HIGH EFFICIENCY BRIDGELESS SINGLE POWER CONVERSION BATTERY CHARGER FOR ELECTRIC LOAD

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ABSTRACT:

Charging batteries of light electric vehicles require chargers with high efficiency and a highpower factor. To meet this need, this paper presents a bridgeless single-power-conversion battery charger composed of an isolated step-up AC-DC converter with a series resonance circuit. The bridgeless configuration reduces the conduction losses associated with the input diode rectifier, and the series-resonance circuit reduces the reverse recovery losses of the output diodes by providing zero current switching. In the proposed rectifier, a back-to-back bridgeless boost PFC topology is adopted at high-line conditions and a three-level bridgeless boost PFC topology Keywords is rebuilt to reduce the switching losses at low-line conditions. The bridgeless boost topology is for plug-in hybrid electric vehicle and electric vehicle battery chargers to achieve high efficiency, which is critical to minimize the charger size, charging time and the amount and cost of electricity drawn from the utility.

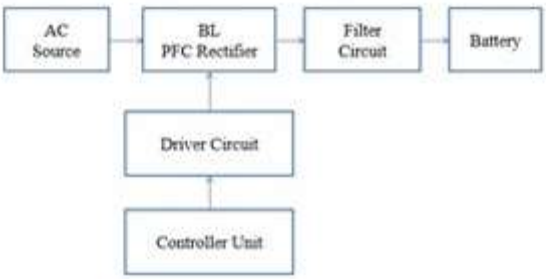
Keywords: Boost Converter, Single phase PFC, flexible mode, high efficiency.

1. INTRODUCTION

The AC mains utility supply ideally is supposed to be free from high voltage spikes and current harmonics. Discontinuous input current that exists on the AC mains due to the non-linearity of the rectification process should be shaped to follow the sinusoidal form of the input voltage. Traditionally there are two ways of shaping the input current waveform so that the overall off-the-line AC-DC converter is seen as a resistive load by the ac mains. The first is the passive approach in which a 50 Hz inductor connected to the ac mains is used, but this is not a practical solution, as it adds to the size and weight of the power supply, in a time when these parameters are minimized by the use of higher switching frequencies. Power supplies with active power factor correction (PFC) techniques are required for wide range of applications for communicasuch as the IEC 61000-3-2. In addition, it is highly recommended to meet new Industry standards such as the 80 PLUS initiative. Many papers have been published in the literature to provide a solution for single-stage power factor correction (PFC) integrated topologies [1–7]. These solutions have been effective to provide cost-effective approach for achieving both the function of high PFC and fast output voltage regulation. Most of the PFC rectifiers utilize boost converter at their front end. Boost converter provides many advantages such as natural power factor correction capability and simple control. However, low voltage applications such as telecommunication or computer industry an additional converter or an isolation transformer is required to step down the voltage. However, classical boost arrangement has lower efficiency due to significant losses in the diode bridge [1]. In addition, boost converters suffer from high inrush current which increases the cost of safety required disconnection devices between the load and the line voltage. To minimize the losses of the full bridge, many bridgeless PFC rectifiers have been introduced to improve the rectifier power density and/or reduced noise emissions [2–5] via soft switching techniques or coupled magnetic topologies. Several non-boost bridgeless rectifiers have been published lately [6–10]. A bridgeless PFC rectifier based on Sepic topology is presented in [8].

However, the topology has only a step up capability like a boost transformer; however, an isolation transformer can be used to step down the voltage, hence increasing the cost and size of the rectifier. Even though Cuk converter topology is typically a lower efficiency converter however it presents many advantages, such as isolation capability, step up/step down output voltage, continuous output current and lower electromagnetic emissions.

2. DC-DC boost converter Power for the boost converter can come from any suitable DC sources, such as batteries, solar panels, rectifiers and DC generators. A process that changes one DC voltage to a different DCvoltage is called DC to DC conversion. A boost converter is a DC to DCconverter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it "steps up" the source voltage. Since power ( ) must be conserved, the output current is lower than the source current. Examples of DC to DC converter are: Boost converter is power converter which DC input voltage is less than DC output voltage. That means PV input voltage is less than the battery voltage in system. Buck converter is power converter which DC input voltage is greater than DC output voltage. That means PVinput voltage is greater than the battery voltage in system. Existing System Single-stage bridgeless topologies based on two-stage boost-flyback converter and half-bridge PFC converter. Dual-boost bridgeless PFC rectifier (DBBL PFC). Single-stage resonance converters with inherent PFC and current-fed full-bridge converters. Demerits Less efficiency. More no of components. More Losses Proposed system Anovel FMBL PFCrectifier is proposed, in which the high efficiency over a wide input range can be achieved. In the proposed rectifier, a BTBBL PFC rectifier is adopted at highline voltages and a three-level bridgeless boost PFC rectifier (TLBL PFC) is formed to achieve high efficiency at low-line voltages. Compared with the traditional bridgeless boost PFC rectifier, an extra low-voltage bidirectional switch (usually composed of two switches) is added; therefore the increased cost is low. At both high- and low-line conditions, the Low CM noise can be achieved due to the direct connection between the input power grid and the output electrolytic capacitor during halfline cycle. The proposed FMBL PFC can be simply treated as two independent boost PFC circuits according to the line voltage. Compared with the traditional bridgeless boost PFC rectifier, an extra low-voltage bidirectional switch (usually composed of two switches) is added; therefore the increased cost is low. At both high- and low-line conditions, the Low CM noise can be achieved due to the direct connection between the input power grid and the output electrolytic capacitor during halfline cycle. The proposed FMBL PFC can be simply treated as two independent boost PFC circuits according to the line voltage.



Merits

High efficiency.

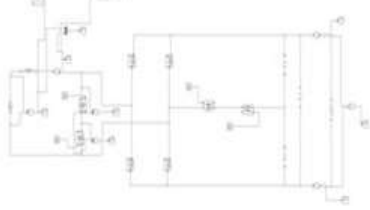
Cost is low.

High Voltage

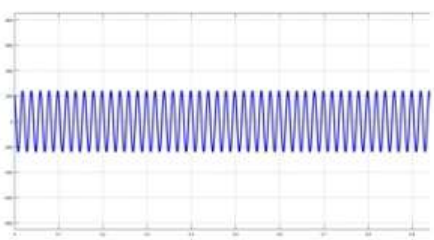
3. BRIDGELESS POWER FACTOR CORRECTION A new concept of flexible converter is proposed in [11]. There are two or more topologies or operating modes involved in a flexible converter, where different topologies are formed for different applications. In order to solve the problem of low efficiency at low input for the rectifier, a flexible mode bridgeless boost PFC (FMBL PFC) converter is proposed based on the flexible converter concept. The basic design principle can be concluded as follows. According to the input voltage, the rectifier can be flexibly adapted to the suitable topology and mode for obtaining the maximum efficiency. Meanwhile, in order to reduce the extra cost, the circuit components should be reused as much as possible in different topologies and modes. Based on this idea, a novel FMBL PFC rectifier is proposed, in which the high efficiency over a wide input range can be achieved. In the proposed rectifier, a BTBBL PFC rectifier is adopted at high-line voltages and a three-level bridgeless boost PFC rectifier (TLBL PFC) is formed to achieve high efficiency at low-line voltages. Compared with the traditional bridgeless boost PFC rectifier, an extra low-voltage bidirectional switch (usually composed of two switches) is added, therefore the increased cost is low. At both high- and low-line conditions, the low CM noise can be achieved due to the direct connection between the input power grid and the output electrolytic capacitor during half-line cycle. The detailed principle analysis about the proposed FMBL PFC rectifier is presented. Finally, an experimental prototype is built to verify the feasibility and the effectiveness of the proposed topology.

4.SIMULATION RESULT

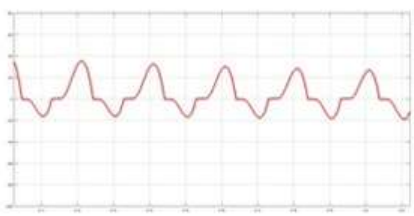
Proposed Circuit



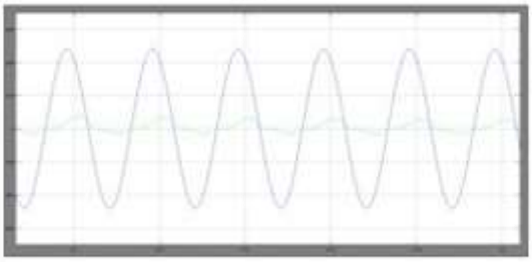
Input Voltage



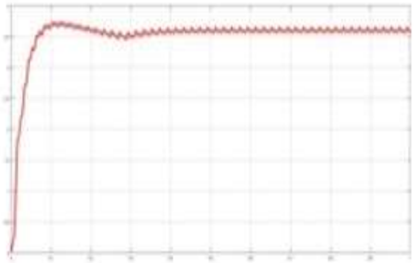
Input Current



PFC

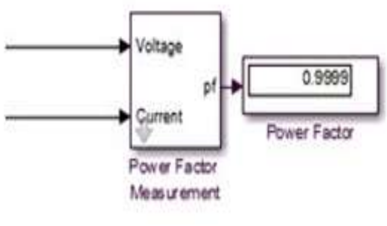


Output Current



Output Voltage

PFC



5. CONCLUSION In this project, a novel FMBL PFC rectifier is proposed, in which the high efficiency over a wide input range can be achieved. Compared with the traditional bridgeless boost PFC rectifier, an extra low-voltage bidirectional switch is added therefore the increased cost is low. Therefore, the proposed charger with its control method is an effective solution for EVs, which require high charging efficiency, a high power factor, and a simple structure.

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AUTHOR'S DETAILS

Mogili Sriharshitha, pursuing her M.Tech in Electrical Power Systems at Abdul Kalam Institute of Technology and Science, Kothagudem, following the successful completion of her B.Tech from G. Narayanamma Institute of Technology and Science, Hyderabad. She worked as an Associate at Sutherland Global services. She also completed an internship at RINEX technologies, focusing on IoT and Robotics, and gained hands-on experience in automation technologies. Her academic projects include a UPS Battery Monitoring System that allows automatic switching between solar and grid power sources, and an IoT-based Transformer Health Monitoring System for early fault detection. These projects involved the use of microcontrollers and real-time monitoring techniques. She also participated in extracurricular activities alongside her studies. She ranked 1st in the State Poetry Writing Test in 2016 and won 1st place in a State-Level Dance Competition at Rishi Engineering College in 2021. She earned 2nd place at Antaragni event, IIT Kanpur, and won 2nd place at Sreevision'22, SNIST.

Babu Rao Paddam(Aravind) currently working as Associate Professor and Dean of Academics in Abdul Kalam Institute of Technological Sciences, Kothagudem, Telangana, India. He received his Bachelor of Technology in Electrical & Electronics Engineering from JNTUH and completed his Master of Technology in Electrical & Electronics Engineering with specialization in Power Electronics from JNTUH, Hyderabad and pursuing PhD in Sri Satya Sai University of Technology and Medical Sciences, Sehore, Bhopal.He has a teaching experience of 20+ years. His areas of interest include Hybrid electric vehicles, power system operation and control, power semiconductor drives, power electronics and Electrical machines. He is also interested in research related to drives control with help of advanced power device controllers.