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Research Article

POWER FACTOR IMPROVEMENT IN MODIFIED BRIDGELESS LANDSMAN CONVERTER FED EV BATTERY CHARGER

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Abstract

This work presents the design and implementation of a novel charger for battery-operated electric vehicles (EVs) with enhanced power factor correction at the front end. The proposed configuration replaces the conventional diode converter typically used in EV chargers with a modified Landsman power factor correction (PFC) converter. This PFC converter is cascaded with a flyback isolated converter, allowing for efficient charging of the EV battery by first operating in constant current mode and then transitioning to constant voltage mode. The modified PFC converter is controlled using a single sensed parameter, ensuring robust regulation of the DC-link voltage and unity power factor operation. The proposed charger topology offers several advantages, including improved power quality, low device stress, and reduced input and output current ripple, alongside lower input current harmonics compared to conventional chargers. To validate compliance with IEC 61000-3-2 standards, a prototype was developed and tested to charge a 48V, 100Ah EV battery under varying input voltage conditions. The performance of the charger was found to be satisfactory across all tested scenarios, demonstrating its effectiveness and reliability in improving , EV charging systems.

Keywords: PFC, Power Factor, EV.

INTRODUCTION

With increasing concerns over emissions, fuel consumption, global warming, and the finite nature of energy resources, the adoption of electric mobility presents a significant opportunity for sustainable and efficient transportation solutions. In recent years, research efforts have focused on surveying the present scenario and exploring future technologies for electric vehicle (EV) propulsion to address these pressing challenges. Electric mobility offers numerous advantages over conventional petrol and diesel-powered vehicles. However, the comprehensive integration of electric transportation requires careful attention from researchers. Effective control strategies must be developed to seamlessly integrate electric vehicles with the existing distribution system. Many of these strategies intersect with the power quality issues addressed by EV chargers during the battery charging process. EVs rely on rechargeable batteries to provide traction force, which are typically recharged using AC-DC converters known as EV chargers. The most common architecture of EV battery chargers consists of a boost converter at the front-end and an isolated converter at the subsequent stage. The performance of such chargers is primarily determined by the DC-DC converter's performance, ensuring regulated output voltage and current. Various approaches have been explored to improve the performance of EV chargers. Interleaved and zero voltage switching (ZVS) Power Factor Correction (PFC) converters have been implemented to reduce inductor size and output current ripple. However, interleaving comes with the drawback of increased current stress on switches. Full-bridge topologies offer high power density and efficiency but introduce complexity in charger control due to the arrangement of four switches. LLC (Inductor-Inductor-Capacitor) resonant converters provide an attractive solution with high efficiency, low electromagnetic interference (EMI) noise, and high-power density across a wide input range. However, the design and analysis process of LLC converters present challenges, leading to the adoption of unidirectional or bidirectional AC-DC converters in integrated on-board or off-board configurations.

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LITERATURE SURVEY

An Author The methodology for designing and implementing the proposed charger for battery-operated electric vehicles (BEVs) a new charger design for battery-operated electric vehicles (BEVs) that improves power factor at the front end. Instead of using a conventional diode converter, the design employs a modified Landsman power factor correction (PFC) converter. This PFC converter is paired with a flyback isolated converter, enabling the charger to first operate in constant current mode and then switch to constant voltage mode for battery charging. Ensures robust regulation of the DC-link voltage and unity power factor operation. Offers low device stress, reduced input and output current ripple, and low input current harmonics. A prototype was built to charge a 48V, 100Ah EV battery, and its performance under varying input voltage was tested to meet IEC 61000-3-2 standards. This comprehensive approach ensures the proposed charger delivers high power quality, efficiency, and compliance with regulatory requirements.[1]

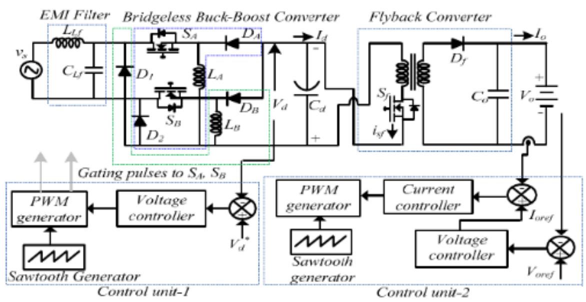

Fig.1. Proposed system of designing and implementing the proposed charger for battery-operated electric vehicles (BEVs)

The proposed work involves the design and implementation of an improved charger for electric vehicles (EVs) that addresses the limitations of existing chargers, particularly the poor power factor. Analyze the performance of conventional diode converters used in current EV chargers, focusing on issues like poor power factor and inefficiencies. Replace the conventional diode converter with a modified Landsman power factor correction (PFC) converter to improve the power factor. Integrate the modified Landsman PFC converter with a flyback isolated converter. This integration helps in converting the input AC power to regulated DC power suitable for charging the EV battery. Implement a control strategy for the flyback converter that allows it to operate in constant current (CC) mode initially and switch to constant voltage (CV) mode as the battery charges. Develop a control mechanism using a single sensed parameter to regulate the DC-link voltage and ensure unity power factor. This simplifies the control system while maintaining robust performance. Test the prototype to ensure it meets the IEC 61000-3-2 standard for harmonic emissions. [2]

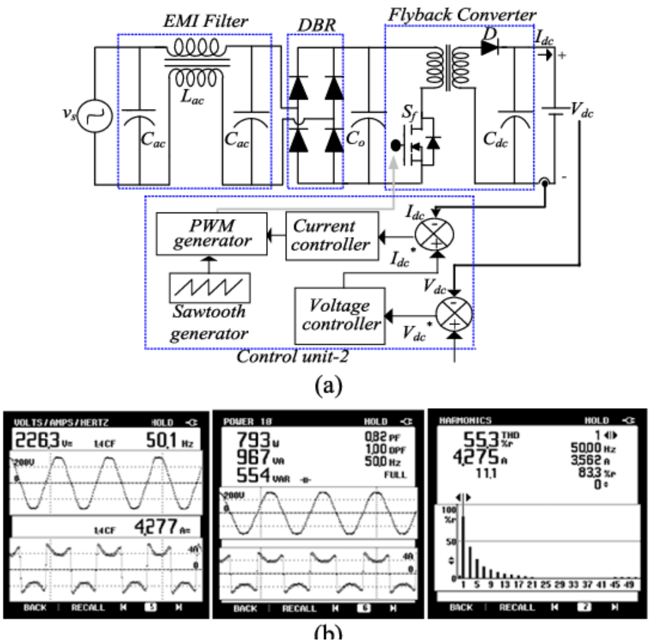

Fig.2. Implementation of an improved charger for electric vehicles (EVs)

This research work focuses on the design and construction of a novel Battery powered Electric Vehicle (BpEV) and to enhance the power-factor of the input AC. This is accomplished by substituting the prevalent diode converter with a newer, high-quality Landsman converter that is equipped with power-factor tuning. The Flyback-isolated and PFC converters work together to let the EV battery to switch between constant current and constant voltage modes. The recommended PFC converter is regulated using a single entity to attain consistent DC-link voltage and to boost the power-factor close to unity, with simulation carried out using MATLAB. As per the findings, a minimum of 60V DC output is required for charging the battery and suppressing input harmonics. In comparison to the usual architecture, the suggested scheme could provide increased power quality, very little device stress, less ripple at both input and output, and significantly lower harmonics. To validate the simulation results, a prototype is developed and deployed to charge a 48V EV battery with a rating of 100Ah in order to make it compliant with the IEC 61000-3-2 standard, particularly in the case of high voltage spikes at the input. The charger's performance has been deemed to be good in all conditions based on matlab simulation results. [3]

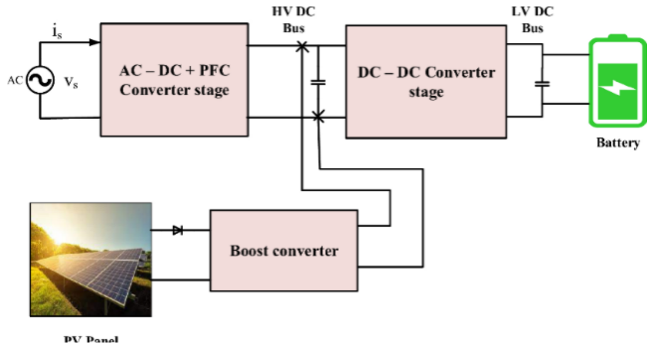

Fig.3. Design and construction of a novel Battery powered Electric Vehicle (BpEV)

This research work aims to design and construct a novel Battery-powered Electric Vehicle (BpEV) with enhanced power factor correction (PFC) capabilities. Assess the limitations of the prevalent diode converter used in current EV chargers, particularly regarding power factor and efficiency. Substitute the conventional diode converter with a high-quality Landsman converter equipped with power-factor tuning capabilities to improve power quality and efficiency. Integrate the Landsman PFC converter with a flyback isolated converter to facilitate the transition between constant current and constant voltage modes during battery charging. Implement a control mechanism using a single sensed parameter to regulate the DC-link voltage and improve power factor close to unity. Conduct simulations using MATLAB to validate the proposed control strategy and assess the performance of the PFC converter under various operating conditions. Validate the charger's compliance with the IEC 61000-3-2 standard, particularly concerning input voltage spikes and harmonic emissions. This research aims to demonstrate the effectiveness of the proposed Battery-powered Electric Vehicle charger with enhanced power factor correction. By substituting the diode converter with a Landsman PFC converter and integrating it with a flyback isolated converter, the charger offers improved power quality, efficiency, and compliance with regulatory standards, thereby addressing the limitations of existing EV chargers. [4]

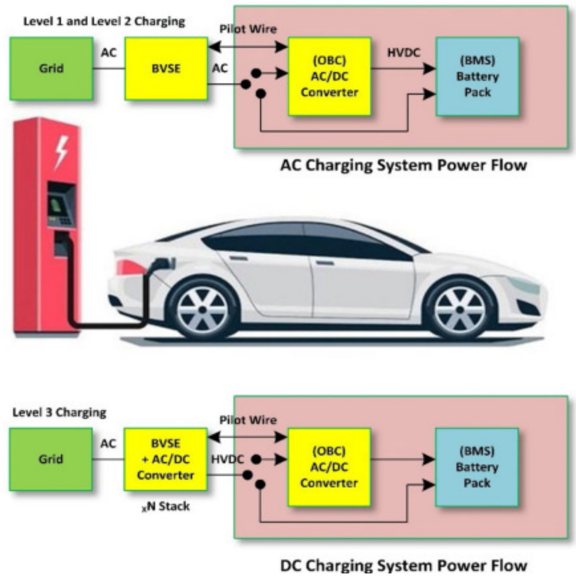

Fig.4. Design and construct a novel Battery-powered Electric Vehicle (BpEV)

This research focuses on designing and implementing a new charger for battery-operated electric vehicles (EVs) with improved power factor at the front end. Evaluate the shortcomings of the conventional diode converter used in current EV battery chargers, particularly in terms of power factor and overall efficiency. Replace the conventional diode converter with a modified Landsman power factor correction (PFC) converter to enhance power factor and improve power quality. Build a prototype charger based on the designed configuration, incorporating the modified Landsman PFC converter and flyback isolated converter.Test individual components and subsystems to ensure they meet design specifications and function correctly. Large a 48V EV battery with a capacity of 100Ah using the prototype charger under varying input voltage conditions. Evaluate the charger's performance in terms of charging efficiency, power factor improvement, device stress, and ripple reduction. [5]

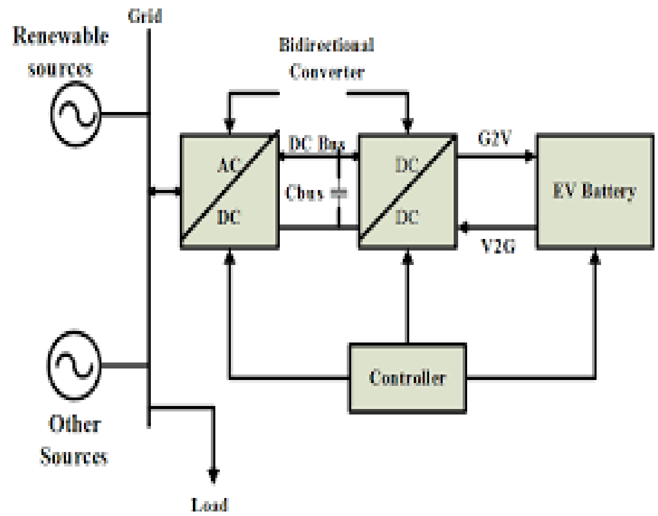

Fig.5. Designing and implementing a new charger for battery-operated electric vehicles (EVs)

Conclusion

In conclusion, the reviewed papers highlight significant advancements in EV charger technology, focusing on enhancing power quality, efficiency, and compliance with standards. The use of modified Landsman Power Factor Correction (PFC) converters integrated with flyback isolated converters stands out as a key solution for improving power factor and reducing harmonics. The proposed designs are rigorously tested to meet IEC 61000-3-2 standards, ensuring robust performance and regulatory compliance. These innovations contribute to the development of more efficient and reliable EV charging systems, supporting the transition to sustainable electric mobility.

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