A SOLITARY SWITCH HIGH ADVANCED DC-DC CONVERTER BASED ON QUADRATIC BOOST

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Abstract: This paper presents function of a solitary switch high advanced dc-dc converter based on quadratic boost. The proposed converter has the simple structure low cost and ease of control. quadratic boost and switched capacitor is used as primary and secondary circuit, here for the connection coupled inductor is applied between them, so the converter achieves high step up voltage gain with appropriate duty cycle and reduction of voltage stress on the power switch moreover the energy stored in leakage inductance of coupled inductor is recycled to the output and stress on the input source is reduced, so input current of the converter is continuous. The main aim of this converter is to obtain at the same time high conversion ratio and excelling efficiency for a wide source voltage range. The dc voltage conversion ratio of these converters have a quadratic dependence on duty cycle Providing large step up and offering the possibility of higher switching frequency. Solitary switch Quadratic boost converter is presented and assessed using MATLAB/Simulink (MLS) with the SimPowerSystem block set and the results of simulations are presented to evaluate the behaviour and feasibility of the proposed topology. The circuit is reproduced with 24v information voltage for a yield voltage of 400v. The activity of the proposed framework has been discovered attractive.

***Index Terms* - Quadratic boost converter, high voltage gain converter, MOSFET, MATLAB/Simulink (MLS).**

I. INTRODUCTION

In recent decades, environmental concerns and depletion of fossil fuels have made great interest toward Renewable Energy Sources (RES). A portion of these sources are Fuel Cell (F.C.), Photovoltaic (PV) and wind vitality. The output voltages of these sources are low. So as to get high voltage, By combining the components of two boost converters by using single switch which improves the switching frequency and output voltage of the converter Quadratic boost converter proposed two stage boost converter with single switch topology [1].

So as to get high voltage, customary PV string compose inverter utilize arrangement association with various modules to acquire higher dc connect voltage to the fundamental power through a dc-ac inverter. In spite of the fact that this design is valuable as far as framework checking and repair the incomplete shading, module confuse, and dc association link misfortunes are inescapable issues and prompt Altogether decreased framework vitality yields the ac, modules Which has been acquainted with enhance these issues [2].

So Therefore dc-dc boost converter is utilized for enhancing voltage pick up. Regular lift converter can't give such a high dc voltage increase notwithstanding for an extraordinary duty cycle, it’s also May results in serious reverse recovery problem can be solved by high efficiency high voltage gain converter with coupled inductor [3].

In electric vehicle application[4] where the input power is low voltage source, such as battery, and the required output is high dc voltage there is need to develop a high power density boost dc-dc converter dual converter is introduced for low voltage application which gives reduced switch current stress ,extended duty cycle and a wide input voltage range.

Many non-isolated topologies have been researched to achieve high conversion ratio and avoid operating at extremely high duty cycle, these converter includes the switched capacitor types [5], switched inductor types [6], the voltage doubler circuits, and the voltage lift types, all of them can present higher voltage gain the conventional boost converter resulting in high cost and complex circuit.

To achieve a high conversion ratio without operating at extremely high duty ratio, some converters based on transformer or coupled inductor[7] have been introduced , the conventional fly back converter[8] is usually adopted for achieving high voltage gain by adjusting the turn ratio of the transformer. Anyway the spillage inductor of the transformer may not just aim high voltage spikes on the power gadget, yet in addition prompt vitality misfortunes.

The regular zeta converter gives either a stage up or advance down capacities to the yield, in a way like that of the buck boost or SEPIC converter [9] topologies.

As the turn proportion of the coupled inductor is expanded to broaden the voltage transformation proportion, the information current swell end up bigger. In order to satisfy the extremely high step-up application and low input current ripple a cascaded high step up dc-dc converter was introduced [10].
By falling two distinct converters being a quadratic advance up converter and receiving voltage multiplier accomplish additional proportion of voltage change with proper obligation proportion and low turn proportion of the coupled inductor the quadratic converter performs extensive voltage proportion yet little compelling obligation proportion [11].

Quadratic converters operate basically two conventional converter in cascade therefore to reach soft commutation such converters usually use two commutation cell quasi resonant converters provide zero current switching (ZCS) or (ZVS) and therefore they can operate at high frequencies[12].

[13] In DC-to-DC converters applications requiring high conversion ratios, elementary PWM topologies must operate with a duty cycle α close to one. Thus, on the one hand the regulation range is very low and on the other hand the switching frequency is limited by the off times of the controllable switch. Moreover, in the case of step-up converters, high conversion ratios are achieved for values of α close to one which correspond to an operating area where the efficiency is lower. This can be avoided with a new family of DC-to-DC converters using only one controllable switch and three diodes and whose conversion ratio has a quadratic dependence on duty cycle α.

Quadratic boost is an interesting topology because its voltage gain is the function of quadratic of duty cycle; however, the voltage stress on the active switch is equal to output. In a quadratic boost converter using coupled inductor and diode–capacitor techniques are presented. These topologies reach the object of extreme high voltage gain without larger turn ratio and duty cycle. In my work, a solitary switch high advanced dc-dc converter based quadratic boost is exhibited. The proposed converter utilizes coupled inductor and exchanged capacitor methods.
The proposed converter has higher output voltage gain in comparison of other converters based on quadratic boost. Some properties of proposed converter are:
1) The quadratic boost converter is effectively extended to a voltage conversion ratio and the first boost stage is also benefited the input current ripple reduction.
2) A clamped capacitor is embedded in the path of switch to clamp the voltage across the active switch. So R_{DS} (ON) of the active switch is alleviated. Furthermore, increasing output voltage is another advantage of the clamped capacitor existence.
3) The spillage inductor vitality of the coupled inductor can be reused, which lessens the voltage weight on the dynamic switch, and furthermore the transformation productivity is fundamentally moved forward.

II.WORKING PRINCIPLE OF THE PROPSED CONVERTER

A proportionate circuit arrangement of the proposed converter is appeared in Fig. 1.This converter consists of quadratic boost as primary and switched capacitor as secondary part. Quadratic boost includes an inductor L_1, two diodes D_1 and D_2, a capacitor C_1, and the primary side of coupled inductor Lp with Np turn. Likewise exchanged capacitor incorporates diodes D_3 and D_4, and capacitors C_3 and C_4. These capacitors are charged in parallel and discharged in series; when the secondary side of the coupled inductor current is changed to positive, they are charging in parallel; conversely, when the secondary side of coupled inductor current is changed to negative, they are discharging in series. Finally, the proposed clamped circuit includes diode D_5 and capacitor C_2, capacitor C_1 of quadratic boost also helps C_2 to fix voltage on the active switch. It should be mentioned that the coupled inductor is replaced by leakage inductor L_k, magnetizing inductor L_M, and ideal transformer with Np turn as primary and Ns turn as secondary.

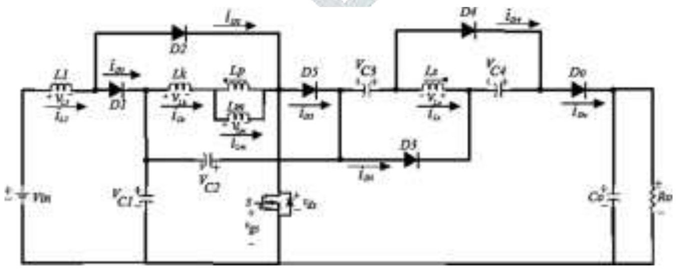


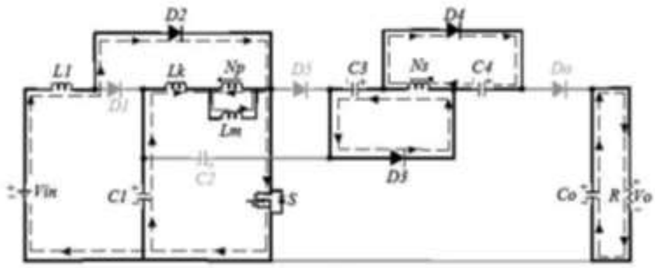
Fig. 1. A proportionate circuit arrangement of the proposed converter.

A few presumptions are considered for streamlining investigation of the proposed converter.1) Capacitors C_1, C_2, C_3, C_4, and Co are large enough. Thus, the voltages crosswise over them are thought to be steady in one time of exchanging. The input inductance L1 is assumed to be large enough so that iL_1 is continuous.
2) The switch is considered to be ideal and dissipations of
The power devices are neglected.
3) The coupling coefficient of the coupled inductor k is equal to Lm/ (Lm +Lk), and the turn ratio n is equal to Ns /Np. The equivalent series resistance of capacitors and parasitic resistance of the coupled inductor are neglected.

CCM Operation

The waveforms of proposed converter are shown in detail in Fig. 3, and the ways of streams are shown in Fig. 2 and the proposed converter can be analysed in CCM mode as follows:

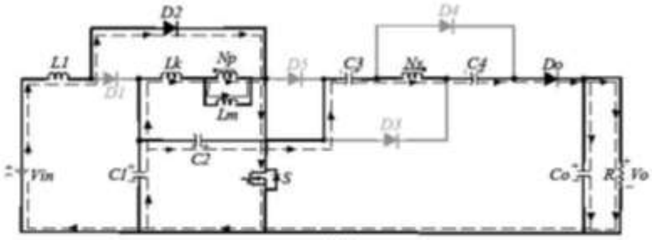
1) **Mode I** [t_0, t_1]: Amid this mode switch s is turned on diodes D_2, D_3, and D_4 are directing. Lm is exchanging its vitality to C_3 and C_4 by auxiliary side of the coupled inductor. Lm is exchanging its vitality to C_3 and C_4 by auxiliary side of the coupled inductor. C_1 exchanges its vitality to the primary so I_{LK} is expanding. Fig.2 a. shows the current stream way in mode 1.
The diode D_1 is reverse biased by Vc_1 meanwhile L_1 charged by Vin through D_2 and s. the diode current I_{D3} and I_{D4} are decreasing, Co transfers its energy to the load and this modes ends when decreasing I_{LM}=I_{LK} at t_1 .



(a)

Fig.2 a. current stream way in mode 1

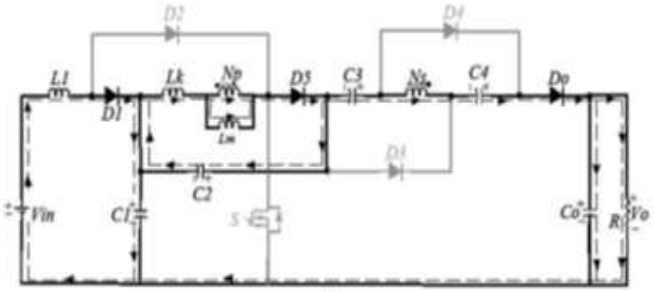
2) **Mode II** [t_1, t_2]: Amid the mode2 switch s is as yet directing, diodes D_3 and D_0 are leading and D_1, D_3, D_4, D_5 are not leading. Capacitors C_1, C_2, C_3 and C_4 are associated in arrangement with auxiliary side of windings N_S and exchanges their vitality to the R_o and C_o. Fig.2 b. shows the current stream way in mode 2 clamped capacitor C_2 exchanges its vitality to the C_O and Ro. Meanwhile Vin releases its energy to the L_1 through D_2 and S. C_1 discharges its Parts of vitality to Lm and L_k. Currents I_{do} and Ins are increasing and I_{c1} is decreasing. This mode finished when switch is turned off at t_2.



(b)

Fig.2 b. current stream way in mode 2

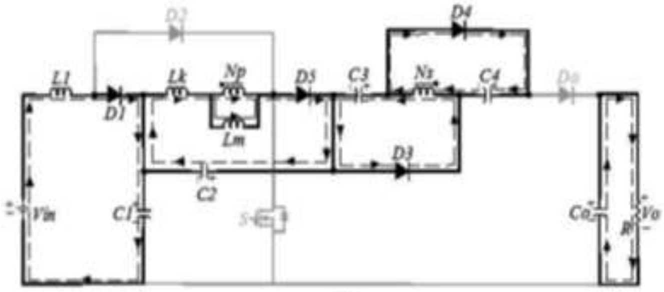
3) **Mode III** [t_2, t_3]: Amid the mode 3 switch S is not conducting or switch s is turned off and the diode D_1 is conducting because I_{L1} is continuous and the diode D_2, D_3, D_4 are reverse biased. Diode D_5 and D_o are biased leakage inductance L_k transfers its energy to clamped capacitor C_2 through D_5 and C_1 is charged by Vin through L_1 and D_1. Capacitors C_3 and C_4 realises their energy the C_o and R_o throughout D_O. Fig.2 c. shows the current stream way in mode 3. I_{LK} and I_{NS} decreases instantly and magnetising current I_{LM} increases. Mode 3 ends when I_{LNS} equals to zero at t_3. The voltage over the switch S is the summation of voltage of qudratic boost capacitor Vc_1 and voltage clamped capacitor Vc_2.



(c)

Fig.2 c. current stream way in mode 3

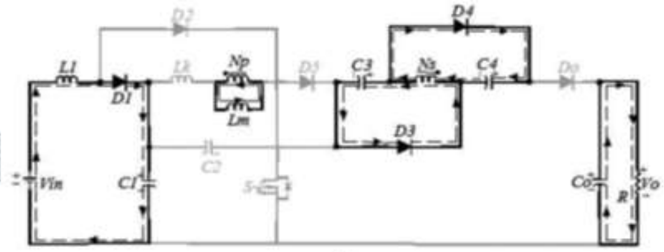
4) **Mode IV** [t_3, t_4]: Amid the mode 4 switch S is still not conducting like farmer mode. The diodes D_1, D_3, D_4 and D_5 are conducting or biased. Diodes D_2 and Do are not directing. The energy of magnetism current I_{Lm} transfer from secondary side of winding to C_3 and C_4 when I_{NS} is negative. L_k is continued to transfer their energy to C_2 by means of D_5. Fig.2 d. shows the current stream way in mode 4. I_{D5} and I_{LK} decreases immediately. C_1 is furthermore charged by input source Vin and L_1.The voltage across switch is same as mode 3. I_{LM} decreasing and I_{D3}, I_{D4} are increasing. This mode finished when I_{LK} =0.



(d)

Fig.2 d. current stream way in mode 4

5) **Mode V** [t4, t5]: Amid the mode switch S isn't directing. Meanwhile, diodes D_1, D_3 and D_4 are biased. Attraction inductor Lm is exchanges its vitality totally to C_3 and C_4 through the optional side of the coupled inductor. Fig.2 e. Shows the current stream way in mode 5. There is a path between Vin, L_1, and C_1, so that the C_1 is charged by input sources Vin and L_1. R_o is receiving its energy from C_o and the voltage stress on the switch is the same as previous mode. This mode is done when switch S is turned ON.



(e)

Fig.2 e. current stream way in mode 5

III.STEADY-STATE ANALYSIS OF THE PROPOSED CONVERTER

To simplify the analysis of the steady state of a converter, two modes II and V are considered.
The leakage inductor of the secondary side of the winding is neglected; as illustrated in Fig. 3, the following equations can be written by using voltage Balance on L1, Lp, and Ls :

$V_{C1} = (1/1 – D)Vin$ (1)

$V_{C3} = V_{C4} = (nkD/1 – D)V_{C1} = nkD/(1 − D)^2)Vin$ (2)

$DC = 2 (1 − D)/1 + n$ (3)

$Vc_2 = (D/DC)VC1 =(D(1 + n)/2(1 − D)2) Vin .$ (4)

As $V^{(II)}_{Ls}$ is calculated in mode II, $V^{(II)}_{o}$ is obtained as follows:

$Vo =(1/1 – D)Vin +(D (n + 1)/2(1 − D)^2)Vin +(2nkD/(1 − D)^2)Vin + (nk/1 – D)Vin .$ (5)

So, converter gain will be:

$Mccm = n(2kD + D + 2k) + (2 − D)/2(1 − D)2 .$ (6)

Voltage gain of the proposed converter is higher than the similar topologies after D=0.4, so this converter is preferred to the other converters where high voltage gain is required.

IV.SIMULATION RESULTS

Simulation was obtained for a Solitary switch high advanced DC-DC converter using MATLAB/Simulink for input voltage24v, 50 Hz. Switching frequency have been provided using pulse generator. The scheme of block the diagram describing a solitary switch advanced dc-dc converter based on quadratic boost.

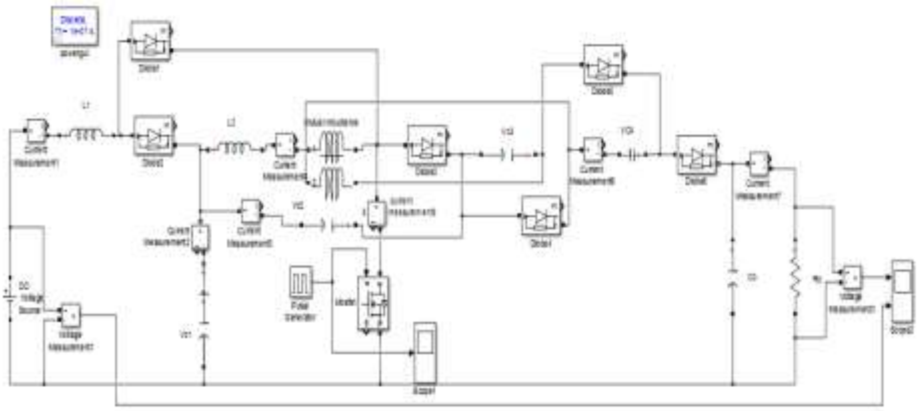


Fig .4. Simulation model of a solitary switch high advanced dc to dc converter based on quadratic boost.

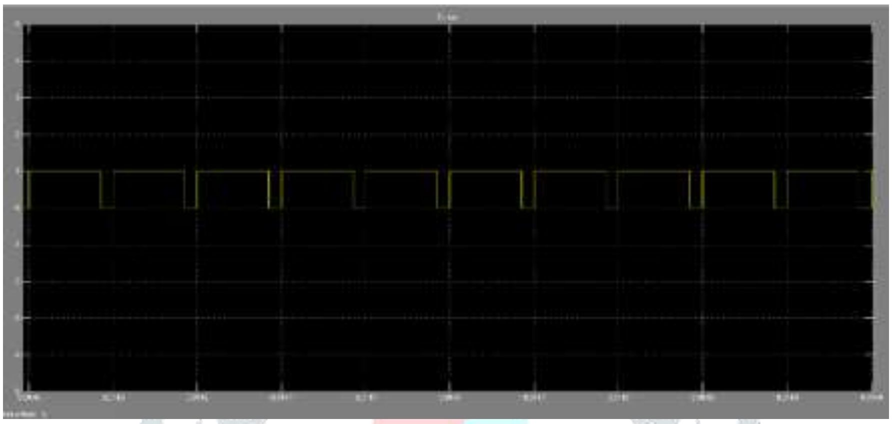


Fig. 5. Yield waveform of pulse generator

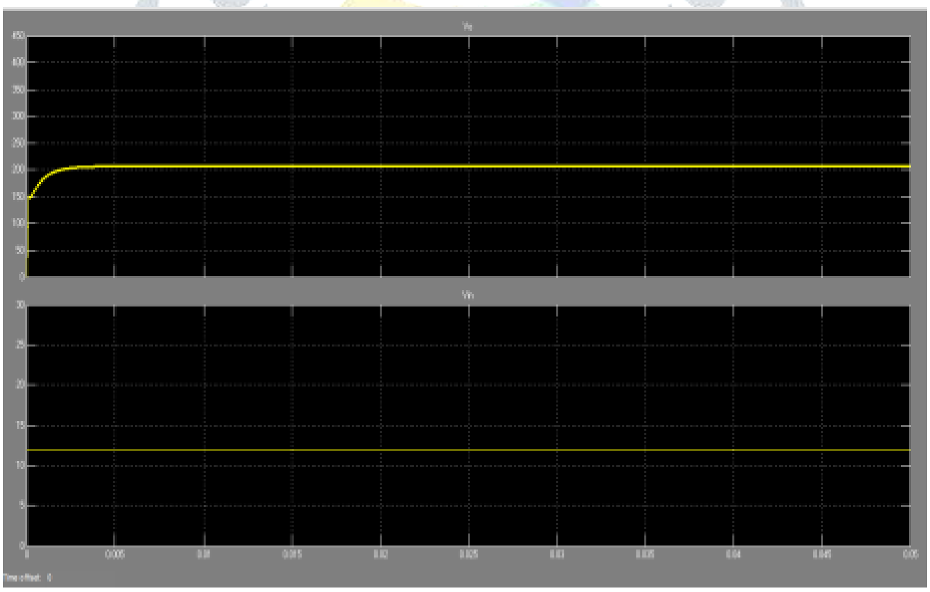


Fig. 6. Yield voltage at an input 12V

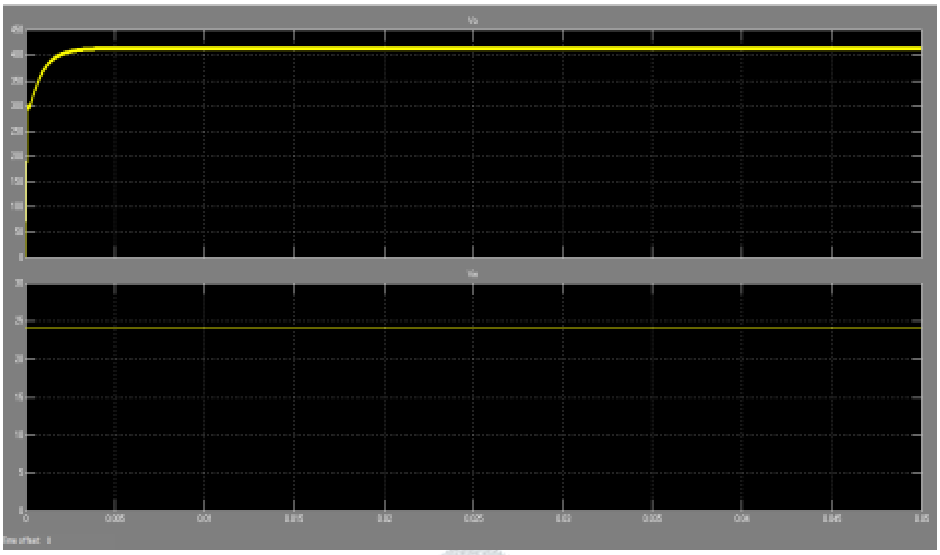


Fig.7. Yield voltage at an input 24V

V.CONCLUSION

In this work, modelling and simulation of a solitary switch high advanced dc to dc converter based on quadratic boost has been developed using MATLAB/Simulink [R2014a]. Simulation results were observed to confirm the predicted performance of the proposed topology. The developed simulation results are obtained for resistive load. Because, the resistive load has been used to reduce the complexities of the circuit. Under this loading condition, the converter's performance has been tested for an input voltage 24v and 12v then we observed an output voltage as 400v and 200v. The MOSFETs are used as the main power switching device due to its high power applications and fast switching frequency for fine control.

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