ACCOMPLISHMENT OF VOLTAGE MULTIPLIER FOR HIGH VOLTAGE EFFICIENCY DC TO DC CONVERTER BASED ON DICKSON CHARGE PUMP

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Abstract-DC distribution systems have gained popularity recently as they offer better efficiency, higher reliability and low cost as compared to ac distribution systems. They help in easier integration of renewable energy and its storage systems. But the main challenge faced by such dc distribution systems is the use of power electronic converters for integrating renewable sources into the dc bus. So a high-voltage-gain dc-dc converter is introduced in this paper. The converter consists of a two-phase interleaved boost converter on its input side and a Dickson charge pump based voltage multiplier on its output side so that it provides an output voltage of 400 V for an input voltage as low as 20V.The voltage multiplier circuit associated with the converter offers low voltage across the capacitors which potentially leads to reduction in size. The converter can be fed to a three phase induction motor so that analysis can be done efficiently and its simulation results are obtained using MATLAB/ Simulink.

Keywords-*Dc distribution system; RES network; Dickson converter; Voltage multiplier.*

I. INTRODUCTION

Though PV cells can be made into an array and can connected in series to produce high voltage there exist some serious problems such as shadowing effects, short circuit etc which drastically reduces its efficiency. In order to overcome such adverse effects, a high step up converter is required. Thus high step up dc-dc converters are used as front end converters to step up from voltage as low as 20V to high voltage. When the output voltage is high, it becomes necessary to reduce the voltage stress on the active switches and diodes; otherwise, it will cause high conduction loss and becomes more expensive. Due to the presence of parasitic parameters such as the equivalent series resistance of inductor, conventional boost converters cannot provide a high voltage gain and thus results in high duty ratio. However this extreme duty ratio can cause serious reverse recovery problems and electromagnetic interferences. The extremely narrow turn-off time will result in large peak current and considerable conduction and switching losses. A typical choice would be using two cascaded converters; but it results in inefficient operation, reduced reliability, increased size, and can even result in stability issues .Another option is the use of isolated topologies like, half-bridge, full-bridge, flyback, forward and push-pull converters; but it has a disadvantage that it will produce discontinuous input currents and hence would require bulky input capacitors.

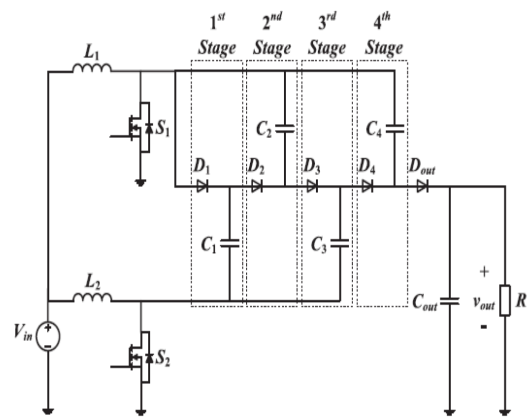

Fig.1.1: Model diagram.

II. PREVIOUS STUDY

Due to the effect of power switches, rectifier diodes, and the equivalent series resistance of inductors and capacitors the step-up voltage gain is limited. Moreover, the extremely high duty-ratio operation will result in a serious reverse-recovery problem. Typically high-frequency transformers or coupled inductors are used to achieve high-voltage conversion ratios. But the transformer design is complicated and the leakage inductances increase for achieving larger gains, as it requires higher number of winding turns. This leads to voltage spikes across the switches and voltage clamping techniques are required to limit voltage stresses on the switches. Consequently, it makes the design more complicated. Villard voltage-doubler used to achieve high gain is a combination of the clamper and peak holder circuit. A high-voltage-gain dc–dc converter based on the modified Dickson charge pump VM circuit is introduced in this paper. This converter is capable of stepping up voltages as low as 20 to 400 V. The proposed converter offers continuous input current and low voltage stress (one-fourth of its output voltage) on its switches. This converter can draw power from a single source or two independent sources while having continuous input currents, which makes it suitable for applications like solar panels. Compared to the topology presented, the proposed converter requires lower voltage rating capacitors for its VM circuit and also one less diode. The inductors and switches experience identical current stresses, making the component selection process for the converter simpler.

III. PROPOSED SYSTEM

The proposed converter resembles a two-phase interleaved boost converter on its input side while having a Dickson charge pump based voltage multiplier on its output side. This converter offers continuous input current which makes it more appealing for the integration of renewable sources like solar panels to a 400-V dc bus. Also, the proposed converter is capable of drawing power from either a single source or two independent sources. Furthermore, the voltage multiplier used offers low voltage ratings for capacitors which potentially lead to size reduction. The Dickson charge pump VM circuit, shown in Fig, offers a boosted dc output voltage by charging and discharging its capacitors. The input voltage V_{AB} is a modified square wave (MSW) voltage. The voltages of the capacitors in the Dickson charge pump double at each stage as one traverses from the input-side capacitor $C1$ to the load-side capacitor $C4$. For an output voltage of V_{out} = 400V, the voltages of capacitors $C1$, $C2$, $C3$, and $C4$ are 80, 160, 240, and 320 V, respectively. The authors propose to make a slight modification to the Dickson charge pump circuit, as shown in Fig. For a same output voltage, the voltages of all the capacitors in the modified Dickson charge pump are smaller than the voltage of capacitor $C2$ in the Dickson charge pump. For an output voltage of V_{out} = 400 V, the voltages of capacitors $C1$, $C2$, $C3$, and $C4$ are only 150, 50, 50, and 150 V, respectively. Therefore, the volume of the capacitors used in the proposed modified Dickson charge pump VM circuit is potentially less compared to the Dickson charge pump.

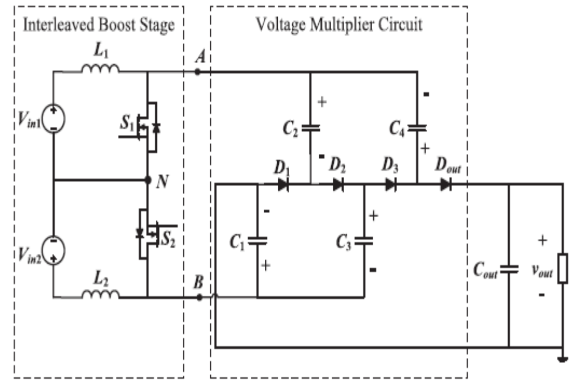

Fig.3.1: Proposed working model.

IV. SIMULATION RESULTS

The inductor currents are equal and are 180° out of phase from each other as the two phases of the interleaved boost are operated in such way. The output voltage is 400 V, and the voltage ripple is almost negligible. Fig. shows the inductor currents along with the gate signals of the switches. The voltages of switches $S1$ and $S2$ are shown inFig. 16. The turn-off voltage of both switches is around 100 V. The resonant attributes from the greater current changed outcome is actually usually refined by use a result capacitor. An exterior or even additional circuit steers the changing, normally at 10s from kilohertz around a number of megahertz. The higher regularity lessens the quantity from capacitance demanded, as much less fee must be actually held as well as discarded in a briefer pattern. Cost pumps could multiply currents, three-way currents, cut in half currents, invert currents, fractionally increase or even size currents (including × 3/2, × 4/3, × 2/3, and so on) and also create random currents through swiftly varying in between methods, depending upon the operator and also circuit geography. They are actually typically utilized in low-power electronic devices (like smart phones) to elevate and also reduced currents for various aspect of the integrated circuits - lessening energy intake through regulating source currents thoroughly.

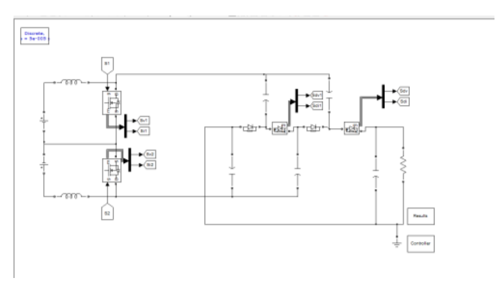

Fig.4.1:Simulation diagram

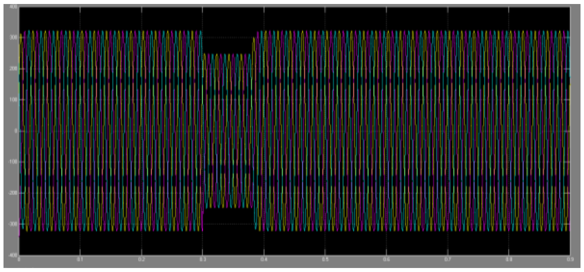

Fig.4.2:Voltage Sag Condition.

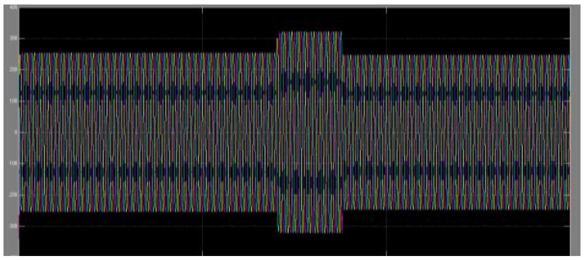

Fig.4.3:Voltage Swell Condition.

V. CONCLUSION

In this paper, a high-voltage-gain dc–dc converter is introduced that can offer a voltage gain of 20, i.e., to step up a 20 V input to 400 V output. The proposed converter is based on a two-phase interleaved boost and the modified Dickson charge pump VM circuit. It can draw power from a single source as well as from two independent sources while offering continuous input current in both cases, making the converter well suited for renewable applications like solar. The proposed converter is symmetric, i.e., the semiconductor components experience the same voltage and current stresses, reducing the effort and time spent in the component selection during the system design. The proposed converter has smaller VM capacitors compared to a reference converter based on Dickson charge pump VM cells; hence, it is smaller in size. The converter finds its application in integration of individual solar panels onto the 400 V distribution bus in data centers, telecom centers, dc buildings, and microgrids.

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