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Hybrid Z-Source Boost DC-DC Converters

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ABSTRACT: This paper presents a replacement process of hybrid Z-source boost dc-dc converters intended for photovoltaic (PV) applications, whereas the high step-up converters are declared to spice up the low source voltages to a predefined grid voltage. As the boost capabilities of the normal Z-source networks are limited, the proposed converters are included of combine traditional Z-Source networks in several ways to reinforce the boost abilities of the traditional Z-source networks. The revised version of the proposed Z-source converters is termed hybrid Z-Source boost dc-dc converters to satisfy the traditional benefits of Z-source networks with stronger voltage boost abilities which can also be applied to many power conversions. The performances of the newly designed converters are compared with other Z-source networks behaviours. The simulation and experimental results of the newly designed converters are validated at different operating conditions.

KEYWORDS: Photo Voltaic, Step-up Converters, Z-Source Networks.

I.INTRODUCTION

In the last several years, with the tension of global fossil energy, the renewable energy power systems, which are mainly on the photovoltaic (PV) power systems, are developing rapidly. In a PV power grid, the output voltages of the PV panels are usually low and vary widely under the influences of weather and environment, therefore, a step-up stage is often demanded. The two-stage systems, which consist of step-up dc-dc converters and inverters. The unregulated low dc voltage of PV panels, which can't be provided for inverters, must be boosted and controlled through the high-gain converters. Then, the step-up converters output diverted to high dc voltage to the grid-connected inverters. Thus, the planning of the step-up dc-dc converters is extremely important to the PV power systems. So far, various voltage-boost techniques have been greatly explored, such as the voltage multiplier, switched inductor, switched capacitor and cascaded boost techniques. However, the upcoming techniques are all complex with low efficiency and very high costs.

Due to the increase of global fossil energy there is a great demand in the usage of photovoltaic (PV) power system this helps to reduce global pollution and also helps to improve voltage ability in the system. The system possesses three different constructions and each possess three different voltage boost abilities. Thus to supply constant voltage step-up converters are used because when using photovoltaic (PV) system fluctuations will occur due to environmental and weather conditions. Thus the upcoming systems are majorly depending on photovoltaic systems.

II.SYSTEM MODEL

This paper has an associated converter and inverter which helps us get continuous supply without getting an interruption in the passage supply. This ZSI converter called as Z-Source converter consists of step-up converter this converter helps to maintain constant supply source when the system approaches any fluctuation from the input. Thus the unregulated low dc voltage of PV panels, which cannot be provided for inverters, must be boost and regulated through the high-gain converters. Then the step-up converters output regulates high dc voltage to the grid connected inverters. So far various voltage-boost abilities techniques are used which are low efficiency and high cost, to rectify this new technique called Hybrid Z- Source converters are used.

The main objective of this system are as follows:

- Improved version of traditional Z-source converters.
- Increase voltage ability and power conversions.
- Continuous power supply and High voltage boost ability.

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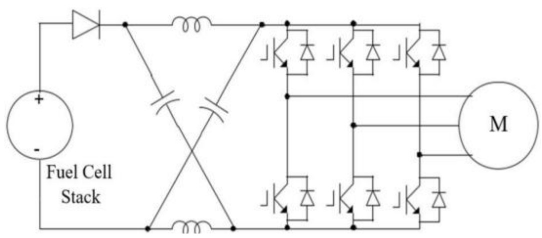
III.PROPOSED CONVERTERS

Three new hybrid Z-source dc-dc converters are presented in this project, which can be categorized as hybrid two-quasi-Z- source boost dc-dc converter, hybrid three-quasi-Z-source boost dc-dc converter and hybrid Z-source/quasi-Zsource boost dc-dc converter.

The hybrid two-quasi-Z-source boost dc-dc converter is which consists of a hybrid two-quasi-Z-source network (L1-D1-C1-C2-L2-C3-D2-C4-L3), an active switch S, an output diode D3, and an output capacitor C5. It can be seen from Fig. 4 that the proposed hybrid Z-source network is obtained by replacing inductor L2 in the quasi-Z-source network I with the quasi-Z-source network II, which adds an inductor L3, two capacitors (C3 and C4), and a diode D2 to the quasi-Z-source network I.The hybrid two-quasi-Z-source network has higher step-up ability than that of the quasi-Z-source network and inherits the merits of the quasi-Z-source network I, such as continuous input current and common ground between the input and output.



IV.WORKING PRINCIPLE

The hybrid two-quasi-Z-source boost dc-dc converter is which consists of a hybrid two-quasi-Z-source network (L1-D1-C1-C2-L2-C3-D2-C4-L3), an active switch S, an output diode D3, and an output capacitor C5. It can be seen from 17 that the proposed hybrid Z-source network is obtained by replacing inductor L2 in the quasi-Z-source network I with the quasi-Z-source network II, which adds an inductor, two capacitors, and a diode to the quasi-Z-source network I. The hybrid two-quasi-Z-source network has higher step-up ability than that of the quasi-Z-source network I and inherits the merits of the quasi-Z-source network I, such as continuous input current and common ground between the input and output. The proposed hybrid Z-source network during this section is that the integration of the quasi-Z-source network I and quasi-Z-source network II. It can be noticed that the proposed hybrid Z-source network (L1-C1-D1-C2-L2-D2-C3-C4-L3-C5-D3-C6-L4) is obtained by replacing all the inductors (L1 and L2) in the quasi-Z-source network I with the quasi-Z-source network II.

In addition to the hybrid three-quasi-Z-source network, the proposed converter employs a lively switch S, an output diode D4, and an output capacitor C7. Though the voltage gain of the proposed converter is higher than that of the 18 hybrid two-quasi-Z-source boost dc-dc converter, it draws a discontinuous current from the dc voltage source. To smooth the input current, a simple improvement on the proposed converter is done, where dc voltage source is placed in series with the inductor L1. However, the voltage gain of the improved hybrid three-quasi Z-source boost dc-dc converter isn't influenced by the modification, which is that the same because the hybrid three-quasi-Z source boost dc-dc converter. Increments to the high voltage gain and continuous input current, the improved hybrid three-quasi-Z-source network. This proposes a hybrid Z-source network which combines the original Z-source network with the quasi-Z- source network II. The proposed Z-source network (L1-C1-D2-C2-L2-C3-C4-L3-C5-D3-L4-C6) replaces the inductors (L1 and L2) in the original Z-source network with the quasi-Z-source network II. Additionally, the proposed converter comprises a lively switch S, two diodes (D1 and D4), and an output capacitor C7. Like the traditional Z-source network, the hybrid Z-source/quasi-Z-source network has a symmetrical structure. And the step up ability of the propose hybrid Z-source network is similar to that of the hybrid three-quasi-Z-source network.

V.OUTPUT ANALYSIS

In this system, the Z-source inverter is used to drive a BALDOR motor ZDM4115T. The motor is implemented mechanically with the alternator 2733-G. The output voltage of the alternator is altered by a rectifier and fed back to the input of the Z-source inverter by a boost converter. In this way, we will control the motor torque by controlling the present fed to the dc input with the boost converter. The output voltage of the Z-source inverter may be a PWM signal. To extract and measure the elemental component of the output voltage, a filter is employed, as shown in

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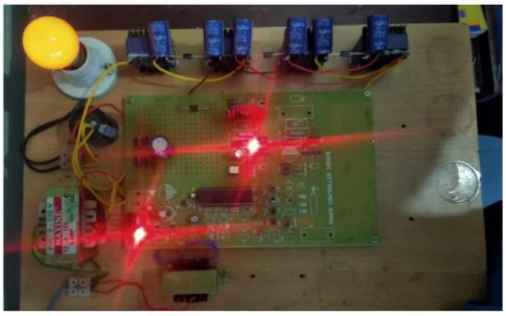
Fig. 6.12 This filter can eliminate the switching frequency PWM ripple. The resistor mostly employed for damping the LC resonance.



The inverter with no battery could self-boost when the modulation index or the load PF is low. During our test, the modulation index was set to 1.15 and load torque was controlled by the dc boost 44 converter connected to the generator and waveforms of the Z-source inverter during normal operation mode without boost. The input voltages were 110 V, 196 V, and 305 V, respectively.

At high-frequency operation, when a better voltage is required, the inverter turns into boost mode. The input voltages of those two conditions were 280 and 250 V, respectively. As seen from the demo results, the inverter works in boost mode with shoot-through. In both cases, the PN voltage across the IPM is integrated for around 380 V, thus increasing the output voltage. The modulation form of index of the PWM for 40-kW conditions is 1.01. The output voltage of the inverter is boosted to 230 V; for a standard inverter, the available voltage is merely 171 V with a modulation index of 1. The modulation form of index of the PWM for 50-kW conditions is 0.957. The output voltage of the inverter is 218 V forms a line to line, while the derived output voltage for a traditional inverter at 250 V input is 153 V with a modulation index of 1. It was successfully proved that the Z source inverter can greatly increase the output voltage as desired. Also, the motor current is purely sinusoidal, which indicates that the Z-source inverter will produce very low harmonics.

VI.CONCLUSION

The major work completed in this project includes,

- Development of a comparatively low-cost, higher efficiency traction drive Z-source inverter for FCVs;
- A detailed comparison of the Z-source inverter with montage inverter topologies;
- the planning and fabrication of a 30-kW Z-source inverter; and
- Testing and implementation of the Z-source inverter developed.

First, a singular Z-source inverter was developed for FCVs. This inverter is particularly fitted to a cell that needs unidirectional current/power flow and features a wide voltage range. At present, there are two existing topologies for FCVs: the normal PWM inverter and therefore the dc/dc boosted PWM inverter. The traditional PWM inverter topology uses the cell voltage directly, which ends up during a limited CPSR for the motor and a freeze-start problem for the cell. The dc-dc boosted PWM inverter topology has the problem of high cost, low efficiency, and complexity. The specially developed Z-source inverter can able to rectify these problems. Second, a comprehensive comparison was conducted of the Z-source inverter and therefore the two existing inverter topologies mentioned. The comparison results showed that the Z source inverter is highly suitable for FCVs, having a low cost, high conversion efficiency, a wider CPSR, and greater reliability. A 30-kW Z-source inverter was designed and fabricated. The detailed design process involved circuit design, 3-D implementation, and thermal design.

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