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Solar Panel for House Hold application with Input Voltage Feed Forward for the Two Switch Buck Boost DC DC Converter

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***Abstract*- Now days we are facing voltage crisis, shortage of generated power make as to this to think about an alternate source such as solar panel. This paper focus on solar panel for house hold application with input voltage feed forward for the two switch buck boost (TSBB) dc dc converter. It consist of a solar panel , input voltage feed forward(IVFF) for the two switch buck boost dc dc converter, inverter, load, we know panel voltage may vary according to time but even if solar power changes output will remain constant based on reference value. for wide input voltage applications two-switch buck-boost (TSBB) converter is suitable. By two mode control scheme we can easy buck or boost the input voltage. TSBB converter is said to be two-mode control scheme when it is operated in buck mode at high input voltage and boost mode at low input voltage in order to achieve high efficiency over the entire input voltage range. The influence of the input voltage disturbance on the output voltage is reduced by this method that is whatever the input voltage output will be constant based on reference voltage.**

***Index terms*- Two switch buck boost converter, small signal model, input voltage feed forward, two mode controls**.

I. INTRODUCTION

Now a days it is an effective way to use solar panel in house hold basis, a lot of energy can conserve by this way. In this paper we are using solar panel along with TSBB converter for buck operation and boost operation. If available solar power is low we boost the voltage up to the reference voltage, here we kept dc output as constant based on reference and we provide an inverter for ac output. Simplified cascade connection of buck and boost converters are shown in fig 1

Various control methods for this converter is achieve by two active switches in the TSBB converter. TSBB converter behaves the same as the single switch buck-boost converter, If Q_1 and Q_2 are switched ON and OFF simultaneously, this method is known as one mode control scheme. Other controlling methods are possible for Q_1 and Q_2 . Operation is said to be buck mode, when $Q1$ is controlled to regulate the output voltage and $Q2$ is always kept OFF, when the input voltage is higher than the output voltage TSBB converter is equivalent to a buck converter. On the other hand operation is said to be boost mode when $Q2$ is controlled to regulate the output voltage, $Q1$ is always kept ON, and when the input voltage is lower than the output voltage, the TSBB converter is equivalent to a boost converter.

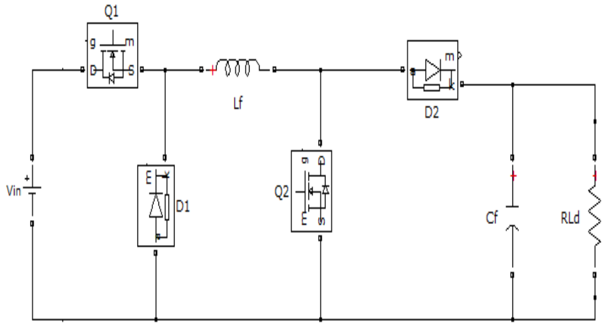


Fig 1 Two switch buck boost converter

This type of control method is called two mode control scheme. Two modulation signals with one carrier or one modulation signal with two carriers was proposed in order to achieve automatic switching between buck and boost modes.

Only one voltage regulator is used for both buck and boost modes. Several methods are there to implement IVFF.

1) finding value of duty ratio, duty ratio is inversely proportional to the input voltage.2) changing amplitude of carrier signal or change value of modulation signal. Both this are inversely proportional to input voltage.

II. TWO-MODE CONTROL SCHEME WITH AUTOMATIC MODE-SWITCHING ABILITY

In continuous current mode (CCM) the voltage conversion of the TSBB converter is

$$V_0 = \frac{d_1}{1 - d_2} V_{in}$$

Duty cycles of switches Q1 and Q2 are d_1 and d_2, d1 and d2 are controlled independently in two mode control scheme.

According to fig 2, TSBB converter operates in buck mode, When the input voltage is higher than the output Voltage, Q_2 is always OFF where $d_2 = 0$ and d_1 is controlled to regulate the output voltage. TSBB converter operates in boost mode, when the input voltage is lower than the output voltage Q_1 is always ON, where $d_1 = 1$ and d_2 is controlled to regulate the output voltage. As shown in figure output voltage is compared with reference signal and given to PID controller. Output signal of PID controller is compare with saw tooth Waveform ,pulse generated by this trigger Q_2 .In order to limit triggering of Q_1 with same signal we add bias before comparing it with saw tooth. Two-mode control scheme the voltage conversion of the TSBB converter can be written as

$$V_o = \begin{cases} d_1 V_{in},\ d_2 = 0\ (V_{in} \geq V_O) \\ \frac{V_{in}}{1-d_2} * d_1 = 1 (V_{in} < V_O) \end{cases}$$

As shown in figure output voltage is compared with reference signal and given to PID controller. Output signal of PID controller is compare with saw tooth Waveform ,pulse generated by this trigger Q_2 .In order to limit triggering of Q_1 with same signal we add bias before comparing it with saw tooth

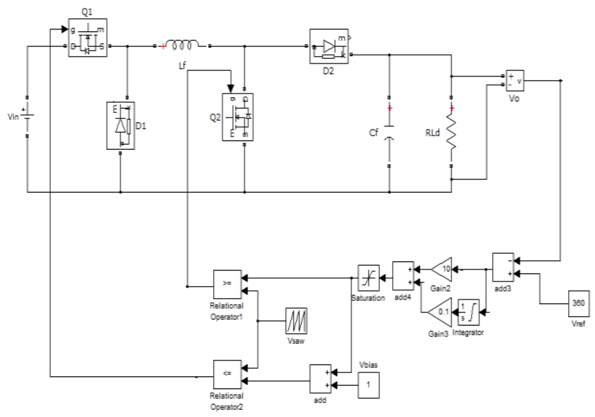


Fig 2.TSBB converter under the two-mode control scheme.

Control scheme is shown in fig 3

$V_o = V_H - V_L$ is the peak to peak value of the carrier. only one of V_e buck and V_e boost can intersect V_{saw} at any time With the same carrier, in order to achieve the two-mode operation. So, it is required that

$V_{ebuck} - V_{eboost} \geq V_{saw}$.

$V_{e\ boost}$, and $V_{e\ buck}$ is composed by adding a dc bias voltage, V_{bias}, to V_{ea}. The output signal of the voltage regulator v_{ea}

$V_{e\ buck} = V_{ea} + V_{bias}$

$V_{e\ boost} = V_{ea}$

$V_{bias} \geq V_{saw}$

Two modulation signals and one carrier, V_{buck} and V_{boost} are modulation signals of Q_1 and Q_2 and V_{saw} is the carrier signal, V_H and V_L are maximum minimum value of carrier, When V_{buck} is within V_H and V_L ,d_1 Ts pulse generate. If same signal is given to trigger both switch we can't get desire output. So we introduce a bias value, that is bias value is added to the error signal before compare with saw tooth waveform in order to trigger Q_1.When V_{boost} with in V_H and V_L ,d_2 Ts pulse generate and it will trigger switch Q_2.

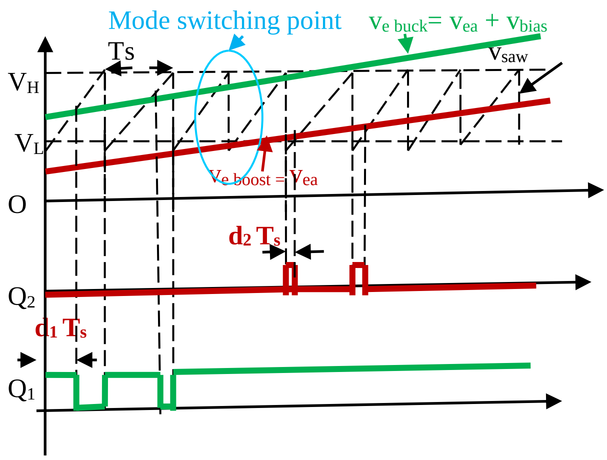
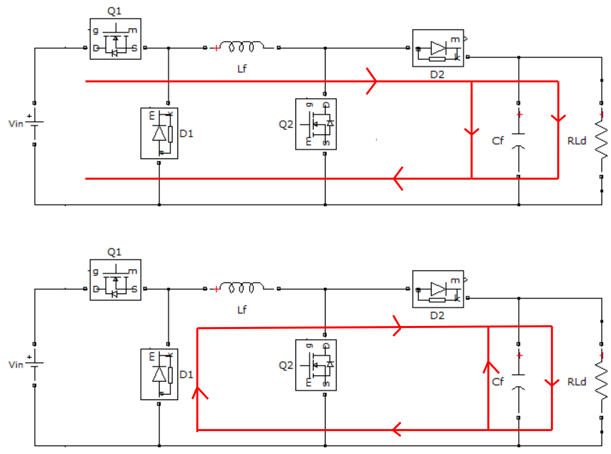
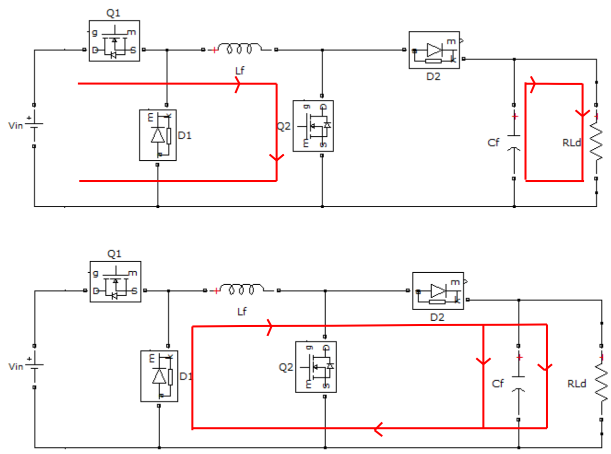


Fig 3 two-mode control scheme with two modulation signals and one carrier

A. Modes of operation



(a)



(b)

Fig4.Modes of operation (a) Buck mode: When $V_{in} > V_o$ (b) Boost mode :When $V_{in} < V_o$

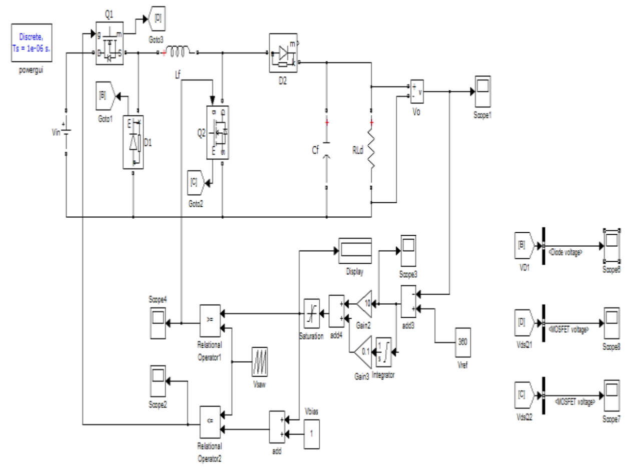


Fig 5. Stimulation model of TSBB converter under the two-mode control scheme.

Table 1.Parameters of the prototype:

parameter	symbol	value
Input voltage	V_{in}	250-500V
Output voltage	V_o	360V
Output power	P_o	6KW
Full load resistor	R_{Ld}	21.6Ω
Switching frequency	f_s	100KHZ
Switches	Q_1, Q_2	SPW47N60C3
Diodes	D_1, D_2	SDP30S120
Filter capacitor	C_f	4080µF
Filter inductor	L_f	320µH
Peak to peak value of the carrier	V_{saw}	2.5V

III. DESIGN

Input voltage, V_i = 250-500V
Output voltage V_O = 360V
Output power P_O = 6KW
Full load resistor = 21.6Ω
Switching frequency =100KHZ
Filter capacitor= 4080µF
Filter inductor= 320 µH
Peak to peak value of carrier = 2.5V
T=10µS

$$\frac{V_2}{R} = P$$

$$R = \frac{360^2}{6KW} = 21.6\Omega \quad (1)$$

$$I_{OMAX} = \frac{P}{V} = \frac{6KW}{360} = 16 \quad (2)$$

A. Design of capacitor Value

Buck converter:

$$\frac{V_O}{V_d} = \frac{t_{on}}{T_s} = D$$

V_{in}=500V, V_{out}=360V

$$D = \frac{360}{500} = 0.388 \quad (3)$$

$$L = \frac{T_s * V_O * (1-D)}{(2 * I_{OMAX})}$$

$$L = \frac{10*(10-6)*360*(1-.388)}{(2*16.67)} \quad (4)$$

L=66.08*10^{-6} H

Boost converter:

$$\frac{V_O}{V_d} = \frac{T_S}{t_{off}} = \frac{1}{1-D}$$

V_{in}=250V, V_{out}=360V

$$D = \frac{360}{250} = 1.44 = 1 \quad (5)$$

$$L = \frac{T_s * V_O * D(1-D)}{(2 * I_{OMAX})}$$

$$L = \frac{10*(10-6)*360*(2*16.67)}{(2*16.67)} \quad (6)$$

L=107.978*10^{-6}H

Comparing buck and boost value we choose a higher value as 320µH Ripple R_C =.004%

B. Design of inductance value

Boost converter:

$$\Delta V = \frac{R_C * V_0}{100}$$

$$\Delta V = \frac{.004*360}{100} = .0158 \quad (8)$$

$$C = \frac{V_0 * D}{F * \Delta V * R}$$

$$C = \frac{360*.388}{100*10^3*.0158*2} \quad (9)$$

=4092.82µF

Buck converter:

Ripple R_C=.011%

$$\Delta V = \frac{R_C * V_0}{100}$$

$$\Delta V = \frac{.011*360}{100} = .0408 \quad (10)$$

$$C = \frac{V_0 * D}{F * \Delta V * R}$$

$$C = \frac{360*.388}{100*10^3*.0408*21.6} \quad (11)$$

$= 4084.96\mu F$

Comparing buck and boost value we choose a value as 4080 µH

IV. MODIFIED CIRCUIT

Here we incorporate solar panel for house hold application with input voltage feed forward for the two switch buck boost (TSBB) dc dc converter. As we know voltage availability of solar panel chances with time, so we have to keep output voltage constant.
Fig 6 shows modified circuit.

Circuit consist of two switch buck boost cascaded circuit with input voltage feed forward path. Input voltage is from solar panel, for house hold application we have to keep output voltage constant. We keep a reference as 230V.When ever input voltage increase or decrease it keep output voltage constant. When input higher that output voltage buck operation occur, that is switch Q_1 will trigger and step down the voltage to 230V.When input voltage is lower than output voltage boost operation occur, that switch Q_2 will trigger and step up the voltage to 230V.

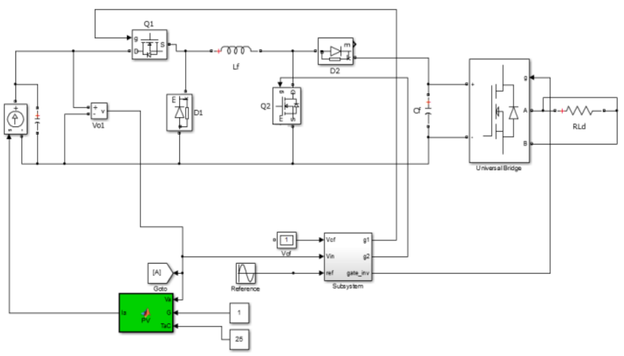
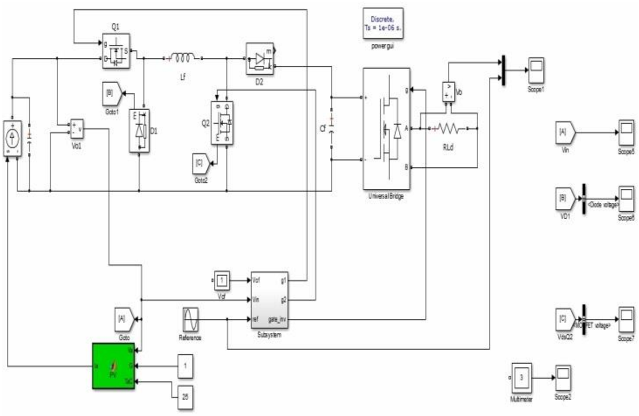
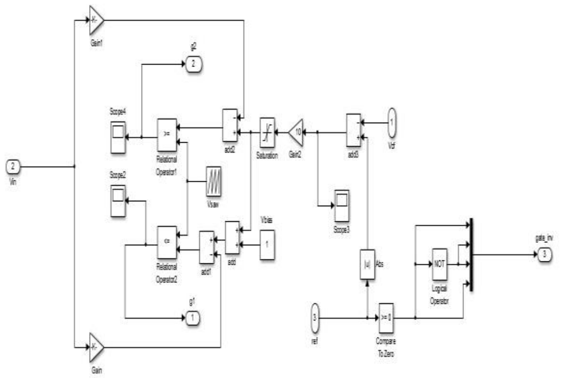


Fig 6 .modified circuit

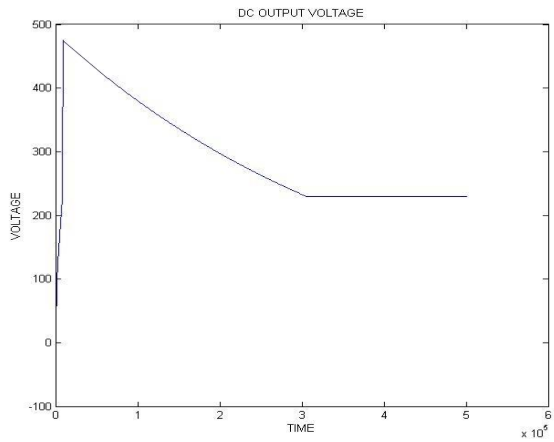


(a)

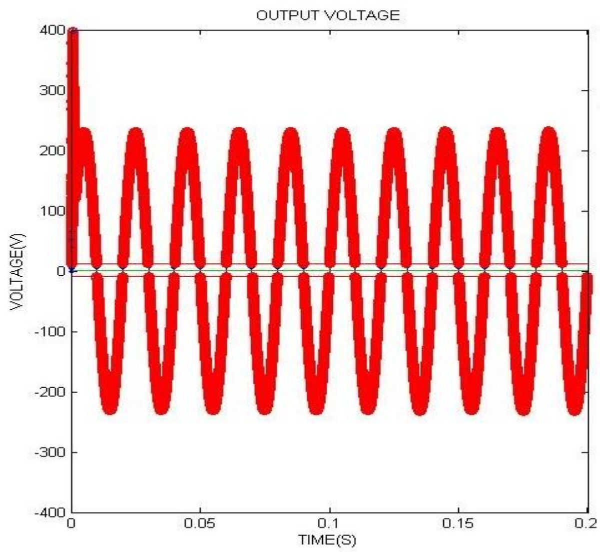


(b)
Fig 7 (a) stimulation diagram of modified circuit(b) Sub system stimulation diagram

V. EXPERIMENTAL RESULT



(a)



(b)

Fig8 .waveform of (a)DC Voltage(b)AC output

VI. CONCLUSION

By implementing solar panel along with two mode control scheme input voltage feed forward we can keep the output voltage a constant even if input voltage available from solar panel varies. The switching between buck and boost modes in this proposed control scheme is nearly smooth Reduce conduction loss, Reduce switching losses. High efficiency over the whole input voltage range and improved input voltage transient response. Reduce input disturbance.

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