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A Novel Solution to EV Battery Charging System Using Bridgeless Topology

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ABSTRACT

This study presents a new electric vehicle (EV) battery charger featuring an active power factor correction (PFC) converter for better performance and efficiency. The innovative bridgeless buck-boost design reduces energy losses from traditional diodes, enhancing overall efficiency. An 850W prototype was created to charge a 48V/100Ah battery using a flyback converter in constant current (CC) and constant voltage (CV) modes. A dual PI controller manages the charger in discontinuous conduction mode (DCM), ensuring it operates at unity power factor (UPF) and complies with the SAE J2894 standard. By using two series-connected buck-boost converters, the system maintains a stable DC link voltage and adapts to varying mains voltages while optimizing input current quality. The paper also discusses how the buck-boost converter functions as a PFC controller for EV battery charging, operating in both buck and boost modes based on input and battery voltages. It describes a simple control scheme for achieving near-unity power factor and compliance with IEEE 519 harmonic standards. The control performance is simulated in Matlab/Simulink for both open-loop and closed-loop systems.

Keywords – Active Filters, Ev Battery, Flyback Converter, Bridgeless Buck Boost Converter.

1. Introduction

Introduction Electric vehicles (EVS) are necessary to reduce greenhouse gasoline emissions and promote sustainable transport. However, current power grid controls are not ready for out of battery charging, which may have an impact on electric quality and balance. To pay EV battery fees, an on-board charger AC wants to convert AC into DC and control charging technology. This charger usually performs between three kW and 7 kW and consist of the most important components in it: an AC-DC converter and DC-DC converter for battery to connect to the grid. This paper assessment is currently experts of EV Battery Charger Technologies, which converter topology and charging infrastructure. It exposes various AC-DC converters with energy-perfect reform (PFC) capabilities and discusses DC-DC converters, along with half-pulls and interactive types. We introduce a new unidiraveseal Bridgeless Improve-Buck Converter for EV Chargers, featuring a Bridgeless Rise-grind AC-DC Converter and an interrelated dollar-crus DC-DC converter. This design provides blessings such as the efficiency of progression, decrease in the size of the output filter and more desirable overall performance than standard solutions. Bridgeless layout of the proposed converter enhances performance on traditional PFCs, improves converters, as well as its voltage-dabber feature helps in popular-line applications. The battery enhances ripple frequency in the current day, taking into account the interleaved DC-DC converter layout, keeping in mind the small output filter. This innovation is aimed at customizing the charging method for electric cars, using existing power grid barriers and addresses challenges by contributing to more durable power ecosystem.

PRINCIPLE OF OPERATION

The Front-End Bridgeless Converter plays an important role in the form of battery charger for electric vehicles (EVs), which allows efficient power transfer from the vehicle to the battery system. This innovative converter is efficiently operated on positive and negative parts of the alternative current power voltage (AC). By taking advantage of advanced control strategies and high demonstration circuit components, the converter increases overall performance and improves energy quality, making it an essential component in the modern ecosystem of electric vehicles. The converter configuration converter configuration includes two separate deer converters: one dedicated to the positive AC supply line and the other to the negative semi-power. In a positive half line, the system includes a high existence switch (designated as S_A) responsible for converting and regulating the voltage. It is complemented by one (L_A) a prone that plays an important role in the storage and release of energy, necessary to support deer operations. A (da) output diode is also included in this segment, when the switch is in its disconnected state allows the flow to flow. Similarly, the negative midfielder has a high existence (S_B) key, which operates as analog as analog, ensures efficient voltage regulation for half negative circles. An inductor (L_B) is used to effectively store energy during operation, while an output diode (D_B) is included to conduct the current when Switch S_B is not active. Converter design allows you to operate in unsatisfactory mode for both inducers, which is particularly beneficial as it facilitates a wide range of voltage variations simultaneously, and maintaining power factor improvement. By restricting the two inducers within the discontinuous region, the design of the converter reaches the superior quality of energy, significantly minimizing driving losses and thus increasing overall efficiency. Switching characteristics During the positive operating cycle, the converter acts in three distinct modes, labeled as P-I mode, P-II mode and P-III mode. Each mode defines specific interactions between the various components along the various phases of the switching cycle. Notably, the switching sequence that occurs during the negative middle cycle is a mirrored image during the positive cycle. This process employs Switch S_B, L_B inductor and D_B diode to ensure that the system maintains high efficiency throughout the line cycle, demonstrating robustness and converter reliability. Performance and Control The converter employs a voltage follower control strategy that simplifies the general control mechanism using a single sensor. This simplified approach not only contributes to reducing costs, but also decreases the complexity of the project, making it more accessible for practical applications. In addition, this project significantly reduces the thermal voltage in the switches, effectively by half the conduction losses in each switching cycle. Consequently, this improvement leads to a better longevity and reliability of the components involved. To further increase performance, an LC bass filter is strategically included in the PFC input. This filter serves to alleviate higher order harmonics, which is critical to minimizing distortion in the supply system that may arise from high frequency switching.

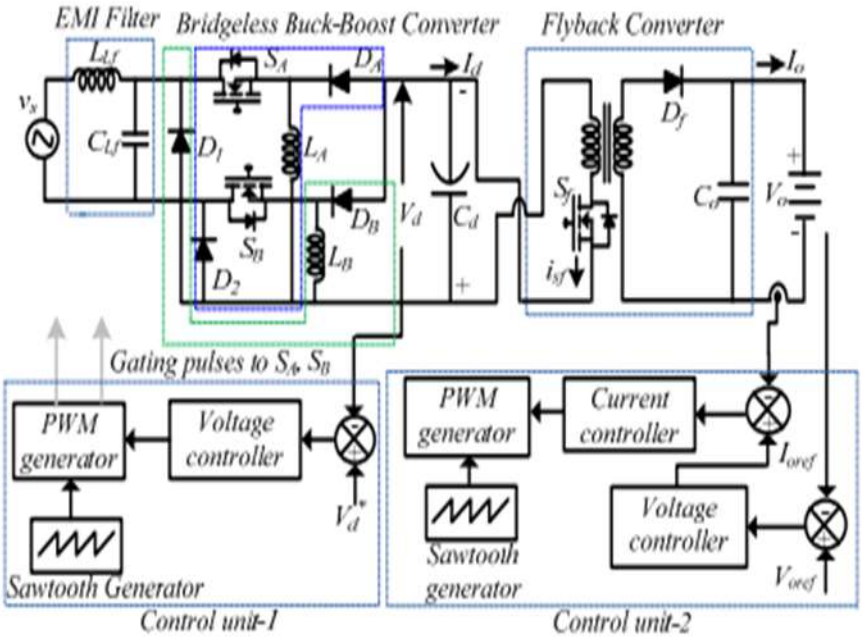
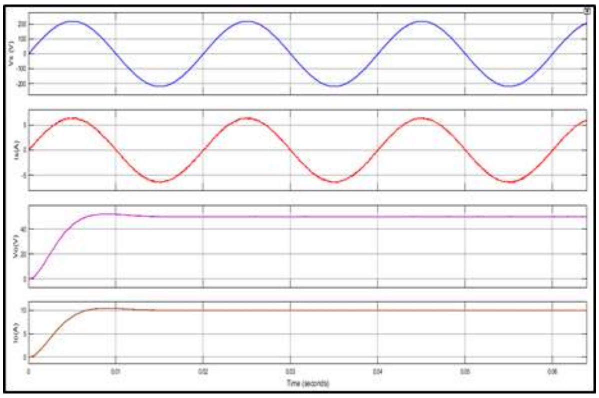


Figure no. 1

RESULTS



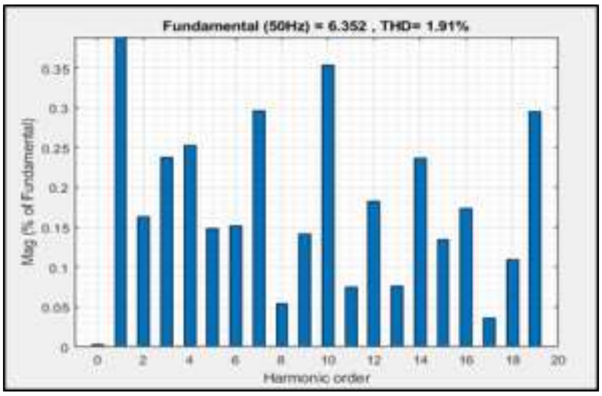


Figure no.2 Figure no. 3

Figure no. 2 gives a chain of domain charts that depict the conduct of electrical indicators in special parameters. The first graph painted with a blue line indicates the source voltage (VS) that over time with -2 hundred V and +200 V, over time, is a sign of an essential opportunity current source (AC). The 2d graph, inside the purple, shows a sequence of origin (IS) is also nearly +five and +5A. This modern supply seems in the phase with the voltage, shows a simply resistance load. The 1/3 graph, inside the pink, shows the output voltage (VO), which shows a totally tender infection and quick stabilizes at approximately forty V, indicating a specific role of the voltage law within the electronic circuits. The final graph shown in Brown describes the output modern-day (IO) that gradually grows over the years, shows a loading process and stabilizes close to 10A, it exhibits that the system reaches a constant output contemporary after some time. Collectively, these elements provide essential information about relationships and dynamics among voltage and contemporary inside an electrical circuit over the years, highlighting the primary features of AC alerts and the response of electronic components. The diagram (figure no. 3) is a bar chart that illustrates the magnitude of different harmonic orders relative to the fundamental frequency, which is at 50 Hz. The height of each bar represents the magnitude as a percentage of the fundamental frequency magnitude, denoted as 6.352. The harmonic orders are plotted on the x-axis, ranging from 0 to 20, with noticeable peaks at certain harmonic orders, particularly around the 2nd, 4th, 7th, 10th, 12th, and 14th harmonics. The Total Harmonic Distortion (THD) is noted at 1.91%, indicating a relatively low level of distortion. Overall, the chart provides a visual representation of harmonic content and how it relates to the fundamental frequency.

Conclusion

The performance of Buck-boost converter as power factor correction converter for battery charging applications is demonstrated using Matlab/Simulink. A control strategy using PI controller for wave shaping of the source current is implemented which improved the source current wave shape significantly. The effect of presence of filter capacitor at the output of diode bridge rectifier on source current is reduced. Also, nearly unity power factor at the source side is attained by the implemented control strategy. The source current distortion and the THD is also reduced with higher degree of significance. The system studied is applicable for high voltage and high-power application also gives more reliability to converter.

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