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Power Devices Aging Equalization with High Gain Single Switch Quasi DC-DC Boost Converter

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ABSTRACT

Wind energy is one of the greatest advantageous and unconventional renewable energy resources.A power converter is mandatory to connect the load or grid through wind energy conversion system (WECS). This wind energy conversion system is a very significant and challenging converter in which it consists of quasi DC-DC converter. The voltage-fed quasi-Z-source converter (qZSC) has been presented for wind power applications mainly because of its single-stage boost capability and improved reliability. Furthermore this project addresses detailed modeling and control issues of the qZSC used for electrical vehicle (EV), such as wind power conditioning. Due to the mutual control between the shoot-through duty ratio and modulation index of qZSC, constant capacitor voltage control method is adopted in a two-stage control mode. The lowest switching tension of device is attained by choosing an appropriate capacitor voltage reference.

KEYWORDS:*PID Controller, Zero Voltage Switching, Pulse Width Modulation, Permanent Magnet Synchronous-Generator.*

I. Introduction

Nowadays, attention for renewable energy resources is considered for electrical energy generation. The rapid reduction in the amount of fossil fuels coupled with the growing global demand for energy makes it very important to switch to newfangled energy resources [1]. Ecological issues have also developed enough to increase the significance of a renewable energy usage. Generators has dissimilar types, in those types, for Wind Energy Conversion system(WECs),Permanent Magnet Synchronous Generator (PMSG) is a perfect choice.

It has remarkable benefits such as high efficiency, high power density, high reliability, low maintenance and exclusion of slip rings [2]. PMSGs with high number of poles are presented and it is appropriate for direct propulsion systems. The load need command to connecting a PMSG to the mains or to load, needs an electronic power supply interface consisting of one reversing and two rectifying stages. Two main functions were used in PMSG-based WCES for the rectification. A convenient quasi-Z-source DC/DC converter is proposed with improved efficiency, isolated output and high voltage gain.The developments in performance and size were achieved by using electric vehicle application. The compatible of the converter for applications requires a high voltage gain, improved efficiency, especially for renewable energy sources like photovoltaic application.

Like a traditional wind energy conversion system (WECs), the basic elements required to complete a closed system is a Wind turbine which converts rotary mechanical energy from the kinetic energy of wind energy [3, 4]. Generator is used to provide a mechanical energy to electrical energy. Quasi DC-DC conversions were used with LC network to connect with the main circuit. Quasi Converter is an unconventional power conversion system for a steady state voltage boost and buck characteristics by an exceptional impedance network.

The dual network has a separate connected choke-capacitor that provides a source of wind resistance. The combination of switching devices with diodes is used as switches for the converter [5]. The PIC controller is controlled by a closed loop based on the PWM signal with its switching power. The main requirement is to increase the energy consumption of the closed loop system.

II. CONFIGURATION OF PROPOSED CONVERTER

A quasi-Z-source with high step-up DC–DC converter with a switched-capacitor division has proposed for this converter. When compared to the other high step-up DC–DC converters, this proposed converter can offer lower current stress across the switches, higher output voltage gain, and also the output diodes has lower voltage stress by using the similar or same active and passive components. Therefore, the improved reliability and efficiency of the converter has been attained.

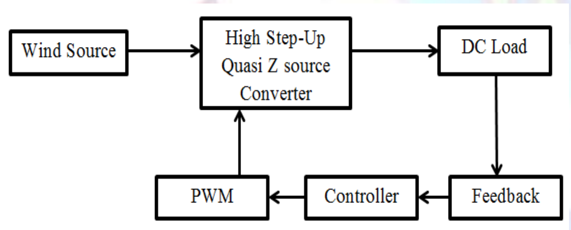


Fig.1 Block diagram of proposed system

The parameter selection, operating principle, topological derivation and evaluation with other DC converters are obtained. The block diagram of High Gain Single Switch Quasi Dc-Dc Boost Converter is shown in the fig 1.The switched capacitors can also be used in DC– DC converter topologies to control high voltage gain. However, all of the above DC–DC converters are very difficult and the output voltage is still not sufficient for many practical applications. The Circuit diagram of proposed Converter is shown in the fig 2.

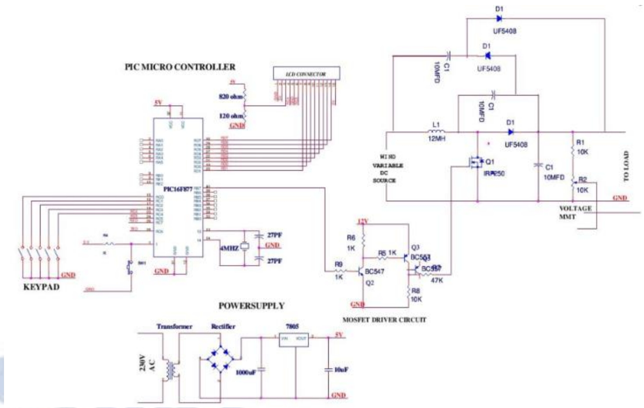


Fig.2 Circuit diagram of proposed system

III. OPERATING STATES OF THE CONVERTER

The Z-source impedance network consists of two inductors and two capacitors, connected as shown in fig 3. The Z-source network was firstly applied in DC–AC inverters, i.e., the traditional Z-source converter (ZSC), which gives the converter both buck and boost conversion ability in a single-stage topology. Since then, the Z-source network has greatly advanced due to its distinct advantages, e.g., it utilizes the shoot-through zero state to realize high voltage gain, no dead time is needed, and to avoid gate switching caused by the electromagnetic interference (EMI).

Therefore, the Z-source converter is suitable for renewable power generation systems, such as, fuel cells and photovoltaic (PV) applications. Based on the Z-source network, many publications have been reported to develop the performance of ZSI, e.g., the improved ZSC in and the quasi-Z-source converter (qZSC). Especially, the quasi-Z-source converter, not only retains the main characteristics of the ZSC, but also has its own new features, such as continuous input current, low capacitor voltage stress and a common ground for the input and output.

The Z-source network and the quasi-Z-source network can also be applied to boost the output voltage gain of DC–DC converters. In, a PWM Z-source DC– DC converter is proposed, and its output voltage gain is higher than the traditional boost converter. In, a novel Z-source DC–DC converter is presented, which uses the Z-source network to replace the traditional inductor in a conventional boost converter. In, based on the quasi Z-source network, a modified Z-source DC–DC converter is proposed, which provides a higher voltage gain than the converter. However, the output voltage-gains of these Z-source DC–DC converters are still not large [6].

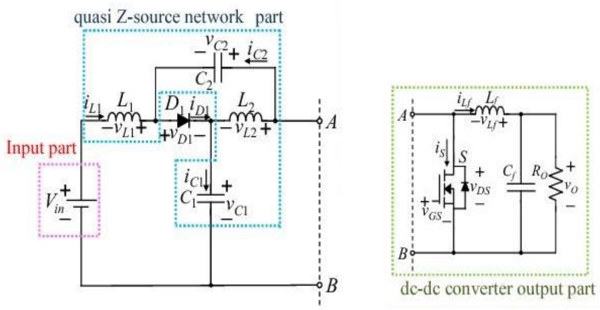
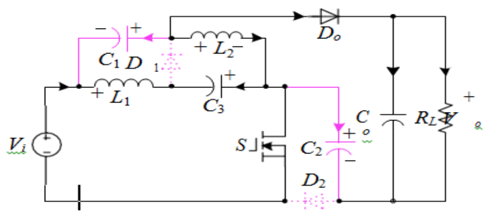


Fig.3 Configuration of the proposed converter

For purity, the projected converter is based on the following expectations.

1) The power circuit has load resistors, switch S (MOSFET), ideal inductors and capacitors, diodes, and the parasitic effect is ignored.

2) L_1= L_2= L and C_1=C_3=C in the quasi-Z-source network, and C_1=C_2=C in the switched-capacitor cell, thus C_1=C_2 = C_3=C.



(a) Mode 1: S, D_o on, D_1, D_2 off

(b) Mode 2: D_1, D_2 on, S, D_o off

Fig.4 Switch on and off states of the proposed converter

Mode 1, switch is on, (b) Mode 2, switch is off

When power switch S is turn on, as shown in Fig. 4, diodes D_1 and D_2 are in off state due to with capacitors as the reverse parallel connection.

The input voltage $V_i$and C_3chargeL_1, and V_i and C_1 charge L_2. Meanwhile, C_1 and C_2 are in series with V_i to supply the load through S. By applying kirchhoff's voltage law, the following steady-state equations can be derived: $V_{L1}=V_i+V_{C3}$, $V_{L2}=V_i+V_{C1}$, and $V_0=V_i+V_{C1}+V_{C2}$. When S is in off state, as shown in Fig. 4 (b), D_1 and D_2 are on, D_0 is reverse blocking, inductor L_1 charges C_1, L_2 charges C_3, V_i and L_1 are in series with L_2 to charge C_2, and the load R_L is powered by capacitor C_0. Thus, similar relationships can be obtained:

$V_{L1}+V_{C1}=0, V_{L2}+V_{C3}=0$, and $V_i=V_{L1}-V_{C3}+V_{C2}$.

According to the voltage balance principle, the average voltage over inductor is zero in the steady state. Defining the duty cycle of S as D=T_{ON}/T_S, where T_{ON} is the conduction time of switch S, T_S is the corresponding switching period [8]. Thus, we have:

$$V_{C1}=V_{C3}=\frac{D}{1-2D}V_i \tag{1}$$

$$V_{C2}=V_i+V_{C1}+V_{C3}=\frac{D}{1-2D}V_i \tag{2}$$

From (1) and (2), the output voltage V_0can be derived as:

$$V_0=V_i+V_{C1}+V_{C2}=\frac{2-D}{1-2D}V_i \tag{3}$$

Thus, the output voltage gain G of the proposed SCqZSC converter can be obtained as:

$$G=\frac{V_0}{V_i}=\frac{2-D}{1-2D} \tag{4}$$

IV. SIMULATION EXPERIMENTALPARAMETERS

The simulation parameters used in the proposed system with its specifications, input range, output ranges are represented in table 1 and table 2.

Wind Turbine	
Base rotational speed	1.2p.u
Base wind speed	12 m/s
Base power of the electrical generator	1500/0.9 VA
Nominal mechanical output power	1500W
Permanent Magnet Synchronous Generator	
Voltage Constant	150V
Three phase capacitor load	50Micro F
Three Phase Transformer (Two Winding)	
Nominal power and frequency	20mVA, 50 Hz

Table 1 Input Parameters and Values

Single Phase Quasi DC-DC Converter	
C1, C2, C3	500Micro F
C4, C5	100mF
L1, L3	3.7 micro H
L2	1mH
PID	
Proportional (P)	0.01
Integral (I)	0.23
Derivative (D)	0.001

Filter coefficient (N)	100
PWM	
Gain	1/10
Output Value	0,1,0
R Load	100 Ohm
Feedback reference	500V
Output Value	230V, 12A

Table 2 Output Parameters and Values

V. SIMULATED QUASI DC-DC BOOST CONVERTER

The Simulink model for high gain single switch quasi dc-dc boost converter is shown in the fig 5.

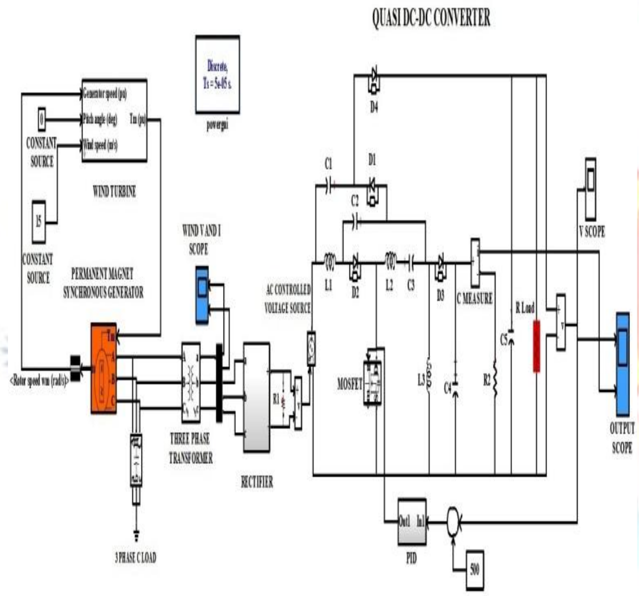


Fig.5 Simulation of High Gain Single Switch Quasi Dc-Dc Boost Converter

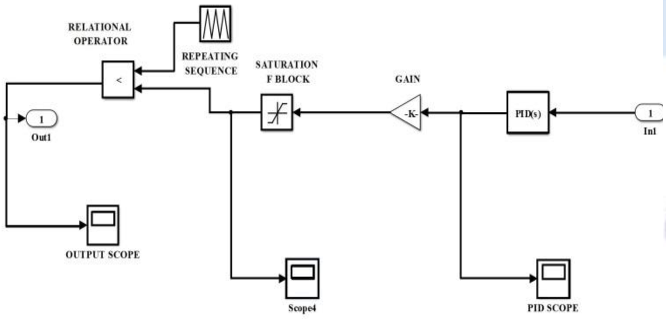


Fig.6 PID Circuit Diagram

VI. EXPERIMENTAL RESULTS

A high gain single switch quasi dc-dc boost converter to increase voltage gain. The simulated output for the proposed system is shown in the below.

INPUT WAVEFORM

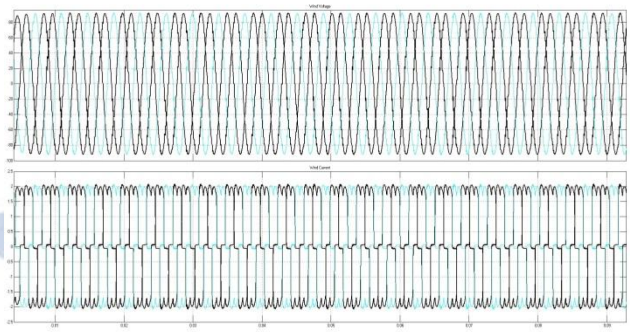


Fig.6 Wind Input Voltage and Current

OUTPUT VOLTAGE

The simulated output voltage is represented in the fig.7, when the DC source input voltage is fed, after simulating it will provide the output value which will be boosted while comparing with the input value of voltage.

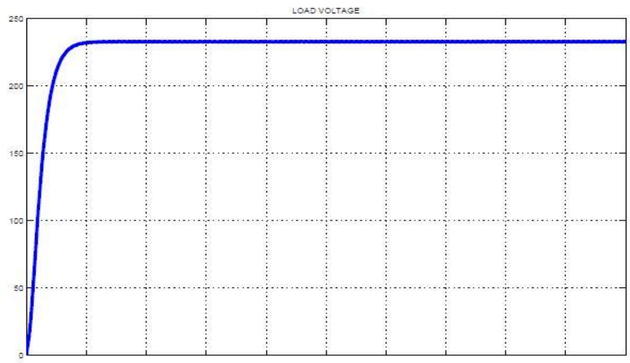


Fig. 7(a)Output Voltage Waveform

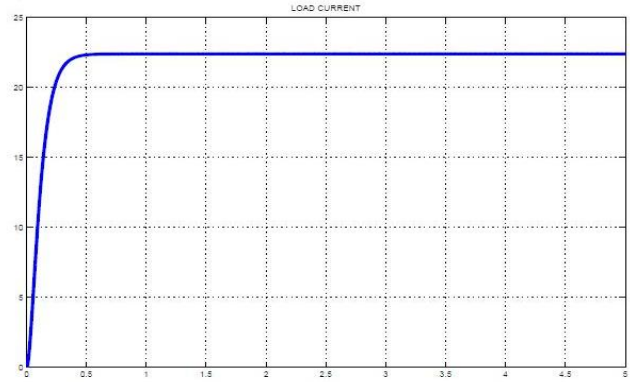


Fig. 7(b) Output Current Waveform

OUTPUT CURRENT

The simulated output current is represented in the fig.7 (a) (b), when the DC source input voltage is fed, after simulating it will provide the output value which will be boosted while comparing with the input value of voltage.

VII. CONCLUSION

In this work architecture for a high Gain single switch Quasi DC-DC boost converter with continuous input and output current is achieved. The time interval between the ON/OFF mode of power switch and all diodes illustrated how to increase the voltage. In this topology the Wind power transfer ratio is improved without using any isolated transformers or coupled inductors.

Compared to the conventional boost converter, this converter offers much lower voltage stress across its power switch which contributes to the much higher reliability in practice. Also, the voltage stresses across all diodes are same as voltage power switch which are considerably low. It should be noted that due to the presence of the inductor on the input and output of the converter, the proposed converter offers much proper choice to be used in applications such as wind power application.

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