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Development of Battery Charging System for EV

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Abstract: ***The rapid growth of Electric Vehicles (EVs) has created an increasing demand for efficient and reliable battery charging systems. The performance and lifespan of an EV battery are directly dependent on the quality of its charging system, making its development a critical engineering challenge. Many existing systems face issues related to voltage instability, thermal management, and energy inefficiency. In this paper, we present the development of a Battery Charging System for Electric Vehicles operating at 48 V and 10 A. The proposed system employs a Constant Current/Constant Voltage (CC/CV) charging methodology along with overvoltage and overcharge protection to ensure safe and efficient energy transfer. This paper makes a detailed analysis and comparative study of various charging topologies, discussing the merits and demerits of each method with respect to efficiency, cost, and complexity. The system is validated through simulation and hardware testing, demonstrating stable output performance under varying load conditions, making it suitable for light-duty EV applications.***
Keywords: Electric Vehicle, Battery Charging System, 48V 10A, CC/CV Method, Power Electronics, DC-DC Converter.

I. INTRODUCTION

A Battery Charging System for Electric Vehicles (EVs) is an electrical and electronic system designed to transfer energy from an external power source to the rechargeable battery of an electric vehicle in a controlled, safe, and efficient manner. The growing concerns over fossil fuel dependency and vehicular emissions have accelerated the global shift toward Electric Vehicles as a cleaner transportation alternative. EVs rely entirely on onboard lithium-ion battery packs, which require a carefully regulated charging process to ensure safe and efficient energy replenishment. The battery charging system serves as the critical interface between the external power supply and the vehicle's onboard battery, and a poorly designed system can lead to overcharging, overheating, and voltage instability, causing irreversible battery damage. The Constant Current/Constant Voltage (CC/CV) method is widely recognized as the most effective charging technique for lithium-based batteries. The system discussed in this paper operates at 48 V and 10 A, targeting light-duty EV applications such as electric scooters and e-rickshaws, incorporating a DC-DC converter topology along with essential hardware protection features for reliable and safe operation.

II. LITERATURE SURVEY

Revanth B.C et al. (2022) [1]– Review on Electric Charging Systems conducted a examining various charging infrastructures and technologies available for EVs. The study analyzed different charging levels — Level 1, Level 2, and DC Fast Charging — along with their power ratings and suitability for different EV applications. The authors also discussed various converter topologies used in onboard and off-board chargers, evaluating their efficiency and performance. The paper concluded that the development of efficient and accessible charging systems is essential for accelerating the mass adoption of Electric Vehicles globally.

1) The Application Allows Users To

a. Useful for selecting appropriate charging levels
b. Guide for public charging station deployment
c. Supports smart grid energy management planning

2) Advantages

a. Improves battery life
b. Enhances safety
c. Prevents overcharging and overheating.

3) Disadvantages

a. Requires accurate sensors
b. Increases system complexity and cost.

Samyak Negrale et al. (2023)[2] –Presented a literature survey on Electric Vehicle Battery Management Systems (BMS), examining various techniques and methodologies used for efficient battery monitoring and control. The study reviewed key functions of a BMS including State of Charge (SOC) estimation, State of Health (SOH) monitoring, cell balancing, thermal management, and overcharge/overdischarge protection. The authors compared different BMS topologies and control algorithms, analyzing their accuracy, complexity, and real-time performance. The paper concluded that an efficient BMS is essential for maximizing battery life, ensuring safety, and improving the overall performance of Electric Vehicles.

1) The Application Allows Users To

a. Electric & Hybrid Electric Vehicles
b. EV Charging Systems
c. Renewable Energy Storage
d. Smart Grid & Vehicle-to-Grid (V2G) Systems
e. Automotive Safety & Protection Systems

2) Advantages

a. Compact design
b. Improved power density
c. Better efficiency.

3) Disadvantages

a. Requires accurate sensors,
b. Increases system complexity and cost.

Shahid Aziz Khan et al. (2024) [3]– Integrated Super Planar Inductor-Rectifier Design for EV Drive, this paper addresses the limited vertical space on the EV chassis for charging electronics by presenting an integrated distributed planar magnetics design combined with a rectifier for vehicle-side wireless charging. A planar-distributed inductor module using 16 EI cores with PCB-embedded windings was designed, modeled via a novel high-fidelity model, and fabricated using design space optimization, achieving a 66% increase in power density. A hybrid approach using metal core PCB for the rectifier board and FR4 PCB for the inductor module was established as optimal considering weight, cost, reliability, and thermal performance.

1) The Application Allows Users To

a. Inductive wireless EV charging receiver electronics
b. Plug-in Hybrid EV (PHEV) underbody power systems
c. High-power density automotive power converters

2) Advantages

a. Compact design
b. Improved power density
c. Better efficiency.

3) Disadvantages

a. Thermal management issues
b. Complex manufacturing process.

Literature Survey Table

Author	Year	Title	Drawback
Revanth B.C	2022	Review on Electric Charging Systems	Requires accurate sensors Increases system complexity and cost.
Samyak Negrale	2023	literature survey on Electric Vehicle Battery Management Systems	Requires accurate sensors, Increases system complexity and cost.
Shahid Aziz Khan	2024	Integrated Super Planar Inductor-Rectifier Design for EV Drive	Thermal management issues Complex manufacturing process.

III. CONCLUSION

The development of an efficient battery charging system is essential for ensuring the safe and reliable operation of Electric Vehicles. A few years back, EV charging systems were bulky and inefficient, but with advancements in power electronics, more compact and efficient solutions are now achievable. The proposed 48V 10A Battery Charging System using the CC/CV charging method demonstrates stable and efficient energy transfer suitable for light-duty EV applications. With the growing global demand for Electric Vehicles, well-designed charging systems will continue to play a vital role in accelerating the adoption of sustainable transportation.

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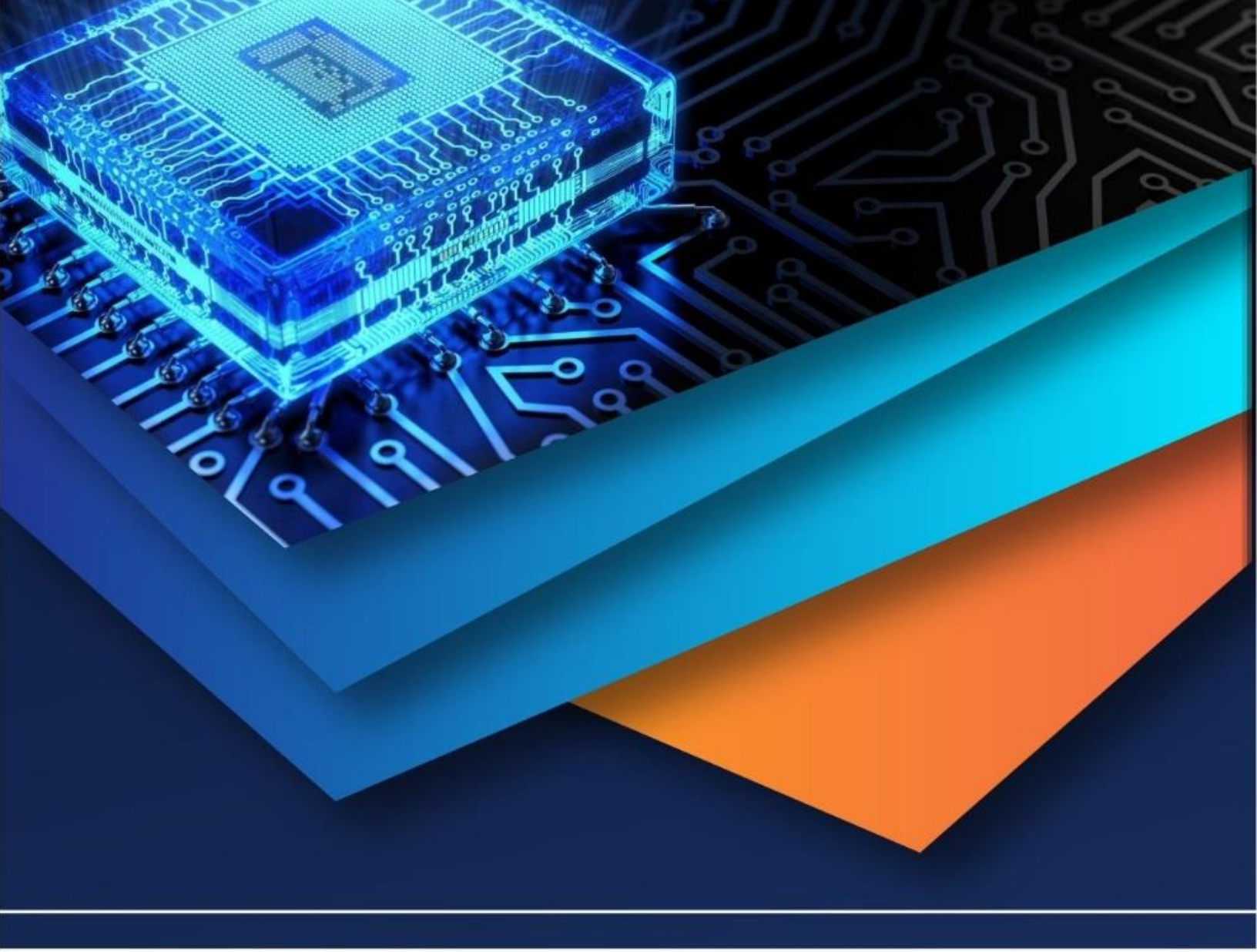

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