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# A Pv Fed Buck Boost Converter Combining Ky And Buck Converter With Feedback

Anilkumar K K[1], Elizabeth Sebastian[2], George John P[3]
[1]*P.G Student, EEE Department, M A College of Engineering, Kothamangalam*
[2,3] *Professor, M A College of Engineering, Kothamangalam.*

**Abstract:-** As the demand for electrical energy is increasing, renewable energy sources has come into popularity especially photovoltaic systems (PV). PV can act as a voltage source which is feeding a power circuit. This study proposes a PV fed buck boost converter combining KY converter and synchronously rectifier converter. Both the converter uses same power switches. Basic circuit has no control loop, for more efficiency and to reduce harmonic distortion added a feedback controller. THD was reduced by 45%. Using the control loop, we can achieve the desired output. The transfer function analysis of such converter shows that it has no right half plane zeros, so that stability is increased. Since both the converter uses the same power switches correspondingly the cost is reduced and also the circuit is made compact. Simulation has been carried out to study the performance of the proposed topology in MATLAB/SIMULINK environment. Simulation results analysed and results presented for circuit.

**Keywords:-** Photovoltaic, Synchronous Rectifier converter, KY converter

## I. INTRODUCTION

The ever increasing energy consumption has created a booming interest in renewable energy generation systems, one of which is photovoltaic. Such a system generates electricity by converting the sun's energy directly into electricity. Photovoltaic systems [2, 3] can be integrated to portable electronic devices to power these systems. Portable electronics industry progressed widely during recent years. So the requirements of such converters such as low power consumption, small and cheap systems also increased. Also battery has large variation in output voltage. So additional equipments are required to convert these variable dc input voltage to constant dc output voltage. We are aware about several types of non-isolated buck boost converters such as Single Ended Primary Inductor Converter, Cuk converter, Zeta converter, Luo converter [5] and its derivatives. These converters operating in CCM, on taking the transfer function we can see that they have right half plane zeros. Due to these right half plane zeros their stability will be low. In order to avoid these problems a KY converter [6] has been proposed. But the KY converter has four power switches causing the cost to be high. Increase in the number of power switches also increase the switching losses.

Inorder to reduce the cost and the switching losses a new PV fed converter is proposed combining the KY converter and the conventional synchronously rectified buck converter [1] with a feedback. Thus the problem of increased number of power switches and also the switching losses are reduced. Also, comparing with other types of buck boost converters these converters have no right half plane zeros, improving the stability of the converter. These non-inverting converters have positive output voltage different from the negative output voltage of traditional buck boost converters. In the proposed buck boost converter the voltage boosting range is not so high, that is, the voltage across the two energy transferring capacitors $C_1$ and $C_2$ are both D times the input voltage, where D is the duty cycle. Analyses of Operating principles and switching functions are carried out and simulation results are presented.

## II. PROPOSED CONVERTER STRUCTURE

The proposed converter is fed from a PV cell. The buck boost converter combines the KY converter and the traditional SR converter [4]. A feedback circuit is provided so that the output can be changed according to the constant value. The proposed converter has individual output capacitor so that the converter has non pulsating output current.

### A. *PV Array Model*

The optimum power of the PV is useful for any purposes. Due to the various level of insolation, the power output of the PV varies instantly. The overall output of PV depends on the number of cells in the array, the total power is the contribution of each cell. So, by calculating the output of one cell, we may calculate the total output. The Fig .1 shows the equivalent circuit of a PV cell.

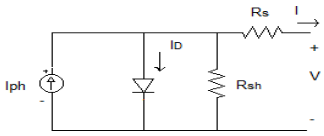



**Fig. 1 Equivalent circuit of a PV cell**

Using equivalent circuit, the nonlinear Vpv-Ipv characteristics of PV module is:

$$V_{pv} = \frac{1}{\lambda} \ln \left(\frac{Isc - Ipv + I_0}{Io}\right) - R_s I_{pv}$$

Where Isc is the cell short-circuit current, Io is the reverse saturation current, Rs is the series cell resistance, and λ is a constant coefficient and depends upon the cell material. Equation expresses a nonlinear relation between voltage current characteristic of a PV module. The PV array is formed by the combination of many PV cells connected in series and parallel fashion to provide the desired value of output voltage and current. This PV array exhibits a nonlinear insolation-dependent V-I characteristic, mathematically expressed consisting of Ns cells in series and Np cells in parallel as

$$V_A = -I_A \left(\frac{N_S}{N_P}\right) + \left(\frac{N_S}{\lambda}\right) \ln\left\{1 + \frac{NpIph - I_0}{NpIo}\right\}$$

**B. *Proposed Converter Topology***

Fig .2 shows the proposed PV fed converter combining SR converter and KY converter with a feedback circuit. The converter uses same power switches. The two power switches $S_1$ and $S_2$ along with inductor $L_1$ and energy transferring capacitor $C_1$ forms the SR buck converter. Also the two power switches $S_1$ and $S_2$ along with the power diode $D_1$, which is disconnected from the input voltage source and connected to the output if the SR buck converter, energy transferring capacitor $C_2$ and inductor $L_2$ and one output capacitor $C_0$ forms the KY converter. $R_0$ forms the output capacitor. The input voltage of the KY converter comes from the input voltage source during the magnetization period and the input voltage of the KY converter comes from the output voltage of SR converter during the demagnetization period.

$L_1$ and $L_2$ are both magnetised during the start-up period with $S_1$ ON and $S_2$ OFF. At the same time $C_1$ is charged so that the voltage across $C_1$ is positive and $C_2$ is reverse charged so that voltage across $C_2$ is negative. Also during start-up period with $S_1$ OFF and $S_2$ ON both $L_1$ and $L_2$ gets demagnetised. Since $C_2$ is connected in parallel with $C_1$, $C_2$ is reverse charged with the voltage across $C_2$ being from negative to positive, and finally, the voltage across $C_2$ is the same as the voltage across $C_1$

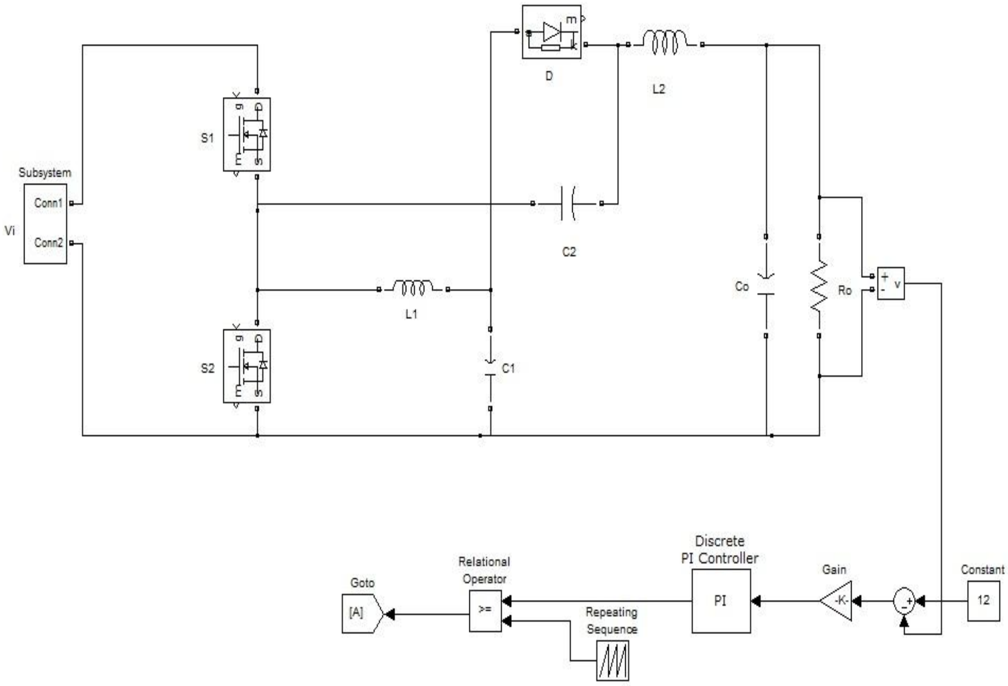



**Fig. 2 Proposed PV fed converter structure with feedback circuit**

## III. WORKING OF THE CONVERTER

The proposed system structure is derived from the conventional positive buck boost converter. All the components are considered to be ideal. The values of $C_1$ and $C_2$ are large enough to keep $V_{c1}$ and $V_{c2}$ constant. Thus the variations in $V_{c1}$ and $V_{c2}$ are small during the charging and discharging period. The voltages on $S_1$ and

$S_2$ are denoted by $V_{s1}$ and $V_{s2}$. The gate driving pulses for S1 and S2 are signified by $M_1$ and $M_2$. The voltage across the inductor is denoted by $V_{L1}$ and $V_{L2}$. The currents in $L_1$ and $L_2$ are denoted by $I_{L1}$ and $I_{L2}$. The turn-on type, as the converter inherently operates in CCM is (D, 1-D), where D is the duty cycle of the gate driving signal for S1 and (1-D) gate driving signal for S2. There are two modes of operation.

Mode 1: In mode 1, as shown in Fig. 2, $S_1$ is turned ON and $S_2$ is turned OFF. Energy for $L_1$ and $C_1$ are provided by input voltage.

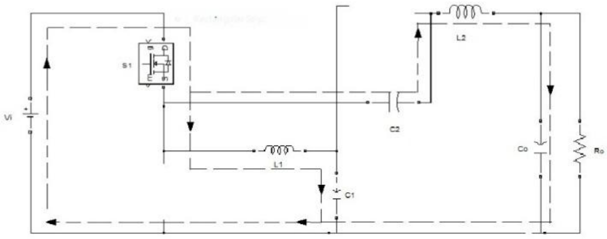



**Fig. 3 Current flow in mode 1.**

Hence voltage across $L_1$ is $V_i$ minus $V_{c1}$ so that $L_1$ gets magnetized and also $C_1$ is charged. The energy for $L_2$ and the output is provided by the input voltage and $C_2$. So the voltage across inductor $L_2$ is $V_i$ plus $V_{c2}$ minus $V_o$ causing $L_2$ to be magnetized and $C_2$ discharges.

Mode 2: In mode 2 as shown in Fig 3. $S_1$ is turned OFF but $S_2$ is turned ON. In this mode the energy stored in $L_1$ and $C_1$ is released to $C_2$ and output via $_{L2.}$

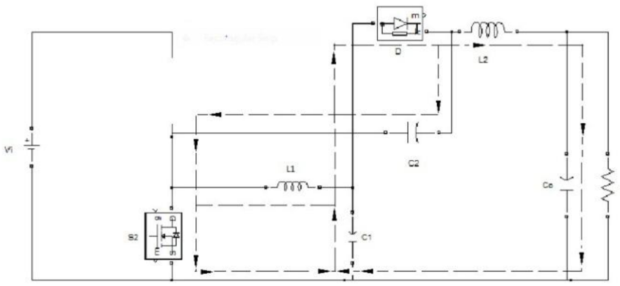



**Fig. 4 Current flow in mode2.**

Thus we get the voltage across $L_1$ as minus $V_{c1}$. This causes the inductor $L_1$ to be demagnetized and $C_1$ discharges also the voltage across $L_2$ is $V_{c2}$ minus $V_o$

## IV. SIMULINK MODEL

Fig. 5 shows the Simulink model of the circuit. . Parameters adopted in the simulation were $L_1 = L_2 =$ 600mH, $C_1 = C_2 =$ 470μF, Switching frequency= 200 KHz. PI controller is used in the feedback circuit. The output of the PI controller is compared with a repeating sequence to obtain the gate pulses.

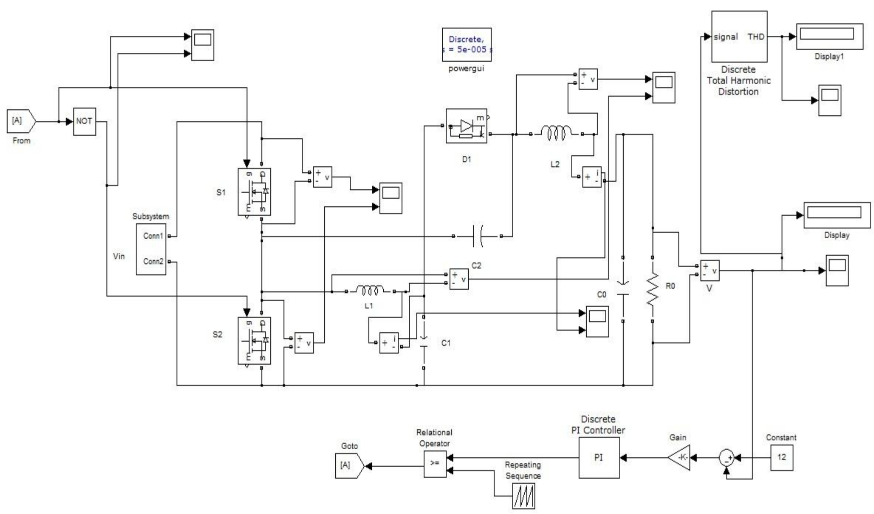
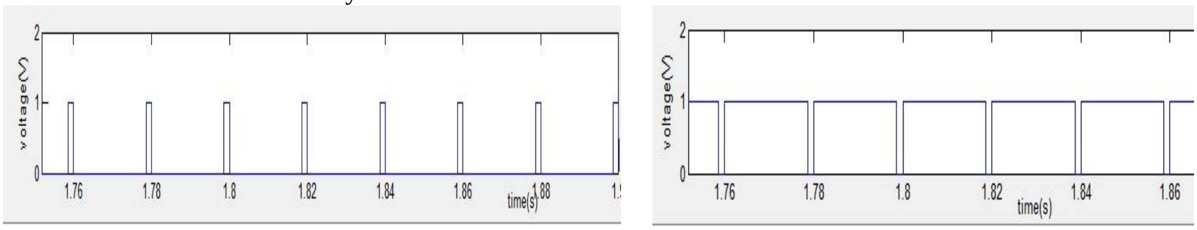



**Fig. 5 Simulink Model**

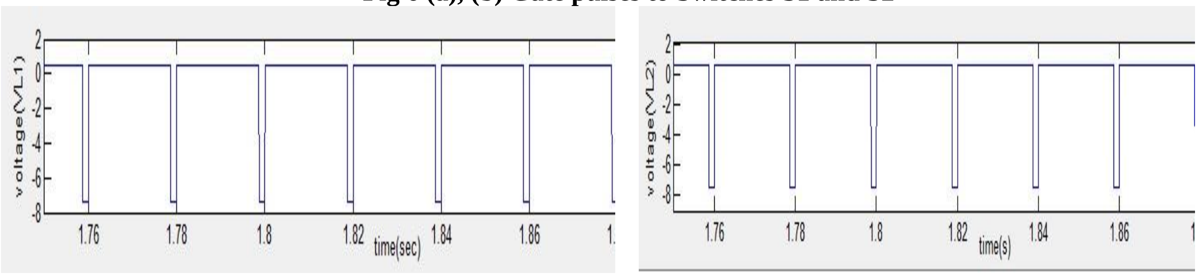
## V. SIMULATION RESULTS

The simulation result of the proposed PV fed Buck Boost converter combining KY and Buck converter with feedback has been simulated using MATLAB. The gate pulses were obtained from a PWM generator. Fig. 6 (a), (b) shows the gate pulses to the switches $S_1$ and $S_2$. The simulation results waveforms are shown. The % THD was found to be reduced by about 45%.



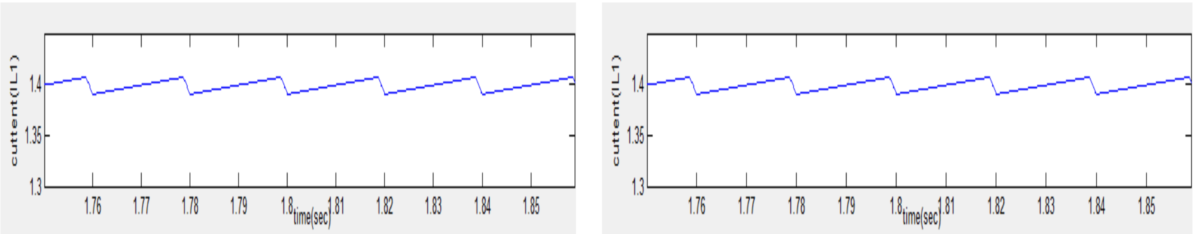

**(a)** **(b)**

**Fig 6 (a), (b) Gate pulses to Switches S1 and S2**




**(a)** **(b)**

**Fig. 7(a), (b) Voltage across inductor L1 and L2.**




**(a)** **(b)**

**Fig. 8 (a), (b) Current through inductor L1 and L2**

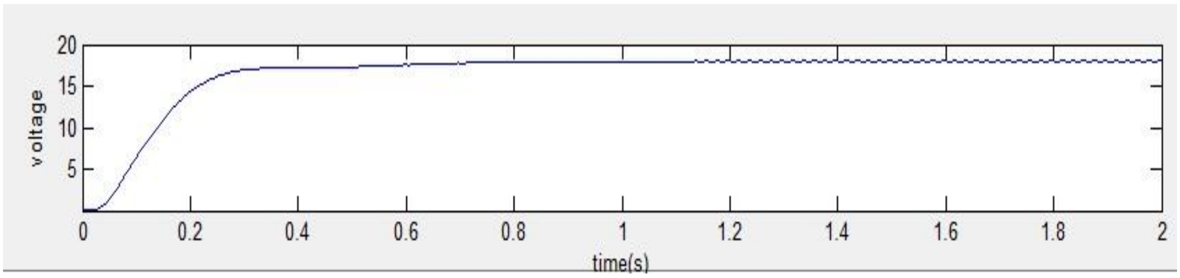



**Fig 9. Output voltage**

## VI. CONCLUSION

Proposed buck boost converter has been simulated and wave forms have been observed. This topology is able to perform both buck and boost operation. Input voltage of the proposed converter can be varied from 10-16 volt. With an input of 12 volt applied in the open loop system, the output voltage was obtained as 8.409 volt for duty ratio 0.4, that is, buck operation and THD as 78.78% for the same input voltage for boost operation, that is, duty ratio 0.8, the output voltage obtained was 15 volts with THD of 62%. The proposed buck boost converter combining KY and SR Buck converter fed with a photovoltaic module with feedback, with same input for an output voltage of 8 volts got THD as 33%. Basic circuit has no control loop, for more efficiency and to reduce harmonic distortion a feedback controller is added. Using the control loop, we can achieve the desired output. Total harmonic distortion is also decreased.

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