MODELING OF MULTIPHASE BOOST CONVERTER WITH QUASI-Z-SOURCE INVERTER FOR AC LOAD APPLICATIONS

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Abstract--- **To track the maximum power from the Photovoltaic (PV) array suitable DC-DC converter has to be used with the Maximum Power Point Tracking (MPPT) algorithm. In this paper, quasi Z source network is used with the multiphase boost converter for increasing the reliability of the system. Quasi Z source network is used to increase the power reliability and boost the voltage at a single step. It consists of one inductor, two capacitors and one diode. After the conversion of DC to DC, the inverter is added to the system through which AC load is connected. ZVS and ZCS are also implemented to reduce the switching losses.**

Keywords: PV, Maximum Power Point Tracking (MPPT), Quasi Z Source Network, DC-DC Converter, Inverter.

I. INTRODUCTION

The fossil fuel usage and carbon dioxide emission can be reduced using renewable energy source such as the Photovoltaic (PV) power system. Because of the unpredictable environmental conditions, such as irradiation and temperature, bring negative impacts to output characteristics of PV arrays. Therefore, an effective Maximum Power Point Tracking (MPPT) converter is necessary to improve the efficiency of the PV power system.

Usually, the boost converter is used in PV power systems to boost the voltage from the PV panel. Moreover, the interleaving technique, which can increase the input power rating but decrease the current ripple, has been adopted for PWM converters. For an m-phase interleaved boost converter, the current of each phase is only 1/m times of the total current. So that the current stresses and the power losses of the power switches can be reduced. It can improve the efficiency of the MPPT as well as increase the total output power of the PV system. Therefore, the boost converter with interleaved operation is adopted for high power system to achieve high power conversion efficiency and better MPPT performance.

II. RELATED WORKS

Tsai-Fu Wu, Chien-Hsuan Chang, Yyong-Jing Wu has proposed the Single-Stage Converters for PV Lighting Systems. The single stage conversion uses Maximum Power Point tracking topology. The Voltage can be tracked from the PV panel and it can be boosted in a single step.. The efficiency of the converters has been improved in this system compared to the other existing one. Here in order to govern the operation of the system both Pulse Width Modulation (PWM) and variable frequency control are used. The one disadvantage is that the switching losses are high in the proposed topology. [1]

Roger Gules, Juliano De Pellegrin Pacheco, Hélio Leães Hey. has described the MPPT for PV Stand- alone applications. The load can be either connected in series or parallel to the converter. Here the converter is connected in parallel with the PV panel and load which reduces the negative influence of power converter losses. Hence the switching losses are less. A simple bidirectional dc–dc power converter is proposed for the MPPT implementation. The only drawback of this paper is the ripple content of the current is more. [2]

M.A. Alsumiri, L. Jiang, W.H. Tang has proposed a MPPT controller for PV system using Sliding Mode Control(SMC) in order to overcome the power oscillations and obtain a satisfactory operation of a PV power system. Here both Incremental Conductance algorithm and Perturb & Observe algorithm was implemented. A control strategy based on feedback and high frequency switching is described. There is confusion in tracking the maximum power. A constant gain should be maintained which introduces a steady state error into the system. [3]

III. PROPOSED METHODOLOGY

The proposed system block is shown below.

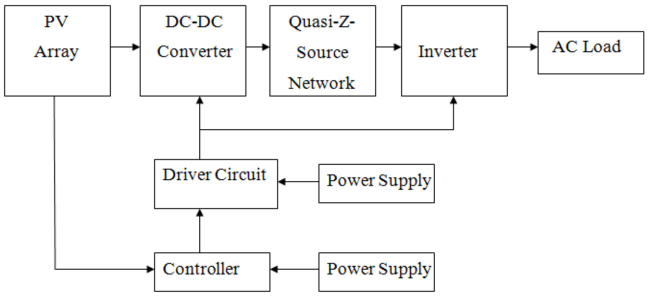

Fig 1. Block diagram of proposed system

The Converter used here is a Multiphase Boost Converter .The current gets divided in the paralleled power stages and thermal stress in each switch is reduced. In multiphase boost converter the gate signals of the switches are phase shifted. The output of Converter is fed into the Quasi Z Source Network. This network decreases the fluctuation produced in the DC input and therefore the power regulation is increased. Cascading of Quasi is possible so the same network is used to boost the voltage and maintains voltage reliability. The output of this quasi network is fed into the inverter where it is converted into AC output and given to the AC load.

IV. MAXIMUM POWER POINT TRACKING ALGORITHMS

MPPT algorithms are necessary in PV applications in order to track the Maximum power from the PV panel because solar panel varies with the irradiation and temperature.

There are many MPPT algorithms have been developed and published based on required sensors, complexity, cost, range of effectiveness, convergence speed, correct tracking when irradiation and/or temperature change etc. From these techniques, the P&O and the Incremental Conduction algorithms are the most common.

A.Perturb and Observe (P&O) algorithm

Perturb and observe based MPPT is PV array independent. The tracking efficiency of this algorithm is good. The implementation is simple and the sensing parameters in this algorithm are voltage and current. The P&O algorithm is also called as “hill-climbing”. In P & O method the controller adjusts the voltage by a small amount from the array and measures power, if the power increases, further adjustments in the direction are tried until power at certain point starts to decrease. This point is known as Maximum Power Point (MPP). This is called P&O method. Due to simple implementation and cost effectiveness, it is the most commonly used MPPT method.

V.MULTIPHASE BOOST CONVERTER

A multiphase boost converter is a step up converter in which the gate signals to the switches are phase shifted. Usually, the output voltage of the boost converter is greater than the input voltage. The multiphase boost converter used here is three stage boost converter. It consists of 3 switches (MOSFET), 3 inductors and 3 diodes. Here three boost converters are operated in parallel to get the maximum voltage.

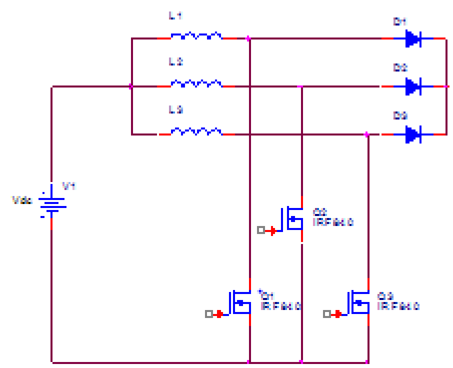

Fig 2. Multiphase boost converter

VI. QUASI Z-SOURCE NETWORK

Quasi Z source network consists of an inductor, capacitor and a diode. The quasi network can be operated in both shoot through state and non-shoot through state. In non-shoot through state it acts as a Voltage Source Inverter (VSI) i.e. it simply fed the voltage to the inverter. During shoot through state the high voltage is produced at this time the inductors are charged using this energy and the capacitors are used to absorb the ripple contents in the voltage. Hence the ripple content can be minimized and the voltage can be boosted using this network.

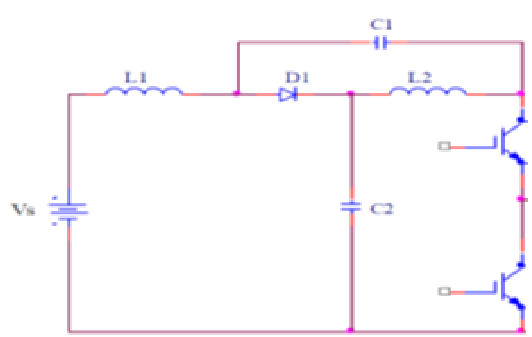

Fig 3.Quasi-Z-source Network

VII. PULSE WIDTH MODULATION

Pulse width modulation (PWM) is a technique used to encode the message into pulsing signal. This technique decreases the Total Harmonic Distortion (THD) of load current. THD is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental. PWM technique controls the power to be supplied for the electrical devices. The main advantage of PWM technique is that it reduces the power losses in the switching devices.

VIII. SIMULATION RESULT

The simulation circuit of the proposed model is shown in fig 4. The output voltage from the PV panel is given to the multiphase boost converter where the voltage is boosted to its maximum level.

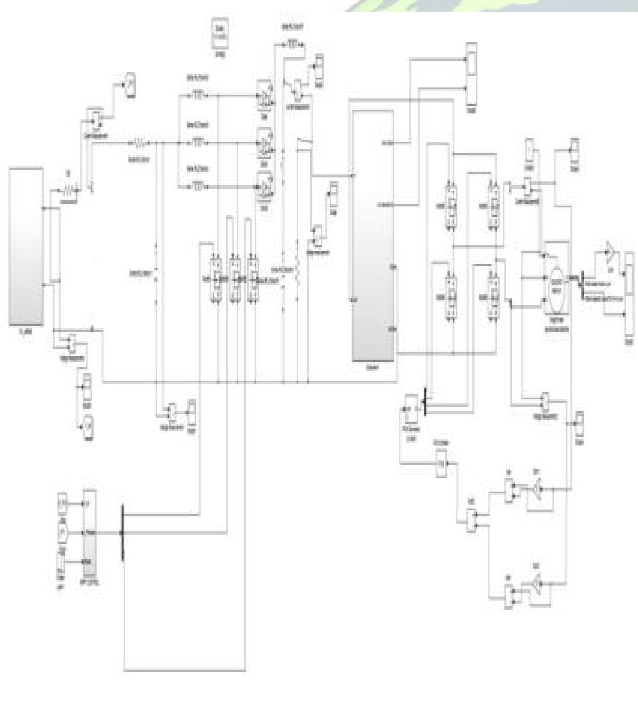

Fig 4. Simulation diagram

The MPPT controllers are used to control the output of interleaved boost converters in which P & O algorithm is coded. The Multiphase boost converter is followed by quasi Z source network. The boosted voltage from the multiphase boost converter is given to the quasi Z source network. Here the quasi is operated in shoot through state to produce high voltage. Finally, the boosted DC voltage is given to the single phase inverter to run the AC load

Simulation specifications are listed in the table I below.

TABEL I

Parameters	***Values***
Input voltage	50 V
Capacitor C1	100 mf
Inductor L1,L2,L3	1000 µH
QZ-source capacitors C2,C3	1e-2F
QZ-source inductors L3,L4	10 mH
Output Voltage	230 V
Output Current	4 A
Induction Motor Rating	230V,4A,50Hz,1500RPM

The input voltage to the system is nearly 50 V this can be boosted to 180 V using Multiphase boost converter. The waveform is shown in the fig 5.

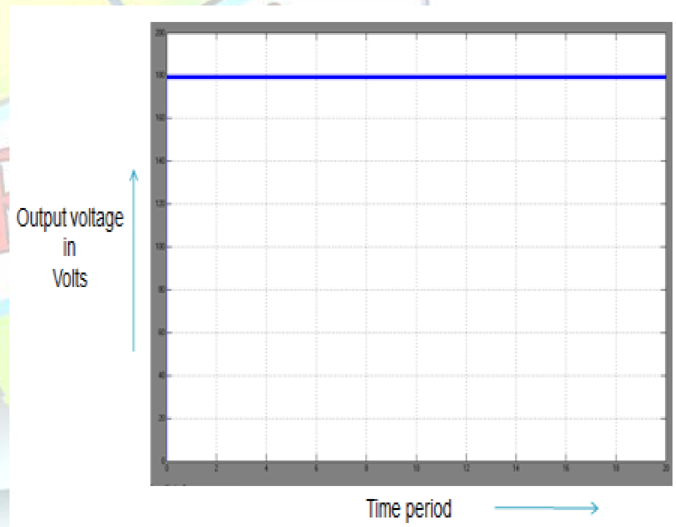

Fig 5. Three boost converter output voltage

The the boosted DC voltage is converted into AC voltage using single phase inverter. The voltage is boosted to 230 V. The output phase voltage waveform shown in fig 6.

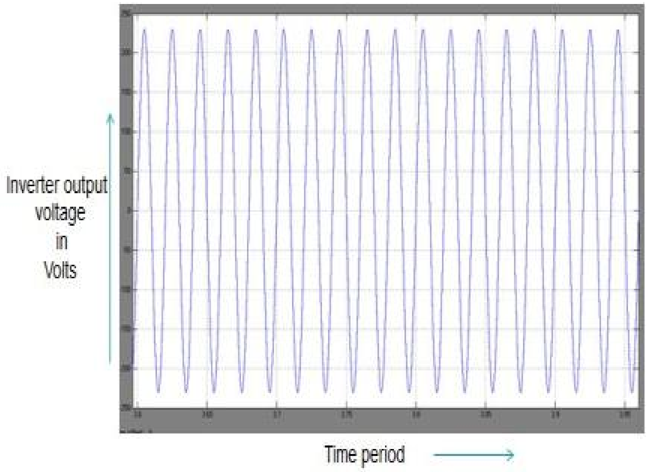

Fig 6. Inverter Output voltage

The output speed and torque waveform of the single phase induction motor is shown in fig 7.

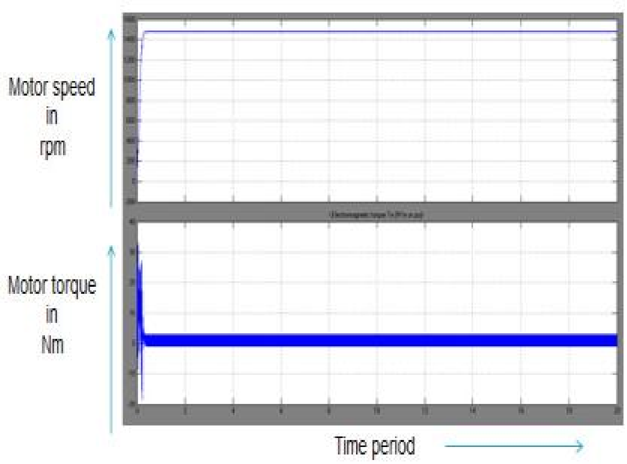

Fig 7. Motor output Speed and Torque

IX.CONCLUSION

PV array has been simulated ,boosted and integrated to the QZSI with maximum power point tracking algorithm (perturb and observe method) .In this paper, analysis of multiphase boost converter with quasi Z source network for PV array is described. Quasi Z source network is used to increase the power reliability and boost the voltage at a single step and it reduces the ripple content in the voltage. Using MATLAB simulink we designed the circuit and verified the output efficiency.

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