International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-2, Issue-4, March 2013

A Novel Digitally Controlled Converter for Renewable Energy Resources

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Abstract— ***A digital PWM controller for Buck-boost converter is designed using MATLAB-Simulink. The mathematical model of PWM controller is derived to design in MATLAB simulation model. In this Proposed model, the digital PWM controller is used to obtain the positive ouput voltage from the buck boost converter in the range of 101V from the variable input voltage of 50-200V. The proposed model is highly efficient and flexible for all kind of renewable energy conversion methods. In this paper, the basic principles of the proposed digitally controlled Positive buck boost converters are illustrated in detail and also we discussed about the proposed model ouput voltage is employed for DC Motor applications.***

Index Terms —Pulse Width Modulation (PWM) Positive Buck-Boost Converter (PBB), DC motor.

I. INTRODUCTION

In many applications with BB converters required for charging the battery has significantly large variations in output voltage, and hence, the additional switching power supply [1], [2] is indispensable for processing the varied input voltage to create the stabilized output voltage. There are several types of non-isolated converters [1]–[9], such as the Cuk converter, SEPIC converter, etc. As for Cuk, SEPIC, and Zeta converters, each not only possesses the disadvantages of the right-half-plane zero but also needs two inductors, In [3]–[8], the Luo converter and its derivatives, also possessing the disadvantages of the right-half-plane zero, are presented to realize output voltage, but need two or more inductors and hence, also have difficulty in control due to the corresponding high-order transfer functions. This capacity is utilized for improving the dynamic response of PBB to disturbances due to an increase in load or decrease in input voltage [10]. There are some DC-DC applications like hybrid vehicles [12-13] and hybrid power sources [11] which require bidirectional power flow. When there is a requirement for step up and step down voltage conversions using PWM controller (Fig. 1) may be promising. This converter is based on PBB converter

Manuscript received on March 2013.
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II. PROPOSED SYSTEM MODEL

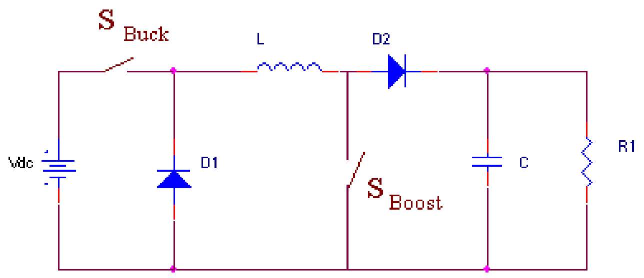

Fig.1: Buck Boost Converter

So we had employed the digital PWM controller which responds to change in the input voltage maintained the output voltage range.

In addition it has advantage of a capacity for extra current storage in the inductor. Comparing the inductor Current in Buck, Boost, inverting Buck Boost and positive Buck Boost, we have:

$$I_1 = \frac{I_0}{D'} = \frac{V_0}{RD'} = \frac{V_1}{RD'^2} \quad \text{Boost converter} \tag{1}$$

$$I_1 = \frac{I_0}{D'} = \frac{V_0}{RD'} = \frac{DV_1}{RD'^2} \quad \text{PBB converter} \tag{2}$$

$$I_1 = I_0 = \frac{V_0}{R} = \frac{DV_1}{R} \quad \text{Buck Converter} \tag{3}$$

The equation for PBB converter is to

$$I_1 = \frac{1}{D'_{boost}} I_0 = \frac{1}{D'_{boost}} \frac{V_0}{R} = \frac{D_{buck}}{D'^2_{boost}} \frac{V_i}{R} \tag{4}$$

The output equation is

$$V_0 = \frac{D_{buck}}{D_{boost}} V_i \tag{5}$$

III. DIGITAL PWM CONTROLLER FOR PBB CONVERTER

We had developed the digitally controlled pulse width modulation schemes using MATLAB/ Simulink for PBB converter to obtain the high efficiency conversion and flexible of the system. Fig.1 shows that sense circuit for PWM controller, Fig.2: shows the design of open and closed loop PBB converter, Fig.3 shows the Digital PWM control for Buck Mode Operation, Fig.4 shows the Digital PWM control for Boost Mode Operation

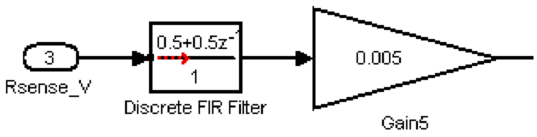

Fig.1 R_{sense} loop for Digital PWM Signal

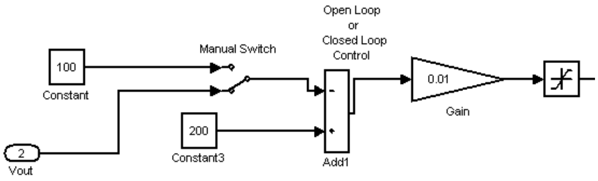

Fig.2 PBB converter designed to operate at both open and closed loop

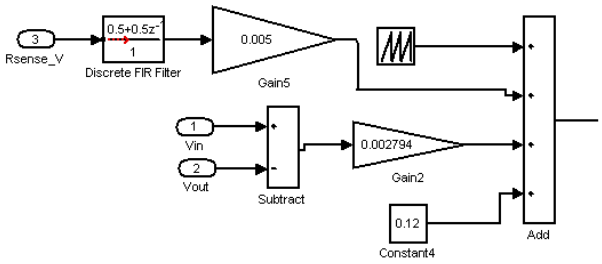

Fig.3 Digital PWM control for Buck Mode Operation

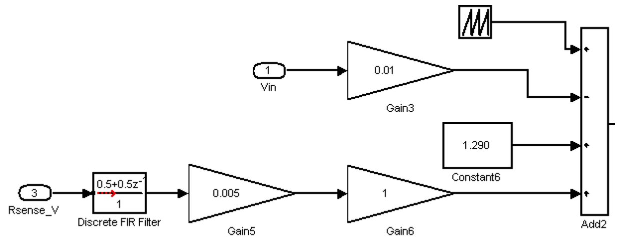

Fig.4: Digital PWM control for Boost Mode Operation

IV. SIMULATION RESULTS AND DISCUSSIONS

The employed PWM control schemes are used to obtain the positive output voltage. The designed simulation circuit for digitally controlled PBB converter is used for DC motor applications shown in below Fig.5 and simulation values used in this circuit to perform operations of digitally controlled PBB converter is shown in table.

L	10e-03
R1	10 ohm
Rs	0.01 ohm
C1	100e-6
MOSFET Switches (Resistance values)	0.001ohm
Smoothing Inductance	2H

Table.1: Simulation Parameters

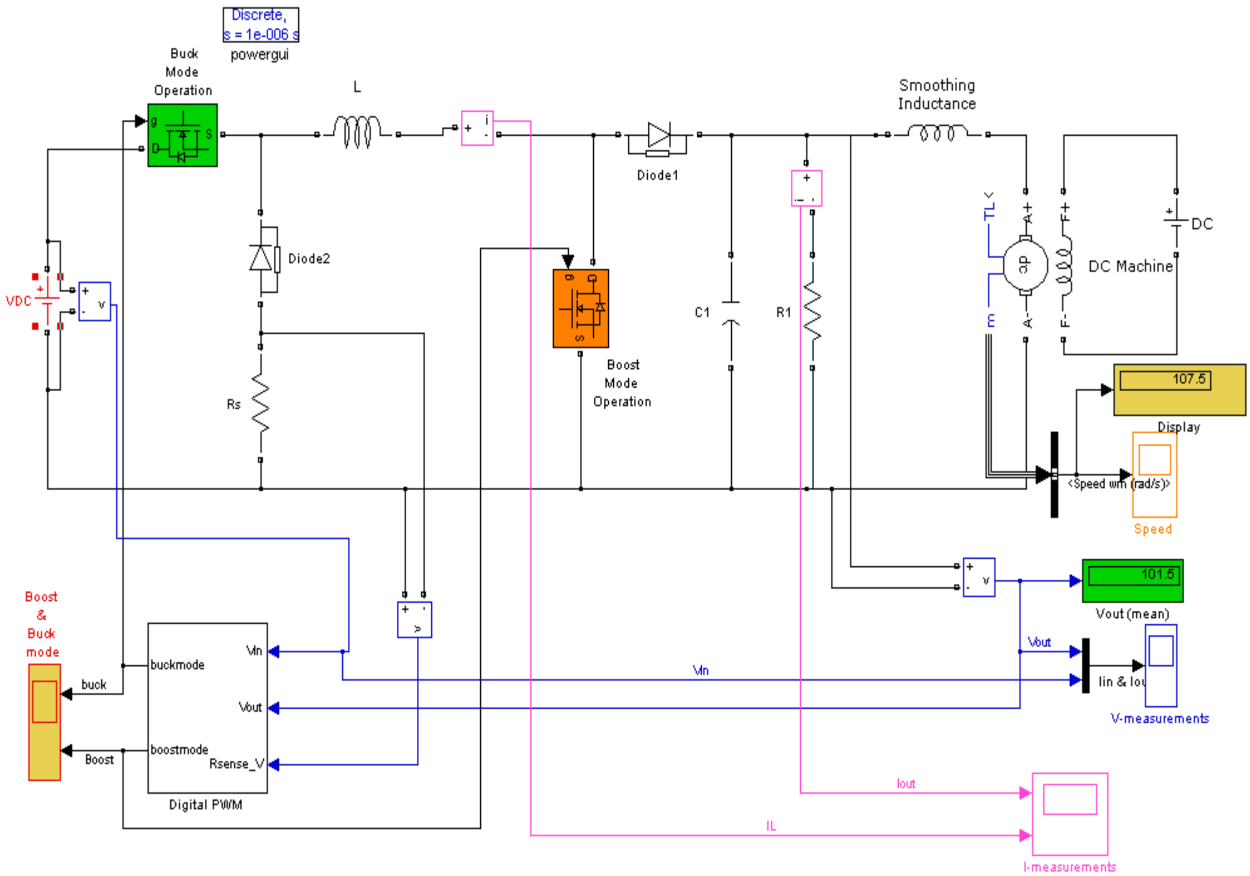

Fig.5 Digital PWM control PBB converter

The simulation results are shown below for input DC voltage for 50V (Fig.6) and 200V (Fig.7). The results show the efficiency of the PBB converter while operating in buck and boost mode.

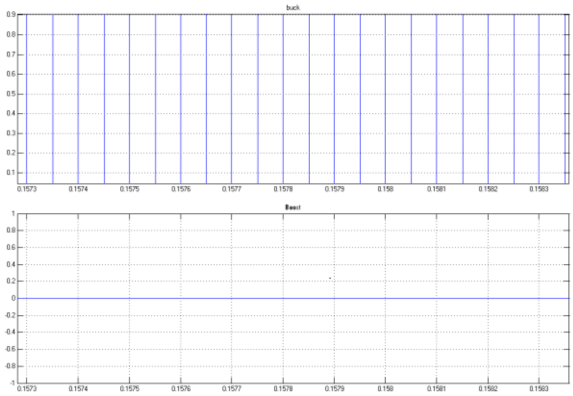

Fig.6 (a) Waveforms for Buck Mode Signals (Input V_{dc}=200V)

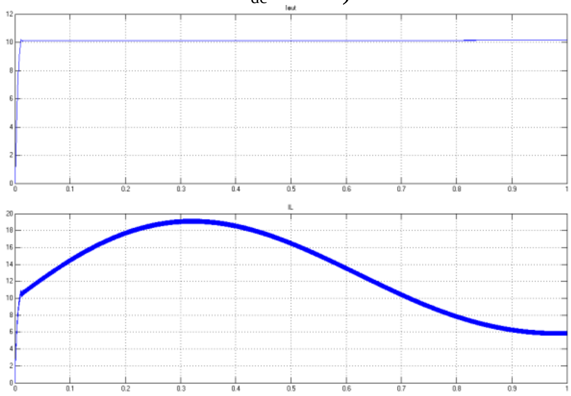

Fig.6(b) Waveforms for I_{out} and I_L (Input V_{dc}=200V)

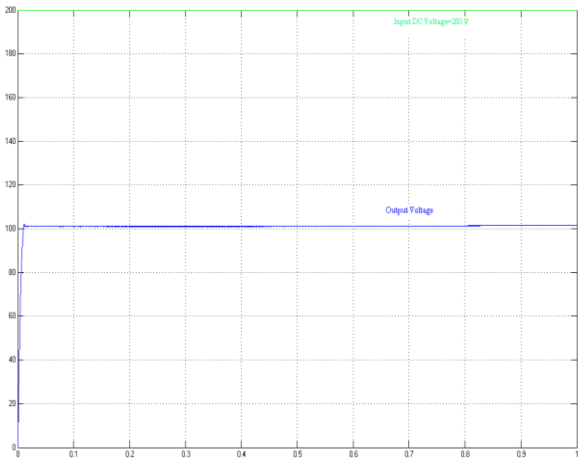

Fig.6(c) Purposed PBB converter output voltage Waveforms (Input V_{dc}=200V)

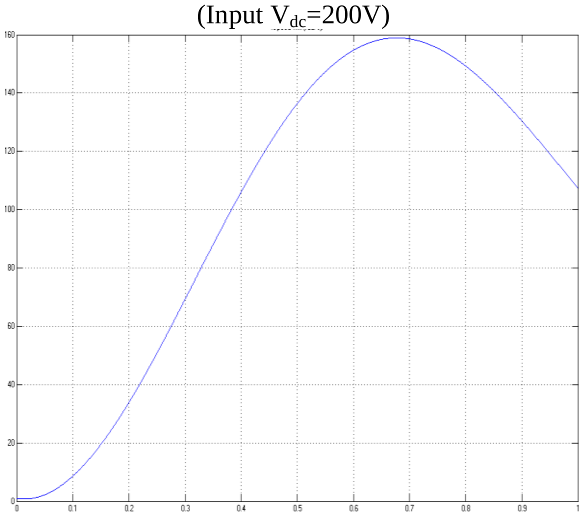

Fig.6(d) Waveforms of PBB converter output for DC motor Applications (Input V_{dc}=200V)

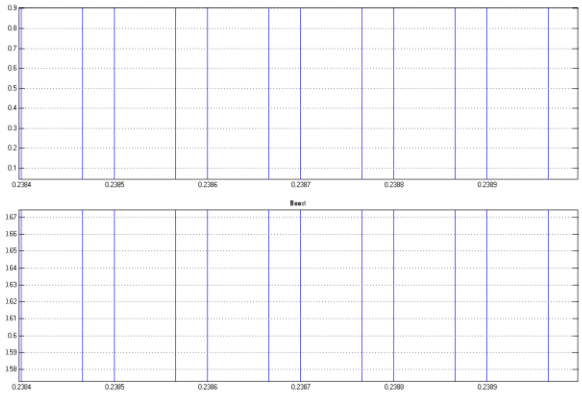

Fig.7 (a) Waveforms for Buck and Boost Mode Signals (Input V_{dc}=50V)

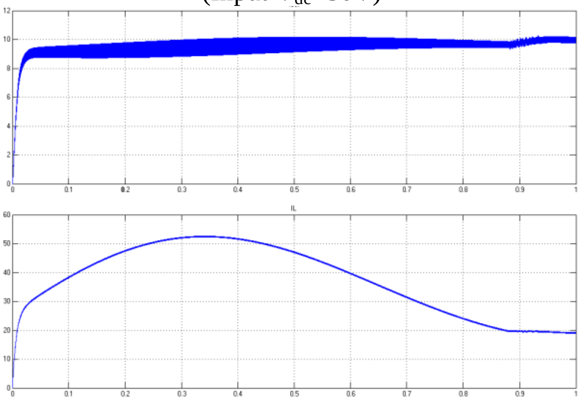

Fig.7(b): Waveforms for I_{out} and I_L (Input V_{dc}=50V)

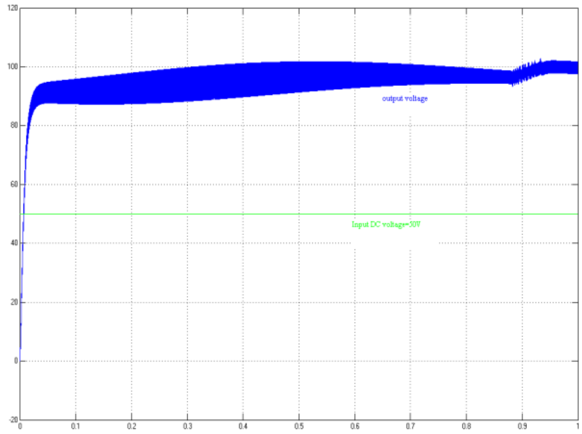

Fig.7(c) Purposed PBB converter output voltage Waveforms (Input V_{dc}=50V)

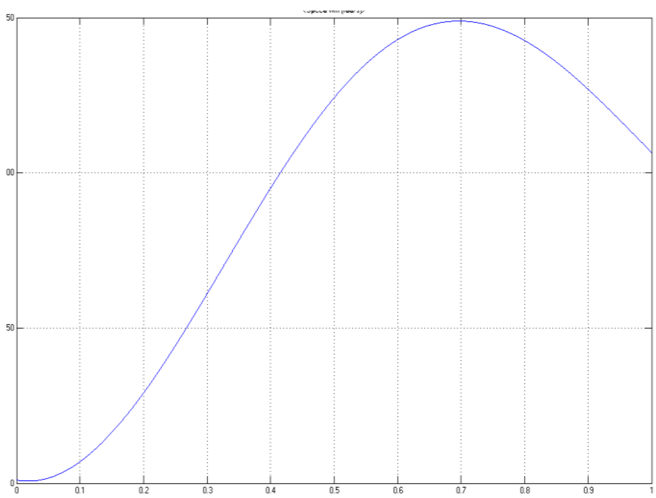

Fig.7 (d) Waveforms of PBB converter output for DC motor Applications (Input V_{dc}=50V)

V.CONCLUSION

The proposed Digital control for PBB converter has a positive output voltage. Furthermore, this converter always operates in CCM inherently, thereby causing variations in duty cycle all over the load range not to be so much, and hence, the control of the converter to be easy .A high-efficiency positive buck–boost converter with PWM circuit is proposed in this paper. When the positive buck–boost converter operates in buck– boost mode, the switching loss is comparatively low compared to the other methods. The proposed positive buck–boost converter can precisely provide an adjustable input with a voltage range from 50 to 200 V with constant voltage of 101V and constant output current of 10A. By using Digital PWM techniques, the proposed converter can achieve faster transient response when the supply voltage changes.

VI. ACKNOWLEDGMENT

The authors are would like to thank to the Principal, Prof.Dr.S.S.Jayachandran, IFET College of Engineering, Management Trustees of IFET College of Engineering and the Principal, Management trustees of Adhiparasakthi College of Engineering for providing necessary facilities for the preparation of paper.

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