FINDING CHARACTERISTICS ON BI-DIRECTIONAL AC-DC CONVERTER FOR LOW VOLTAGE DC

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ABSTRACT:

In this paper, the high efficiency isolated bidirectional AC-DC converter system with several improved techniques will be discussed to improve the performance of a low voltage DC distribution system. In this paper, a direct AC-DC power electronic converter topology is proposed for efficient and optimum energy harvesting from low-voltage micro generators. The proposed converter uses the bidirectional current conduction capability of MOSFET to avoid the use of front-end bridge rectifier which operates in discontinuous conduction mode. In the single inductor based direct AC-DC converters, external inductors are connected to the output of micro generators for boost operation. The presented converter consists of a line frequency commutated unfolding bridge and an interleaved buck-boost stage. The low semiconductor losses of the line frequency commutated unfolding bridge contribute to the comparatively good efficiency of this converter. The buck and boost operating modes of the interleaved buck-boost stage provide operation over a wide battery voltage range. The interleaved structure of the interleaved buck-boost stage results in lower battery current ripple. In addition, sinusoidal input current, bidirectional power flow and reactive power compensation capability are also guaranteed. This paper presents the topology and operating principles of the presented converter. The feasibility of the converter is validated using MATLAB simulations, as well as experimental results.

Keywords: *AC-DC Converter, Boost Converter, MOSFET.*

1.0 INTRODUCTION:

The DC distribution system is one of important future power systems to save energy and to reduce CO2 emission, because it can improve the efficiency of power consumption due to the reduction of the number of power conversion stages. In addition, the DC distribution system brings other many advantages such as easier interface of renewable energy sources to DC systems, easier expansion of power capacity, and less interference with AC grid. There are no issues of frequency stability and reactive power, and no skin effect losses In order to increase the power conversion efficiency of isolated bidirectional ACDC converter, two power conversion topologies are proposed in this paper. In order to increase the efficiency of the non-isolated full-bridge AC-DC rectifier, the switching devices are designed by using IGBTs without an anti parallel diode, MOSFETs, and SiC diodes. Through the analysis of operational modes, each switch is selected by considering switch stresses. Finally, design guides and gain characteristics of the bidirectional full-bridge CLLC resonant converter with the symmetric structure of the primary inverting stage and secondary rectifying stage will be discussed for low voltage DC distribution system. Experimental results will verify the performance of the proposed methods using a 5 kW prototype converter. The detailed description of the proposed isolated bidirectional AC-DC converter for a residential house will be discussed.

2.0 LITERATURE REVIEW:

R. Rajasekaran et al (2017) This paper breaking down the operation of Standalone Photo voltaic framework coordinated DC/AC converter topology, the fundamental power transformation work, the framework interface arrangement in Nano network interface converter is critical to effectively interconnect the Grid and dc frameworks and also satisfy the power quality and EMI direction codes on both dc and Grid conditioning sides.

Ragini Singh et al (2017) presents a single-stage circuit topology consisting of the association of a full-bridge isolated dc–dc converter and two input inductors and two input diodes connected to the mains network, in order to obtain an isolated ac/dc switch mode power supply, with sinusoidal input current. The proposed topology does not use an input bridge rectifier, common in similar applications. The current in the two input inductors can therefore, flow in both directions.

Ho-Sung Kim et al (2016) the high efficiency isolated bidirectional AC-DC converter system with several improved techniques will be discussed to improve the performance of a low voltage DC distribution system. Through the analysis of operational modes, each switch is selected by considering switch stresses. Finally, design guides and gain characteristics of the bidirectional full-bridge CLLC resonant converter.

Golam Sarowara et al (2015) A new topology of single-phase AC-DC converter using Buck-Boost conversion with high efficiency at extremely low duty cycle is proposed. Proposed double stage converter consists of single phase rectifier followed by a switched capacitor buck-boost DCDC converter. The input current THD is kept low and the input power factor is kept high with two-loop feedback control. The proposed scheme can be used for new generation LED lighting.

Young-Joo Lee et al., (2014) formulated a novel integrated bidirectional ac/dc charger and dc/dc converter (henceforth, the integrated converter) for PHEVs and hybrid/plug-in-hybrid conversions is proposed. The integrated converter is able to function as an ac/dc battery charger and to transfer electrical energy between the battery pack and the high-voltage bus of the electric traction system.

Bhim Singh (2013), deals with a comprehensive review of improved power quality converters (IPQCs) configurations, control approaches, design features, selection of components, other related considerations, and their suitability and selection for specific applications. It is targeted to provide a wide spectrum on the status of IPQC technology to researchers, designers and application engineers working on switched-mode ac-dc converters.

3.0 CIRCUIT CONFIGURATION OF THE PROPOSED ISOLATED BIDIRECTIONAL AC–DC CONVERTER

Below Fig shows the circuit configuration of the proposed isolated bidirectional ac–dc converter. It consists of the single phase bidirectional rectifier for grid interface and the isolated bidirectional full-bridge CLLC resonant converter for galvanic isolation. To control the proposed converter, a single digital signal processor (DSP) controller (TMS320F28335) was used. The power flow directions in the converter are defined as follows: rectification mode (forward direction of power flow) and generation mode (backward direction of power flow). The switching method of the proposed single-phase bidirectional rectifier is uni polar SPWM. In order to reduce the switching losses caused by the reverse recovery current in the rectification mode, the high-side switches of the proposed rectifier are composed of two IGBTs without anti parallel diodes (S1 and S3) and two SiC diodes (DS1 and DS3). The low side switches are composed of two MOSFETs (S2 and S4) for reducing conduction loss and for using ZVS operation in the generation mode. The detailed circuit operation of the proposed bidirectional rectifier and advanced PLL method will be discussed in Section III. The proposed bidirectional full-bridge CLLC resonant converter has the full-bridge symmetric structure of the primary inverting stage and secondary rectifying stage with a symmetric transformer. Using the high-frequency transformer, the converter can achieve galvanic isolation between the primary side and the secondary side. The transformer Tr is modeled with the magnetizing inductance Lm and the transformer's turn ratio of 1:1. The leakage inductance of the transformer's primary and secondary windings is merged to the resonant inductor Lr 1 and Lr 2, respectively. The resonant capacitors Cr1 and Cr2 make automatic flux balancing and high resonant frequency with Lr 1 and Lr 2.

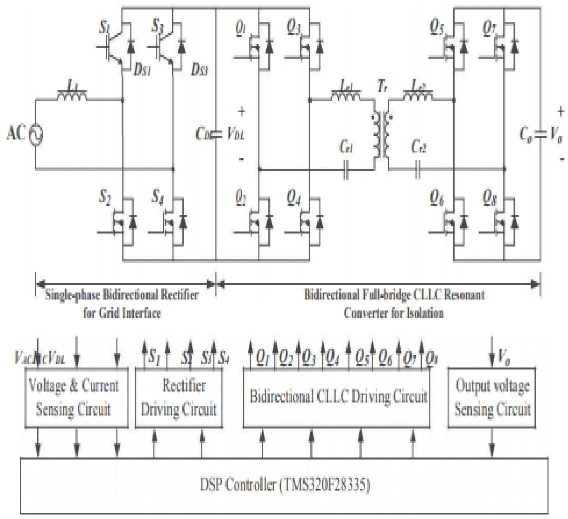


Figure shows the Circuit configuration of the proposed isolated bidirectional ac–dc converter

4.0 SYSTEM STUDIED FOR THE PROPOSED METHOD USING MOSFET

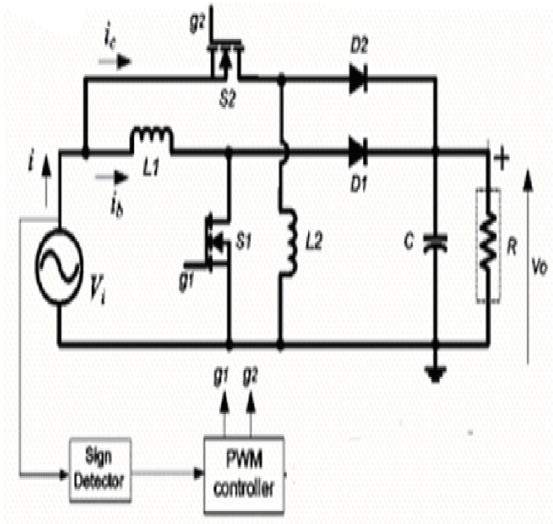


Figure shows Circuit for proposed method using MOSFET

Figure presents an efficient AC to DC power converter that avoids the bridge rectification and directly converts the low ac input voltage to the required high dc output voltage at a higher efficiency. The proposed converter have boost converter in parallel with a buck–boost converter, which is operated in the positive half cycle and negative half cycle respectively. It utilizes an n and p-type MOSFET pair to form a bi-directional switch. However a single semiconductor device capable of both bidirectional conduction and blocking capability does not exist. A MOSFET channel is capable of conduction in both directions when it is sufficiently turned ON. Bidirectional switch is realized by connecting drain of n-MOSFET to the source of p-MOSFET so that their body diodes block current in opposite directions. The converter operates in discontinuous conduction mode.

A (i) Modes of operation 1:

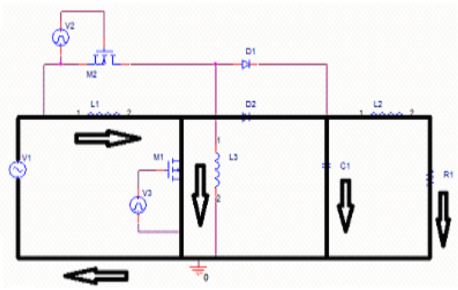


Figure shows Operation of positive half cycle

In the Figure the inductor current increases linearly from zero when the switch is turned ON when switch is turned OFF the body diodes block the circulating current. The diode D1 is forward biased and current flows into the capacitor to complete the charging process.

a(ii) Mode of operation 2

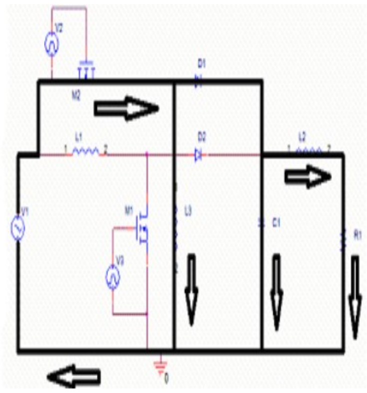


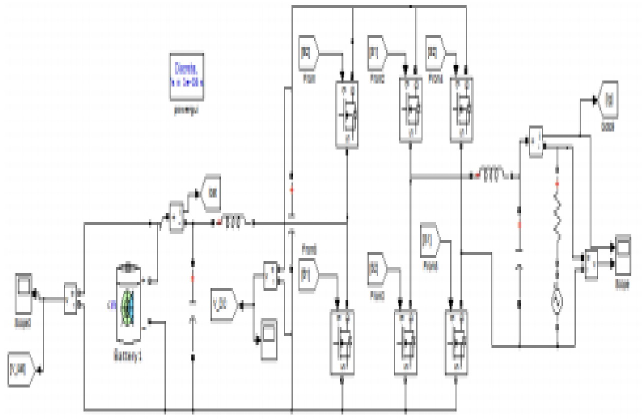
Figure shows the Operation of negative half cycle

In the Figure it describes the current rises in the opposite direction when switch is turned ON. However this time when switch is turned OFF, diode D1 remains off and diode D2 is forward biased. The inductor energy is transferred to capacitor and the negative gain of the buck–boost converter is utilized to boost the voltage of the negative half cycle of the micro generator to positive dc voltage.

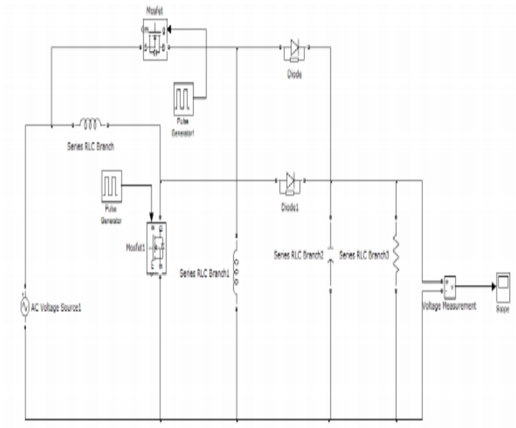
5.0 RESULTS:

Bidirectional AC/DC Converter Circuit Diagram (Mode I) Forward Direction:

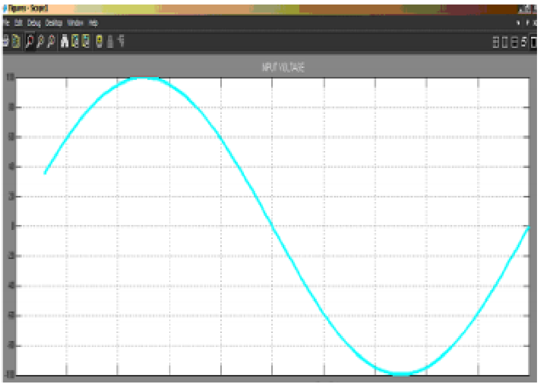
Figure shows the simulated input voltage, which is measured across the input side by connecting a voltage measurement with scope. Vin=220V.



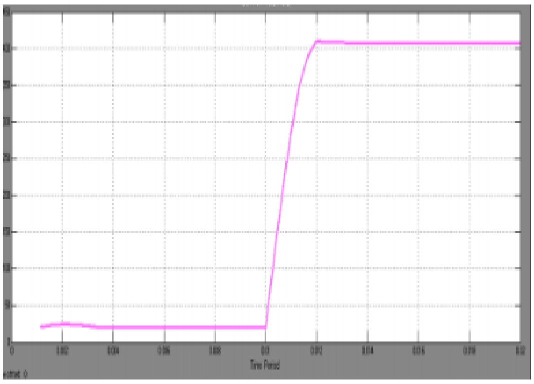
The performance of dual converter and the input given is ac supply and the output measured across the load



a) Modal of MOSFET based converter



a) Input waveform



b) Output waveform without PI controller

6.0 CONCLUSION

In this paper the proposed method of AC-DC boost converter for low power factor, low voltage energy harvesting is presented. The proposed configuration along with the associated control scheme is found to have a stable performance for all possible operating conditions to be encountered. A bidirectional switch, based on series connected n-MOSFET and p-MOSFET is proposed. Bidirectional AC/DC Converter Circuit Diagram (Mode I) Forward Direction is analyzed. The converter utilizes bidirectional switch to boost the low AC micro generator voltage to a steady DC voltage in both the input half cycles. Experimental results for a low voltage micro generator have been proposed to verify the operation of the converter and the proposed auxiliary circuits. The designed auxiliary circuits draw minimal power and are able to operate the converter at a higher efficiency. The isolated bidirectional ac–dc converter is proposed for the 220-V dc power distribution system to control the bidirectional power flow and to improve its power conversion efficiency. In addition, the low-side switches are composed of two MOSFETs to reduce the conduction loss in the rectification mode.

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