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A PFC Based EV Battery Charger Using a Bridgeless Modified SEPIC Converter

E. Chandru[1], S. Aravind[2], P. Balagan[3], S. Bharath[4], R. Sugina[5]

[1] Assistant Professor , Department of Electrical and Electronics Engineering, Stella Mary's College of Engineering- Kanyakumari Dist-629202, Tamil Nadu, India

[2, 3, 4, 5] Department of Electrical and Electronics Engineering, Stella Mary's College of Engineering - Kanyakumari Dist-629202, Tamil Nadu, India

ABSTRACT

For reducing conduction losses the semiconductors Bridgeless power factor correction converter plays a vital role. The bridgeless Cuk PFC converter proposed in this research. The proposed bridgeless Cuk PFC converter lowers loss in the conductor by using fewer conducting semiconductors than the traditional Cuk PFC converter. Meanwhile, the suggested converter has less modules overall than its bridgeless Cuk PFC rivals, especially when taking the electrolytic capacitor and big-volume magnetic module into account. The proposed converter also has a common ground for all power switches, allowing for simple drivers and a single control for functioning them. In Discontinuous Conduction Mode (DCM), a theoretical model of the recommended converter is described. It has the advantages of natural power sharpening, easy control, and switching zero-power in semiconductors. The suggested bridgeless Cuk PFC converter was then tested using a simulation and a 100W laboratory prototype.

Keywords: lowconduction losses, less component, Power factor correction (PFC), converter, Bridgeless Cuk, Discontinuous conduction mode (DCM).

1. Introduction:

PFC converters are often used in AC/DC power supplies, and one of their key functions is to supply a sinusoidal current source in order to satisfy the strict harmonic requirements. Like, IEC 61000-3-2 limitations. Due to its excellent power structuring capabilities, the boosted PFC topology is typically regarded as the most well-known PFC converter [1]-[3]. Its voltage output, which would be typically set at about 400V, is undoubtedly higher than the maximum input voltage. This big output voltage falloffs electric pressures for slight voltage uses. Discontinuous output current and no galvanic isolation are further issues that the boost PFC converter faces. The inherent dead angles in the input current of the buck PFC converter will significantly affect the power factor (PF) and current source harmonics for low voltage applications, yet it can produce low output voltage and good efficiency [4]-[6]. Because of this, various topologies with no dead angles and voltage step-down capability like fly back circuits, SEPIC, buck-boost, Zeta and Cuk can be the significant solution to the above-mentioned drawbacks.

2. Components Explanation

2.1 Maximum Power Point Tracking (MPPT)

Under specific conditions, an algorithm in a charge controller device known as MPPT extracts the greatest power feasible from a solar PV system. The maximum power point is the voltage at which solar PV will produce its maximum power. Maximum strength is influenced by solar irradiation, surrounding temperature, and cell temperature. An electronic device known as the MPPT is utilized as a DC to DC converter to enhance the compatibility between solar PV systems, battery packs, and utility grids. Simply described, they scale down a higher voltage DC output from a solar PV panel to the lower voltage necessary to charge the batteries. In our proposed system SEPIC converter will act as MPPT and if MPPT requires, there we program P&O algorithm to extract available peak power at thatparticular solar irradiance.

2.2 DC-DC Converter

By effectively converting voltage utilizing DC-DC converters, a controlled voltage can be sent from a source which may or may not be controlled to an applied load that may or may not be constant. DC-DC converters, on the other hand, are large power converting circuits that use transformers, inductors and capacitors along with rising MOSFET switching to regulate the output voltage of the circuit while lowering switching noise. Here, we given brief explanation about our applied converters, (i) Bidirectional Converter: In our proposed system, this converter is utilized in switching to charging then discharging at the same instant of time to run the system more reliable. This converter consists of inductors, diodes and MOSFET switching. This converter is a particular kind of buck-boost converter. Here, implementing with two switchbuck-boost converter for high speed switching application. And this converter used as step up and step down thevoltage. In storage area, it is used as step down and at load section – this converter used as boost type. In a simple word, this bidirectional converter is key device to run the motor and charge the battery at the same time. (ii) SEPIC Converter: (Single Ended Primary Inductive Converter) Like a buck-boost converter, a SEPIC converter is frequently used as a boost converter before an MPPT charge controller. But it has the following benefits over a buck-boost converter: Ability to react more accurately to a short circuit output, a voltage polarity-compatible output that matches the input's, a non-inverted output, a series capacitor used to link an output to the energy coming from an input and actual shutdown capability when the switch is turned S1 (iii) Bridgeless SEPIC Converter: A device known as an AC-DC Converter transforms an AC voltage into a DC voltage with a controlled DC voltage output. This study employs a bridgeless SEPIC converter as an AC-DC converter. This converter is utilized in the suggested system to offer lower conduction losses whilst decrementing component counts. Although a converter operates in DCM, our suggested system's control loop circuit is described as simplified and does not call for a current loop.

2.3 Solar Panel

Solar energy is among the most useful renewable energy sources. Direct current electricity is produced by solar panels using sunlight as a source of energy. Solar panels take up sunlight and turn it into power.

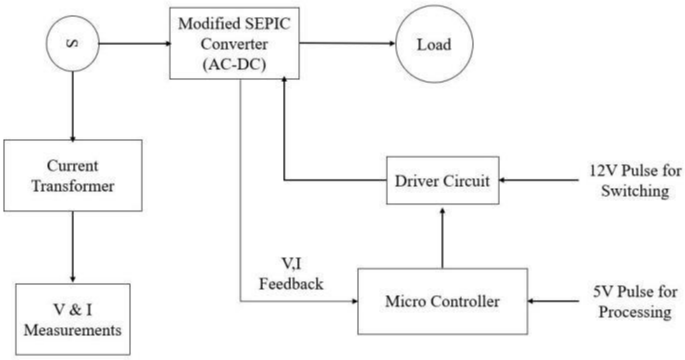

Figure 1: *Block Diagram of proposed system*

Inverter, MPPT charge controller and batter all have an impact on the solar panel choice. For instance, a 12V battery is required if we decide to use a 12V solar PV. You may use a 24V battery with a 24V solar panel. The fact that a 24V battery can only be created by connecting two 12V batteries in series is important to keep in mind even though 24V batteries are not currently available on the market. Therefore, Solar Cell Power rating is directly proportional to the battery power rating. While charging the bidirectional converter works in lowest mode. Then the converter works in enhancement mode when battery-operated discharging the charge to the load as per switching process takes place.

2.4 Traction Motor

Traction Motor is powered by electrical energy and generating the power to rotate wheels of the vehicle. There is a few types of DC motor used in Electric Vehicle and today, various electric vehicle manufacturers choose BLDC and PMSM motors to run the vehicle. Because, this two motors are very good in torque and efficiency andthere is no power dissipation. Electric Motor is a main icon or domain to dominate whole vehicle industry. By thedevelopment of Motors, after 10 years – all ICE vehicle users switch their vehicles to Electric Vehicle because of the development of DC Motors.

Figure 2: *Gate to Source Waveform*

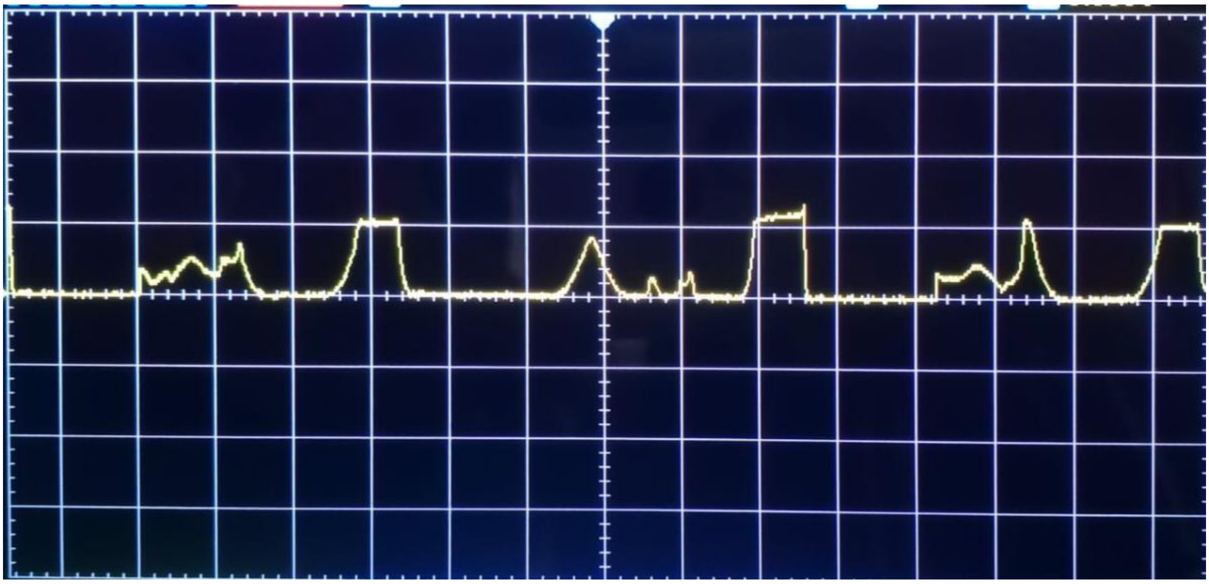

Figure 3: *MOSFET Switching*

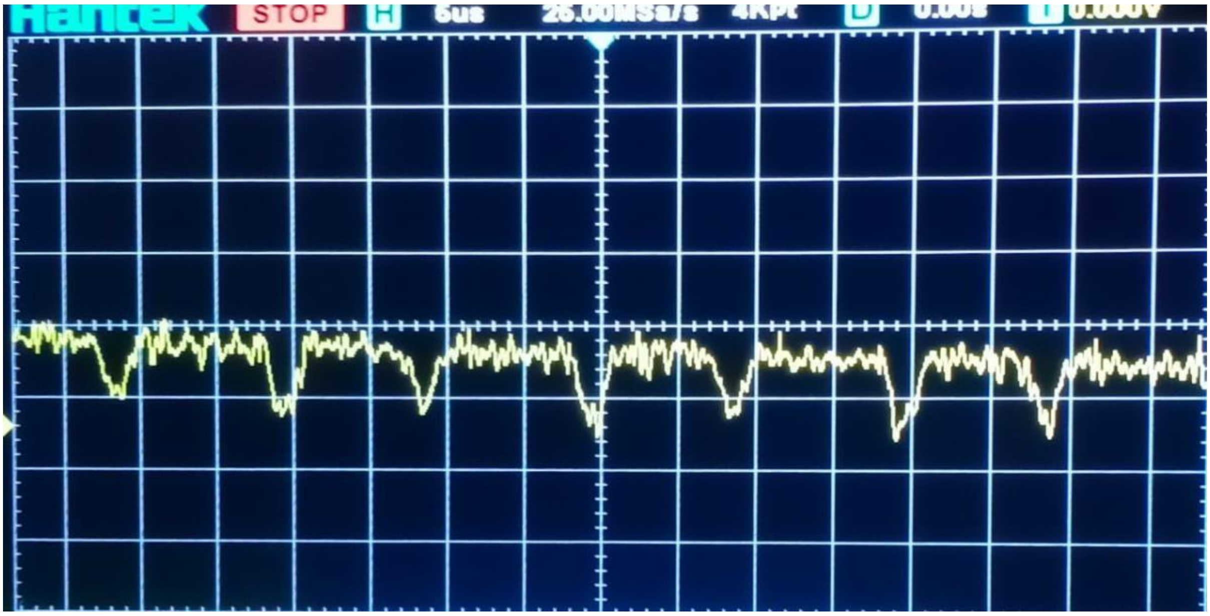

Figure 4: *DC Load Output*

3. Experiment Results

The experimental current source and voltage source for the proposed bridgeless Cuk PFC converter at Vin = 110Vrms are shown in Figure 2. It is clear from this image that the simulated and experimental waveforms are identical. The current supply is sinusoidally sharpened and in phase with the source voltage. The suggested bridgeless Cuk PFC converter has superior PFC capacity, which is supported by the measured PF of 0.996 under this condition. Figure 3 displays the experimental key-waveforms of the proposed bridgeless Cuk PFC converter during a positive line cycle. The outcomes of this experiment are consistent with those of the simulations. Key-waveform is depicted in a closed view in Figure 3. During a switching time the proposed converter clearly works in three stages, which is consistent with the theoretic study.

4. Conclusion

This paper proposes, evaluates, and then verifies the novel bridgeless Cuk PFC converter.The suggested bridgeless Cuk PFC converter having high power factor, common-ground power switches, simpler circuit design, and much lower conduction losses. DCM is given a theoretical analysis. According to simulation and testing data, proposed bridgeless Cuk PFC converter outperforms quasi totem-pole bridgeless Cuk PFC converter in terms of PFC capacity and efficiency. Additionally, the described bridgeless Cuk PFC converter is merely capable of reaching the IEC 61000-3-2 Class D restrictions. Finally, the suggested bridgeless Cuk PFC converter is a serious contender for real world applications.

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