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BIDIRECTIONAL DC-DC CONVERTER WITH LOSSLESS SNUBBER

SWATI M. LIKHAR¹, M. J. KATIRA²

1. Student, M. Tech (PEPS) Department of Electrical Engineering, G.H.Raisoni Institute of Engg. & Tech. for Women.
2. Head of Department, Department of Electrical Engineering, G.H.Raisoni Institute of Engg. & Tech. for Women.

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Abstract: A bidirectional dc-dc converter with a soft switching and a lossless active snubber is proposed. In the proposed converter, zero-voltage-switching (ZVS) of main switches is achieved by utilizing an active snubber. It consists auxiliary diodes and switches, and also the an inductor and capacitor. Conduction losses associated with additional components increases the switching losses which are significantly reduced due to the ZVS operation of main switches. Hence, the total efficiency of converter is improved. An active snubber is used to enhance the efficiency of dc-to-dc converter and soft switching technique is applied to non-isolated bidirectional dc-dc converter.

Keywords: Bidirectional dc-dc converter, lossless active snubber.

Corresponding Author: MS. SWATI M. LIKHAR



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INTRODUCTION

In present years, alternative energy systems and applications like eco-friendly cars have been focused on due to the exhaustion of fossil fuel, several environmental pollution and global warming. Bidirectional dc-dc converters are one of the most important energy conversion systems in the applications such as plug-in hybrid electric vehicle (PHEV), fuel-cell vehicle, renewable energy system, and uninterruptible power supply (UPS)[1]. In PHEV system, the bidirectional dc-dc converter acts as an energy transfer system from a low voltage battery to a DC-link that is an input voltage of an inverter for operating a vehicle motor, or from a DC-link to a battery for charging regenerative energy [1],[2].

In the renewable energy systems, including fuel cell systems, photovoltaic system and wind power system, the bidirectional dc-dc converter is essential for power conversion. The bidirectional dc-dc converter is divided into two types- an isolated bidirectional converter and non isolated converter [10][19]. Non isolated bidirectional dc-dc converter has high efficiency due to its simple structure [14] [19]. In an isolated bidirectional dc-dc converter it has more than 4 switches and an isolated transformer. This transformer has higher conduction losses and lower efficiency as compared to non isolated bidirectional converter [1][15]-[18]. In order to solve the problem of voltage ringing, conduction losses and reverse recovery, and active snubber are required [27].

The simple snubber consists of a series resistor and capacitor placed around the thyristor. These components along with the load inductance form a series RLC circuit. Snubber theory follows from the solution of the circuit's differential equation. Many RC (resistance and capacitance) combinations are capable of providing acceptable performance. Snubber circuit can be connected in proper manner otherwise it can cause unreliable circuit operation and damage to the semiconductor device. Both turn on and turn –off protection should be necessary for reliability. Sometimes thyristor must function with a range of load values. The type of thyristor used, circuit configuration, and load characteristics are influential. Snubber design involves compromises. They include cost, peak voltage, voltage rate and turn-on and turn-off stress. Practical solution of the device depends on the circuit physics.

The efficiency of non isolated bidirectional dc-dc converter can be improved with or without coupled inductor, if they are implemented with zero-voltage-switching (ZVS) [15]. Circuit diagram of conventional and proposed bidirectional dc-dc converter are as shown.

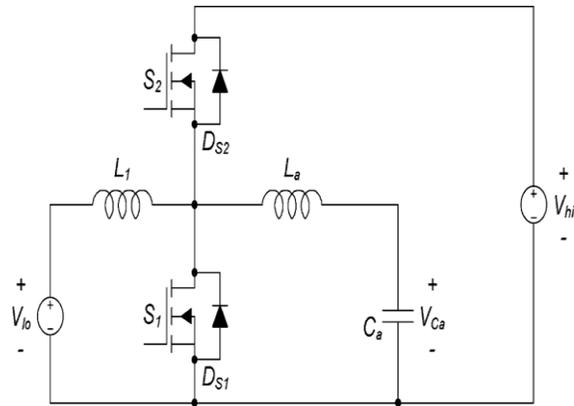


Fig.1 Conventional Bidirectional Dc-Dc Converter

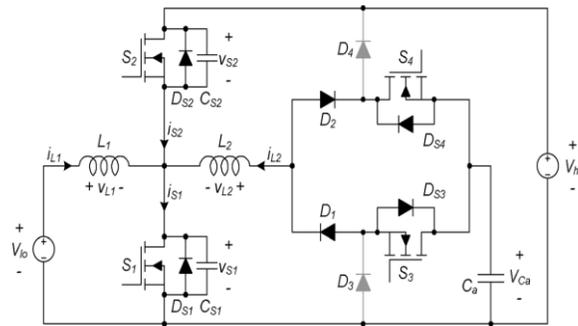


Fig.2 Bidirectional Dc-Dc Converter

The circuit diagram shown in fig.1 is conventional bidirectional dc-dc converter. It has a disadvantage that large circulating current always flows through a due to auxiliary inductor

The circuit diagram of the bidirectional dc-dc converter is shown in Fig. 2. The switch s1 acts as a boost switch and switch s2 acts as a synchronous switch in boost operation. In buck operation switch s1 acts as a synchronous switch and s2 acts as a buck switch in buck operation. For reducing the conduction losses in active snubber and provide soft switching operation of the main switches S1 and S2, lossless active snubber operates for a short duration.

- Operation

Snubber circuit

Auxiliary Thyristor active snubber circuit makes the output current ripple large. In addition, the energy stored in the resonant inductor during the reverse-recovery of the auxiliary diode can cause large voltage ringing across the switch and diode in circuit.

Switches

Switches are used for selection of boost and buck operation. Two MOSFET switches are used.

Boost operation

In boost operation output should be more than input supply. Since the current is larger then, the switch current changes the current flow direction from negative to positive.

Buck operation

In the buck operation of the proposed converter is output is less than the input supply.

Auxiliary diodes

The diodes are the intrinsic body diodes. The diodes are clamping diodes to clamp the voltages across the auxiliary switches.

• CONCLUSION

The main objective are to minimize the switching lossles by using the technique of soft switching of power switches (ZVS or ZCS). Soft switching technique makes it possible to have high efficiency by reducing switching losses. It minimizes the switching loss. With the help of an active subber overall efficiency is improved.

IV. EXPECTED WORK

In the proposed converter an active snubber is used to enhance the efficiency of dc-dc converter and soft switching are applied to non isolated bidirectional dc-dc converter due to its simple structure and high efficiency. The expected outcome is to overcome the problem of high conduction losses and over voltage with the use of thyristor.

V. Waveforms

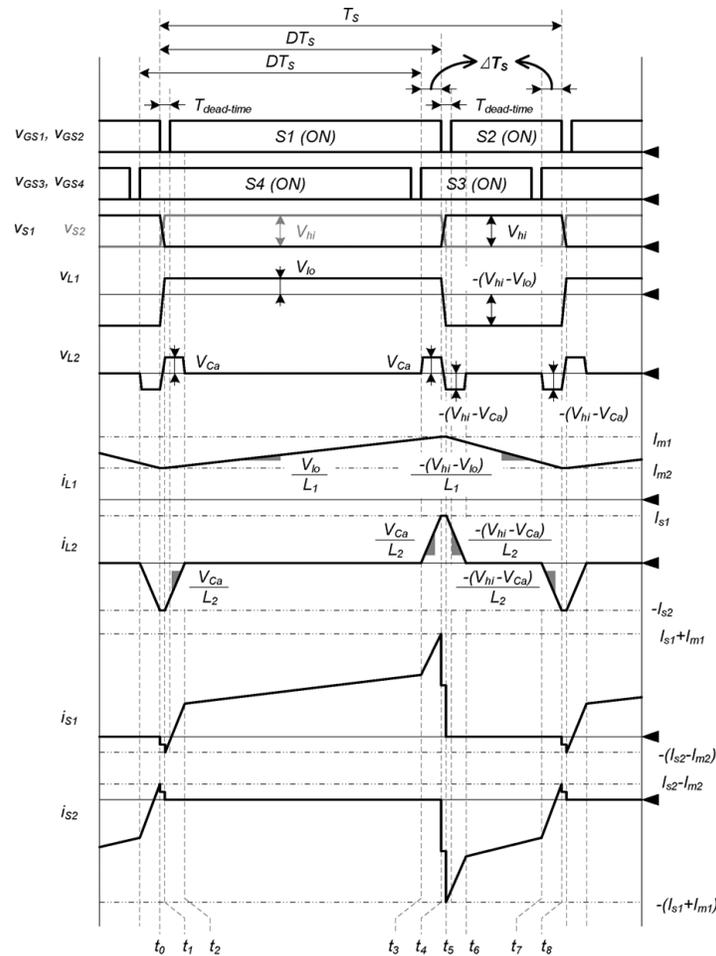


Fig.3 Waveforms of Bidirectional Boost Converter

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