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HIGH POWER IGBT BASED DC-DC SWITCHED CAPACITOR VOLTAGE MULTIPLIERS WITH REDUCED NUMBER OF SWITCHES

[1]Prabhakaran.A, [2]Praveenkumar.S, [3]Vinoth Kumar.L, [4]Karthick.K, [5]Senthilkumar.K,
[1,2,3,4]UG Scholar, Dept Of Electrical And Electronics Engineering, The Kavery Engineering College,
[5]Asst Prof, Dept Of Electrical And Electronics Engineering, The Kavery Engineering College.

ABSTRACT

High Power IGBT Based Dc-Dc Switched Capacitor Voltage Multipliers With Reduced Number Of SwitchesStress Is Proposed In This Paper. Through Employ Of Coupled Inductor And Switched Capacitor, The Proposed Converters Attain High Step-Up Conversion Ratio Without Operating At Extreme Duty Ratio. Due To Reutilize Of Leakage Energy, The Efficiency Is Developed And The Large Voltage Spike On Switch Is Improved, These Kinds A Medium Voltage-Rated Igbt Can Be Implemented For Decreases Of Conduction Losses. Simulation Results Are Presented To Demonstrate The Effectiveness Of The Converter.

Keywords: PV Model, Coupled Inductor, Switched Capacitor, High Step Up Converter.

1. INTRODUCTION

The advent of renewable energy sources like solar and wind based system as clean and viable alternatives to conventional sources such as fossil fuel based energy generation, demands high gain DC-DC converters to step up the voltage significantly to be used either practically as a domestic stand-alone system or for connection to the grid. Initially cascaded and interleaved boost converters (IBC) were used to obtain the required high gain [3]-[4]. These converters however faced inherent problems of high ripple current and high power losses. This prevented higher efficiency at a higher gain when using these topologies. Isolated topologies using transformers or coupled inductors with suitable turns-ratio were used to achieve the required voltage gain. When using transformer the losses are a function of switching frequency, this in turn puts an upper limit on the operating frequency of the converter. Also this increases the size of the converter besides making the converter heavier and costlier. The high current flowing through the boost inductor also imposes large voltage stress across the devices. For efficient utilization of renewable energy, compact non-isolated converters are required. Coupled inductors were used in conjunction with switched capacitors in [2]. The main disadvantage of this topology is that many numbers of components were used. In [1] and [8], coupled inductor was used in conjunction with a voltage multiplier cell.Switched inductor and switched capacitor based topologies were used to reduce the switch stress in [9].The concept of multi-level based DC-DC power conversion proves to be a suitable non-isolated alternative solution to obtain the required high voltage gain and high power level[10]-[12].The main advantage of multilevel conversion is that only low voltage level devices are required as each device only block one voltage level. The advantage of multi-level conversion can further be extended by including a coupled inductor into the converter. This provides further control over the gain. The presence

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of the coupled inductor in addition to the voltage multiplier reduces the duty cycle required to achieve a particular gain Some literatures have researched the high step-up DC-DC converters that do not incur an extremely high duty ratio. The transformer less DC- DC converters, such as the cascade boost type, the quadratic boost type, the switched-inductor type , the voltage-lift type , the voltage doubler technique , the capacitor-diode voltage multiplier type , and the boost type that is integrated using a switched-capacitor technique . These converters can provide higher voltage gain than the conventional DC-DC boost converter. However, the voltage gain of these converters is only moderately high. If higher voltage gain is required, these converters must cascade more power stages, which will result in low efficiency. The DC-DC flyback converter is adopted to achieve high step-up voltage gain by adjusting the turn's ratio of the transformer.

2. PROPOSED SYSTEM

This paper presents a novel high step-up dc/dc converter for renewable energy applications. The suggested structure consists of a coupled inductor and two voltage multiplier cells in order to obtain high-step-up voltage gain. In addition, a capacitor is charged during the switch-off period using the energy stored in the coupled inductor, which increases the voltage transfer gain. The energy stored in the leakage inductance is recycled with the use of a passive clamp circuit.

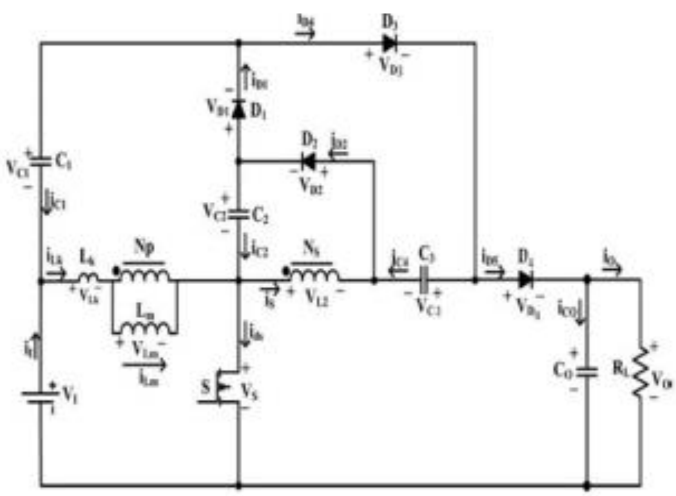

Fig.1.Circuit Configuration

The voltage stress on the main power switch is also reduced in the proposed topology. Therefore, a main power switch with low resistance RDS(ON) can be used to reduce the conduction losses. The operation principle and the steady-state analyses are discussed thoroughly.A conventional high step-up DC-DC converter with coupled-inductor technique. The structure of this converter is very simple and the leakage-inductor energy of the coupled inductor can be recycled to the output. However, the voltage stresses on switch S1 and diode D1, which are equal to the output voltage, are high. This paper presents a novel high step-up DC-DC converter.

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3. OPERATION

There are five operating modes in one switching period. Fig. 4 shows the current-flow path of each mode of the circuit. a) Mode I [t0, t1]: In this mode, S is turned on. Diodes D1 and D3 are turned off, and D2 and D4 are turned on. The current-flow path is shown in fig. 4(a). The DC source magnetizes Lm through S. The secondary-side of the coupled inductor is in parallel with capacitor C2. As the current of the leakage inductor Lk increases the secondary-side current of the coupled inductor (is) decreases. The capacitor CO supplies the energy to R0. This interval ends when the secondary-side current of the coupled inductor becomes zero.

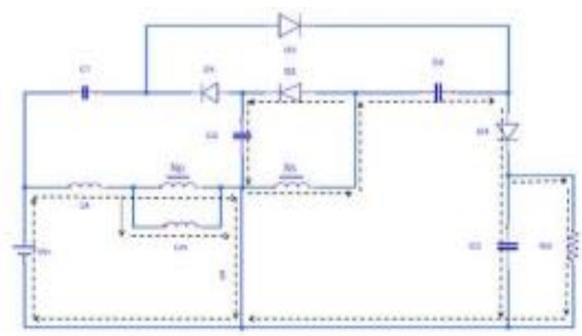

Fig.2.Mode 1

Mode II [t1, t2]: In this mode, S remains turned on. Diode D1, D2, and D4 are turned off and D3 is only turned on. The current-flow path. Vin magnetizes Lm through switch S. So, the current of the leakage inductor Lk and magnetizing inductor Lm increase linearly. Dc source Vin, clamp capacitor and the secondary-side of the coupled inductor are charge the capacitor C3. Output capacitor CO supplies load R0. This interval ends when switch (S) is turned off.

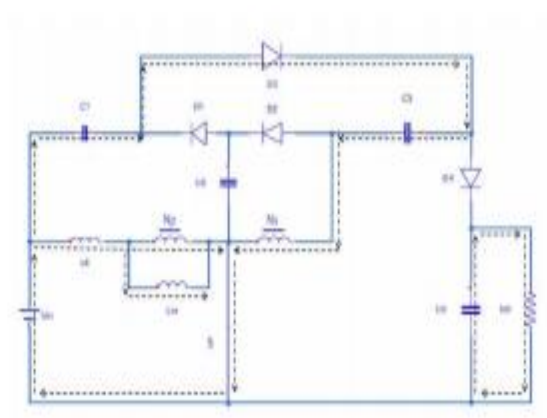

Fig.3.Mode 2

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Mode III [t2, t3]: In this mode, S is turned off. Diodes D2, and D4 are turned off and D1 and D3 are turned on. The current-flow path is shown in fig. 4(c). The clamp capacitor C1 is charged by using capacitor C2, leakage inductor Lk and magnetizing inductor Lm. The currents of the secondary-side of the coupled inductor (is) and the leakage inductor are increased and decreased respectively. The capacitor C3 is still charged through D3. This interval ends when iLk is equal to iLm. Output capacitor C0 provides its energy to load R.

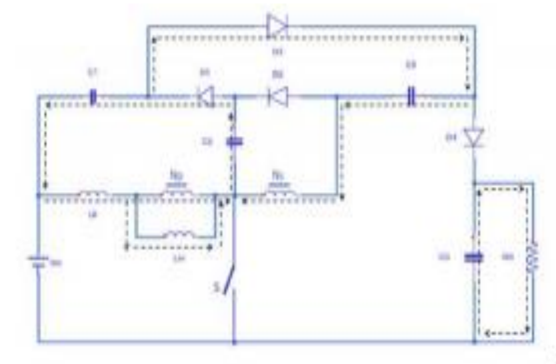

Fig.4.Mode 3

Mode IV [t3, t4]: In this stage, S is turned OFF. Diodes D2 and D3 are turned OFF and diodes D1 and D4 are turned ON. Energies of capacitor C2 ,leakage inductor Lk and magnetizing inductor Lm are charge capacitor C1. The currents of the leakage inductor Lk and magnetizing inductor Lm decrease linearly. Also, a part of the energy stored in Lm is transferred to the secondary side of the coupled inductor. The dc source Vin, capacitor C3 and both sides of the coupled inductor charge output capacitor C0 and provide energy to the load R0.

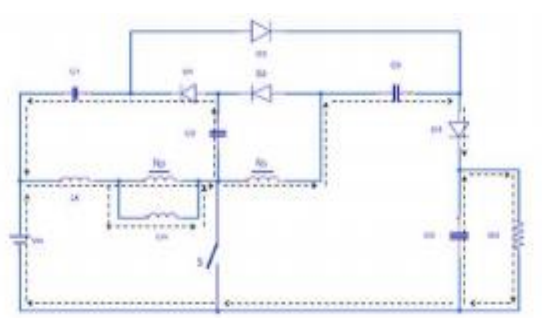

Fig.5.Mode 4

Mode V [t4, t5]: In this stage, S is turned OFF. Diodes D1 and D3 are turned OFF and diodes D2 and D4 are turned ON. The currents of the leakage inductor Lk and magnetizing inductor Lm decrease linearly. Apart of stored energy in Lm is transferred to the secondary side of the coupled inductor in order to charge the capacitor C2 through diode D2 .

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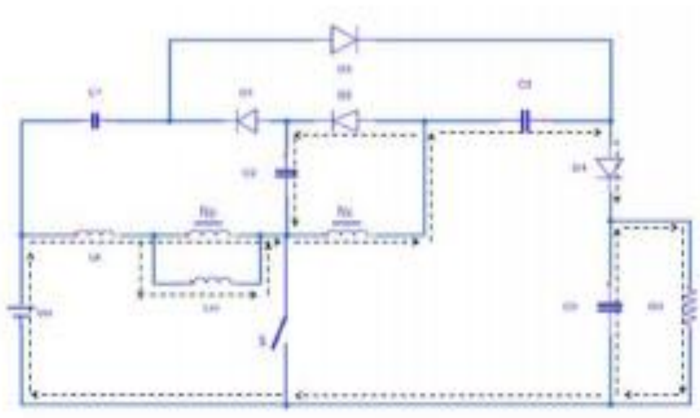

Fig.6.Mode 5

4. SIMULATION RESULTS

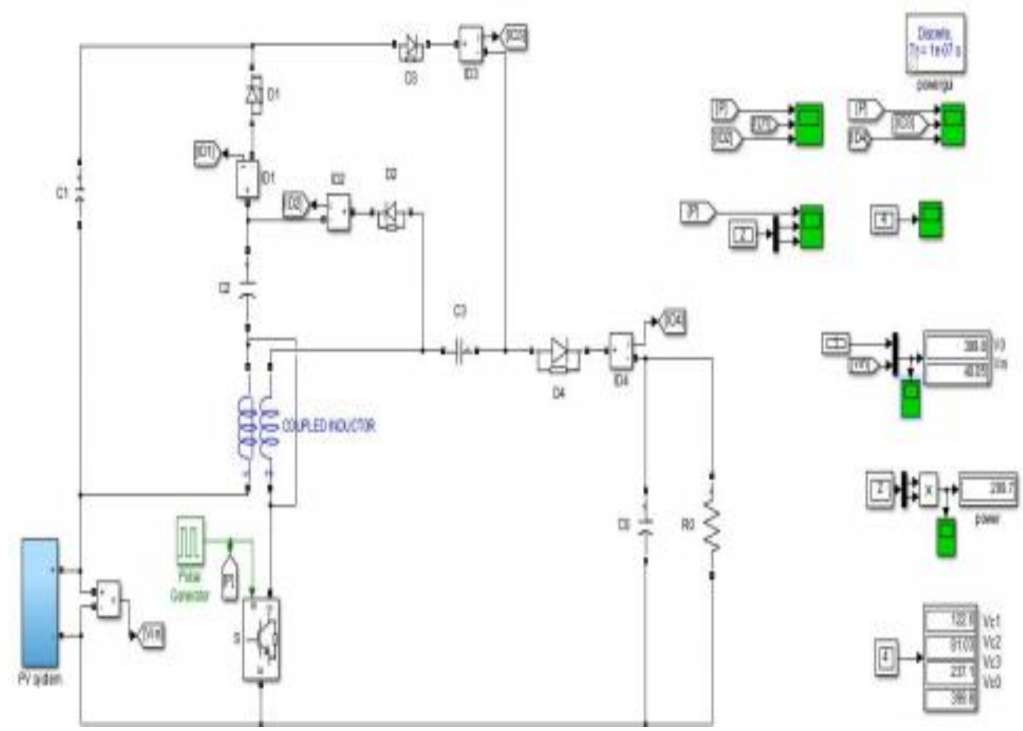

Fig.7.Simulation Fig

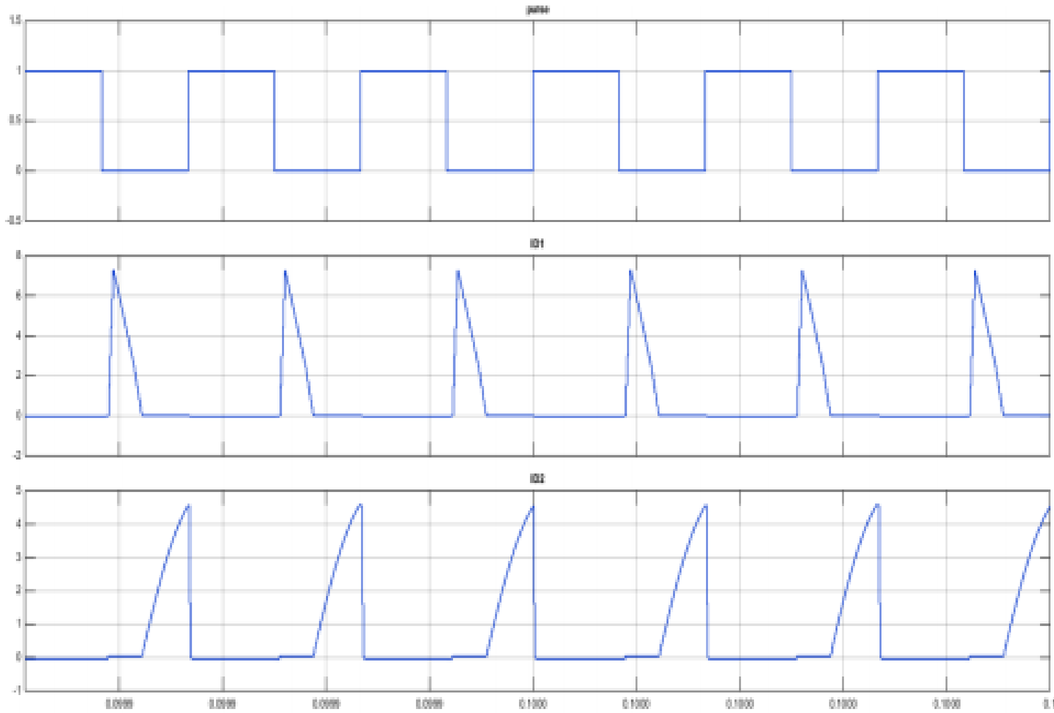

Fig.8.Waveform Output

CONCLUSION

This paper presents a new high-step-up dc/dc converter for renewable energy applications. The suggested converter is suitable for DG systems based on renewable energy sources, which require high-step-up voltage transfer gain. The energy stored in the leakage inductance is recycled to improve the performance of the presented converter. Furthermore, voltage stress on the main power switch is reduced. Therefore, a switch with a low on-state resistance can be chosen. The steady-state operation of the converter has been analysed in detail.

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