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Flyboost Converter with PI Controller for High Voltage High Power Applications

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ABSTRACT:This paper presents a flyboost converter with PI controller for high voltage high power applications. The proposed converter composed with a conventional boost converter and flyback converter with a feedback circuit .Thus the higher gain converter can be achieved in the proposed flyboost converter by the summation of both the output voltages of boost and flyback converter**.** With the feedback circuit the output become smooth and ripple free.The conventional boost converter cannot realize high voltage step up due to the narrow allowed duty cycle.If high duty cycle is used in the boost converter,the nonlinear voltage conversion characteristics due to the parasitic resistance is difficult to regulate the output voltage. Cascade boost converters have proposed for non isolated circuit applications, but the main disadvantages are more components and difficult to control compared with conventional boost converter.

KEYWORDS: flyboost converter, cascaded boost converter, nonlinear,

I.INTRODUCTION

Recently high voltage step-up converters have been proposed for fuel-cell based DC converter, battery discharged DC converter in UPS system,car auxiliary power supplies, automobile HID headlamps , and medical equipment.The conventional boost converter cannot realize high voltage step up due to the narrow allowed duty cycle. If high duty cycle is used in the boost converter,the nonlinear voltage conversion characteristics due to the parasitic resistance is difficult to regulate the output voltage. Cascade boost converters have proposed for non-isolatedcircuit applications. Therefore the drawback of a conventional boost converter can be overcome by these circuit topologies for high voltage step up applications.but the main disadvantages are more components and difficult to control compare with the conventional boost converter.Generally fig1 shows the conventional boost converter circuit.If the switch is in "on" position, then there is a short circuit through the switch.If the load is disconnected during operation, then L continues to push power to the right and very quickly charges C up to a high value.

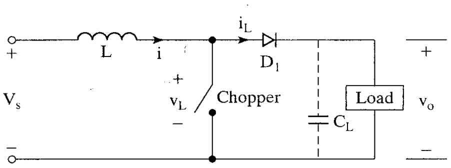

Fig1: conventional boost converter circuit

The low circuit efficiency, from which the high duty cycle operation for high voltage gain, can be improve with the cascade boost converter is shown in fig2.The votage gain of cascade boost converter is given by V_0=[V_s*(1/1-D)^2] where D is the duty cycle of power switch. The cascade boost converter seems to be improve an efficiency of boost converter but the main disadvantages are more components and difficult to control compare with conventional boost converter.

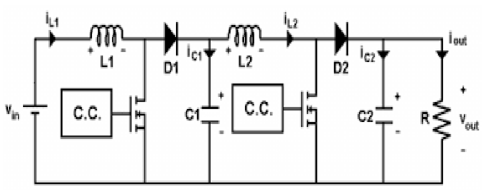

Fig2:cascade boost converter circuit

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II.LITERATURE SURVEY

In year 2004 F. Z. Peng, H. Li, G. J. Su and J. S. Lawler presented a new zvs bidirectional dc-dc converter for fuel cell and battery application. The proposed bidirectional dc–dc converter circuit consists of an inductoron the battery side and two half-bridges each placed oneach side of the main transformer. The main disadvantage of this system is the use of more number of components and different types of switching devices.In 2008 Julio C. Rosas-Caro, Juan M. Ramirez and Pedro Martin Garcia-Vite proposes a Novel DC-DC Multilevel Boost Converter.An Nx MVM can be built with two switches, 2N-2 diodes and 2N-2 capacitors, free of magnetic components. It is based on the multilevel converters principle and designed for unidirectional power transfer applicationsThe reduced number of switches is an advantage of this system .However the as the voltage level increases the number of switches and capacitors increases.A. Reatti proposes Low-cost high power-density electronic ballast for automotive HID lamp in 2000. The purpose of this paper is to present a high power-density and low-cost ballast circuit suitable for automotive applications. The main limitations of the single switch class E ZVS inverters are high rms currents and a high reverse voltage across the switch.

III.PROPOSED SYSTEM

The proposed system consist of a conventional boost converter and flyback converter with a PI controller.The output of the flyboost converter is the summation of boost converter and flyback converter. The block diagram of proposed system is shown in fig3.

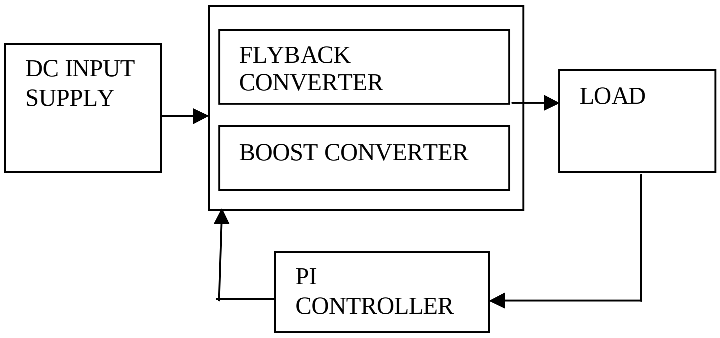

Fig3: Block diagram proposed system

The circuit configuration of proposed converter with high step up voltage gain is shown in fig4.There are two circuit sections in the proposed configuration to achieve a high voltage ratio .The conventional boost converter, consist of C_1,L_1,Q_1,D_1 and C_2 ,and flyback circuit, including L_2,$D_2$and C_3.They are connected in series in order to step up an output voltage with low duty cycle.

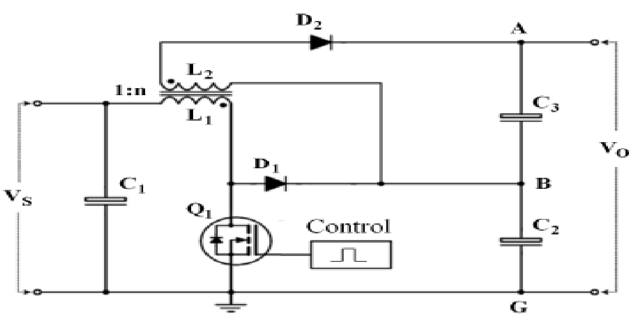

Fig4: Circuit diagram proposed system

In the boost converter section there are two modes of operation. In mode 1 switch is ON, the voltage across switch is 0V, and the voltage across inductor is input voltage (V_{in}).In mode 2 switch is OFF, the voltage across switch is V_0 and voltage across inductor is V_{in}-V_o. In the flyback converter section there are also two modes of operation.When switch ‘Q1’ is on, the primary winding of the transformer gets connected to the input supply with its dotted end connected to

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the positive side.At this time the diode 'D1' connected in series with the secondary winding gets reverse biased due to the induced voltage in the secondary.When Switch turns off, the current in the primary winding drops suddenly, the voltage across the primary winding reverses.The diode becomes forward biased.In order to design the proposed circuit the following equations are needed,

For a boost converter $\frac{VO}{Vin} = \frac{1}{1-D}$

The boundary inductance and the optimal output capacitance for a desired ripple voltage of conventional boost converter is equal to $L_b = \frac{(1-D_{min})^2 D_{min} V_O}{2 f_{sw} I_o}$

$C_O = \frac{D_{min} V_O}{R_O f_{sw} V_r}$

The primary current is,

$I_{peak} = \frac{2P_{out}}{\eta V_{in} D_{min}}$

Then, the primary inductance becomes

$L_{pri} = \frac{V_{in} D_{min}}{I_{peak} f_{sw}}$

Turns number of primary side of fly back converter can be determined by,

$N_P = \frac{V_{in} D_{min}}{B_{max} f_{sw} A_e}$

The secondary turns depend on a duty cycle and output voltage of converter and approximately determined by,

$N_s = \frac{V_O N_P}{V_{in} D_{min}}$

Hence, the high voltage output is equal to,

$V_O = (V_{in}/(1-D)) + (N_S V_S D)/(N_P)$

IV.RESULT OF SIMULATION

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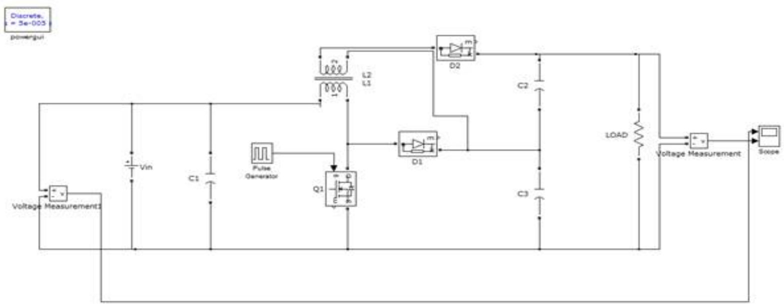

Fig4:Simulation model of flyboost converter without PI controller

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The simulation model of fly boost converter without PI controller is shown in fig4.It consist of input dc source ,input filter capacitance C1,primary inductance L1 ,secondary inductance L2,diodes D1 and D2, switch Q1,output capacitors C2 and C3.

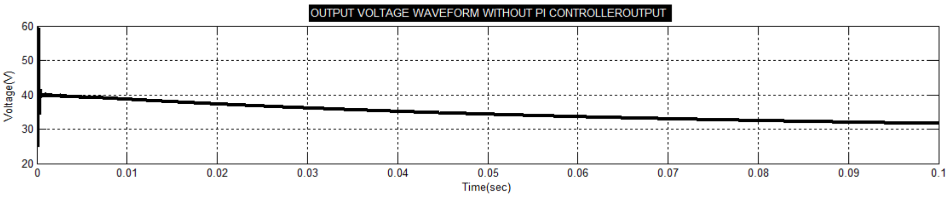

Fig5: Simulation result of flyboost converter without PI controller

Fig 5 shows the simulation result of fly boost converter without PI controller. Here the input to the system (Vin) is 12V.and the output is designed for (Vo) 42V.From the simulation result it is clear that the output is not constant .and at t=0.1sec the output voltage is about 31V.

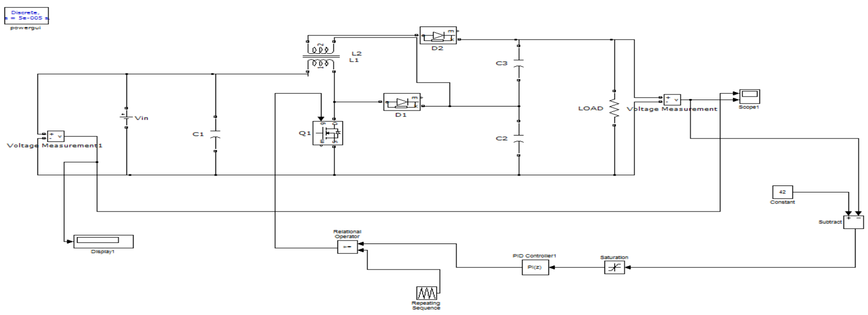

Fig6:Simulation model of fly boost converter with PI controller

Fig 6 shows the simulation model of fly boost converter with PI controller .It consist of conventional boost converter and flyback converter and PI controller. Here the reference is set as 42V.

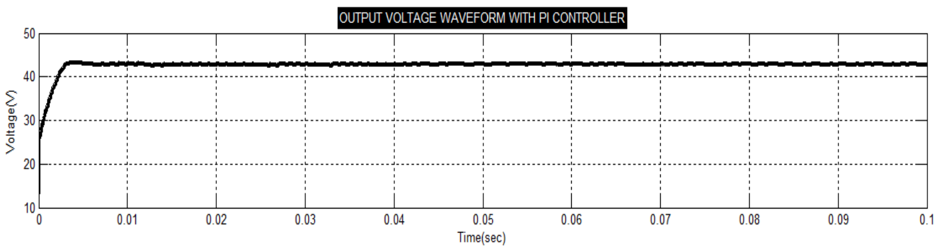

Fig 7: Simulation result of fly boost converter with PI controller

fig7 shown the simulation result of flyboost converter with PI controller.From the figure it is clear that with the addition of feedback system the output become constant and ripple free.

Name	C1	L1	L2	C2	C3	R0
Value	12 µF	22µH	80µH	2200µF	2200µF	50Ω

Table 1. The names and values of circuit component

Table 1 shows the names and values of components used for simulation. The table includes input capacitor ,inductors value ,and output capacitor ,load values

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V.HARDWARE IMPLIMENTATION AND EXPERIMENTAL RESULTS

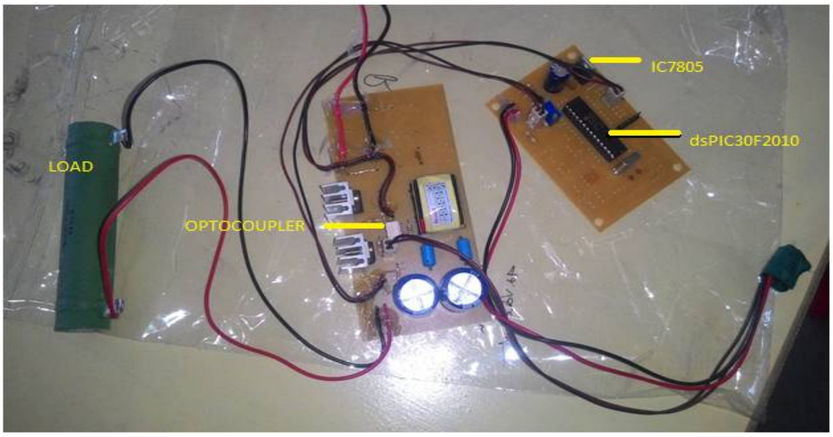

Fig 8: Hardware implementation of flyboost converter with PI controller

Fig 8 shows the hardware implementation of the proposed system. It mainly consist of two section. The first section is the converter section, which consist of C1 ,L1, L2,D1,D2,C2,C3 and switch Q1.The second section is the controlling section. In which dsPIC30F2010 controller is used .For isolation optocoupler is used .It also provide the function as mosfet driving circuit.

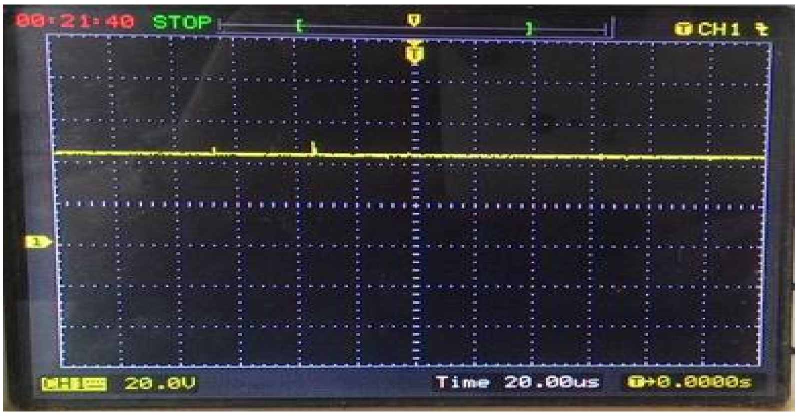

Fig 9:Experimental result of flyboost converter with PI controller

The experimental result of the proposed system is shown in fig9.It is clear from the figure that the output voltage is constant and ripple free.

Name	Specification
Switch	STP60NF06FP
Diode	HF04
Controller	dsPIC30F2010
Optocoupler	TL250
Voltage Regulator	7805

Table 2. The names and specification of circuit component

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Table 2 shows the names and specifications of components used for hardware implementation. Mosfet is used in the hardware implementation.dsPIC30F2010 is the controller used. for isolation and mosfet driving optocoupler is used.

VI. CONCLUSION

High voltage step-up converters have been proposed for many high voltage applications such as fuel-cell energy DC converter ,vehicle auxiliary power supplies, automobile HID headlamps, and battery charged discharged DC converter. To achieve a high step-up gain the boost converter should be operated at high duty cycle.With high duty cycle, a nonlinear voltage characteristic occurs and difficult to regulate a high output voltage of converter.Fly boost converter with PI controller produces a high output voltage ,which is constant and ripple free. The simulation result of the flyboost converter without feedback and with feedback are also shown for comparison. The hardware model is implemented for 42V ,35W with 12V input.

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