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A Development Of Charging System For Electric Vehicles

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ABSTRACT

The increasing use of electric vehicles (EVs) requires adequate and efficient charging system infrastructure. One of the main things is the charging system for electric vehicles (EV) batteries. This study aims to develop a charging system infrastructure for EVs using a DC to DC converter. This study examines the design and implementation of a charging system with a DC to DC converter to transform DC voltage from the grid to a DC voltage that meets the needs of EV batteries. This system is designed to ensure safety, efficiency, and compatibility with various types of EVs. The system is also capable of producing voltages from 12 volts to more than 60 volts, which is sufficient to charge electric vehicle batteries. Correlation analysis simulations with MATLAB and experimental testing were conducted to evaluate the performance of the charging system. The results show that this system is capable of charging EV batteries safely and efficiently. This system is also compatible with various types of EVs and can be easily integrated with the electricity grid. The development of a charging system infrastructure with a DC to DC converter is expected to support widespread EV adoption and contribute to a sustainable energy transition.

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INTRODUCTION

Electric vehicles have emerged as an innovative solution to environmental challenges and dependence on fossil fuels. With increasing awareness of the negative impacts of climate change and related environmental issues, the demand for electric vehicles continues to increase significantly. The main advantages of electric vehicles include low emissions, better efficiency, and reduced dependence on finite fossil fuels.

One of the crucial elements in the electric vehicle ecosystem is the charging system or charger. A charger is a device that converts electrical energy from an external power source into energy that can be used by the electric vehicle battery. The development of charger technology has played a significant role in driving the adoption of electric vehicles by ensuring the availability of reliable, efficient, and easily accessible charging infrastructure.

In this background, we will explain the important role of charger systems in supporting the growth of electric vehicles, the challenges faced in developing charger systems, and the latest developments in electric vehicle charging technology. In addition, we will also discuss several types of chargers that are commonly used, from home chargers to superfast charging networks on public roads.

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This research will also discuss the factors that need to be considered in designing and implementing a charger system, including charging power, compatibility, charging efficiency, and communication standards related to charging protocols. Through an in-depth understanding of the charger system for electric vehicles, it is hoped that solutions can be found that can overcome technical and infrastructure barriers that are currently still a challenge in accelerating the global electric vehicle ecosystem.

Literature Review

Electric Car

One of the main issues is climate change caused by increased greenhouse gas emissions, such as carbon dioxide (CO2), due to the burning of fossil fuels for transportation, including motor vehicles. The increase in greenhouse gas emissions has caused serious impacts, including rising global temperatures, changes in extreme weather patterns, and rising sea levels. This has prompted global action to reduce emissions, including through the transition to environmentally friendly vehicles such as electric cars. Considering these factors, the transition to electric cars is one of the steps considered important in the effort to combat the current environmental crisis.

An electric car is a vehicle that uses one or more electric motors to drive the wheels and uses a battery as a source of energy for its electric motors. As an alternative to conventional cars that use fossil fuel-powered internal combustion engines, electric cars are considered more environmentally friendly because they do not produce exhaust emissions when used.

Generally, electric cars have a more limited range than conventional cars, but advances in battery technology have made it possible to produce electric cars with increasing range. Some electric cars even have enough range to be used for daily activities without the need for repeated charging. Charging an electric car can be done at home using a regular wall socket or special electric charging stations that are increasingly widespread in public places. In addition, some electric car models are also equipped with a fast charging feature that allows users to charge the battery in a shorter time.

Another advantage of electric cars is lower operating costs compared to conventional cars, because electricity is usually cheaper than fossil fuels. However, the selling price of electric cars currently still tends to be higher than conventional cars, even though the operating costs are cheaper in the long run.

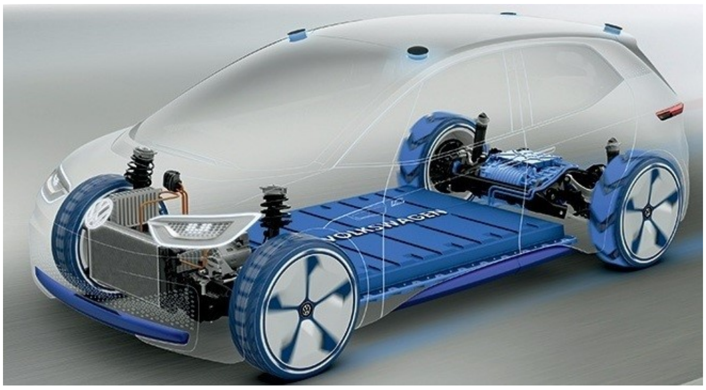

Figure 1. Main Parts of an Electric Car

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Lithium-Ion/Polymer Battery

Lithium-ion/polymer rechargeable batteries, which have been widely used today, have different properties, but are very fragile and must be used with great care. Improper use of Li-ion batteries will have disastrous consequences. Incidents of Li-ion batteries catching fire and exploding have been heard many times. Carefully understanding their properties and implementing proper battery management methods are the most important things to make good use of Li-ion batteries.

Figure 2. Lithium-Ion/Polymer Battery

Lithium Ion/Polymer Battery Properties

It may not be easy to have a complete understanding of something, as different perspectives may lead to different final understandings. Some important perspectives, which may affect the charging strategy, will be taken to investigate the properties of Li-ion/polymer batteries. The following diagram illustrates the relationship between cell capacity and cycle life at various charging voltages of a Li-ion battery with a cell capacity of about 950 mAH.

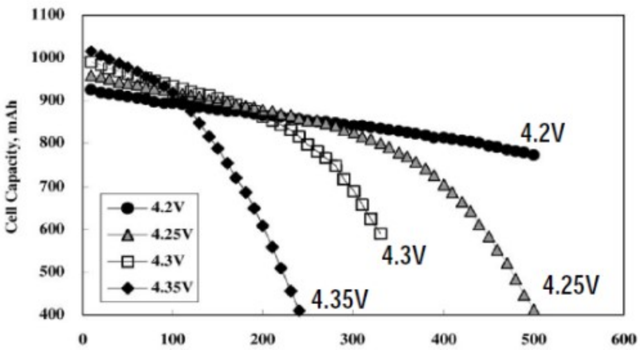

Figure 3. Relationship Between Cell Capacity and Cycle Life with Various Charging Voltages of Li-Ion Batteries

From the diagram, higher charging voltage increases the initial capacity, but results in lower cycle life and vice versa.

Electric Vehicle Charger Circuit

An electric vehicle charger circuit is a system specifically designed to charge the battery of an electric vehicle. This circuit has several main components that work together to convert electrical current from an external power source into energy that can be stored in the vehicle's battery. With these components working together, an electric vehicle charger circuit can charge the vehicle's battery safely, efficiently, and reliably, allowing users to use their electric vehicle comfortably without worrying about running out of power.

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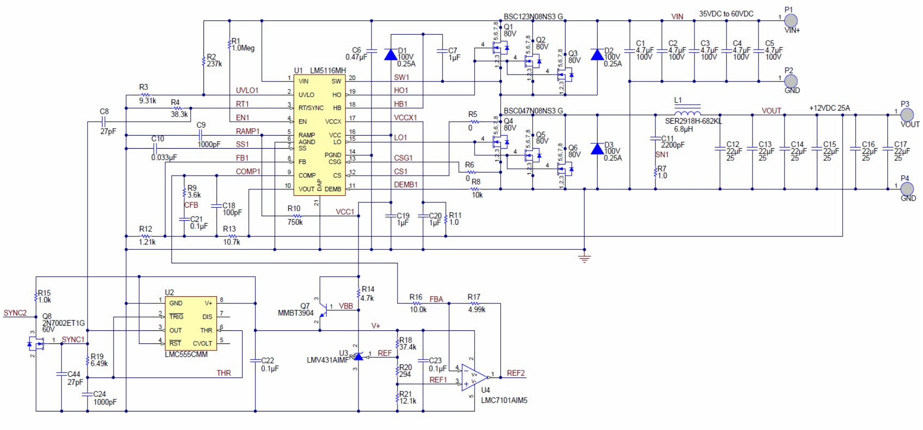

Figure 4, Electric Vehicle Charger Circuit With Buck-Boost Converter

The input voltage of the 600W DC Buck Boost Converter circuit is 35V...60V DC. The LM5116 12V 50A output for DC control DC Buck Converter is capable of using adjustable operating frequency from 50kHz to 1MHz available Current limit, soft start, etc. It has many features. The output power of the 12V 600W 50A DCDC Converter circuit is very high, this power can be provided by combining two of the same LM5116 synchronous operating units. LMC555C LMC7101 integrated circuit. With full load (25a-50a) and short circuit, heat test with input voltage of 35V, 48V, 60V.

RESEARCH METHODOLOGY

Research Approaches to Improving the Efficiency and Affordability of Electric Vehicle Charging Systems.

1. Key Challenge Identifiers
   Identify critical challenges faced in the development of electric vehicle charging systems, including charging speed, interoperability, and infrastructure costs.
2. Critical Analysis of Existing Technology
   Evaluates existing charging technologies, including AC and DC charging, as well as wireless charging, with a focus on the advantages and disadvantages of each in the context of efficiency and cost.
3. Research Method Design
   Developing a systematic research method to test and analyze the performance of charging systems, with an emphasis on charging speed, energy efficiency, and implementation costs.
4. Prototype Development and Simulation
   Design a prototype charging system and use simulation software to model performance under various charging scenarios and environmental conditions.
5. Field Testing and Evaluation
   Conduct field testing to validate simulation results and analyze the performance of the charging system in practical settings.
6. Data Analysis and Findings
   Analyze data from field testing and simulations to evaluate the effectiveness and efficiency of the proposed charging system.

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7. Recommendations and Implications
   Formulate recommendations based on research findings to improve the efficiency and affordability of electric vehicle charging systems, as well as their implications for infrastructure development and industry standards.

With this approach, the research is expected to provide deeper insights into how to improve the efficiency and affordability of electric vehicle charging systems, as well as make a meaningful contribution to the development of electric vehicle charging infrastructure in the future.

RESULTS AND DISCUSSION

A DC-DC converter (DC to DC converter) is an electronic circuit that functions to change the DC voltage level from an input source to the desired DC voltage level output.Each part in the DC-DC converter has an interrelated function to change the input DC voltage level to the desired output DC voltage level. The configuration and selection of the right components will determine the characteristics of the DC-DC converter, such as efficiency, input and output voltage ranges, and the ability to regulate the output voltage.

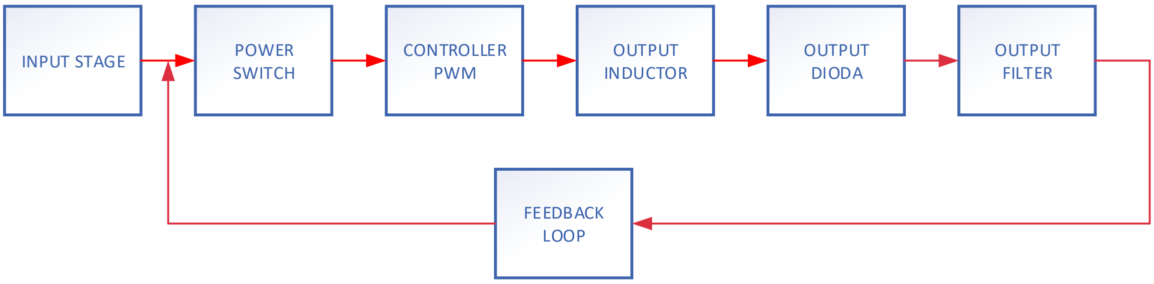

Figure 5. Block Diagram of Dc To Dc Converter

This circuit can deliver a maximum current of 15 amps at 66 volts. With such a large voltage and current range, it is sufficient as an electric vehicle battery charger for slow charging.

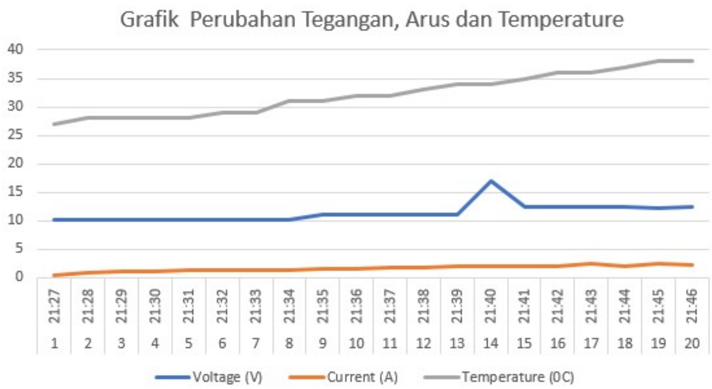

Figure 6. DC to DC converter output voltage

For testing in this study, a 12v 7.2Ah battery was used as a sample, and the test results can be seen in the following table.

Table 1. Results of Charging Test on 12V, 7.2Ah Battery

No	Time	Voltage (V)	Current (A)	Temperature (^{0}C)
1	21:27	10.26	0.5	27
2	21:28	10.28	0.8	28
3	21:29	10.28	1.2	28
4	21:30	10.15	1.2	28
5	21:31	10.12	1.3	28
6	21:32	10.14	1.35	29
7	21:33	10.11	1.35	29
8	21:34	10.12	1.38	31
9	21:35	11.08	1.55	31
10	21:36	11.07	1.58	32
11	21:37	11.03	1.72	32
12	21:38	11.03	1.87	33
13	21:39	11.01	2.05	34
14	21:40	17.03	2.07	34
15	21:41	12.39	2.09	35
16	21:42	12.37	2.11	36
17	21:43	12.35	2.42	36
18	21:44	12.37	2.12	37
19	21:45	12.32	2.41	38
20	21:46	12.41	2.21	38

CONCLUSION

From the results of the observations and analysis above, the following conclusions can be drawn: The DC to DC converter circuit for charging electric vehicle batteries has been successfully created and works as expected. This circuit can charge batteries with voltage variations from 12 volts to 60 volts which are widely used in electric vehicles. The results of the correlation analysis show that there is a correlation between charging current and charging time. Where the greater the charging current, the faster the charging time will be. The battery temperature while charging must also be taken into account to prevent overheating which can damage the battery cells.

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