Elysium Journal of Engineering Research & Management

P-ISSN: 2347-4408
E-ISSN: 2347-4734

Working Principle of Semidual Dynamic Bridge Converter with Dual Source

G. Varathan[1], G. Ganeshkumar[2] and Dr. A. Arunya Revathi[3]

[1,2]Department of EEE, Sethu Institute of Technology, Kariapatti, Tamil Nadu, India

[3]Assistant Professor, Department of EEE, A.C.College of Engineering and Technology, Karaikudi, Tamil Nadu, India

Email id: varathan.g@gmail.com[1], ganesh8571@gmail.com[2]

Abstract—A soft-switching circuit topology derived from the semi dual-Dynamic-bridge converter(S-DDB) get wide attention for applications requiring unidirectional power flow such as the dc-dc stage of a photovoltaic power converters, and battery charger for electrical vehicles. The topology named as the semi dual Dynamic bridge (S-DDB) is obtained by replacing the fully Dynamic (four switches) bridge on the load side of a DAB by a semi Dynamic (two switches and diodes) bridge. In addition to the reduced number of Dynamic switches, the topology offers several other advantages including extended zero-voltage switching (ZVS), and smaller output filter requirement. The principle of operation, waveforms in various intervals and power transfer expression are different from the basic DAB topology which presented in detail. In this project Dual source semi dual Dynamic bridge converter is proposed and it exhibits efficient dc power distribution and higher degree of reliability compared to the single source semi dual Dynamic bridge converter. The performances of S-DAB are validated through extensive simulation and its results are verified using MATLAB software

Keywords—dc-dc converter, semi dual Dynamic bridge converter, zero voltage switching

1. INTRODUCTION

Many papers in the area of power electronics and drives propose the use of different type of DC-DC converters especially isolated converters. According to the application area and power levels, these converters are selected. Due to safety considerations, all papers in power electronics are encouraged to use the isolated DC-DC converters [1]. In that, half bridge converter has important role in power electronics application.

Most of the power converters are unidirectional with the power supplied from the source to load and used for soft switching method. At zero voltage, the Zero Current Switching (ZCS) resonant converters switches are turned off and turned on. For achieving Zero Voltage Switching, the capacitor (C) is connected in parallel with the switch (S1).

When the internal switch capacitance (Cj) is added with the capacitor (C), the resonant frequency will be affected. So there is no power dissipation in the switch. To achieve ZVS and increased efficiency, the soft switching method is applied. Dual source DC/DC converter plays a vital role in interface of different energy sources to form hybrid energy system which delivers power at regular voltage [2]. The energy sources like fuel cell, battery, ultra capacitor and renewable energy sources of same or different category with distinct V–I characteristic are connected together through MSC to supply the load instantaneously. Traditionally these energy sources are combined together through a separate single source converter and their outputs are connected to a common dc bus. However, such configurations are costly, bulky and relatively complex in design and reduce overall efficiency as well as reliability of the system. Two single sources DC/DC converters can be replaced by a single DC/DC converter successfully. It offers simple and more compact design and reduces the cost and complexity of the system. In addition, efficient dc power distribution and higher degree of reliability can be achieved.

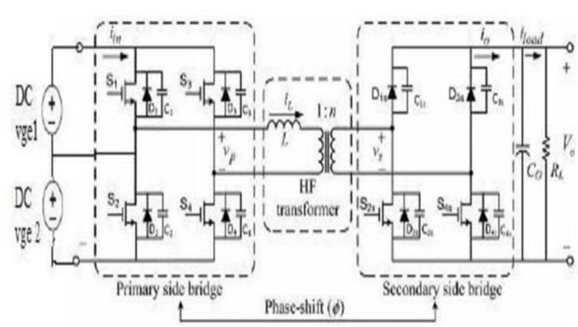


Fig.1.Circuit schematic of the Dual sources S-DAB Converter.

Elysium Journal of Engineering Research & Management

P-ISSN: 2347-4408
E-ISSN: 2347-4734

2. DUAL SOURCE SEMI DUAL-DYNAMIC-BRIDGE CONVERTER

2.1 Converter Operation

The operation and working principle of the MSC is same as the basic DC/DC converter. The converter's fundamental operation is to charge the passive elements during actual period of time and then discharge the stored energy of passive element through load during remaining period of time over a single switching cycle. The architecture of two input DC/DC converter with PVSC-1 and PVSC-2 are represented by their corresponding voltage sources V1 and V2, switch Switches S1 and S2and diode D1 and D2 respectively. Basically conduction of switch Switches S1 and S2decides the working state and the source in operation, whereas conduction of switch T3 and T4 decides the operating mode (buck, boost and bidirectional operation). All possible combinations of working states of the converter for two input sources are shown in Fig. 5 and detailed description of working states has been given in Table 1. A similar analysis and working state can also be obtained for Dual sources connected in series rather than two input sources. Based on switching strategy of switch S1 and S2, there are four possible working states as illustrated in fig 1.

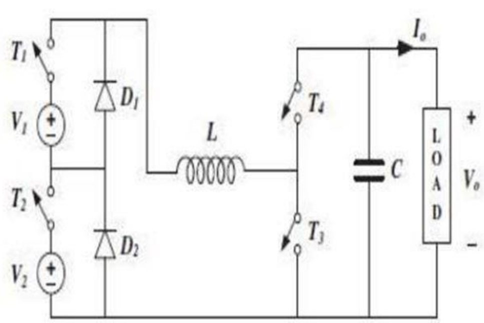


Fig.2.Conceptual circuit diagram of proposed MSC for two input sources.

State-I: The circuit configuration of state-I is shown in Fig. 5a. In state-I, switching signals are given such that switch S1 conducts and S2 remains non-conducting. Consequently voltage source V1 supplies the load. The conduction of switch S1 makes the diode D1 reverse biased whereas diode D2 becomes forward biased. The conduction of diode D2 with switch S1 forms a network through which source current of V1 bypass the voltage source V2. In this state volt- age source V1 charges the storage elements (inductor and/or capacitor) while supplying power to the load individually.

DC/DC converter, power flow from source to load can be controlled by controlling the charging and discharging of inductor. Similarly in MSC, inductor can be charged by Dual voltage sources instead of single source by adopting appropriate switching pattern that connects or disconnects Dual sources to inductor individually or simultaneously. The proposed MSC two PVSC connected in series are taken along with converter cell and load (a two input DC/DC converter) as shown in Fig.2.

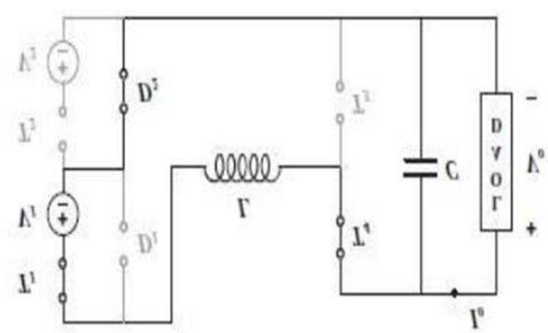
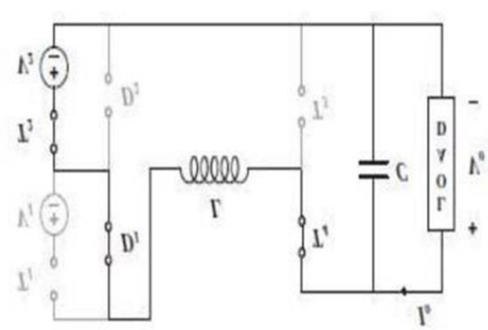


Fig.3.Contribution of the voltage source V1.

State-2: The operation in state-II is similar to state-I as shown in Fig. 5b. In this state switching signals are planned such that switch S2 conducts and S1 remains non conducting, consequently voltage source V2 supplies the load. The conduction of switch S2 makes diode D2 reverse biased whereas diode D1 becomes forward biased. The conduction of diode D1 with switch S2 forms a network through which source current of V2 bypass the voltage source V1 to meet the power demand of the load. In state II voltage source V2 charges inductor and/or capacitor while supplying power to the load individually.



P-ISSN: 2347-4408
E-ISSN: 2347-4734

Fig.4.Contribution of the voltage source V2.

State-3: The equivalent circuit of state-III is shown in Fig.5. In this state switching signals are planned such that the switches Switches S1 and S2conduct simultaneously. Consequently voltage source V1 and V2 comes in series. The conduction of Switches S1 and S2reverse biases the diode D1 and D2 respectively. In this state voltage source V1 and V2 simultaneously charges the storage elements while supplying power to the load. When the sources are supplying together, the load current is limited by voltage source which has lower current rating. Therefore, each source should be selected so as to meet the maximum current requirement of the load over certain period of time.

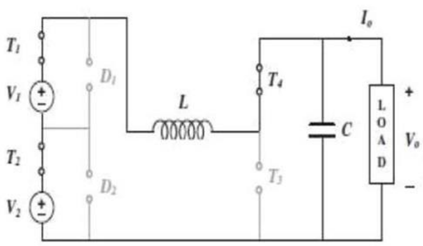


Fig.5.Contribution of the voltage source V1 and V2 together

State -4: In this state both the switch Switches S1 and S2remains in OFF state. Consequently voltage source V1 and V2 are disconnected from converter cell and diode D1 and D2 become forward biased as shown in Fig. 5d. The stored energy of inductor and/or capacitor freewheels through the load and diode D1 and D2. The sequence of working states can be taken in any manner based on the load profile and control scheme. In the proposed topology, two input sources either with symmetrical or asymmetrical voltage magnitudes provide power to the load individually or simultaneously and causes significant variation in output voltage. Therefore a large capacitor is connected across the load to stabilize output voltage and compensate the unfiltered output current so that stable DC load current can be achieved. Moreover, if some fault occurs and one source gets disconnected, the other source can deliver power to the load normally and hence reliability of the system enhances.

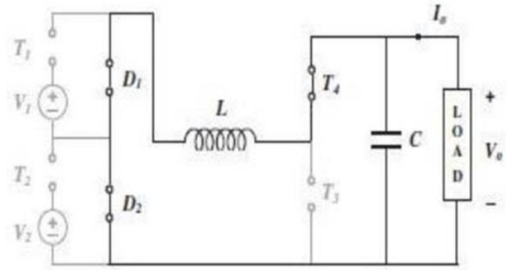


Fig.6.Freewheeling of load current

2.2 Operation of the Dual Source S-DAB

The Dual source S-DAB converter can be simplified by referring the entire model to the primary of the transformer such that the two bridges are linked by the leakage inductance of the transformer. Resistances of the transformer and semiconductor switches and the threshold voltages of diodes and MOSFETs are neglected in this analysis. The primary side bridge HB1 produces a square wave voltage waveform (PWM control of HB1is possible and is pursued as future work) at constant frequency indicated as Vpin Fig. 1. The voltage produced by the secondary bridge indicated as Vsin Fig. 1, has a quasi-square waveform with the pulse width determined by the operating conditions, in particular by the conduction of the diodes in the secondary bridge. The control of the converter is achieved by phase shifting (delaying) the rising edge of Vs with respect to the rising edge of Vp. Shifting the phase of the secondary bridge by an angle φ changes the effective voltage across the leakage inductance thereby controlling the current through the transformer. The net power always flows from the leading (primary) to the lagging (secondary) bridge. Similar to the DAB, many of the converter waveforms depend strongly on the voltage ratio, m, where $m = Vo/n$ Vin and n is the secondary to primary turns ratio of the transformer. Fig. 2shows the operating waveforms of the converter for different voltage ratios, $m < 1$ (buck) and $m > 1$ (boost). Unlike in the DAB, the operation here involves inherent freewheeling of the secondary winding for an angle α as the diodes on the upper section of each leg in the secondary bridge prevent reverse current flow.

2.3 ZVS Range and Constraints

The ZVS range of control on the output power with the variation of phase-shift φ as the varying parameter for the

P-ISSN: 2347-4408
E-ISSN: 2347-4734

DAB and its derivative. Neglecting the small current required to charge and discharge the capacitances, the condition iL0 >0ensures ZVS in HB1, while switches in HB2 require iL1 >0. Therefore, for any m _= 1 there is a minimum phase shift associated to maintain soft switching as inferred from below equations φ requirement for bridge HB1 (i_{L0} >0),

$$\frac{1}{m} m\,, (0 < m)$$

φ requirement for bridge HB2 (i_{L1} >0)

$$\frac{1}{2} m\,, (0 < m)$$

It can be concluded that the leading bridge HB1 always operates with ZVS when m <1, whereas the lagging bridge has a minimum requirement on the phase shift angle. Similarly, HB1 has a minimum φ condition when operated in the boost mode, whereas HB2 operates inside the soft-switching region.

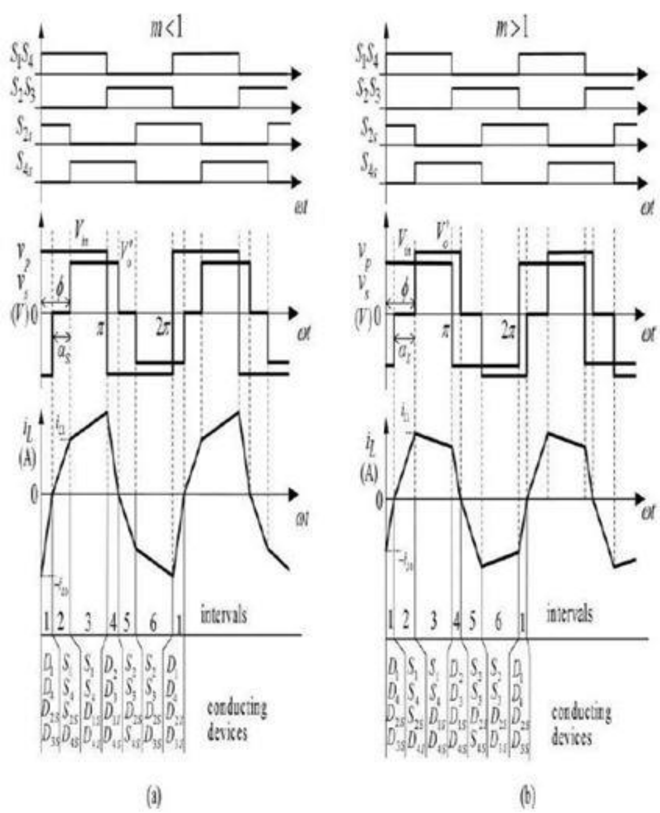


Fig.7.Voltage across the transformer ports and converter current waveforms

2.4 Gate pulses for the switches

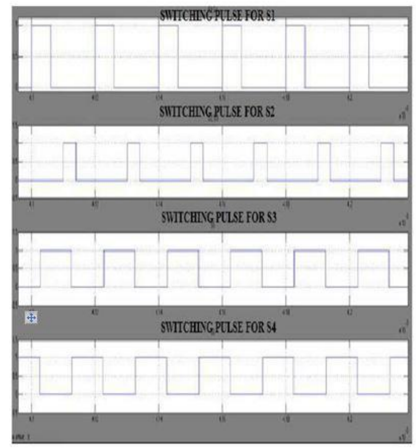


Fig.8.Gate signal waveform given to switches S1-S4

E. Input voltage, output voltage and output current waveform of proposed system

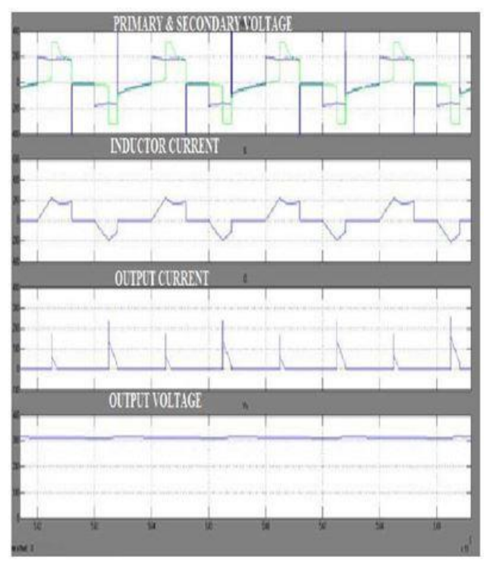


Fig.9. Input voltage, output voltage and output current waveform of proposed system

3. CONCLUSION

In the modern power electronics era, Dc- Dc converters plays a vital role in the applications requiring unidirectional power flow such as the Dc-Dc stage of pv power conversion system, charger for electric vehicle ,and other Dc-Dc converters, requiring Dual, regulated outputs. In this project a semi dual

Dynamic bridge converter for single input is realized and simulated using matlab software. The above configuration is modified with Dual input semi dual Dynamic bridge converters. This proposed semi dual Dynamic bridge converter is designed and simulated using MATLAB software and waveforms are obtained.

REFERENCE

[1] K. Vangen, T. Melaa, S. Bergsmark, and R. Nilsen, "Efficient high frequency soft-switched power converter with signal processor control,"in Proc. 13th Int. Telecommun. Energy Conf., 1991, pp. 631–639.

[2] Lalitkumar*,Shailendrajain,"A Dual source DC/DC converter topology " Electrical power and energy systems, 51(2013), 278-291.

[3] L. Mweene, C. Wright, and M. Schlecht, "A 1 kW 500 kHz front-end converter for a distributed power supply system," IEEE Trans. PowerElectron., vol. 6, no. 3, pp. 398–407, Jul. 1991.

[4] De Doncker, D. Divan, and M. Kheraluwala, "A three-phase soft switched high-power-density DC/DC converter for high-power applications,"IEEE Trans.Ind. Appl., vol. 27, no. 1, pp. 63–73, Jan./Feb.1991.

[5] M. Kheraluwala, R. Gascoigne, D. Divan, and E. Baumann, "Performance characterization of a high-power dual Dynamic bridge DC-to-DC converter,"IEEE Trans. Ind. Appl., vol. 28, no. 6, pp. 1294–1301, Nov./Dec. 1992.

[6] K. Vangen, T. Melaa, and A. Adnanes, "Soft-switched high-frequency, high power DC/AC converter with IGBT," in Proc. IEEE 23rd Annu.Power Electron. Spec. Conf., 1992, vol. 1, pp. 26–33.

[7] R. Steigerwald, R. De Doncker, and M. Kheraluwala, "A comparison ofhigh power DC-to-DC soft-switched converter topologies," in Proc. IEEEConf. Rec. Ind. Appl. Soc. Annu. Meeting, 1994, vol. 2, pp. 1090– 1096.

[8] C. Zhao and J. Kolar, "A novel three-phase three-port UPS employing a single high-frequency isolation transformer," vol. 6, pp. 4135–4141, 2004.

[9] S. Inoue and H. Akagi, "A bidirectional isolated DC-DC converter asa core circuit of the next-generation medium-voltage power conversionsystem," IEEE Trans. Power Electron., vol. 22, no. 2, pp. 535–542, Mar.2007.

[10] H. Krishnamurthy and R. Ayyanar, "Building block converter module for universal (AC-DC, DC-AC, DC-DC) fully modular power conversion architecture," in Proc. IEEE Power Electron. Spec. Conf., 2007, pp. 483– 489.

[11] H. Krishnamurthy and R. Ayyanar, "Stability analysis of cascaded converters for bidirectional power flow applications," in Proc. IEEE 30th Int.Telecommun. Conf., 2008, pp. 1–8.

[12] H. Bai and C. Mi, "Eliminate reDynamic power and increase system efficiency of isolated bidirectional dual-Dynamic-bridge DC-DC converters using novel dual-phase-shift control," IEEE Trans. Power Electron., vol. 23, no. 6, pp.2905–2914, Nov. 2008.