DESIGN AND ANALYSIS OF BUCK BOOST CONVERTER WITH MODIFIED TOPOLOGY FOR PV APPLICATION

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Abstract— Design of Two switch buck boost converter which will operate on PV system. The proposed converter is used between PV system and load. The converter can operate in both buck as well as boost mode. Changing its mode is possible by controlling gate signals of respective semiconductor switch. As we get the voltage as per requirement at the output of converter we overcome problem of variation in voltage from system. We can overcome the problem of the voltage variation of the electrical output from PV system. Eventually there have been much advancement in solar technology but the technological advancements are still needed for various renewable energy systems for different loading conditions. By using this TSBB convertor, we can get voltage as per requirement which is helping for distribution the electricity during any environmental condition. MATLAB simulated model with PV system followed by converter is presented. Design of converter is for variable input from PV system, according to input obtained output is varied between range of 12 V to 40 V. Position of two semiconductor switches is arranged in such a way that their source is directly connected to the ground leads to give broader selection range for gate driver IC. As in each mode we use only one semiconductor for switching purpose overall performance is improved.

Keywords—solar energy, buck converter, boost converter.

I. INTRODUCTION

The sun is one of the source of non-conventional energy power generation though there are some drawback of such system that when solar power is variable output which is changing as per rate of intensity of light naturally the o/p is also varying thus the grid power is variable so we can’t get constant voltage which can further process.to maintain the o/p voltage constant using buck & boost technology is presented. Developing local sources to meet our energy needs means that we import less fuel from other states, regions, and nations, thus our energy funds are plowed back into the local economy. solar energy can also help diversify the economies of rural communities and can generate jobs.

The concepts of renewable energy generation, connection between an energy storage system (ESS) and a DC line, the direct current (DC) micro grid, high volt- age direct current (HVDC) have been suggested as alternatives for existing power stations and alternating current (AC) lines [1], [2]. A DC-to-DC converter plays an essential role in a DC micro grid, and for an ESS and renewable power generating systems, such as wind power, tide power, and photovoltaic and geothermal power stations [3].A new approach of design of zero voltage source (ZVS) Buck-Boost converter, which acts as a resonant buck-boost DC-DC converters. The modelling of buck-boost converter is done; desired output simulation results along with the waveforms are presented. The auxiliary circuit that just consists of two inductors, capacitors and a diode is very simple in structure, and the cost is effective. The modes of operation of the circuit is analyzed and presented in detail. The converter was designed for 200W power rating and tested under different conditions. [4] Controlling of a single buck-boost converter to regulate the fuel cell output voltage. The implementation of this new method control is very easy. It regulates the output voltage perfectly and there is any unwanted switching between buck, and boost switches. The result shows that regulation is below 0.9%. these mode approaches overload and short circuit approaches easy too. [5] A new topology for two-switch buck boost converter to overcome power loss problems in the existing TSBB converter. The proposed converter can alternate from among three different basic DC-to-DC regulation modes: buck, boost and buck-boost. In this converter has fewer conduction and switching components than a conventional TSBB converter. Therefore, the overall tendency regarding this converter's efficiency is higher than that of the conventional TSBB converter. Also, converter has another advantage in that the source terminals for both the switches are directly connected to ground. This gives a circuit designer a broader selection range for the gate driver IC.[6] Several advantages include reduced switching losses by utilizing only half of the switches during each cycle and decreased conduction losses on power switches by minimizing the average inductor current. Thus, the regulated output and enhanced control accuracy are guaranteed during mode transition. Simulation results show that the output voltage drops is very small during the whole battery life time and the output transition is very smooth during the mode transition by the proposed BB control scheme.[7] There are three basic converters: buck, boost and buck- boost. Each single-switch buck, boost and buck-boost converter has unique advantages corresponding to input and load conditions of its own. A buck converter is basically a step-down converter and is relatively stable. A boost converter is step-up converter but has right- half-plane zero (RHPZ), and is thus rather unstable when the converter operates in continuous conduction mode (CCM). A buck-boost converter can satisfy either step-up or step- down needs, but has higher voltage stresses on semiconductors than buck and boost converters and also has RHPZ [8].

In single switch buck boost converter (with DC source), there are more voltage stresses due to only one semiconductor device.fig.1. In case of two switch buck boost

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converter (With DC source) more losses due to more conducting semiconductors.fig.2. In this paper, a new arrangement of switching devices for a two-switch buck-boost converter is presented along with PV system. The circuit diagram of proposed converter is shown in fig.3.

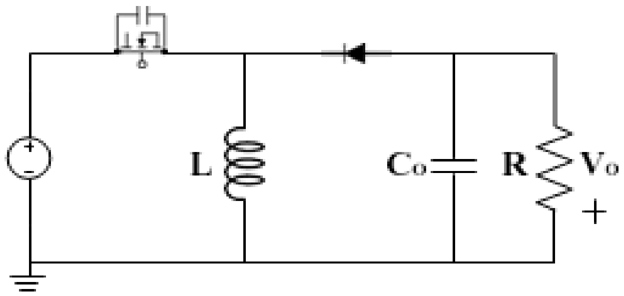


Fig.1.Circuit diagram of the single switch buck-boost converter with DC source.

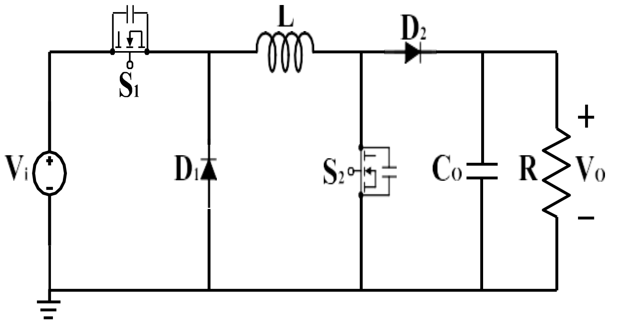


Fig.2. Circuit diagram of two switch buck-boost converter with DC source.

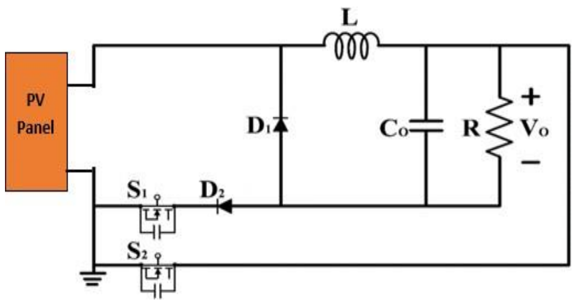


Fig.3. Circuit diagram of two switch buck-boost converter with PV system.

II. OPERATION METHOD

TSBB CONVERTER WITH PV SYSTEM

As shown in Fig. 3 two switch buck-boost converter can alternate from among two different basic regulation modes: buck and boost. Table I presents a control scheme to determine the converter's mode. When converter is connected to PV system there are only two current paths that inductor current flows through. One leads to the load, and the other to switch S_2. Therefore, the average inductor current is dependent on diode d_2, the duty cycle of switch S_2. The average inductor current is equal to $\frac{I_O}{1-d2}$ where I_O is load current. The current path of each mode follows basic buck and boost converter principles.

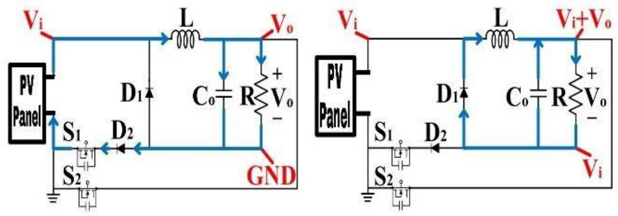
Table I. Control Scheme for TSBB Converter with PV System.

Sr. No.	Mode	Control Scheme
1	Buck	S_1: Switching S_2: Off
2	Boost	S_1: On S_2: Switching

According to Table I, in buck mode S_1 is switching and S_2 is off.in this case the second path which is through S_2 is interrupted and duty cycle of S_1 is control output voltage.in case of boost mode, S_1 is made on through constant supply to gate terminal and S_2 is use for switching. Here the output voltage is depending on duty cycle of switch S_2.

Circuit model base operation of two switch buck boost converter with PV system is discuss below. The input voltage from PV system is V_i.

I. BUCK MODE



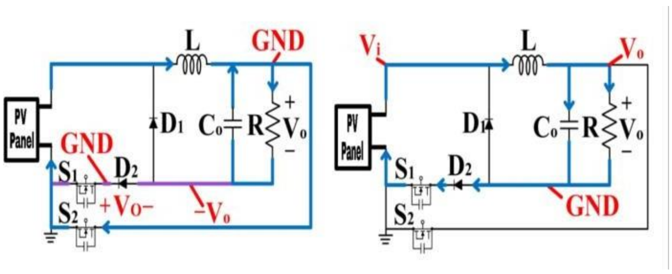
Subinterval-1 Subinterval-2

Fig.4.a) Buck mode

Subinterval 1- As switch S_2 is off it act as open circuit. In buck mode of operation first inductor charge with supply voltage. Total input voltage is appeared across load. The current complete its path through PV- L-Vo-D_2 -S_1 and back to PV system. Here diode D_2 is forward biased.

Subinterval 2- Only the energy stored in the inductor is appear across load. The voltage which is stored in inductor is appear across V_o which is obviously less than that of input supply from PV system. Therefore, output voltage we got is less than supply voltage such that satisfy buck operation.

II. BOOST MODE



Subinterval-1 Subinterval-2

Fig.4.b) Boost mode

Subinterval 1- In case of boost mode operation switch S_1 made on continuously and switch S_2 is use for switching as there are two paths for current one is through load and another is through switch S_2. Here we can control the voltage across the load by controlling switching of S_2. In this interval total input voltage from PV system is appear across the load.

Subinterval 2- In this case as switch S_2 is in OFF state diode D2 is forward biased and current complete its path through PV-L-V_O-D_2-S_1 and complete its path. The voltage appear across the load is now addition of input voltage and voltage stored in inductor hence satisfy boost operation.

III. SIMULATION WITH PV SYSTEM.

The simulated MATLAB model of converter with PV system is designed. The PV system is designed for 36W power output.as per 36W power output all the parameter values are inserted in PV MATLAB model. Similar model which operated on DC supply is presented [6].

At output of PV we connect our converter configuration with two switches connected to ground. As voltage of PV panel is not stable and vary with intensity of light this converter model try to satisfy buck as well as boost operation as per requirement.

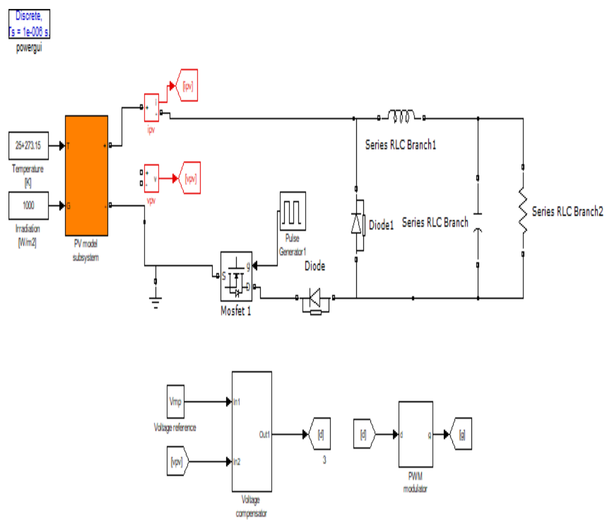


Fig.5 (a). Simulink model for buck mode.

For buck mode operation frequency of pulse generator is set to 100 kHz, which is connected to gate terminal of switch S_1. By varying duty cycle ranges from 0.3 to 0.5 we get respective changes in output voltage as per input voltage. The set of reading are discussed in section IV (buck mode).

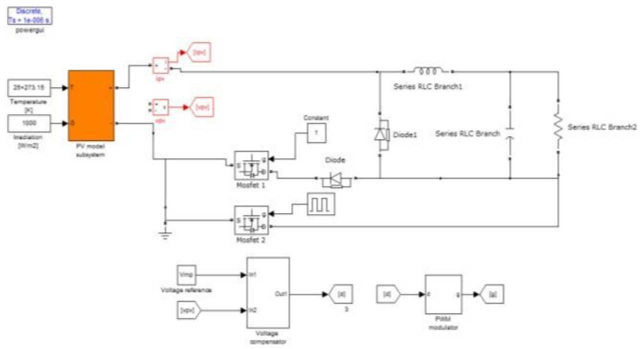


Fig.5 (b). Simulink model for boost mode.

Boost mode operation is performed by connecting gate terminal of switch S_2 with pulse generator having frequency 100 kHz.in this case switch S_1 is supply with constant as shown in fig 5(b). By varying duty cycle ranges from 0.6 to 0.8, we get respective changes in output voltage as per input voltage. The set of reading are discussed in section IV (boost mode).

The values of RLC component for MATLAB model are mention in table 2.

Table II. RLC Component for MATLAB Model

L	C	R
$250 * 10^{-6} H$	$820 * 10^{-6} F$	38

IV. OPERATION WITH DIFFERENT DUTY CYCLES

Table.III. Buck Mode

Duty Cycle (%)	Input Voltage (V)	Output Voltage (V)	Output Current (A)
50	25.79	7.655	0.2028
40	27.2	5.886	0.1563
30	28.34	3.84	0.1025

Table IV. Boost Mode

Duty Cycle (%)	Input Voltage (V)	Output Voltage (V)	Output Current (A)
60	21.06	49.35	9.544
70	21.01	66.05	1.739
80	10.05	44.86	1.181

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V. EXPERIMENTAL RESULT

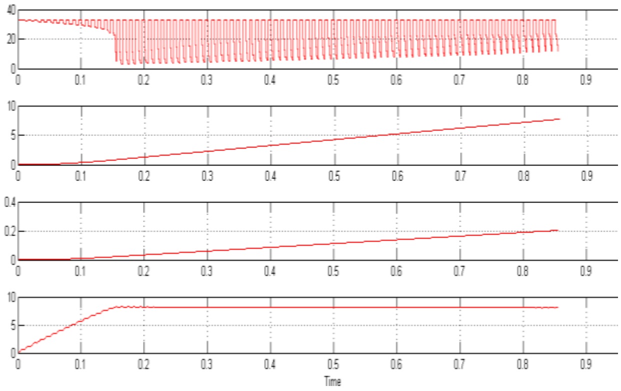

Fig.6 (a). Plot 1-Input voltage, Plot 2-Output voltage, Plot 3-Output current, Plot 4-Inductor current in buck mode operation.

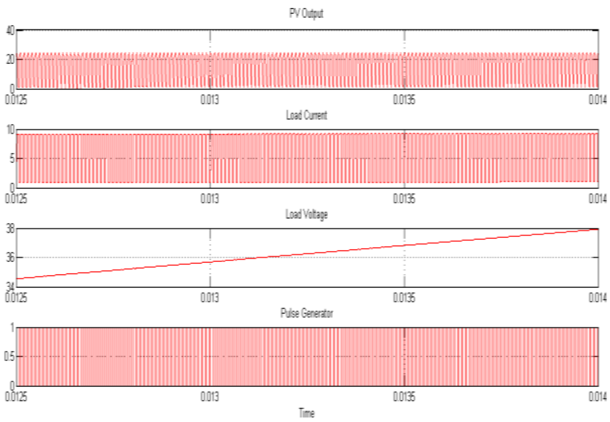

Fig.6 (b). Plot 1-Input voltage, Plot 2-Output voltage, Plot 3-Output current, Plot 4-Inductor current in boost mode operation.

VI. CONCLUSION

The MATLAB simulated of two switch buck boost converter provide voltage ranges as per requirement. The solar powered converter satisfy buck and boost mode operation as per gate controlled scheme discuss in this paper. As we use only one switch during each mode the overall performance of converter is observed to be improved.one of the advantage of connecting both the semiconductor switches directly to the ground is we get broader selection range for gate driver IC.

VII. FUTURE

Solar energy is play vital role in day to day life. The buck boost converter is useful for control voltage variation. Here we are interface solar power with system so the output voltage is we get as per requirement with the help of buck-boost converter. For extension we can use artificial intelligence control instead of PWM technique so that the output voltage becomes more constant and stable. We can use GSM technology to monitor the system output over mobile or computer.

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