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IMPLEMENTATION OF SOFT- SWITCHING DC-DC CONVERTER FOR DISTRIBUTED ENERGY SOURCES WITH HIGH STEP-UP VOLTAGE CAPABILITY BY PI-FILTER

[1]Priyanka.B, [2]Ranjitha.R, [3]Yuvaraj.C,[4]Sudhakaran.M,
[1,2]Dept of EEE, GTEC, Vellore, India
[3]Asst Prof, Dept of EEE, GTEC, Vellore, India
[4]Associate Prof, Dept of EEE, GTEC, Vellore, India

Abstract:

High step- up dc-to-dc converter for low voltage sources such as solar photo voltaics, fuel cells, and battery banks. To achieve high voltage gain without large duty cycle operation, combination of coupled inductor and switched capacitor voltage doubler cells are used. By incorporating active clamp circuit, voltage spike due to the leakage inductance of the coupled inductor is alleviated and zero-voltage switching turn on of the main and auxiliary switch is obtained. Due to the use of MOSFETs of low voltage rating and soft turn on of the switches, conduction loss and switching losses are reduced. This improves the efficiency and power density of the converter. The proposed converter can achieve high voltage gain with reduced voltage stress on MOSFET switches and output diodes by pi-filter.

Keywords –Doubler, MOSFET, Density

1. INTRODUCTION

Renewable energy-based clean and non pollutant distributed power generation (DG) systems are gaining more importance due to the global warming, exhaustion of fossil fuels, and increased demand of electrical energy. Renewable energy sources such as solar photo voltaics (PV), fuel cells, and wind energy systems are widely used for DG power systems. These sources are highly intermitted in nature, and thus, they require a power electronics interface for efficient utilization. In case of series connected PV systems, due to the partial shading and mismatches between PV modules, the output power reduces considerably. As shown in Fig. 1,module integrated converter systems are more efficient than conventional centralized and multistring structure. Advantages of modular structure includes less mismatch losses, efficient maximum power point tracking, independent control of each modules, and flexibility to add new modules as demand increases. Control signals for modular converters can easily derived from a common converter control signal, as given. As the output voltages of PV and fuel cells are low, it is necessary to step up the voltage using high step-up converters. Isolated converters can achieve high voltage gain by adjusting the turns ratio of the transformer. However, for higher voltage gain, it requires large turns ratio. It also suffers from high voltage stress on output rectifier diodes. In high power applications, current fed converters are good alterative over voltage fed converters. Here, boost-type input inductor helps to increases the voltage gain without large turns ratio of transformer. However, additional inductor along with isolation transformer increases the weight and volume of these converters. In addition, active or passive snubber circuit is necessary to overcome the voltage spikes due to the leakage inductor.

2. EXISTING SYSTEM

High step-up dc-to-dc converter for low voltage sources such as solar photo voltaic, fuel cells, and battery banks. To achieve high voltage gain without large duty cycle operation, combination of coupled inductor and switched capacitor voltage doublers cells are used. By incorporating active clamp circuit, voltage spike due to the leakage inductance of the coupled inductor is alleviated and zero-voltage switching turn on of the main and auxiliary switch is obtained. Due to the use of MOSFETs of low voltage rating and soft turn on of the switches, conduction loss and switching losses are reduced. This improves the efficiency and power density of the converter.The system can be use the pi filter. The pi filter A typical capacitor input filter consists of a filter or reservoir capacitor C1, connected across the rectifier output, an inductor L, in series and another filter or smoothing capacitor, C2, connected across the load, RL. A filter of this sort is designed for use at a particular frequency, generally fixed by the AC line frequency and rectifier configuration.

3. ANALYSIS AND DESIGN OF PI FILTER

The capacitor-input filter, also called the pi filter due to its shape that looks like the Greek letter π, is a type of electronic filter. Filter circuits are used to remove unwanted or undesired frequencies from a signal. A simple pi filter, containing a pair of capacitors, an inductor, and a load. A typical capacitor input filter consists of a filter or reservoir capacitor C1, connected across the rectifier output, an inductor L, in

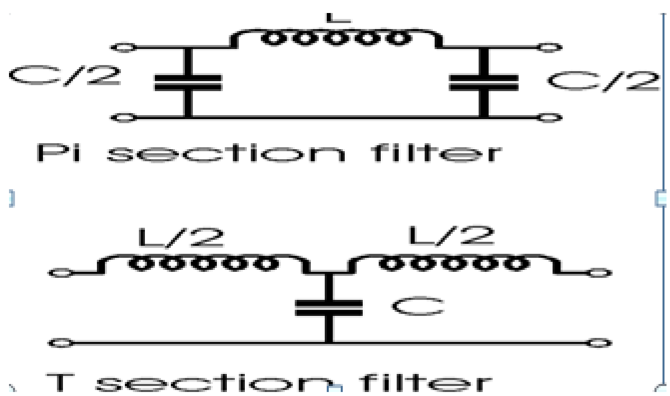

Fig.1. Filter

series and another filter or smoothing capacitor, C2, connected across the load, RL. A filter of this sort is designed for use at a particular frequency, generally fixed by the AC line frequency and rectifier configuration. When used in this service, filter performance is often characterized by its regulation and ripple. Low pass filters are used in a wide number of applications. Particularly in radio frequency applications, low pass filters are made in their LC form using inductors and capacitors. Typically they may be used to filter out unwanted signals that may be present in a band above the wanted pass band. In this way, this form of filter only accepts signals below the cut-off frequency.

4. OPERATION

The proposed converter is shown in , along with a normal direction of currents through the elements. It consists of a coupled inductor and switched capacitor voltage extension cells. A voltage extension cell is comprise of two switched capacitors $C1$ and $C2$ and charging diodes $D1$ and $D2$, respectively. Output diode Do have similar function of an output diode of a normal boost converter. In coupled inductor is

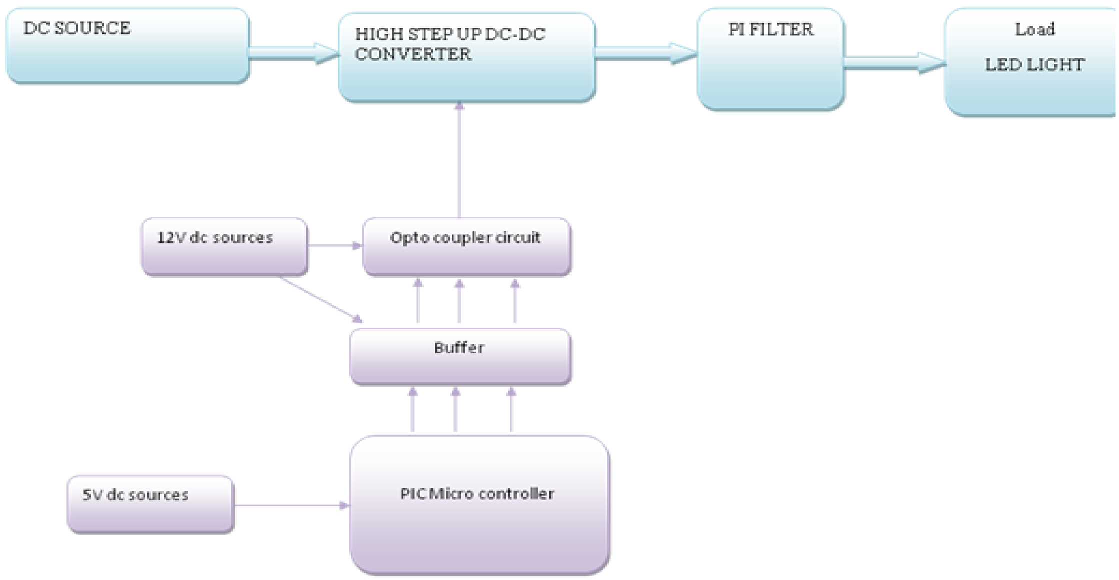

Fig.2. Block diagram

represented by its equivalent transformer model, where Lm and Lk represents the magnetizing and leakage inductance of the coupled inductor referred to the primary. Auxiliary switch SAUX and clamp capacitor Cc formthe active clamp circuit. For the analysis of the converter, all the switches and other elements are considered to be ideal except the leakage inductance of the coupled inductor and parasitic drain-to-source capacitance of the MOSFET switches (Cr). Key waveforms of the converter are given . In the key waveforms $Vg1$ and $Vg-$aux are the gate signals for the main and auxiliary switches. Steady-state operation of the proposed converter can be divided into eight modes. Simplified equivalent circuit for each mode are given below.

5. RESULT ANALYSIS

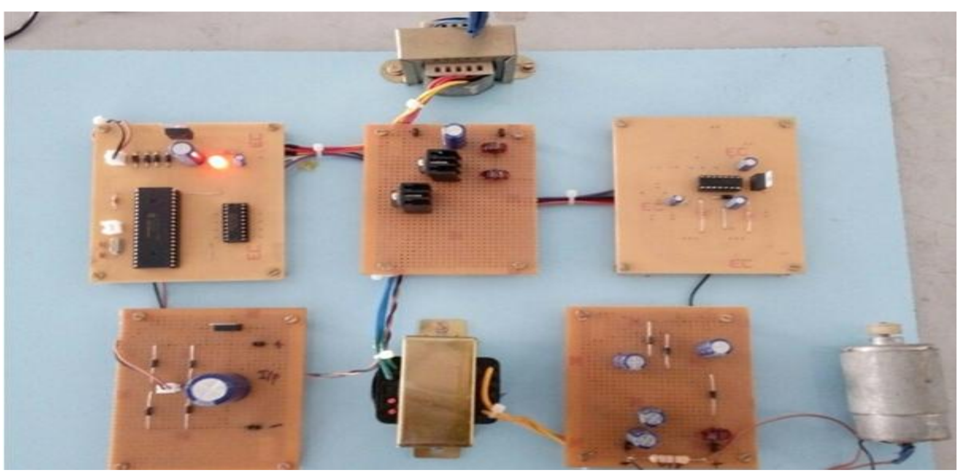

Fig.3.Hardware structure

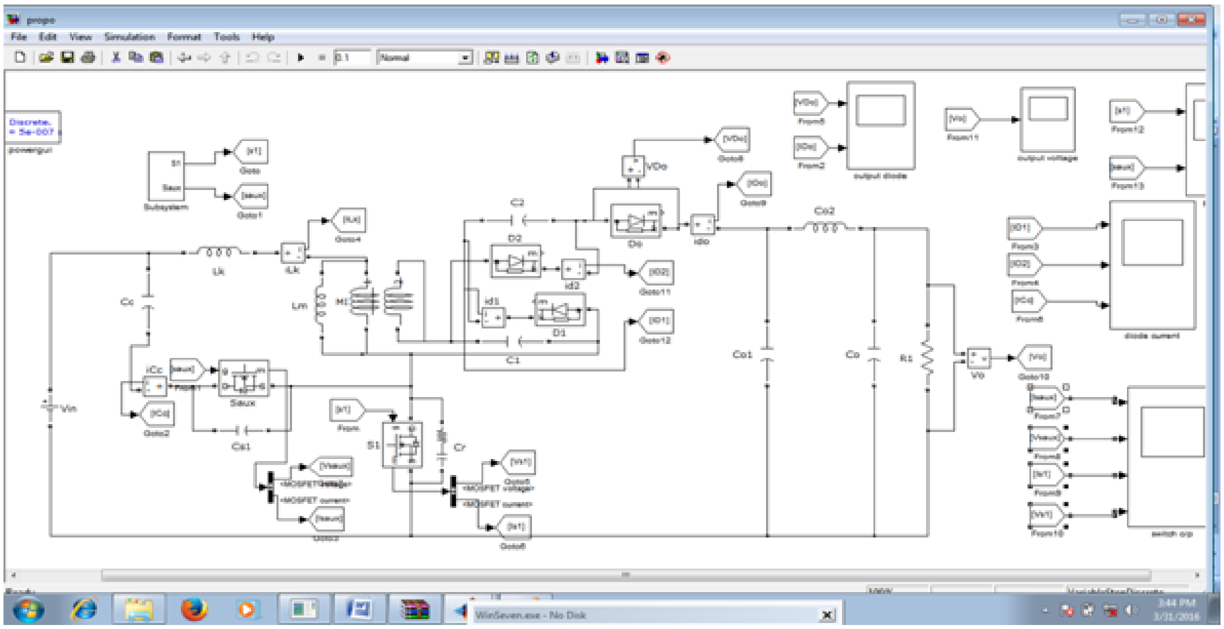

Fig.4.Simulation analysis

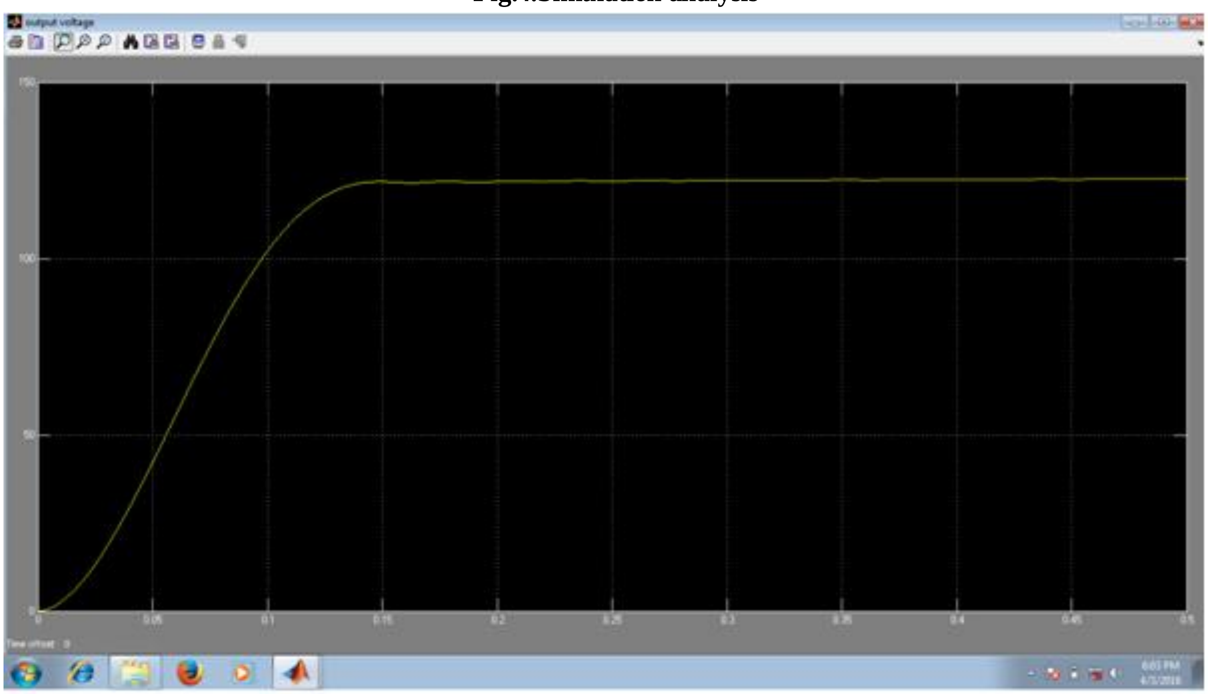

Fig.5.Output analysis

Thus we see that the conduction losses in the IGBT and MOSFET depend on R_d and D, in addition to V_{ce}, I_O and D. Also, as mentioned in the previous section, the turn-off power loss also depends on □D: the larger the, the lower the losses. To validate this, we constructed a simulation model of a buck converter in PSpice . The output filter and load was replaced by a current source assuming that the buck converter operates in continuous conduction mode. With D=0.8 and F_s=50 kHz, repeated simulations were performed with different values of T_d. Figure 5 shows the effect of T_d on the losses. As expected, the IGBT loss reduces but the MOSFET loss increases with increasing T_d. The total loss (IGBT plus MOSFET) thus first decreases with T_d, reaches a minimum and then increases slightly with further increase in T_d. It is important at this point to note also that when the total loss is near minimum, the IGBT and MOSFET losses are equal.

CONCLUSION

A high voltage gain soft-switched coupled inductor converter was presented for low-voltage energy sources. The proposed converter has high voltage conversion ratio, which can further increase by properly selecting the turn's ratio of the coupled inductor. Moreover it is able to obtain high voltage gain with reduced voltage stress on MOSFET switches and output rectifier diodes. This helps to select the active switches of low voltage rating. In addition to this, active clamp circuit is used to obtain ZVS turned on for the main and auxiliary switches. Active clamp also alleviates the voltage spike on the MOSFETs due to the leakage inductance. Leakage inductance of the coupled inductor helps to reduce the reverse recovery problems of the output diode. Finally,a laboratory prototype of the converter is built and tested to verify the theoretical results. From the experimental results, it can be seen that the converter is able to obtain high gain with good efficiency.

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