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ZERO-VOLTAGE SWITCHING USING PHASE SHIFT CONTROL METHOD FOR TWO-WAY DC/DC CONVERTERS WITH VOLTAGE DOUBLER

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ABSTRACT:

It's best to use direct current power. Even at a 50% duty cycle, Power Electronics circuits can achieve a high level of efficiency and power density. DC-to-DC devices can provide higher output voltages, but the voltage cannot be controlled in the conventional manner. To control the output voltage, we advocate the use of active power filters and rectifiers known as active boost rectifiers (ABR). Since pulse-based switch control is required for all activities, the suggested rectifier is essentially a hybrid of a traditional diode rectifier and a bidirectional switch. The output voltage can be changed by adjusting the phase difference between the primary and secondary sides during the switching process. A family of soft-switching devices is possible thanks to the a-b active boost rectifier. Gentle switching continuous conduction mode of the converter allows for zero voltage switching on both the primary and secondary sides. Zero current switching on the primary side and zero voltage switching on the secondary side are both possible when the converter is operating in its discontinuous conduction mode. If the diode ever has trouble with reverse recovery, an active boost rectifier can be used to boost its output. To verify the efficacy of the current concept of this ABR and converters, the examination looks at the full bridge converter outfitted with a doubler diodes filter, dissecting its working principles of voltage conversion ratio and output features. The simulation results for the feasibility and effectiveness are presented in this investigation.

KEYWORDS: Active boost rectifier (ABR), DC–DC converter, full bridge converter (FBC), soft switching, voltage doubler (VD).

1. INTRODUCTION

DC to DC converters can be found virtually anywhere because they are such a widespread and valuable piece of electrical hardware. How valuable is voltage inversion for electronic and power electronic applications, both in general and in particular, and to what extent is it used by those applications? The DC to DC Converter is the foundation of many different types of switching converters, and it plays an important role in preventing issues such as severe switching and switching sparks from occurring. In phase-shift full-bridge converters, a DC-to-DC converter is typically included as a standard safety feature. \

2. PROPOSED DC–DC CONVERTERS WITH ABR FILTER

Figure 1 makes use of a Full Bridge Converter (FBC) rectifier and a Voltage Doubler (VD) rectifier in order to demonstrate the idea of an ABR, which stands for a "Average Boost Rectifier." The duty cycles of all switches have been pre-set to 50% in preparation for the use of DC transformers. Within the voltage inverter are located two switches that can turn the device on or off (S1 and S4) as well as a source of direct current (DC) for the input voltage. It does so by delivering a square-wave voltage of uP, which is an alternating current current, to the primary winding of the transformer. Therefore, the converter depicted in Figure 1 is illustrated in Figure 2a as a depiction of the converter. The circuit is converted into an unregulated rectifier when a transformer T with a turn ratio of one is inserted into it, as demonstrated in Figure 2(b).

You will observe that the output voltage is invariable even if all of the switches are set to the half-power position. A bidirectional switch, denoted by the symbol Sb, is included in the circuit and serves the purpose of regulating the output voltage, as demonstrated in Figure 2(b). Figure 3 depicts an ABR-based Boost circuit, which is comprised of the inductor Lk, the switch Sb, and the capacitor C.

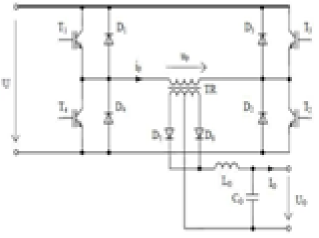

Figure 1
Full-bridge converter

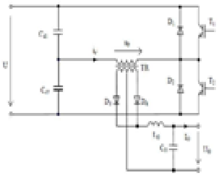

Figure 2
Half-bridge converter

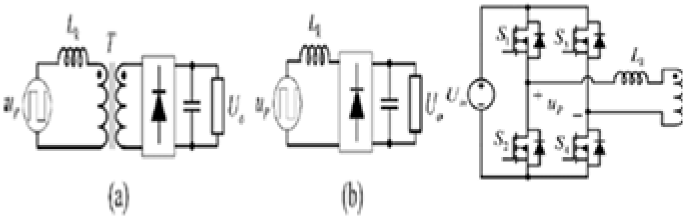

Fig 1.aTopology of Voltage Doubler Rectifier Fig 2.b Simplified Bridge Converter

Figure 1 presents the system block diagram for your perusal. The introduction of pulse width modulation (PWM) logic control contributed to the improvement in performance that was achieved by the suggested system. The following section presents a wealth of information regarding the suggested system's circuit layout as well as its functioning mechanism. Figure 2 illustrates the primary and secondary controls that are utilized by the FBC-VD-ABR. These controls ensure that the duty cycle remains constant at 0.5. S2 and S3 are never activated or deactivated independently of S1 and S4. They are always done together. The difference in phase between the signals coming from the source and going to the destination.

Both the voltage and the current that are produced by the output are subject to change and are managed by a dynamic switch. The total inductance of the transformer, Lf, is equal to the sum of its leakage inductance, Ll, and its external inductance, Lx. Large output capacitors Co1 and Co2 that are identical to one another limit the voltage strains imposed on the switches and diodes on the secondary side to half the output voltage. The drain-to-source voltages of the rectifying diodes S1, S4, and S6 are denoted by the symbols uDS1, uDS4, and uDS6, respectively. This circuit is quite similar to the power factor correction boost converter in a number of different ways. As a result, the output voltage can be altered through the utilization of the bidirectional switch denoted by Sb. The ABR rectifier is composed of diodes and a bidirectional active switch designated as Sb. The output voltage can be easily modified by exchanging the unregulated diode rectifier of the DC transformer for a programmable ABR (Automatic Bridge Rectifier). This will allow the output voltage to remain stable. The application of the ABR to the FBC in Figure 1 results in the formation of a new circuit.

3. DC–DC CONVERTERS BASED ON ABR FILTERS

In earlier research, an ABR circuit was built employing a standard VD diode rectifier as the component. This technology is also capable of rectifying full-wave diodes as well as the more traditional full-bridge rectifiers. This should serve as a helpful reminder of how critically important it is to keep it in mind at all times. Because the transformer has two separate secondary windings, we are going to have to use a pair of unidirectional switches, designated Su1 and Su2, in order to create an ABR. When MOSFETs and diodes are connected in series, the result is a switch that can be used in either direction, while connecting a MOSFET and a diode in parallel results in a switch that can only be used in one direction. Both one-way and two-way switches are commonplace in a variety of settings and applications. The usage of these switches enables a wide variety of different sorts of ABR circuits to be constructed. In various circumstances, it is possible to access a variety of topologies. By using two MOSFETs in place of the diodes in a full-bridge diode rectifier, it is possible to transform the rectifier into a bidirectional switch. In this configuration, the switch is connected in series with the secondary winding of the transformer. The outcome of this is simplified full-bridge ABR topologies, which may be seen illustrated in Figure 8 with the red bidirectional switches. By altering the spacing between the diodes, the spaces between them can be made smaller.

Alternating current must be used in order to generate a square wave voltage on the primary side circuit, as can be shown. There are several different possible configurations for the primary-side circuit, and the voltage-sourced full-bridge topology is just one of them. Several topologies, including the boost full-bridge, have been explored so that it can be determined whether or not this configuration is viable and whether or not it offers any advantages. Additionally, the usefulness of the ABR concept that has been provided here can be highlighted. This study makes an important contribution since, despite the design and evaluation of several circuits, the topological approach within this family of circuits has not been properly documented until now, and this paper provides that documentation.

4. FBC WITH VOLTAGE-DOUBLER ABR

A voltage multiplier is a component that can be found in a full bridge converter. By switching on the power and electricity but without performing any of the necessary repairs, he is conducting research into a potential biological technique. In order to accomplish this, he conducts a comprehensive investigation of the workings of an automated boost rectifier. Even after reproducing the full wave rectifier, there is no change in the duty cycle of any of the primary or secondary controllers. This is the case even after the full wave rectifier was reproduced. In the event that the primary current decreases before the primary side switch commutation, the converter will enter a mode known as Discontinuous Conduction Mode (DCM), in which the voltage differential across the key will reproduce a complete Bridge with eight stages during a single switching period. The following equation only has to take into account a total of four different steps because the circuit is symmetrical. For the purpose of this investigation, high-power applications, the standard phase-shift FBC, and the full-bridge LLC resonant converter were chosen because of the structural and functional similarities between the three. Other converters were omitted from the study since it was determined that they could not fairly be compared with the others. Table I presents an analysis of the expenses and revenue generated by each of the three distinct converters. Using any particular converter comes with its share of benefits and drawbacks. The converter that has been suggested is an excellent choice for solar or battery-powered systems, systems for charging or discharging batteries, and other applications that require high efficiency, high frequency, and a wide input/output voltage range. In addition, the ABR voltage doubler makes it uncomplicated to accomplish a notable rise in voltage gain. This leads one to believe that the proposed converter might be used not only as the initial converter in a system that utilizes renewable energy, but also in other applications in which a significant voltage spike is required.

Has completed the initial task and moved on to the next one. As can be seen in the diagrams that came before this one, the trigger accurately represents the mandated pulse waveforms, as well as the input voltage and output voltage. The input voltage is three-phase, and the output voltage is far higher than what was anticipated. A smooth output that does not contain any spikes or dips is an indication that the execution was successful, as seen in the image..

Soft-Switching Characteristics

According to the principles governing the functioning of the converter, the power MOSFETs on the primary side are capable of achieving ZVS turn-on in both the SS-CCM and HSCCM modes of operation. Primary side MOSFETs can be turned off at zero voltage switching (ZVS) by adding parasitic or parallel capacitors between the drain and source terminals. This allows the MOSFETs to be switched off without applying any voltage. It is possible for the ZVS turn-on of the secondary-side MOSFETs and the ZCS turn-off of the rectifier diodes to occur simultaneously when the converter is operating in the SS-CCM mode. When operating in HS-CCM mode, it is more difficult to transfer devices on the secondary side without interruption. Because the turn-off current in the HS-CCM is the lowest when compared to the turn-off currents in the other two operation modes at the same output power level, it is possible to reduce the loss that is suffered during the turn-off of the secondary side MOSFET. In addition, while the converter is operating in the Discontinuous Conduction Mode (DCM), the MOSFETs on the secondary side of the circuit are able to achieve Zero Voltage Switching (ZVS), while the main switches and secondary rectifier diodes are able to achieve Zero Current Switching (ZCS). During the examination of the operating principle, the magnetizing inductance is neglected so that the analysis can be understood more easily. Conduction losses are minimal as a result of the low magnetizing current that the transformer possesses. In low-power settings, the LLC resonant converter provides an option, and the magnetizing current can assist primary-side MOSFETs in achieving Zero Voltage Switching (ZVS). As a direct consequence of this, circuit conversion can become more efficient.

Control Loop

As can be seen in the characteristic curves, the output voltage and power of the FBC-VD-ABR are both determined by the duty cycle of the rectifier. The phase shift angle is the only direct variable that can be adjusted, and this affects both voltage and power. By establishing the input of the PI regulator with the voltage reference and the sampled output voltage, the time-honored voltage feedback loop may be used to regulate the output voltage. This is accomplished by using the classic voltage feedback loop. The command value of the phase-shift modulator can be found by referring to this input. Because the control loop is so straightforward, it may be realized using either an analog, digital, or digital signal processing (DSP) circuit.

Performance Comparison

In order to assist in the design of tradeoffs and the selection of topologies for engineering applications, it is required to conduct an evaluation of the performance of the FBCVD-ABR in comparison to the performance of other converters.

5. SIMULINK RESULTS AND OUTPUTS

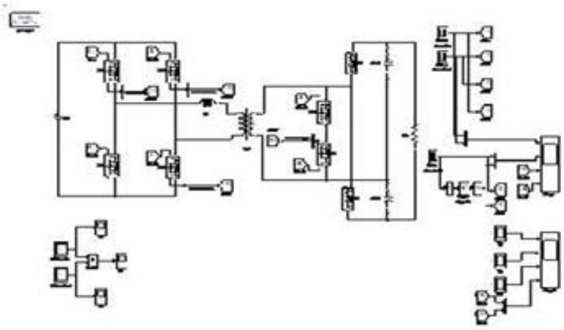

Fig 3 Proposed Circuit Diagram ABF

In order to demonstrate the significance of power, the graphic above uses simulation software that includes active power filters. The device consists of an AC-to-boost rectifier for the purpose of power purification as well as an AC-to-full-bridge converter that features soft switching as well as voltage doubling circuits. In the rectifier, components such as a phase-controlled bidirectional speech converter and a diode rectifier are used. Both data from the real world and simulations show that the pulse control of the rectifier is lacking in some way. As a consequence of these considerations, the sword switching strategy features zero current switching on the secondary side and zero voltage switching on the primary side. Zero voltage switching (ZVS) is an option on both the primary and secondary sides of the converter when it is operating in Synchronous Soft-Switching Current Mode (SS-CCM). However, as shown by the waveforms below, in order for the converter to achieve zero-voltage switching (ZVS) performance on the primary side, it must only function in high-side continuous conduction mode (HS-CCM) with the secondary switches firmly enabled. This is the only mode in which it is possible to run the converter. The on and off current of the switches on the secondary side of the HS-CCM is incredibly low.

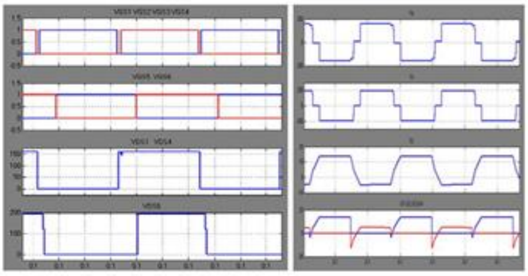

Fig. 4 Gate Pulses (Step input)

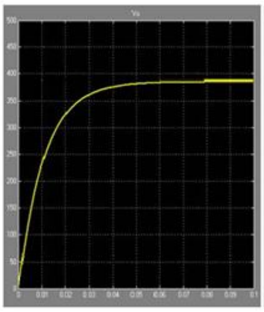

Fig 5 Input Voltage

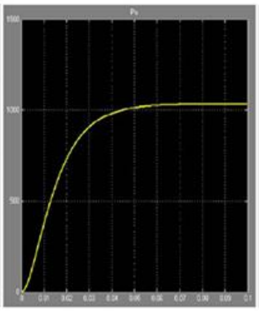

Fig 6 Output Voltage

6. CONCLUSION

A duty cycle of fifty percent is considered to be the optimal level for DC-to-DC converters. Applications that require high frequency, low frequency, and high power density can benefit from reduced switching losses. There are no switching losses that are brought on by an excessive leakage of inductance. In addition, both the input and output voltages have regulators applied to them in order to eliminate voltage spikes. At long last, a switching family that is equipped with ABS voltage has been released.

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