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ANALYSIS OF MULTIPORT BUCK- BOOST CONVERTERS BASED ON DC-LINK INDUCTORS

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Abstract:

With the ever-growing developments of sustainable energy sources such as fuel cells, photovoltaics, and other distributed generation, the need for a reliable power conversion system that interfaces these sources is in great demand. In order to provide the highest degree of flexibility in a truly distributed network, it is desired to not only interface multiple sources, but to also interface multiple loads. Modern multi-port converters use high frequency transformers to deliver the different power levels, which add to the size and complexity of the system. The different topological variations of the proposed multi-port dc-dc converter have the potential to solve these problems. This thesis proposes a unique dc-dc current source converter for multi-port power conversion. The presented work will explain the proposed multi-port dc-dc converter's operating characteristics, control algorithms, design and a proof of application. The converter will be evaluated to determine its functionality and applicability. Also, it will be shown that our converter has advantages over modern multi-port converters in its ease of scalability from kW to MW, low cost, high power density and adaption to countless combinations of multiple sources. Finally we will present modeling and simulation of the proposed converter using the PSIM® software.

Keywords – PV, converter, PSIM, power.

1. INTRODUCTION

In today's society the need for renewable energy sources is in high demand. Over the past few years technological advances have been made in wind power systems, photovoltaics, fuel cells, and hydroelectric power systems, just to name a few.

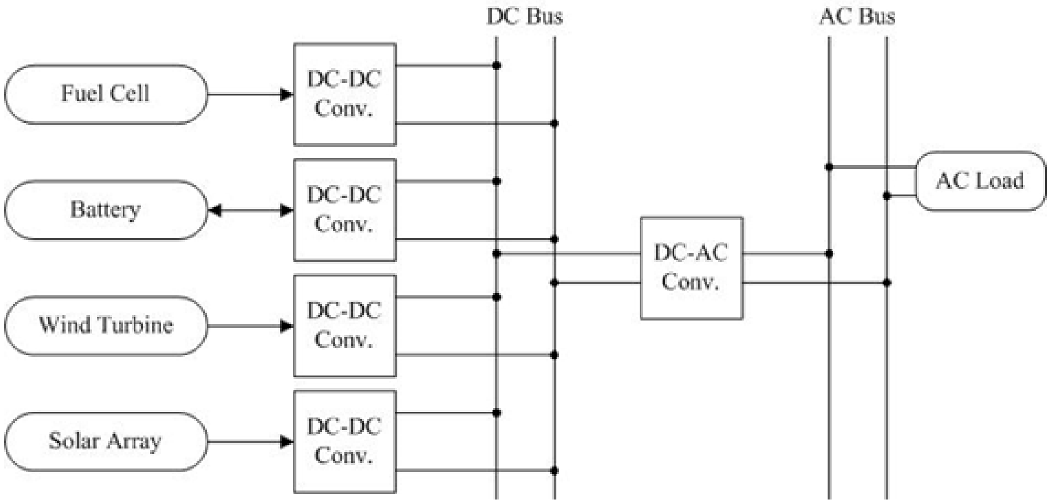

Fig.1.Conventional topology

With these advances comes the question of how to interface these for standalone power generation, whether it is one or all of these sources simultaneously. Along with interfacing multiple inputs, a growing need for interfacing multiple outputs has become an interesting topic in hybrid vehicles. One way to interface multiple inputs and multiple outputs is through the use of DC-DC converters. energy inputs connected to a respective DC-DC converter with its own controller and storage element. Each DC-DC converter is connected to a common DC bus. The common DC bus is where the energy from each input is combined and then distributed to the loads through yet another DC-DC converter for each load. In a system of this nature, each DC-DC converter communicates with each other in order to control the power transferred from each input to its respective output. With this type of topology if one were to add multiple input modules, the overall system could become too large for its particular application where size and weight are an issue, i.e. hybrid vehicles. This conventional topology can also be used for multiple output systems. This is done by connecting each of the loads to the DC bus via a DC-DC converter or DC-AC converter.

2. PROPOSED TOPOLOGY

This chapter will discuss a case study performed on the proposed multi-port power converter. This case study will involve a topological variation of the Inductor Converter Bridge (ICB) family of converters shown in Chapter II, in particular the Inverse Dual Converter (IDC). The IDC will be manipulated into a multi-source converter and various simulation study methods will be presented in this chapter that will determine various operational characteristics of this converter in order to aid in the development of a control strategy. The multi-port IDC is first presented as a multi-load topological variation of the original IDC in [16]. The multi-port IDC is being expanded into a converter that can support multiple sources, i.e. Multi-source IDC, Fig. 23. This will allow for multiple energy sources, renewable or nonrenewable, to be connected and controlled to supply a load. This will also help in instances where the load power demanded is too great for just one connection and must be split into two.

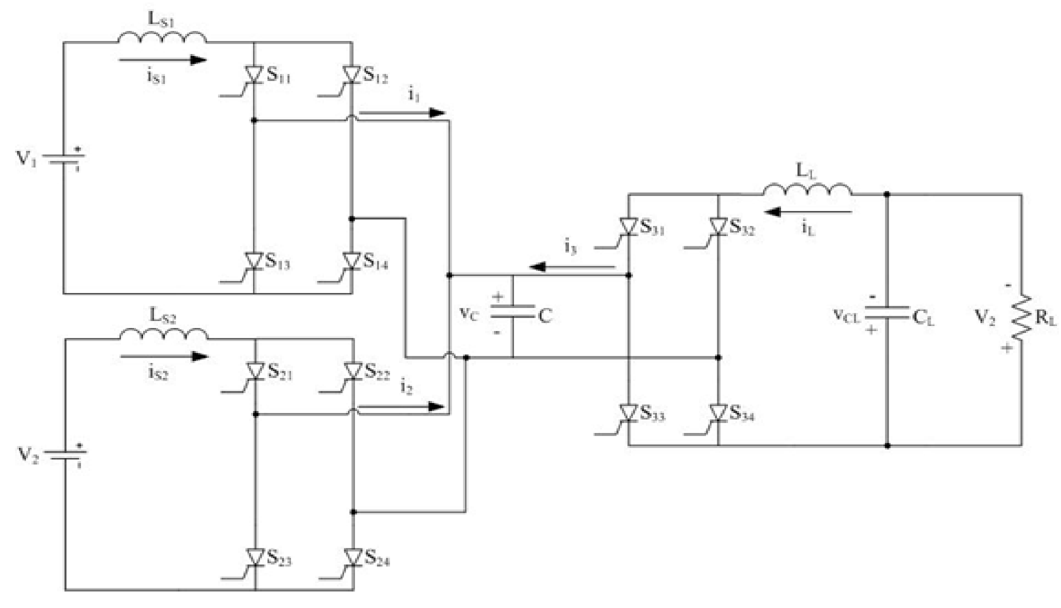

Fig.2.Multi source IDC

The Multi-source IDC is made up of three ports with key components being a single phase thyristor bridge, inductor and center link capacitor, as shown in Fig. 23. The importance of the inductance in the modules is based on the fact that the core technology for this family of converters, the ICB, is of current source type as was shown in Chapter II. As can be seen these ports or modules are very similar to one another regardless of the type of connection, source or load. Therefore, each of these modules, thyristors and inductance, can be designed for the load or source that will occupy that port. More modules can be added to the system by connecting the AC terminals of the thyristor bridge in parallel with the center link capacitor. In order to obtain a better understanding of the operational and possible control characteristics of the Multi-source IDC a simulation study was performed. This converter is made up of two DC voltage sources each connected to a single phase thyristor bridge through an inductor respectively. Each of these modules are then connected in parallel to the AC link capacitor. The AC link capacitor is then connected to another single phase thyristor bridge that is connected to an inductor capacitor filter and then to a resistive load. This converter will be simulated in the PSIM® software package. PSIM® is a simulation software specifically designed for power electronics and motor control. This software will allow for easier control of the Multi-source IDC through programming in C in order to control the on/off timing of the thyristors.

3. SIMULATION STUDY

In order to obtain a better understanding of the operational and possible control characteristics of the Multi-source IDC a simulation study was performed. This converter is made up of two DC voltage sources each connected to a single phase thyristor bridge through an inductor respectively. Each of these modules are then connected in parallel to the AC link capacitor. The AC link capacitor is then connected to another single phase thyristor bridge that is connected to an inductor capacitor filter and then to a resistive load. This converter will be simulated in the PSIM® software package. PSIM® is a simulation software specifically designed for power electronics and motor control. This software will allow for easier control of the Multi-source IDC through programming in C in order to control the on/off timing of the thyristors.There are multiple aspects of this converter to be looked at in order to obtain a thorough understanding of its operational characteristics. One of these aspects is the phase difference angles $\varphi 13$, $\varphi 23$, and $\varphi 12$. These phase difference angles are controlled by controlling the firing angle of the thyristors between the respective converters as stated earlier. For the Multi-source IDC the phase difference angle φ can be used to control how much power each source will send to the load. Therefore, $\varphi 13$ and $\varphi 23$ will be controlled and $\varphi 12$ is a consequence of these by taking the difference between the two. In most applications the sources load is allowed to vary while continuing to send it power. If this load is a voltage sensitive load, it is desirable to send power at a fixed voltage and varying current. In order to do this the load voltage must be regulated for any change in load. For the Multi-source IDC this load is a simple resistive element. An increase or decrease of the element should not result in an increase or decrease in output voltage. If it does then there should be an adjustment to $\varphi 13$ in order to keep this voltage within its predetermined range.

4. RESULT ANALYSIS

In order to better understand the operational characteristics of the Multi-source IDC it was simulated under various conditions. These conditions include the variation of phase difference angle, φ, between each converter, variation of the each source voltage (V1 and V2), and load variation (RL). From these simulation studies, a control method can be determined in order to keep the converter at a stable operating point while maintaining output voltage regulation and converter

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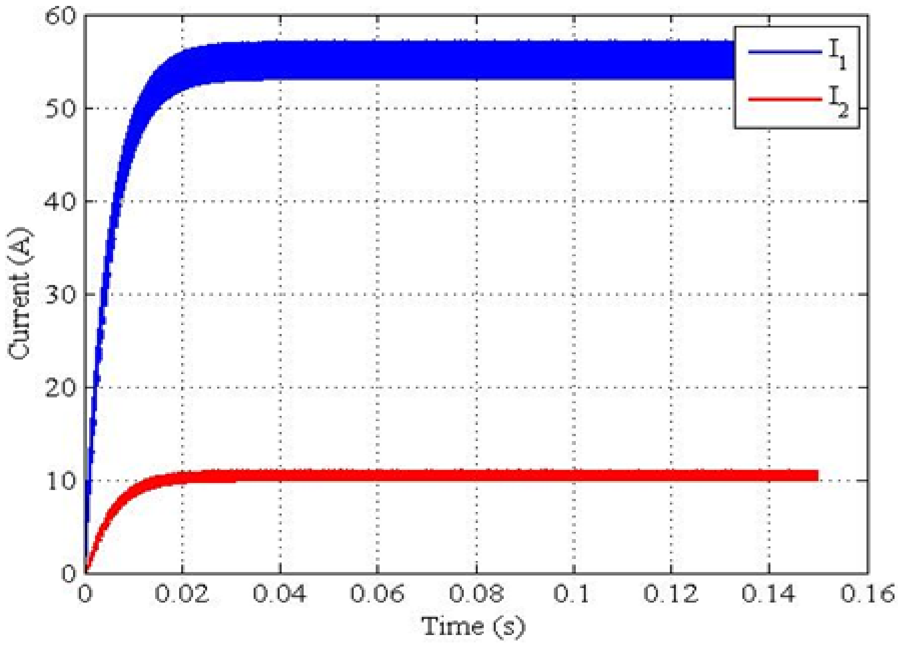

Fig.3.Magnitude waveform

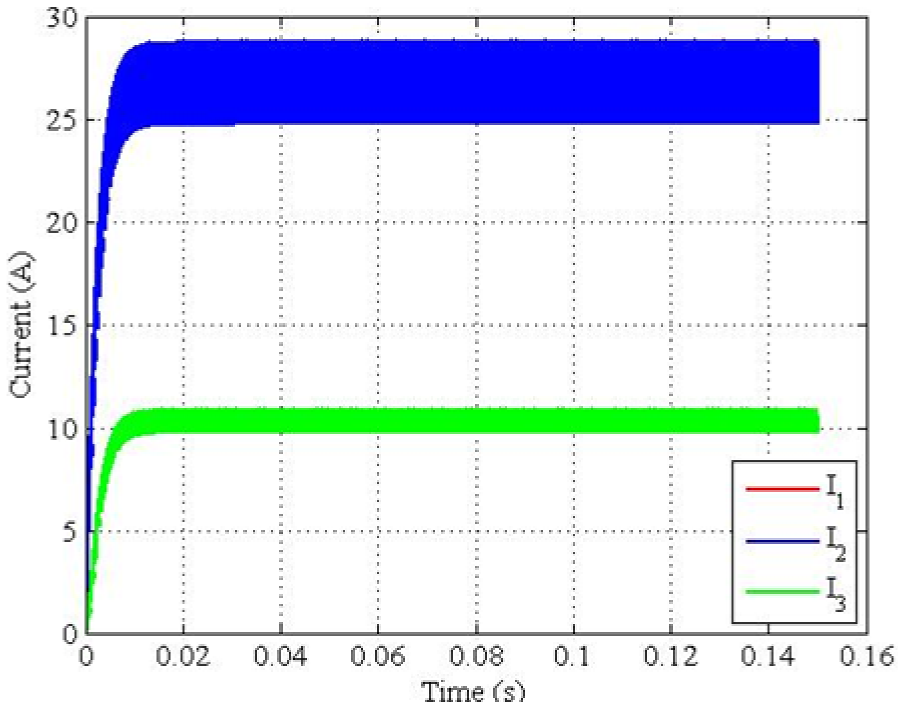

Fig.4.Converter waveform

2 current regulation. This converter was simulated in PSIM®.the larger current is both input currents overlapping one another. From this it was determined that as long as φ13 = φ23 and V1 = V2 or ideal operating conditions the two sources will exactly split the current of the original IDC. Fig. 30 also shows that the capacitor voltage is not biased with an average over a period equal to zero. The smaller currentis the load current shows the load voltage, both of which are the same as the original IDC for

the same phase angle difference of 45°. As φ13 = φ23 was swept form 5° – 85° the shape of the currents and voltages remained the same with the steady state magnitude changing as shown in Figs. 33 and 34. From these figures it can be seen that as φ13 = φ23 increases the converter currents and voltages decrease. These curves are monotonically decreasing meaning the slope of the function is always negative. This will be used as a control method later in the chapter.

CONCLUSION:

With the need for renewable energy sources in high demand, the technology needed to interface these sources has been a big topic in current research with the creation of new conferences and transactions. This thesis has presented a new DC-DC converter, Multi-source IDC, which can be used with multiple energy sources.The Multi-source IDC is a topological variation of the original IDC presented. The original IDC is a DC-DC converter with the capability of continuous voltage step up or step down over a wide range without the use of a transformer. This is done by controlling the phase difference angle φ or the switching frequency f. This converter was then modeled using Gyrator theory in order to gain an understanding about its operational characteristics as well as control.

REFERENCES:

[1] H. Tao, A. Kotsopoulos, J.L. Duarte, and M.A.M. Hendrix, "Family of multiport bidirectional DC–DC converters," IEE Proceedings of Electric Power Applications, vol. 153, no. 3, pp. 451-458, May 2006.

[2] J.L. Duarte, M. Hendrix, and M.G. Simoes, "Three-port bidirectional converter for hybrid fuel cell systems," IEEE Transactions on Power Electronics, vol. 22, no. 2, pp. 480-487, March 2007.

[3] Y.M. Chen, Y.C. Liu, S.C. Hung, and C.S. Cheng, "Multi-input inverter for grid-connected hybrid PV/wind power system," IEEE Transactions on Power Electronics, vol. 22, no. 3, pp. 1070-1077, May 2007.

[4] C. Zao, S. Round, and J.W. Kolar, "Buck and boost start-up operation of a three-port power supply for hybrid vehicle applications," in Proc. 36th Annual Power Electronics Specialists Conference, 2005, pp. 1851-1857.

[5] J.G. Kassakian, H.C. Wolf, J.M. Miller, and C.J. Hurton, "Automotive electrical systems circa 2005," IEEE Spectrum, vol. 33, no. 8, pp. 22-27, Aug. 1996.

[6] H. Krishnaswami and N. Mohan, "A Current-fed three-port bi-directional DC-DC converter," in Proc. 29th International Telecommunications Energy Conference, Sept. 30, 2007-Oct. 4, 2007, pp. 523-526.