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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.

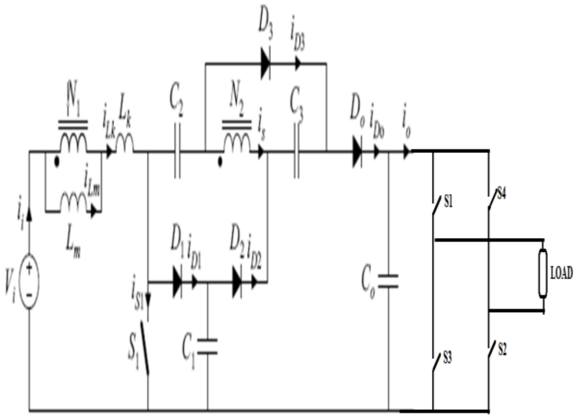

Fig 1.Proposed high efficiency boost converter

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 ($t_0 - t_1$):

In this mode, presented in Figure 3(a), the switch S1 was turned on for a span. Because the magnetizing inductor L_m and the leakage inductor L_k are charged by the input voltage source V_i, both the magnetizing current I Lm and leakage current i_{Lk} increase gradually in an linear way. The voltage v_{L2} across the secondary winding of the couple inductor and the voltage V_{C1} are connected in series to charge the capacitor C_2 through the switch S1 and the diode D1. At the same time, the voltage v_{L2} also charges the capacitor C_3 through the diode D_3. Thus, since vL2 is charging C_2 and C_3, the magnitude of the secondary current i_2 is decreased gradually. Moreover, because the diode D_o is blocked, the load Ro is sustained by the capacitor C_o. This mode ends when the switch S_1 is turn off.

2) Mode II ($t_1 - t_2$):

At the time t = t1, the switch S1 is turned off and the diode D_1 is turned on to conduct the current I_{Lk} of the leakage inductor. Then, the capacitor C_1 is charged by the voltage source V_i and the energy previously stored in the leakage inductor L_k. Because of that, the diode D_2 is cut off, as illustrated in Figure 3(b). On the other hand, the capacitor C_3 continues being charged by the voltage v_{L2} through the diode D_3 and the capacitor C_o keeps providing energy to the load R_o. This mode ends when the current i_{Lk} becomes equal to the current i_{Lm}, i.e., when the current i_2 becomes null.

3) Mode III ($t_2 - t_3$):

In the third mode, shown in Figure 3(c), the diode D_3 is turned off and the diode D_o is turned on. Therefore, the primary and secondary windings of the coupled inductor, the voltage source V_i, and the capacitors C_2 and C_3 are providing their energy to the capacitor Co and the load Ro. Furthermore, the capacitor C_1 continues being charged by the energy stored in the leakage inductance L_k. This mode ends when the current i2 becomes equal to the current i_{Lk}, taking the current at the diode D_1 to zero.

4) Mode IV ($t_3 - t_4$):

During this time interval, presented in Figure 3(d), the diode D_1 is initially turned off, hence, only the diode D_o is turned on. Therefore, the primary and secondary windings of the coupled inductor, the voltage source V_i, and the capacitors C_2 and C_3 are still transferring their energy to the capacitor Co and the load R_o. 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 i_{Lk} is limited by the leakage inductor L_k, the switch S_1 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 C_2 and C_3 remain providing energy to the capacitor Co and the load R_o, as shown in Figure 3(e). This mode ends when the current i_{Lk} becomes equal to the current i_{Lm}, making the operation to return to mode I.

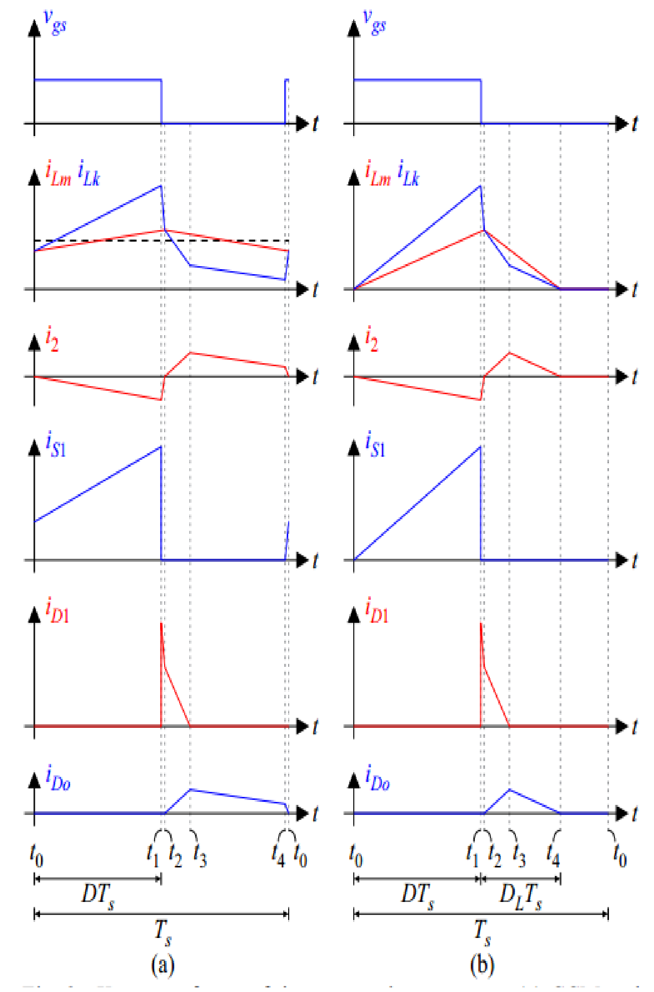

Fig 2. Key waveforms of the proposed converter at (a) CCM and (b) DCM operation

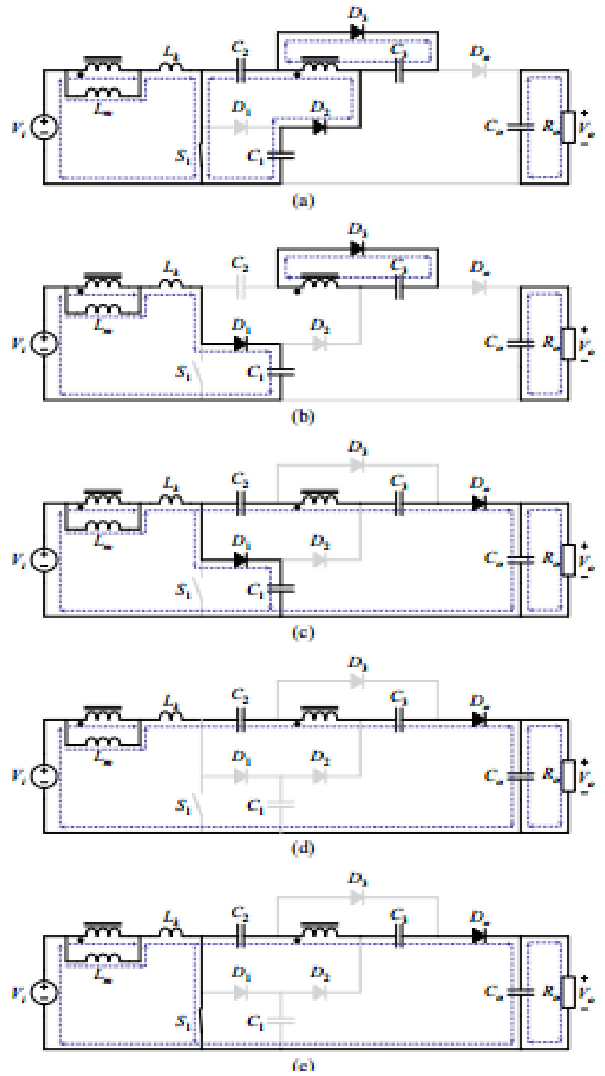

Fig. 3. Operation modes of the proposed converter at CCM operation: (a) Mode I, (b) Mode II, (c) Mode III, (d) Mode IV and (e) Mode V.

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 = t4, the energy of the magnetizing inductor Lm is depleted, therefore the diode Do is cut off and the capacitor Co provides energy to the load Ro; this mode ends when the switch S1 is turn on.

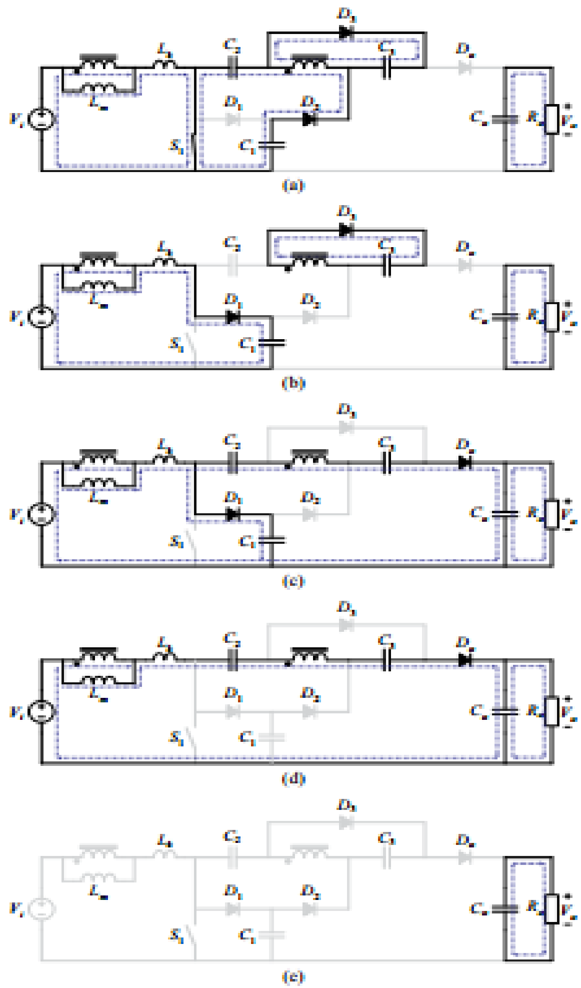

Fig. 4. Operation modes of the proposed converter at DCM operation: (a) Mode I, (b) Mode II, (c) Mode III, (d) Mode IV and (e) Mode V.

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 voltage as input. The coupled inductance is designed. The waveforms switching pulses, output voltage, output power waveforms under MATLAB simulation is given below.

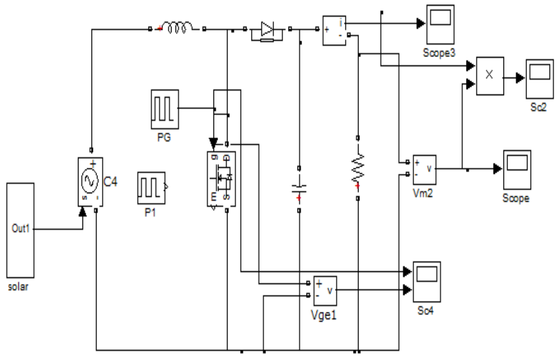

Fig.5 Simulation diagram of proposed converter

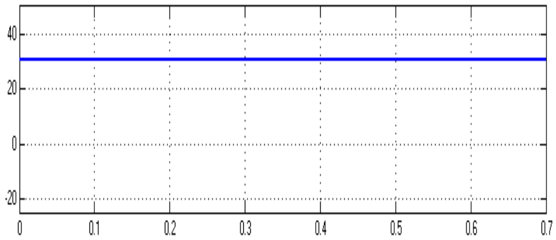

Fig.6 Output of Solar

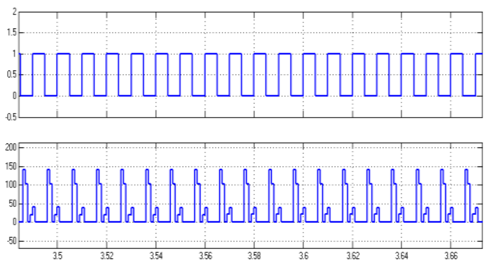

Fig.7 Switching Pulses &Vds

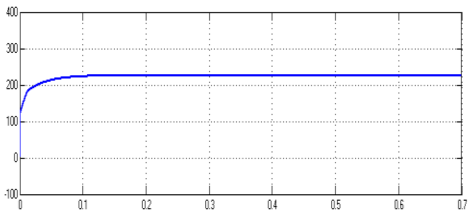

Fig.8 Output Voltage

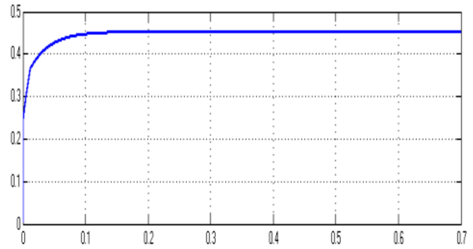

Fig.9 Output Current

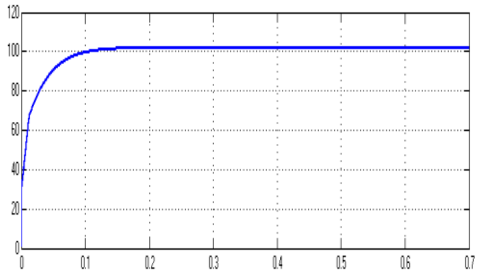

Fig.10 Output Power

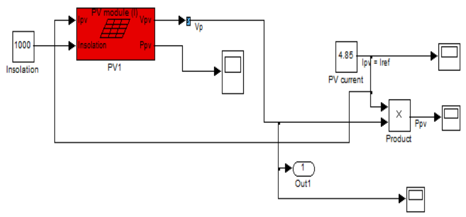

Fig.11 Solar Model

Table -1 comparison of output voltage & Output power

High step–up converter	Vin	Vo	Po
Conventional	30v	230v	105w
Proposed	30v	400v	320w

Table -2 comparison of output voltage ripple

High step–up converter	Voltage ripple
C-filter	0.01
Pi-filter	0.005

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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