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Design and Development of Charger for e-Bike

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***Abstract*: The battery pack of an electric car is a significant energy source that may be used for a variety of things, including charging additional electric vehicles and connecting them to the grid, homes, and homes. The charging modes in this work can be changed to your preference. This essay discusses how electric vehicles charge on-board and how to comprehend the charging process from the vehicle to the home. However, li-ion batteries need safeguards to prevent overcharging or undercharging, which can shorten their useful lives and decrease their efficiency. As the world moves towards a more sustainable transportation system, electric vehicles (EVs) are becoming increasingly popular. However, to support the widespread adoption of EVs, an extensive charging infrastructure is necessary. The shift to a more environmentally friendly and sustainable transportation system depends heavily on electric car chargers. This essay examines developments in EV charging technology, problems with EV charging infrastructure, and future possibilities for EV chargers. So, by including SMPS (Switching Mode Power Supply) we can use it as a converter as well as current controlling device. Additionally, cooling vents in front and inside of the hardware as well are also installed.**

***Keywords*: environment, frequency, hybrid, isolation barrier, PCB, rectifier, SMPS, transformer.**

1. Introduction

The vehicle industry is exploring for alternative energy sources to replace traditional fuel sources due to the growing need for more dependable and efficient transportation. The demand for hybrid and electric vehicles has consequently abruptly grown. When compared to conventional energy sources, the emissions of CO_2, CO, and hydrocarbons from electric cars are quite low. An essential part of operating non-traditional cars is the battery. For electric cars to be a viable transportation alternative, enormous battery packs with high power and energy densities are required [1]. These batteries contain parallel and series connections within the cells and between the modules [2]. These cars improved the effectiveness and practicality EV lately gained popularity environmentally friendly energy, also demand for renewable energy initials [3]. Better battery innovation and the design of electric vehicles are currently the subjects of research. The car industry is making adjustments to satisfy demands for reduced emissions, a limited supply of conventional energy sources, and lower transportation costs. It is essential that we have an incredibly stable system that can supply the necessary electricity. The grid should be able to accommodate the extra demands caused by the electric cars [4].

The environmental issues the transportation industry is presenting might be resolved with the use of electric automobiles. However, a reliable charging infrastructure is necessary for the wide-scale deployment of electric vehicles. Electric vehicle chargers are a crucial part of this infrastructure since they enable EV owners to conveniently and swiftly recharge their vehicles. This paper will examine current developments in EV charging technology, issues with EV charging infrastructure, and future possibilities for EV chargers.

Electric car charging stations need to be able to charge batteries as quickly as feasible in order to compete with petrol stations. We thus developed a method to address the charging time flaw. By using this method, the battery was able to significantly reduce the time needed for charging without sacrificing either performance or longevity. We are utilising multiple batteries (more than one) to accomplish this strategy. The batteries are linked either in series or parallel when the vehicle is in motion. We unplug the batteries from the circuit and charge each one separately when it's time to charge the car. Therefore, the shorter time it takes to charge the more batteries there are [5]. Red regarding switched mode power supply simulation, design, and hardware implementation. This SMPS may be used to increase the voltage in the power electronics lab [6]. When the converter's output voltage is still far from the desired output, more power is provided to the converter to move it in that direction. In this situation, the pulse width is increased to obtain the desired value [7]. Switching regulators are used in SMPS devices to maintain and regulate the output voltage by turning on and off the load current. appropriate system power generation. In contrast to a linear power supply, SMPS carry transistor shifts between full-on and full-off phases with low dissipation and spend less time in high dissipation cycles, which reduces the amount of depleted strength [4]. It could be possible to reduce consumption during peak hours, when there is more demand for electricity and greater strain on the system, by charging your electric car at night when there is less demand for electricity and using that electricity to power your house during the day [5].

2. Significance

This article aims to make a system that charges EVs rapidly

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and effectively than they now do. In the next 20 years, electric cars will make up the majority of new vehicle sales, according to Bloomberg New Energy Finance. Fossil fuels and combustion engines are becoming less common. However, there are now barely a million or so electric cars on US roads. Direct current fast charges bypass the constraints of the onboard charger and the necessary conversion, possibly speeding charging speed dramatically. DC power is sent directly to the battery during these fast charges. The battery's capacity and the dispenser's output, among many other variables, affect how long it takes to charge. However, the majority of Direct Current fast-charging infrastructures now on the market can charge many vehicles to 80% of their capacity in less than an hour. Large fleets, long-distance journeys, and high-mileage trips require DC quick charging Future work on the paper will focus on creating charging facilities for electric cars. Over the next five years, it is anticipated that the market for EV charging stations would increase five to seven times. According to a generous interpretation, it will be worth $35 billion by 2026, or 15% of all new automobiles sold globally, up from the estimated value of $5 billion in 2020. Environmentally friendly transport would account for 15% of all new automobiles sold globally by 2026, representing a $35 billion market. Since the last 10 years, the need for environmentally friendly transportation has driven EV producers, infrastructure builders, and makers of charging stations to continuously innovate and enhance the several hundred-year-old technologies [1]. The competition is to increase vehicle's dynamic range, battery's real time performance, charging effectiveness, and customer pleasure. You might be able to attain energy independence if you combine our renewable energy initials with bidirectional charging of electric vehicles. Following are the benefits of EV charger,

1. *Environmental Advantages:* Using a renewable energy-powered EV charger may greatly cut greenhouse gas emissions and assist to lessen the effects of climate change.
2. *Cost Savings:* EVs frequently cost less to operate per mile than cars fuelled by petrol. EV owners can save their gasoline expenses by utilising an EV charger to refuel their car, especially if they can do so during off-peak hours.
3. *Convenience:* It is getting easier for customers to swiftly and conveniently re-charge the car since there are more EV chargers available in public spaces, businesses, and homes. This lessens worries about running out of battery capacity while driving.
4. *Improved Air Quality:* EVs produce less dangerous emissions than gasoline-powered vehicles, therefore recharging EVs can help to improve air quality in crowded cities.

Electric car chargers are important because of their capacity to promote the use of electric vehicles, lessen their negative effects on the environment, and improve energy security.

3. Objectives

The energy storage system, a crucial component of an electric vehicle (EV), will be having a big impact on the car's stability, effectiveness, and drive real time range. A single battery pack's size mainly cover the vehicle's drive range requirement is used by the majority of current electric cars. The optimum peak-to-average power ratio for batteries is 0.5 to 2, and their energy densities are substantially higher than their power densities. Our goal in this work is to create a charger that is lightweight, interference-resistant, produces a big amount of power, and has an appropriate power consumption range of 60 to 70 percent. The cell equalisation issue can be successfully solved with a voltage equalisation mechanism.

4. Hardware Implementation

Making of an EV charger requires certain number of steps which are explained below:

1. First, a circuit diagram was made with the help of some guidance from some industry experts. Then after reverse engineering in which conversion of PCB into schematic was done. Then, with the help of Protel Tool another PCB was made. Then it was sent to PCB schematic for manufacturing. Then the electronic components were placed into the PCB. Then after understanding the IC16F886 28 pin SMD-IC, under the guidance of a software engineer a code was developed.
2. This code was written in microchip software (MP LABS). With the help of its kit, anyone will able to put this code into the respective IC. As IC16F886 28 pin SMD-IC works on 5V DC, which is further connected to the microcontroller, an input was given of 220V 50Hz AC supply and with the help of rectifier 220V AC to DC conversion was done.
3. The technology for charging electric vehicles has considerably improved recently. Electric car chargers now come in three primary categories: Level 1, Level 2, and DC rapid charging. An electric car can take up to 24 hours to completely charge using level 1 chargers, which use a regular household electricity. 240-volt level 2 chargers can complete a 4- to 8-hour charge of an EV. The quickest charging method is a DC fast charger, which can recharge an EV to 80% of its capacity in as little as 30 minutes. Another area of development in electric car charging technology is wireless charging. Magnetic induction is used in wireless charging to transfer energy from a charging station to the battery of an EV. This innovation does away with the need for wires and connectors and can offer a more streamlined and practical charging process.
4. The frequency may now be raised from 50Hz to 50kHz with the aid of an SMPS transformer attached with a MOSFET and relay (NO & NC Relay Switch), converting the DC supply into an AC supply. The step-down transformer, which is also connected to the circuit, creates a square pulse, which drains 6A of current from the output side to allow the battery to charge.

5. Further, this current is sent to the rectifier to convert AC to DC supply pure supply with the help of the filter. Further connected a fuse for safety. Now, providing feedback with the help of the control circuit & isolation barrier to control & to get the required amount of frequency in the form of output.

The flow chart has been shown in Fig. 1.

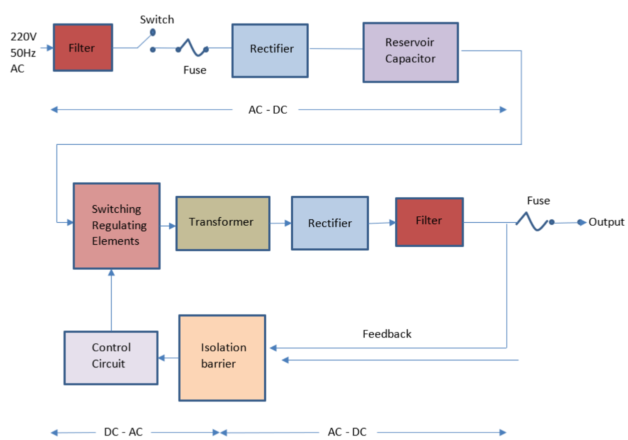

Fig. 1. Flowchart for operation of SMPS

The workings of the SMPS are shown in Fig 1. Although the operation of an SMPS is more complicated than that of a linear regulator, it may be divided into five stages:

1. The entering AC power is rectified and subjected to filtering in the first step to create DC.
2. Because the SMPS operates at high frequencies, the DC signal is processed by a high-frequency switch to produce a high-frequency pulsing DC signal.
3. The power transformer reduces the high-voltage DC signal to the necessary level of DC signal.
4. A steady, consistent DV output is produced by rectifying and filtering the stepped-down DC signal.
5. In order to maintain a constant output stream of the required voltage, the control circuitry continuously checks the output voltage and dynamically modifies the high-frequency switch.

5. Results and Discussion

We know that the lithium-ion cell we used here is of 3.2V. So, the main purpose of the paper is to make the lithium-ion cell's range to 3.6V which will be able to charge the battery of the rating 48-60V with adjustable frequency, nominal & extended charging modes as shown in Fig. 1. The supply we are giving as an output is in DC as shown in Fig. 2.

So, we connected a 48V battery across the output to check results.

Despite the advancements in electric vehicle charging technology, there are still several challenges associated with EV charging infrastructure. One major challenge is the cost of building and maintaining charging infrastructure. The high cost of EV charging infrastructure can be a barrier to entry for many companies and individuals looking to invest in the industry. Another challenge is the range of electric vehicles. The range of an EV is still relatively limited, with most models having a range of 100-300 miles on a single charge. This range limitation can lead to "range anxiety" among EV owners, who may be hesitant to take longer trips due to concerns about running out of battery power.

Fig. 2. Charging indicator

Fig. 3. Upper view of PCB installed inside the EV charger

Fig. 4 shows the charging of a 48v battery with the charger in nominal conditions.

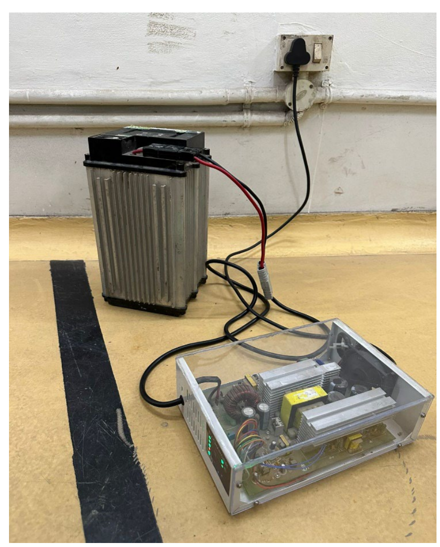

Fig. 4. Charging of 48V e-Bike battery with the EV charger

6. Conclusion

We know that the lithium-ion cell we used here is of 3.2V. So, the main purpose of the paper is to make the lithium-ion cell's range to 3.6V which will be able to charge the battery of the rating 48-60V. The supply we are giving as a output is in DC.

The infrastructure required to accommodate the increasing number of electric vehicles on the road must include electric vehicle chargers. Electric car chargers will become more and more crucial as electric vehicle technology develops and as consumer demand for them rises. To overcome the difficulties with electric car charging infrastructure and create a strong and sustainable charging network for the future, governments, businesses, and individuals must collaborate.

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