DESIGN AND ANALYSIS OF BOOST CONVERTER WITH CLD CELL

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Abstract

In this paper, the output voltage in renewable energy sources is improved by using DC-DC converter topology. Basically Boost converter is used for improving the voltage gain. In this converter switching frequency is limited, hence the output voltage is reduced. To overcome this issue, by using the boost converter with CLD cell is proposed .In this proposed paper for comparing the voltage stress and efficiency by using two converters topology. For the duty ratio of 0.5 the output voltage is compared with the conventional boost converter.

Keywords- Boost converter, Boost Converter with CLD, Voltage stress.

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1. INTRODUCTION

In recent years for a great number of appliances dc-dc converter topology is employed. Normally in renewable energy system,the system having low output characteristics to recover this demand DC-DC converter topology is implemented. For maintaining the dc output voltage range in PV array and fuel cells,converter can be used to improve the output voltage. But during the switching operation the voltage stress will be raised. While choosing the converter the concentrating features are;when switch is turn on it must attain the zero voltage crossing,when Photovoltaic array is connected to the grid the converter should provide the high terminal voltage for low input range. The converter which gives the high output range at low voltage stress is more efficient.Voltage gain generally based on the duty ratio hence by choosing the passive components the duty cycle ratio can be limited [7].

2. BOOST CONVERTER

Boost converter is used to step up the given voltage to the desired voltage. The input to this converter may be from any DC source like rectifiers,solar panel,battaries etc,. The circuit diagram for Boost Converter is shown below,
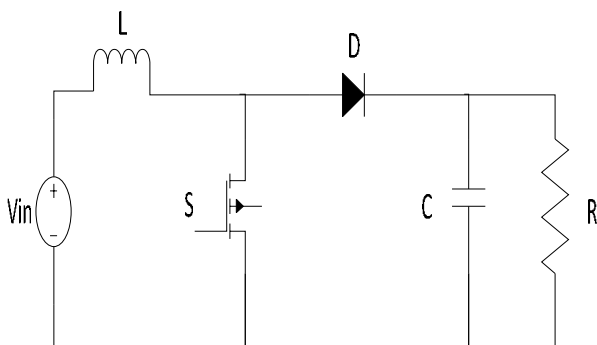

Fig-1: Circuit diagram for Boost converter Two modes of operations are there,

Mode 1:

When the switch S is closed the inductor gets charged through the supply voltage and stores the energy. In this mode inductor current increases gradually, but we assume that the charging and the discharging of the inductor are linear. The diode blocks the current flowing and so load current remains constant which is being supplied due to the discharging of the capacitor.
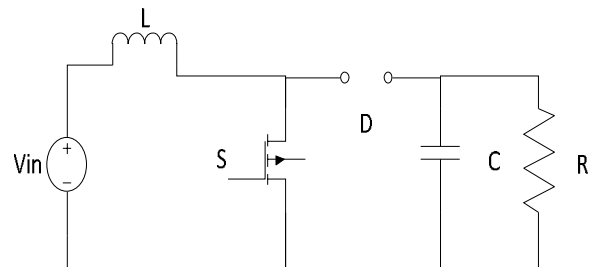

Fig-2: Circuit Diagram for Mode 1 Operation

Mode 2:

When the switch S is open, the diode becomes forward biased. The energy stored in the inductor changes it polarity todischarge through diode and charge the capacitor. Now, the capacitor supplies voltage to load.The load current remains constant throughout the operation.
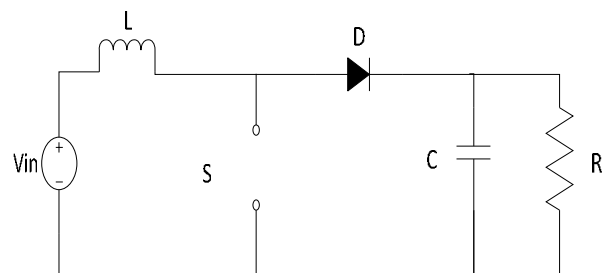

Fig-3: Circuit Diagram for Mode 2 Operation

2.1 Output Equation for Boost Converter

The voltage-current relation for the inductor L is,

$$i = \frac{1}{L}\int_0^t V dt + i_0 \text{ Or } V = L\frac{di}{dt} \qquad \dots\dots \quad \dots (1)$$

When the switch is turned on,

$$\Delta i = \frac{(V_{in} - V_{Trans})T_{on}}{L} \qquad \dots\dots\dots \qquad \dots\dots (2)$$

When the switch is turned off,

$$\Delta i = \frac{(V_{out} - V_{in} + V_D)T_{off}}{L} \qquad \dots\dots\dots\dots \qquad \dots (3)$$

By equating the Δi , we can solve the V$_{out}$

$$V_{out} = \frac{V_{in} - V_{Trans}\delta}{(1-\delta)} - V_D$$

Neglecting the voltage drop across diode V_D and transistor V_{Trans},

$$V_{out} = \frac{V_{in}}{(1-\delta)} \qquad \dots\dots\dots\dots\dots (4)$$

2.3 Simulation results for boost converter

The Boost converter is simulated by using MATLAB 2013 and the circuit is shown in Fig.4. The input voltage given to the circuit is 10V and it works on 1 kHz switching frequency.Duty ratio (δ) is varied to boost the output voltage in desired value.
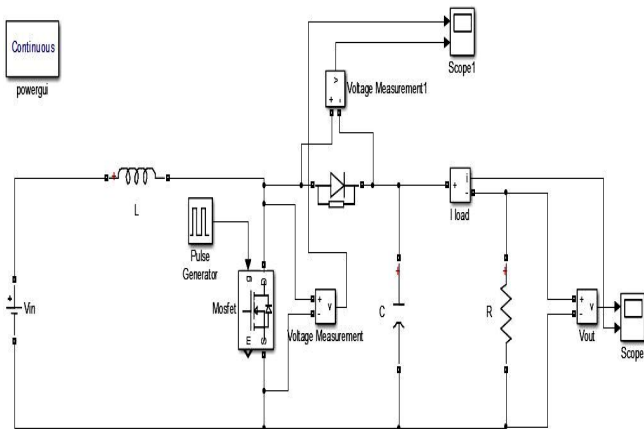

Fig-4: Simulation Circuit for Boost Converter

The inductor values for the converter is designed by using the formula given below,

$$L = \frac{(1-\delta)^2 \delta R}{2F_s} \qquad \dots\dots\dots\dots (5)$$

Where,

      δ = duty cycle
      R = load
      F$_s$ = switching frequency

The capacitor values are designed from the formula given below,

$$C = \frac{\delta V_o}{V_r R F_s} \qquad \dots\dots\dots\dots (6)$$

Where,

                V$_r$= Ripple voltage
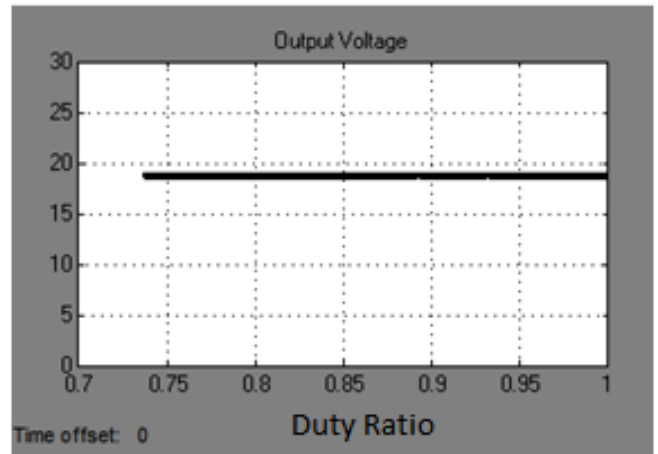
V$_o$ = Output Voltage

Fig-5: Output Voltage for Boost Converter

Theoretically, the switches are ideal so there are no losses in the circuit. But in simulation circuit switches are non-ideal, therefore losses will occurs in the output voltage Thus the comparison is shown in Fig.6
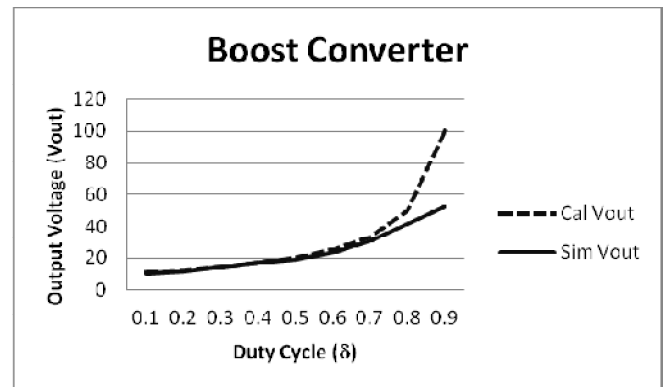

Fig-6: Calculated and Simulated Output Voltage for Boost Converter

3. BOOST CONVERTER WITH CLD

Boost converter is used to step up the given voltage to the desired voltage. By using CLD cell in boost converter the voltage stress on the switches can be reduced and can increase the capability to operate at high switching frequencies. The input to this converter may be from any DC source like rectifiers,solar panel,battaries etc,. Thecircuit diagram for Boost Converter with CLD cell is shown below,

Fig-7: Circuit Diagram for Boost Converter with CLD

Mode 1:

Boost converter is used to step up the given voltage to the desired voltage. By using CLD cell in boost converter the voltage stress on the switches can be reduced and can increase the capability to operate at high switching frequencies. The input to this converter may be from any DC source like rectifiers,solar panel,battaries etc,. The circuit diagram for Boost Converter with CLD cell is shown below,
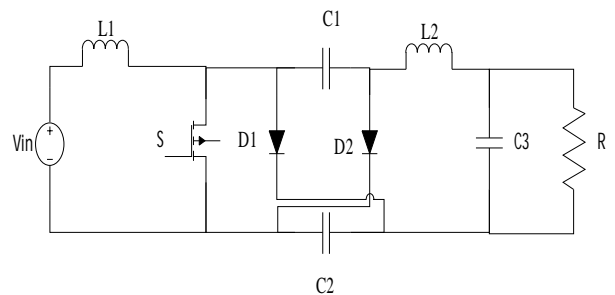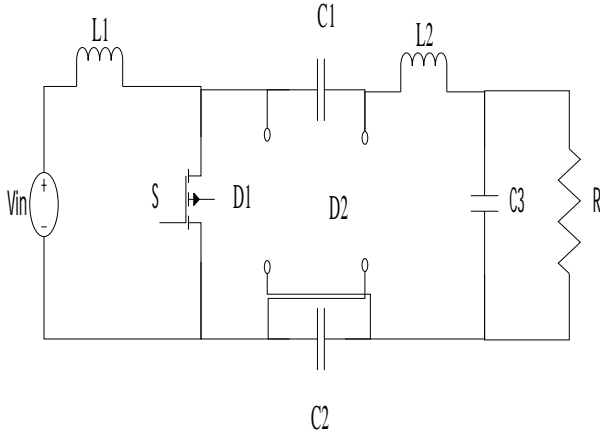

Fig-8: Circuit Diagram for Mode 1 Operation of Boost Converter with CLD

Mode 2:

The switch is open and so the diodes become conducted due to discharge of capacitors. The energy stored in the inductor gets discharged through opposite polarities which charge the capacitor. The load current remains constant throughout the operation.

Fig-9: Circuit diagram for Mode 2 operation of Boost converter with CLD

3.1 Equation Boost Converter with CLD

Through Fig.8, and Fig.9, By applying the volt-second balance law the inductor L1 and L2 will following in equation

$$V_{in}t_{on} + (V_{in} - V_{C2})t_{off} = 0 \qquad \text{........ (7)}$$

$$[2V_{c2} - V_o]t_{on} + [V_{c2} - V_o]t_{off} = 0 \qquad \text{.... (8)}$$

$$\frac{V_o}{V_{in}} = \frac{1+\delta}{1-\delta} \qquad \text{.. ..... (9)}$$

The value of inductor L$_2$calculated from the following equation,

$$L2 = \frac{\delta TR(\delta - 1)}{1+\delta} \qquad \text{..... ..... (10)}$$

The capacitor voltage V$_{c3}$is,

$$Vc3 = \frac{Vo}{1-\delta} \qquad \text{.... .... (11)}$$

3.3 Simulation Results for Boost Converter With CLD

The boost converter with CLD is simulated with the input voltage of 10V. The switching frequency used is 1 kHz. The simulation circuit diagram for the quadratic boost converter is given below in Fig 10.
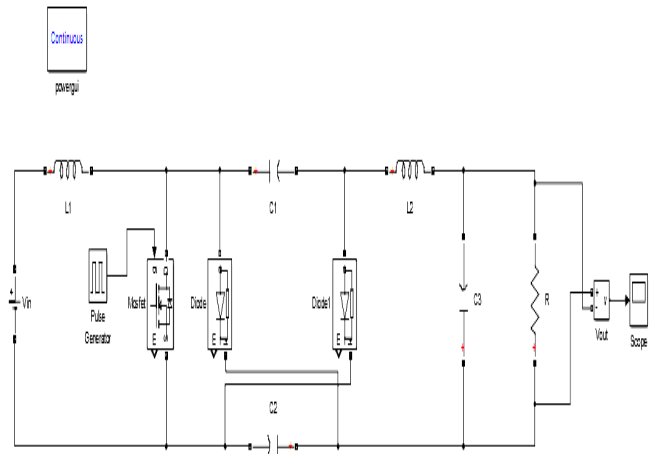

Fig-10: Simulation Circuit Diagram for Boost Converter with CLD

If V_S=10V, δ=0.5 the simulation output is 26V for the same input voltage.The simulation output of boost converter with CLD is shown below in Fig.11
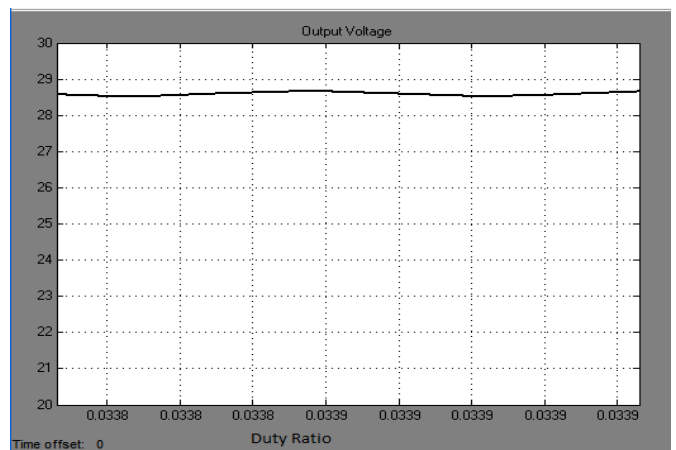

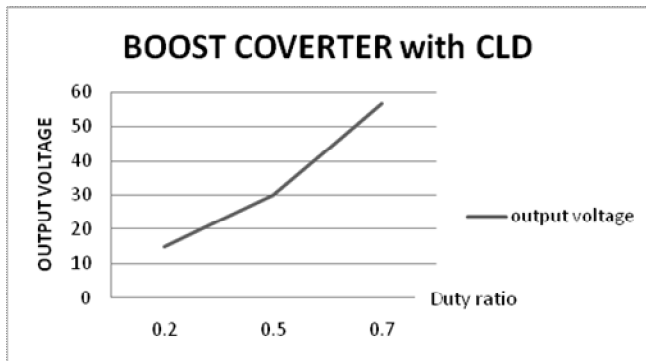**Fig-11:** Output Voltage of Boost Converter with CLD

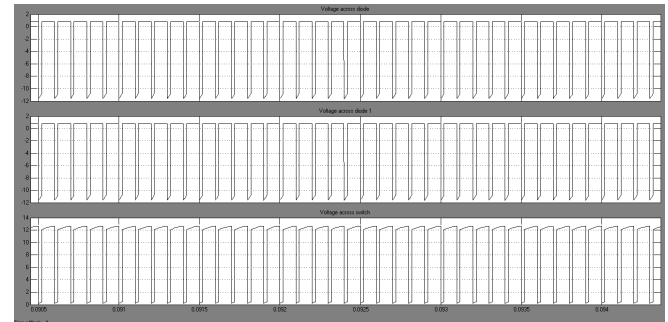**Fig-12:** Calculated and Simulated Output Voltage for Boost Converter with CLD

4. COMPARISON RESULTS

For Boost converter on the basis of theoretical and simulated output it is verified that for the input voltage of 10V the output get boosted only upto 20V at duty ratio 0.5.But in Boost converter with CLD for the same input voltage the output get boosted up to 26V for same duty ratio.

Table-1: Output Analysis of Boost Converter

Duty Ratio	Boost Converter				
	Input Voltage (V)	Input Current (A)	Output Voltage (V)	Output Current (A)	Efficiency
0.2	10	3	11.63	1.173	45%
0.5	10	7.5	18.91	1.891	48%
0.7	10	14.9	30.57	3.057	62%

Table-2: Output Analysis of Boost Converter with CLD

Duty Ratio	Boost Converter with CLD				
	Input Voltage (V)	Input Current (A)	Output Voltage (V)	Output Current (A)	Efficiency
0.2	10	2.9	13.13	1.313	59%
0.5	10	10	26.19	2.619	68%
0.7	10	27	41.92	4.192	70%

Table-3: Efficiency Comparison

Duty Ratio	Efficiency	
	Boost Converter	Boost Converter with CLD
0.2	45%	59%
0.5	48%	68%
0.7	62%	70%

Voltage stress on switches

The switching pulse is given to the switches to transfer the maximum output to the load from the given input. Whenthe switching pulse is given to the switches then there will be some stress on the switches due to frequent turn on and turn off. The stress on the switches is shown below in Fig.13.

Fig-13: Waveform For Voltage Stress On Switches

CONCLUSION

The comparison results shows that Boost converter with CLD cell have better voltage characteristics then the Boost converter.It also reduced the switching losses and voltage stress result will be a high efficiency. Hence the Boost converter with CLD cell is more convenient than the conventional circuit.

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BIOGRAPHIES

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