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ENERGY STORED SINGLE-STAGE PHOTOVOLTAIC POWER SYSTEM FOR QUASI Z-SOURCE INVERTER WITH MOTOR LOAD

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ABSTRACT

The quasi Z source inverter (qZSI) with battery can balance the undetermined fluctuations of the photovoltaic power injected to the load. This paper proposes a energy stored qZSI-based PV power system with constant dc-link peak voltage using motor load.The new topology of energy stored qZSI is employed to improve the power compensation ability of existing topology, new constant dc-link peak voltage control and load related maximum power point tracking are proposed, and the whole system is analysed in detail. Experimental results verify the theoretical analysis and the proposed energy stored qZSI-based PV power system.

I. INTRODUCTION

Now-a-days due to insufficient fossil fuels for producing electricity and increase in demand we search for an alternative resource such as renewable energy. Photovoltaic (PV)[1] power generation is one of the most promising sustainable energies. Also operating silently and without any moving parts or environmental emissions, PV systems have developed into a mature technology that has been used for fifty years in specialized applications, and grid-connected systems have been operating for over twenty years Thus photovoltaic power generation is used as source in my proposal. Traditional two-stage and single-stage inverters are widely employed in most of the photovoltaic grid connected inverters. The quasi Z-source inverter is employed as it has advantages over Z-source inverter, well suitable for interface with photovoltaic system. The quasi-Z source inverter with battery can balance the undetermined fluctuations of photovoltaic (PV) power injected to the load. The existing topology has a power limitation due to the wide range of discontinuous conduction mode during battery discharge. The new topology of energy stored quasi Z Source Inverter is employed to improve the power compensation ability. Also constant dc-link peak voltage control and maximum power point tracking are used.

Z-source inverter (ZSI) is a new single-stage structure to achieve the two-stage inverter's function. It can handle the PV voltage variation over a wide range, which leads to minimum inverter capacity, with the reduced component count and system cost. Quasi-Z source inverter (qZSI), as an improved ZSI, has some new advantages well suitable for application in PV systems draws a constant current from the PV panel, there is no need for extra filtering capacitors; features a lower capacitor rating; and reduces switching ripples seen by the PV panels. Solar power is characterized by intermittency and fluctuation. Energy storage (ES) is a viable solution to mitigate these problems. Load can get a continuous, stable, and smooth power from PV system integrated with the ES. Most of the existing ES technologies employ a bidirectional dc–dc converter to manage the batteries, which makes the system complex, high cost, and low efficiency. According to qZSI, traditional control methods cannot ensure a constant dc-link peak voltage because of battery's voltage clamp.The qZSI with an ES was proposed for the PV power generation system the battery is connected to capacitor inparallel for balancing the power production (PV power) and consumption (load).[7] However, the demerit of their methods is loss of a constant dc-link peak voltage. The topology has a limited battery discharging ability due to discontinuous conduction mode (DCM), which impacts the inverter output power. DCM was avoided through employing an active switch rather than extra active switch makes the cost and power loss increase.

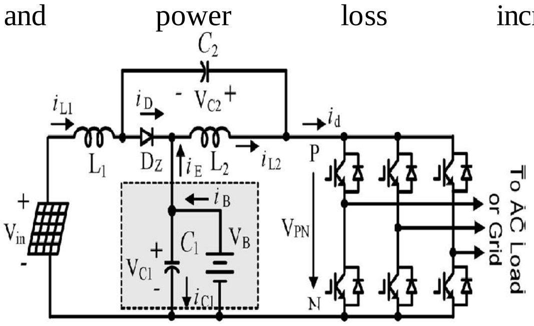

Fig.1 Circuit diagram

This paper proposes a novel energy stored qZSI-based PV power system with constant dc-link peak voltage to overcome the above demerits.

II. NEW QZSI-BATTERY TOPOLOGY

As a counterpart of Fig.1, Fig.2 shows a new topology. As in Fig. 1also has three power sources/consumers: PV panels, battery, and the grid/load. As long as controlling twopower flows, the third one automatically matches the power differencethrough using

$$P \;-P \;+P \;=0$$

Where, P ,P and P are the PV power, the inverter output power, and the battery power, respectively. The PV power isunidirectional; P is bidirectional, and positive when discharging and negative when charging; P is positive when the inverter delivers power to the grid.

A. Operating Principle

Similar to the existing qZSI operating principle [14], Fig. 2 also has shoot-through and non shoot-through states. A shoot-through state of the inverter is produced by any one phase leg, combinations of any two phase legs, and all three phase legs in Fig.1. As a result, the diode D is turned OFF due to the reverse-bias voltage; its equivalent circuit is shown in Fig. 3(a). During this time interval, the circuit equations are presented as follows:

$$\frac{}{} = \;+$$

$$\frac{}{} = -$$

$$\frac{}{} = \;+$$

$$\frac{}{} =$$

Where i and i denote the currents of inductors, respectively; V and V denote the voltages of capacitors , , and PV panel, respectively; C denotes the capacitance of capacitors and ,; L denotes the inductance of inductors , and ,.

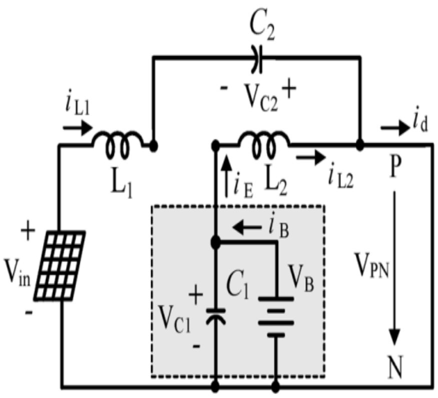

Fig.2 Shoot through state

In the shoot through mode, switches of the same phase in the inverter bridge are switched on simultaneously for a very short duration. The source however does not get short circuited when attempted to do so because of the presence LC network, while boosting the output voltage. The DC link voltage during the shoot through states, is boosted by a boost factor, whose value depends on the shoot through duty ratio for a given modulation index. Non-shoot-through state of the inverter is corresponding to one of the six active states andtwo traditional zero states. During this time interval, if a continuous current flows through diode D, its equivalent circuit is shown in Fig.3 and the circuit equations are presented as follows:

$$\frac{CdV}{dt} = i \quad + i \quad - i$$

$$\frac{CdV}{dt} = i \quad - i$$

$$L\frac{di}{dt} = V \quad - V$$

$$\frac{L\,di}{dt} = -V$$

Where i is the load current going to the inverter.

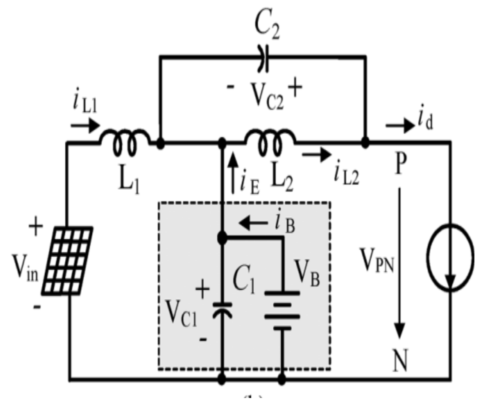

Fig.3 Shoot through state

II. SIMULATION DIAGRAM

The simulation is done for the quasi z-source inverter in both the modes of operation. The simulation diagram are shown in Fig.4 and Fig.5. The two modes are shoot through and non-shoot throughstate. The boost output is obtained in shoot through state. Normal output is obtained in non-shoot through mode.

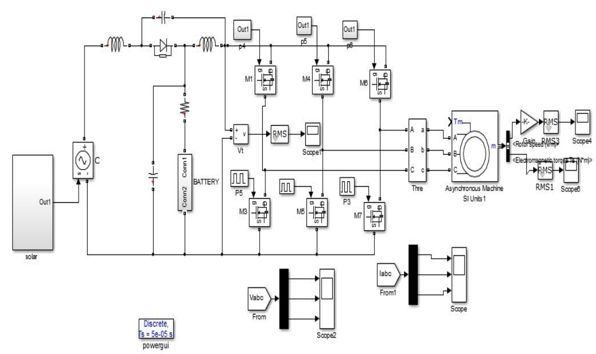

Fig.4 Simulation of shoot through mode

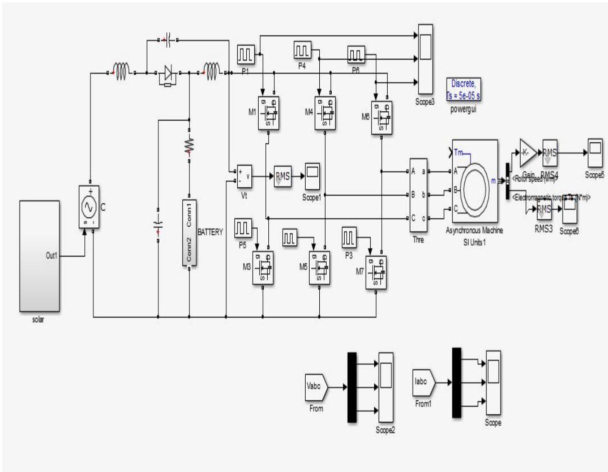

Fig.5 Simulation of non-shoot through mode

III. SIMULATION RESULTS

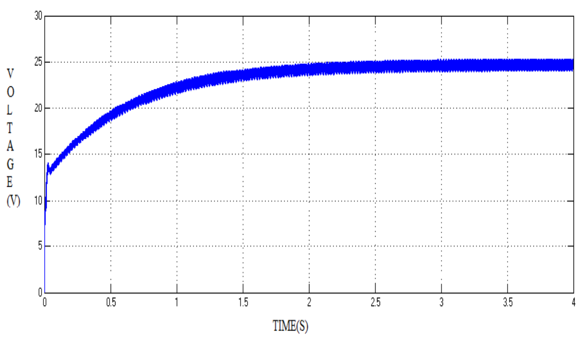

Fig. 6 Impedance network output of non-shoot through mode

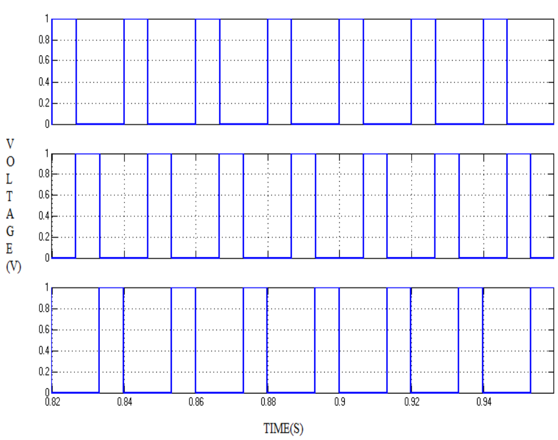

Fig.7 Gate pule of , and of non-shoot through mode

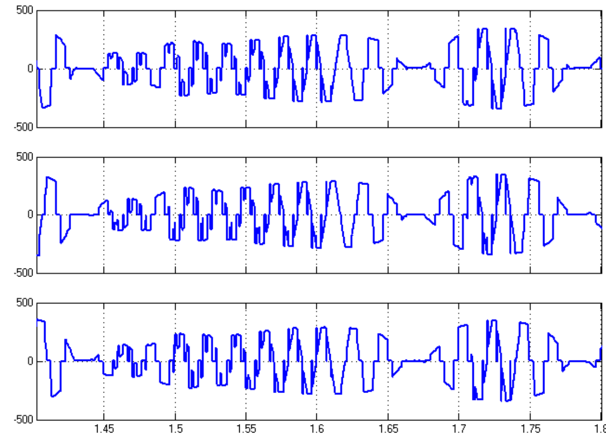

Fig.8 Output voltage of non shoot through mode

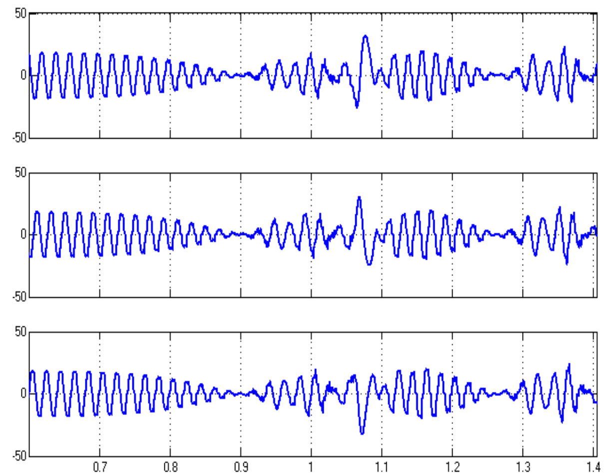

Fig.9 Output current of non-shoot through mode

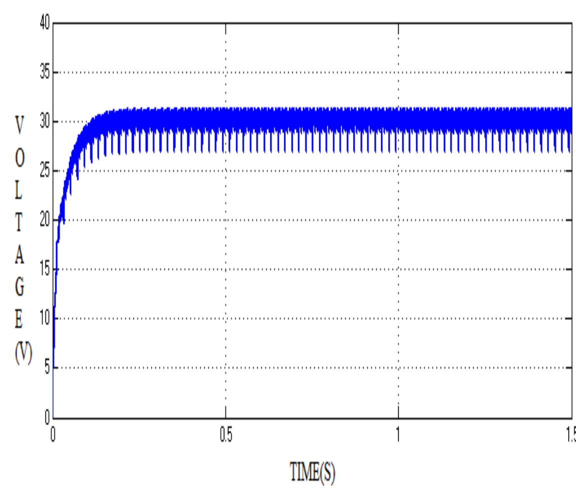

Fig. 10Impedance network output of shoot through mode

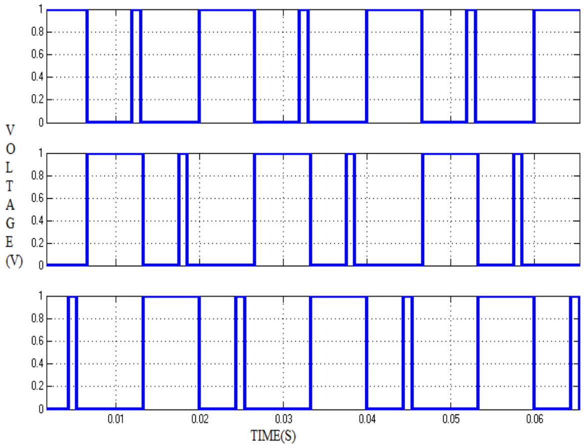

Fig.11 Gate pule of , and of shoot through mode

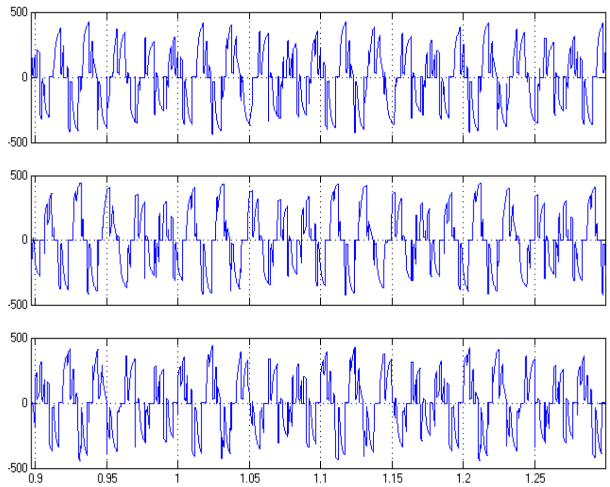
Fig.12 Output voltage of shoot through mode

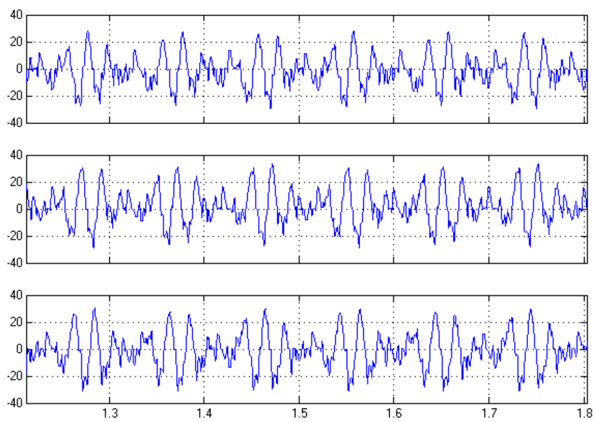
Fig. 13Output current of shoot through mode

IV. CONCLUSION

Quasi Z-source inverter with motor load is simulated under non shoot through and shoot through condition. Higher output power is obtained and THD is reduced under shoot through condition.At the same time, themaximum PV powerwas harvestedand the smooth power was injected to the load even though PV power presented undetermined fluctuations.

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