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POWER QUALITY IMPROVEMENT FOR ELECTRIC VEHICLE CHARGING SYSTEM

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Abstract— The works explores strategies for enhancing power quality in electrical vehicle (EV) charging systems, addressing the challenges maintaining a stable and reliable power supply during charging process. Designing an intelligent process for electric vehicles (EV) charging is crucial for optimizing energy usage and mitigating environmental impact. Efficient charging systems can help address limitation in electrical power distribution, making electric vehicles (EVs) more effective and eco-friendly choice by optimizing charging procedures.

Keywords— Bridge Less SEPIC Converter, Bridge Rectifier, capacitor filter, Coupled inductor.

I. INTRODUCTION

The current situation of constant growth in hazardous carbon emission and the minimal energy efficiency of traditional vehicles has spurred the widespread adoption of electric fleets. Electric vehicles (EVs) bring clear advantages in conserving conventional fuel and reducing air pollution. However, the integration of these EVs into the transport sector demands research efforts to ensure improved power quality (PQ) operations, addressing grids resilience challenges. Additionally, advance battery technology is required to power these vehicles, with electric vehicle battery chargers (EVBCs) playing a pivotal role in charging, influencing grid current quality.

The prevalence of harmonics in grid current, affecting unity power factor (UPF) operation, necessitates research on power factor correction converters.

The standard configuration of an electric vehicle battery charges (EVBC) involves a power factor correction (PFC) stage for AC-DC conversion, typically employing a boost or buck-boost power factor correction (PFC) converter at the input, along with an isolated converter to regulate battery-side quantities. The simplicity and component count of the DC-DC converter significantly impact charger size and efficiency. Notably, the LLC resonant converter emerges as a preferable choice due to low electromagnetic interference (EMI) noise, high efficiency, and improved power density compare to single –switch isolated DC-DC converters.

In the context of power factor correction (PFC), a buck-boost converter is favored over the boost converter at the first stage, benefiting from an attractive duty ratio range. However, the use of an inductor-inductor-capacitor (LLC) converter at the next stage introduces efficiency limitations in two-stage configurations due to fluctuations in operating frequency over input voltage variations. Addressing these challenges is crucial for achieving optimal power quality and operational efficiency in electric vehicle chargers (EVBs), aligning with the society for automotive engineers (SAE) standards.

II. OBJECTIVE

a) To enhance power quality in electric vehicle charging system.

b) Establishment robust charging infrastructure is pivotal for the effective operation of electric vehicles.

c) The study introduces a power converter tailored for electric vehicle battery chargers, designed to accommodate varying input voltage.

III. LITERATURE REVIEW

1. **Namburi Ramya Sri** (M. Tech, Department of Electrical Engineering, JNTUH University College of Engineering Technology and Science Hyderabad, India). This paper compares the bridgeless cut converter and SEPIC PFC converter in EV battery chargers. Result indicate improved power quality , reduced THD, enhanced power factor, high efficiency, and stable output voltage crucial for designing reliable EV charging systems and contributing to grid stability. This research sets the stage for future developments in power electronics for EV charging application.
2. **Radha Kushwaha**, Member IEEE Indian Institute of Technology, New Delhi. This papers introduces an enhanced front –end SEPIC converter for power factor correction in EV chargers, demonstrating advantages such as reduced semiconductor switch voltage and improved efficiency. The proposed converter is particularly suitable for high-power EV chargers, as it achieves the same output voltage with a lower duty cycle, minimizing switch condition losses and enhancing overall charger efficiency.
3. **Jitendra Gupta**, Member, IEEE, Radha Kushwaha IEEE TRANSACTIONS ON INDUSTRIAL APPLICATIONS. This paper presents a switched inductor single- ended primary inductor converter (SISEPIC) topology for electric vehicle charging. The designs achieves a high step-down dc voltage gain, incorporates active power factor correction for improved power quality, and ensure low total harmonic distortion and unity power factor during constant voltage charging. The charger is designed for efficiency with reduced sensing devices and control complexities, validated through both simulation and experimental results, demonstrating its effectiveness for low emission vehicles (LEVs).

IV. FUTURE SCOPE

a) The future of mobility in India holds great promise, marked by a shift towards quiet, effective, and environmentally friendly transportation. Government adoption of four- wheeler vehicles and improved public transportation signals a significant growth trajectory.

b) Investments from fleets operations like Ola and Uber, along with food distribution companies, underscore the economic potential. The younger generation's emphasis on innovation and environmental conservation aligns with this transition.

c) Collaboration between established conglometers and start-ups will play a pivotal role in ensuring indigenous production of electric vehicle battery chargers (EVs), components, and batteries, ultimately improving the charging system and fostering a sustainable transportation ecosystem.

V. BLOCK DIAGRAM

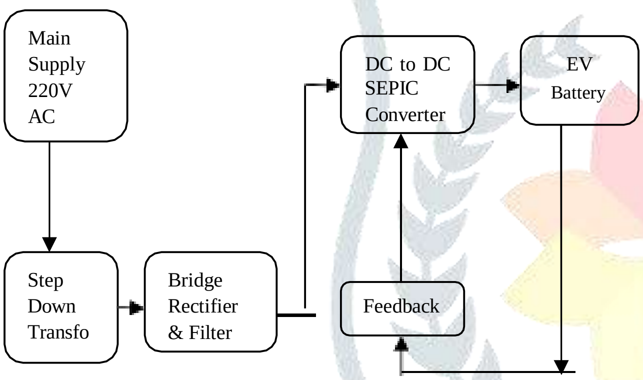

Figure 1. Block diagram of Power Quality Improvement for Electric Vehicle Charging System

The step down transformer is used to reduce the electrical voltage from 230V AC to 12V AC. Four rectifier diode 1N4007 is used to rectify the AC input. These four diodes are used to convert the 12V AC output across the transformer. They form a bridge converter which is a building block for the converter and after converting there is an capacitor filter installed to smooth the output. This output will apply to SEPIC converter for improve the power quality. This output will be adjusted and improve based on the feedback signal. By this feedback signal SEPIC converter will work.

After improve the power quality will store this energy into battery bank for electric vehicle.

VI. RESULT

The power electronic converter designed for EV chargering application, with its dedicated circuit for enhancing power quality, has shown slightly improved performance compared to direct charging from the source. The power quality of the proposed system is good.

VII. CONCLUSIONS

The power electronic converter designed for EV Charger applications, as described, offers several advantages, particularly in its ability to operate under low AC voltage conditions commonly found in residential areas. Its capability to convert low AC voltage into suitable DC input voltage for the converter enable s efficient charging while maintaining power balance. Additionally, the emphasis on improve the power quality (PQ) ensures stable and reliable charging performance, making it a strong alternative to existing chargers.

VIII. REFERENCES

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