c$

Let, y be the Charging time and x is Battery %, slop m is given by,

$m = (y\text{-}y_1/\ x_2\text{-}x_{1)} = (180\text{-}0/\ 20\ \text{-}100) = -9/4$

Let, x = 20 %

$y = mx + c$

$180 = (-9/4)\ X\ 20 + c$

$c = 180 + 45$

$c = 225$

Charging Time (t) = [(-9/4) X battery %] + 225 ....(6)

Chapter 5

Conclusion

5.1 Conclusion

EV are a fundamental element in recognized plans to increase the Indian energy independence and improve the environment. EV owners do not enjoy the benefits of the standardized refuelling facilities familiar to the owners of conventionally-powered vehicles, and there is limited consensus on how to standardize and expand the EVSE infrastructure. Existing EV and recharging facilities are safe and effective to get to the next level of EVSE availability. The benefits of EV's and the need to support drivers of EV's will simulate the installation and use of EV charging stations in industrial and commercial power systems. EV charging stations constitute a significant load. In serving a concentrated number of EV charging stations, the distribution system serving these loads will need to have a much higher capacity than previously used in vehicle parking applications

5.2 Future Scope

There are tremendous potential but considerable constraints as well. Electric vehicle manufacturing in India is picking up with many major auto players (e.g. Tata, Mahindra, Suzuki, TVS, Hero etc.) allocating considerable capex and R&D towards them. Unit economics for producers as well as pricing for consumers are looking favourable and with further reduction in battery costs, it is very probable in a short period of time that the total cost of ownership (TCO) will start looking favourable for the mass-market user. However, private companies are currently restraint from building the charging ecosystem – the Electricity Act 2003 doesn't allow non-power distributors to resell electricity / set charging stations. That needs to be fixed to enhance capacity. There are currently 350 charging points in the country vs. 215,000 in China and the government can't be expected to create the entire eco-system on its own - a supportive framework to enable private enterprise should be deployed instead.

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