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Electric Vehicle Battery Charger with IOT System

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Abstract: *The accelerating adoption of electric vehicles (EVs) has elicited the requirement for modern and developed charging solutions that promise efficiency, as well reliability. In this paper, we propose an Internet of Things (IoT) enabled DC electric vehicle charger to meet these requirements. The solution offers IoT functionalities for full and remote monitoring, diagnostics roadside assistance as well as charging management adapting to the available power. Making use of top-level sensors and connectivity, the charger system optimizes energy usage by intelligent grid balancing as well as enables dynamic load balancing techniques for installation-wise benefits such that it is possible to implement predictive maintenance. Meanwhile, IoT integration ensures a seamless user experience through mobile apps so that users can check the charging status of their vehicle and set up sessions at different times of the day while receiving important notifications. DC EV chargers are faster at charging than normal Alternating Current (AC) ones. They transform electricity from the grid into a form that can be directly applied in the vehicle battery. This ability translates to highly reduce charging times, which explains why they are well-suited for along highways and in commercial applications or urban settings where fast turnaround is critical. These trends are identified by service providers to improve charger placement and availability for drivers.*

Keywords: Battery, IOT, Charging, Charger, Electric vehicle, EV

I. INTRODUCTION

Worldwide electric vehicles are gaining traction because of technological factors, environment, and economics. It can reduce the greenhouse gas emissions because Ev produce zero carbon emission. It reduces dependence on fossil fuels by shifting to electricity, we can reduce reliance on fossil fuels. The need of electric vehicles is to have a sustainable future with the most economical cost. As for that it is necessary to continue improvement in battery technologies, battery charger and charging methods.[1,14]

We know in Electric vehicles electric motors and other parts need the electricity from the batteries. As the demand and the growth of electrical vehicles in India it is necessary to have robust and fast charging technology and infrastructure. [2,3]

There are two different types of EV charging stations: AC and DC. It's important to keep in mind that power from the grid is always AC and EV batteries only accept DC power. That means that at some stage, the current must be converted. The difference between AC and DC charging stations is whether that power converter is located onboard or off-board the vehicle.

a) AC delivers alternating current (AC) to an AC/DC converter off board the vehicle.

b) DC charging stations convert AC before it reaches the vehicle, instead delivering direct current (DC) directly to the battery of an electric vehicle.

With DC charging, the converter can be significantly larger due to the fact that it is located off- board the vehicle. Because the current is already converted to DC by the time it reaches the vehicle, it is possible to deliver more power, faster.

As a result of this different charging technique, DC stations can provide up to 350 kW of power and fully charge an EV in 15 minutes (providing the EV allows it). Due to their fast-charging abilities, DC fast chargers are ideal for short-stop locations, fleet vehicle charging, and are beneficial for passenger vehicles as well as buses and trucks.

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1.1 Various Battery charging methods:

There are various methods to charge the batteries as follows.

1. Conductive method.
2. Inductive method.
3. Hybrid method.

1.1.1 In Conductive there are AC Charging and DC Charging techniques.

AC charging

Level 1: The charging from basic household outlets which takes around 19-20 hours.

Level 2: fast charging with 19-20 kW which takes very less time than level 1 charging. This can be used in places like urban areas mostly in commercial areas where they don't need to make big changes in existing infrastructure.

DC charging

DC fast charging stations like SAE combo (The Society for Automotive Engineers) and CHAdeMO charger which provide 75-80% in just 30-35 minutes. DC charging has 3 levels of charging.

Level 1: 200/450 V for up to 35kW (80 A)

Level 2: 200/450 V for 85-92kW (200 A)

Level 3: 200/450 V for 240kW (400A) [1]

1.1.2 Inductive method.

It is also known as wireless charging method for electric vehicle where it involves that the electrical power is transferred from charging station to electric vehicle without any physical connectors. In this method electromagnetic fields helps to transfer the energy to the electric vehicle. But the only drawback is it is very less efficient than the other methods.

1.1.3 Hybrid method.

The hybrid charging method is combination of the both wired charging and wireless charging method it increases the efficiency of the charger and also optimise the charger or charging technology.

At this level it is very necessary to protect and monitor the electric vehicle which has critical components in ensuring the reliability, safety, and efficiency of the charger. In 1985 an integrated DC charger was introduced. [1,5,10]

1.2 Lithium-ion batteries

Lithium-ion batteries are currently used in most portable consumer electronics such as cell phones and laptops because of their high energy per unit mass relative to other electrical energy storage systems. They also have a high power-to-weight ratio, high energy efficiency, good high- temperature performance, and low self-discharge. [6,7] Most components of lithium-ion batteries can be recycled, but the cost of material recovery remains a challenge for the industry. The U.S. Department of Energy is also supporting the Lithium-Ion Battery Recycling Prize to develop and demonstrate profitable solutions for collecting, sorting, storing, and transporting spent and discarded lithium-ion batteries for eventual recycling and materials recovery. Most of today's all-electric vehicles and PHEVs use lithium-ion batteries, though the exact chemistry often varies from that of consumer electronics batteries. Research and development are ongoing to reduce their relatively high cost, extend their useful life, and address safety concerns in regard to overheating.[6,15]

Lithium ion and LiFePo4 Battery pack solutions for Solar, Electric vehicles, electronic communication and many other applications DC Chargers, also known as level -1 chargers require an extra level of expertise to select and install. EV Safe Charge is here to help. We have a wide selection of equipment, featuring the latest reliable Level 1 DC Chargers. DC charging is the act of charging your electric vehicle very quickly through the means of a DC point. This means that if you are someone who does a lot of driving and is constantly on the road, you will not have to wait very long between charges. Simply connect it to a charging point, and you will quickly be on your way. [4,2]

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You can use DC charging at home (more on this later), or you can hook it up to one of the many DC charging stations around the country. They can be used when you need your car charged quickly as a convenience. For this reason, they are popularly used for long car rides. DC charging is not typically recommended for constant use.[7] The reason for this is twofold. The first reason is that, generally, DC fast charging is far more expensive than regular AC charging.

This is because it costs more to install and use. The second reason is because of the sheer amount of power that is pumped out of a DC charging point. DC charging points are designed for use now and then, especially when you need a quick, efficient charge in a jiffy! The power that flows from a DC charging point can actually put a strain on the battery of your car that has to handle all this extra energy. In turn, this can reduce the lifespan of your battery and its effectiveness if you use it for long periods of time. Keep DC charging for when you really need it? With this in mind, you should not be put off using a DC charging point by any means! Quite the opposite, for they are actually very beneficial when used sparingly. The proposed off-board EV charger has innovative modes for the charging control of lithium-ion batteries with respect to SOC. All these modes are switched on the basis of change in SOC. According to these modes, the reference charging current is adjusted.[9]

The proposed charging topology is composed of three phase AC-DC converter and a bidirectional DC-DC converter, which works as buck converter during G2V operation and it works as a boost converter during V2G operation. The AC-DC converter is controlled by a comprehensive control technique. Compared to the traditional charging control technique, this topology controls the charging reference according to maximum charging acceptance characteristics of lithium-ion batteries. The proposed charging control is validated by home mat e smart app, operating through grid to vehicle including all charging control modes for lithium-ion battery and vehicle to grid control.[12]

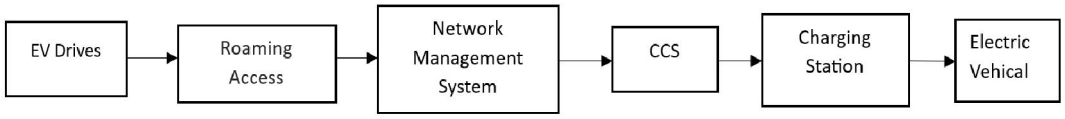

Figure. no. 01 - Block diagram for Process of EV charging

As shown in figure 01 the process of charging is explained:

1. EV Drives - A person who uses the Charging equipment at the location of the Charging station.
2. Roaming Access - The roaming access connected to network management system which helps Electric vehicle drivers to charge their vehicle at Charging station. It collects data from Electric vehicle drivers and after that it is sent to the network management system.
3. Network management system-It helps to verify the identity of the charging station. After the process of verification, it gives a signal to the network management system for availability of space.
4. CCS -It stands for combined charging system. It is a rapid- charging connector for electric vehicles.
5. Charging station - It is a place where electric power supply is provided to electric vehicles for charging.
6. Electrical Vehicle - It is a type of vehicle which is also known as battery electric vehicle. which uses the electric motor supplied by battery.

II. METHODOLOGY

The part's we have used in the charger are. Given bellow:

1. Ac to DC Converter. 24vto27v, /15Amper.
2. Dc to Dc Converter. 1200W. 20 Amp.
3. IOT kit, for ON/OFF Timer Setting. Of Charger.
4. DC Voltage & Amp. Metter. With a 50 Amp shunt.
5. PC Fans for Cooling.
6. DC Socket.
7. Battery Level Indicator.

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2.1 Project Concept and Working:

Input power to the EV charger is an AC voltage in the range of 170V to 300V. The EV charger uses a half-bridge LLC resonant converter design, because of its high-power and high- efficiency characteristics, to obtain DC power for charging the battery.

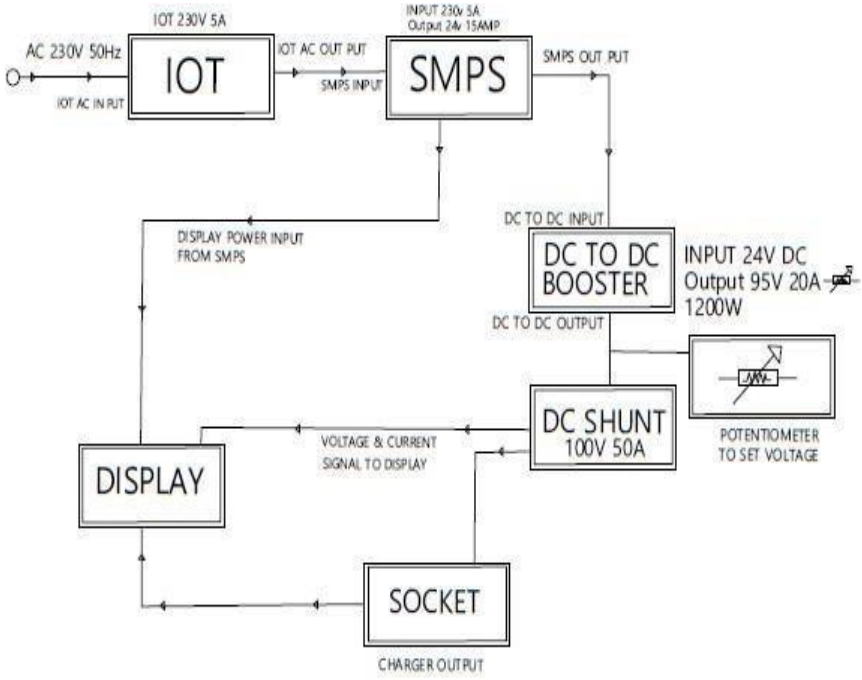

Figure no. 02 - Block diagram of DC EV charger

The design utilizes a rectifier circuit for converting input AC voltage to high-voltage DC output, and it also has an electromagnetic interference (EMI) filter to eliminate high-frequency noise from input power source. A pulse-width modulation (PWM) controller IC, can be used for driving the MOSFETs of half-bridge LLC converter.

As shown in figure 2 the battery charging process is supervised by the IoT (Internet of Things).It monitors the battery voltage and charging current levels and gives feedback to the PWM controller IC. Based on the feedback, the PWM controller varies the duty cycle of its PWM signal and drives the MOSFET circuit to obtain variable output voltage and current for charging the battery.

For better protection, HT45F5Q-2 is isolated from the rest of the circuit (i.e., high-voltage components) using a photo-coupler. Battery-level LED indicators are provided for knowing the charging status. With a DC fast charger, it's best to unplug when your battery reaches about 80% charge. That's when charging slows dramatically—it could take almost as long to fill the last 20% of charge as it did to get to 80% in the first place. Unplugging when you get to 80% charge is not only more efficient for you, it's also considerate to other EV drivers and helps make sure that as many people as possible can use fast charging stations. Check the Charge Point app to see how your charge is going and when to unplug.

2.2 DC to DC Booster:

1) Description:

1. There is a certain range of error in the input over 20A, automatically reducing the output voltage.
2. There is (input 15A. 2 fuse) double short circuit protection, used more securely.
3. Non isolated boost module (BOOST).
4. Input voltage: 12V.
5. Input 12V can output 12-80V adjustable.

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2) Specification:

1. Material: PCB Circuit Board.
2. Size: Approx. 130x52x53mm / 5.12x2.05x2.09 inch.
3. Output Current: 20A.
4. Quiescent Current: 15mA.
5. Output Current: 20A MAX. Over 15A, please enhance heat dissipation For That Used Fans for culling will best (input and output pressure related, the greater the pressure, the smaller the output current).
6. Constant Current Range: 1-20A.
7. Output Power = Input Voltage x 20A.
8. Input 12V.
9. Working Temperature: -40 to 85°C (ambient temperature is too high, please enhance heat dissipation).
10. Working Frequency: 50Hz
11. Conversion Efficiency: up to 95% (efficiency and input/output voltage, current, pressure related).
12. Installation: 4pcs 3mm Screws.
13. Module Weight: 257g / 9.07oz.

2.3 Display:

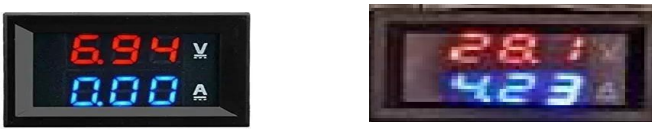

Figure no. 03- Display

Specification:

1. Wiring diagram provided.
2. Internal shunt for 2A.
3. Operating voltage: DC 12V to 24V DC.

2.4 AC to DC converter:

Specification:

1. Overload and Short Circuit Protection.
2. Over voltage protection.
3. Full load burn-in test.
4. Great switching power supply for home appliances.

Level -1	Level-2	Level-3
Current flow in level 1 is AC	Current flow in level 2 is AC	Current flow in level 3 is DC
Use is slow	Use is fast	Use is faster
Charging time is 5-16 hours	Charging time is 2-5 hours	Charging time is 20-60 hours

Table no. 01 - Different levels of charging.

Safety mechanism for EV	Description
1.Short circuit protection	1. Prevent damage to the charger and vehicle during fault.
2.Overcurrent protection	2. Automatically off power in case of overload.
3.Temperature monitoring	3. Ensures components do not overheat.
4.Ground fault detection	4. Detects and electrical leaks.
5.Emergency stop	5. Manual emergency stop button available.

Table no. 02 - Safety mechanism for EV

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III. RESULT & DISCUSSION

This project development was successfully completed. This system is a universal charger which can charge from 25 V to 95 V. In our development of covering, we used carbon fibre and acrylic sheet for protection. This saves money and also benefits the environment and the electricity grid, as prices follow electricity demand. With charging time optimization EV charging balances the supply and demand of electricity and lowers the need for electricity generation.

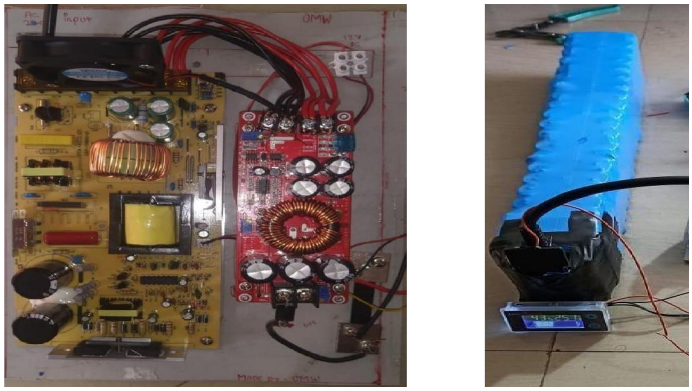

Figure no. 04 - Electric Vehicle battery charger and Battery for charging.

3.1 Observation:

Sr. No.	Input	Output
1.	230V,AC	24V-95V Variable

Table no. 03 - Input and Output

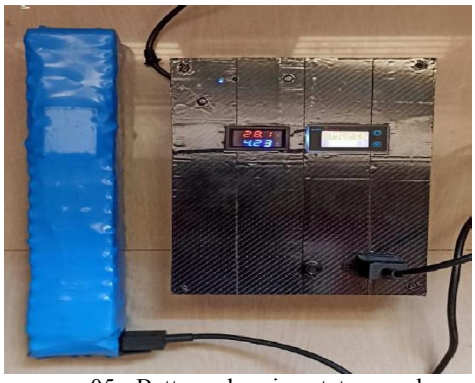

Figure no. 05 - Battery charging status on charger.

In figure no. 05 it clearly shows that while working on a chargerthe battery charging is possible understanding and monitoring the battery charging status.

IV. CONCLUSION

The IoT integrated dc charger is permitted for the management of charging and monitoring. The IoT technology is advanced technology so they optimize charging time, handle energy consumption and provide the current status of the charging. IoT technology provides the real time data so, they help to maximize energy efficiency and decrease the charging time.

The IoT technology is finding an easy way to handle the charging in easily with the charger and a mobile app or web interference. This technology provides such features like remote start, remote stop charging and notification. This technology increases the user satisfaction and modern/advanced expectations for smart technology.

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1. The purpose of this project is to,
2. Enhanced Charging Efficiency and Management.
3. Reduce the environmental Impact.
4. Efficient power delivery.
5. High power density DC charger.

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