HIGH EFFICIENCY DC-DC BOOST CONVERTER FOR MODULE INTEGRATED PHOTOVOLTAIC APPLICATIONS

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Abstract
This project deals with high step-up high efficiency dc-dc converter for photovoltaic energy conversion. The proposed converter employs a coupled inductor and two voltage multiplier cells to achieve high step-up voltage gain. The operating principle and the steady-state analyses of voltage gain are described in detail. Comparing the results of C filter and PI filter is used to reduce the harmonics. Obtaining output voltage 400 V for 20-30 V input via MATLAB simulation. The maximum efficiency of the prototype is nearly 97.7% and the efficiency is higher than 97% over a wide load range.

Key Words: Coupled inductor, C filter, PI filter, voltage multiplier cells, high step-up voltage gain and maximum efficiency, MATLAB simulation.

1. INTRODUCTION

The previous method of photovoltaic system with module integrated converter is only used in medium and low power applications. In this method the string with centralized converter improved energy, low installation cost. The drawback of this method is it cannot be used for high power applications and it cannot be used for ac power application. Nowadays the power requirement is very high. So now we are get the power from the different power plants. His power plants are using the coal, uranium as fuel. but these fuels are not renewable source and it pollute the atmosphere also .so In focusing future the power are produced by renewable source only and maximum amount of energy produced by sunlight. The power produced by this is only by photovoltaic effect. The photovoltaic effect is first observed by Alexander Edmond at 1839. The photovoltaic effect refers photons of light existing electrons into higher state of energy, allowing them is act as charge carriers for an electric current.

The solar cell produced the direct electricity from sun light which can used power equipment or recharge battery. Nowadays the majority photovoltaic modules are used in grade connected power generation. The photovoltaic power generation employs number of solar cell contain photovoltaic material. The power produced from the PV panel based on the size of the panel. If we required more power, the size of panel will panel will increased. So reduced the size of the panel we are using integrated high step-up converter. In this integrated high step-up converter will have coupled inductor, voltage multiplier circuit. In this coupled inductor and voltage multiplier circuit will boost the power produced by the panel. This power dc so we need to convert this power to dc. To reduce the harmonics we are using the C filter and PI filter .so this system will used for both ac and dc power applications.five operating modes in one switching period of the proposed converter. Figure 1 shows the circuit diagram of proposed converter and Figure 3 and 4 presents the operation modes, briefly described as follows

2. CIRCUIT DIAGRAM

The high efficiency coupled inductor integrated dc-dc boost converter is shown in figure 1. It works in continues conduction mode and discontinues conduction mode. The following conditions are assumed to simplify the circuit analysis: all the capacitors are large enough that their voltage can be considered constant in one switching period; the power devices are ideal; the leakage inductance of the coupled inductor is small; and n = N2/N1.
3. OPERATING PRINCIPLE OF THE PROPOSED CONVERTER

A. Continuous-Conduction Mode (CCM) Operation

In CCM operation, there are five operating modes in one switching period of the proposed converter. Figure 2(a) shows the key waveforms and Figure 3 presents the operation modes, briefly described as follows:

1) Mode I (t₀ – t₁):

In this mode, presented in Figure 3(a), the switch S₁ was turned on for a span. Because the magnetizing inductor Lₘ and the leakage inductor Lₖ are charged by the input voltage source Vᵢ, both the magnetizing current Iₘ and leakage current iₖ increase gradually in a linear way. The voltage vₙ across the secondary winding of the coupled inductor and the voltage V₁ are connected in series to charge the capacitor C₂ through the switch S₁ and the diode D₁. At the same time, the voltage vₙ also charges the capacitor C₃ through the diode D₃. Thus, since vₙ is charging C₂ and C₃, the magnitude of the secondary current i₂ decreases gradually. Moreover, because the diode D₆ is blocked, the load Rₒ is sustained by the capacitor Cₒ. This mode ends when the switch S₁ is turned off.

2) Mode II (t₁ – t₂):

At the time t = t₁, the switch S₁ is turned off and diode D₁ is turned on to conduct the current Iₖ of the leakage inductor. Then, the capacitor C₁ is charged by the voltage source Vᵢ and the energy previously stored in the leakage inductor Lₖ. Because of that, the diode D₂ is cut off, as illustrated in Figure 3(b). On the other hand, the capacitor C₃ continues being charged by the voltage vₙ through the diode D₃ and the capacitor Cₒ keeps providing energy to the load Rₒ. This mode ends when the current iₖ becomes equal to the current iₘ, i.e., when the current i₂ becomes null.

3) Mode III (t₂ – t₃):

In the third mode, shown in Figure 3(c), the diode D₃ is turned off and the diode D₆ is turned on. Therefore, the primary and secondary windings of the coupled inductor, the voltage source Vᵢ and the capacitors C₂ and C₃ are providing their energy to the capacitor Cₒ and the load Rₒ. Furthermore, the capacitor C₁ continues being charged by the energy stored in the leakage inductance Lₖ. This mode ends when the current i₂ becomes equal to the current iₖ, taking the current at the diode D₁ to zero.

4) Mode IV (t₃ – t₄):

During this time interval, presented in Figure 3(d), the diode D₁ is initially turned off, hence, only the diode D₆ is turned on. Therefore, the primary and secondary windings of the coupled inductor, the voltage source Vᵢ and the capacitors C₂ and C₃ are still transferring their energy to the capacitor Cₒ and the load Rₒ. This mode ends when the switch S₁ is turned on.

5) Mode V (t₄ – t₀):

At the time t = t₄, the switch S₁ is turned on. Because the rising rate of the current iₖ is limited by the leakage inductor Lₖ, the switch S₁ is turned on under zero-current switching (ZCS) and this soft switching property is helpful for alleviating the switching loss. Furthermore, secondary winding of the coupled inductor and the capacitors C₂ and C₃ remain providing energy to the capacitor Cₒ and the load Rₒ as shown in Figure 3(e). This mode ends when the current iₖ becomes equal to the current iₘ, making the operation to return to mode I.
Fig 2. Key waveforms of the proposed converter at (a) CCM and (b) DCM operation

Fig 3. Operation modes of the proposed converter at CCM operation: (a) Mode I, (b) Mode II, (c) Mode III, (d) Mode IV and (e) Mode V.

B. Discontinuous-Conduction Mode (DCM) Operation

In DCM operation, there are also five operating modes in one switching period of the proposed converter. Figure 2(b) shows the key waveforms and Figure 4 presents the operation modes. In comparison with the CCM operation, only the mode V is different: at the time $t = t_4$, the energy of the magnetizing inductor $L_m$ is depleted, therefore the diode $D_o$ is cut off and the capacitor $C_0$ provides energy to the load $R_o$; this mode ends when the switch $S_1$ is turn on.
4. SIMULATION RESULTS AND DESCRIPTION

In order to investigate the proposed three-level modulation technique, MATLAB simulation is carried out at 320 W output power and output voltage of 400 V with 30 V as input. The coupled inductance is designed. The waveforms switching pulses, output voltage, output power waveforms under MATLAB simulation is given below.

Fig. 4. Operation modes of the proposed converter at DCM operation: (a) Mode I, (b) Mode II, (c) Mode III, (d) Mode IV and (e) Mode V.

Fig. 5 Simulation diagram of proposed converter

Fig. 6 Output of Solar

Fig. 7 Switching Pulses &Vds

Fig. 8 Output Voltage
In the above table conventional and proposed converter output voltage and power are compared. Proposed converter produces output voltage of 400V and output power of 320 W for 30V input.

In table 2 C filter and PI filter output are compared. Voltage ripple is reduced as 0.005V with the usage of PI filter.

5. CONCLUSION

The high step-up high efficiency dc-dc converter for photovoltaic energy conversion is designed. The proposed converter employs a coupled inductor and two voltage multiplier cells to achieve high step-up voltage gain. The operating principle and the steady-state analyses of voltage gain are described in detail. Then a C filter and PI filter is used to reduced the harmonics and these are results are compared. Obtaining output voltage 400 V for 30 V input via MATLAB simulation. The maximum efficiency of the prototype is nearly 97.7% and the efficiency is higher than 97% over a wide load range.

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