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Transformer less Z - Source Inverter using Grid Connected PV System

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Abstract: ***This paper proposes a three phase DC-AC transformer less z – source Inverter using grid connected PV system. The proposed techniques can operate in buck – boost mode depends on desired output voltage. The proposed system employs a pulse with modulation (PWM) DC-AC converter along with feed forward PI close loop control. Its find the real and reactive power of input system. In this system used power semiconductor device IGBTs as bidirectional switch this circuit can easily and steadily maintain regulated voltage supply. This proposed techniques provide steady state output voltage with PI controller; which is verify with theoretical and simulation results.***

Key Terms: Transformerless z source inverter, buck - boost, PI controller, MPPT, IGBT, PV system.

I. INTRODUCTION

Transformer less Z-source inverters are proposed to extend the traditional Z-source inverter with higher buck-boost capabilities and also its reducing the passive components at the same time for PV fed applications. A new scheme for high boost Z-source inverter based on AC grid in this project. The proposed topology has two inductors, two capacitors and three diodes in the Z-impedance network. Photovoltaic (PV) systems is the electric power generation systems due to their low environmental impact and high availability of solar irradiation is most geographical locations. The energy generated by PV systems is highly dependent on the environmental and ambient conditions such as the solar irradiance level and the module temperature.

The grid-tied with PV systems typically use a two-stage power conversion topology: an upstream dc/dc power conversion stage from the PV module to a dc link energy buffer (such as a capacitor), and a downstream dc/ac power conversion stage from the energy buffer to the grid. The upstream conversion stage is only responsible for transferring the maximum available energy from the PV module to the energy buffer. The downstream stage is responsible for controlling the flow of energy to the grid by Generating ac voltages that are synched with the grid voltage and controlling the power factor of the operation.

The first part of this work presents a new control scheme for a grid-tied ZSI based PV energy harvesting system based on the concept of MPPT technique that maximizess the energy harvest performance under dynamic conditions. Active and reactive power control at the same time requires control of both of the power or their power components i.e. id and iq. In this paper based on the mode of operation (MPPT), the power components are adjusted through control of P and Q. During the normal grid condition operation, the reference for active power (Pref) is determined by the MPPT unit. But the output of the result voltage will be not in accurate while to be used PI controller in this techniques.

The main objective of this paper is to propose method exhibits better performance in comparison to conventional hill-climbing methods and requires less computational effort than artificial intelligence-based and complex mathematical methods. This work proposes a method that performs better than the conventional MPPT methods while requiring less computational effort than more modern MPPT techniques, and is backed by a rigorous proof of convergence that guarantees stable operation even in presence of noise and dynamical environmental conditions.

II. PHOTOVOLTAIC SYSYTEM

In PV system connected to the grid required some special conditions to be obtained by a high-quality electric power system. DC-DC boost converter used with the maximum power point tracking (MPPT). Its used to extract the maximum power obtained from the sun and transfer it to the grid. The PV based system, connect to the Z source inverter its convert dc power converts into AC power, before injecting to the grid. The control units to be used for particular power value from the PV system its give the proper value of the voltage.

Commonly, the conventional inverters classified as Voltage-Source Inverters (VSI) can only step-down the voltage while the Current-Source Inverters (CSI) can only step-up the voltage

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Therefore, conventional dc/ac inverters in general, cannot both step-down and step-up the voltage freely. As mentioned above, the MPP voltage of a PV module is not constant and needs to be tracked by the PV harvesting system.

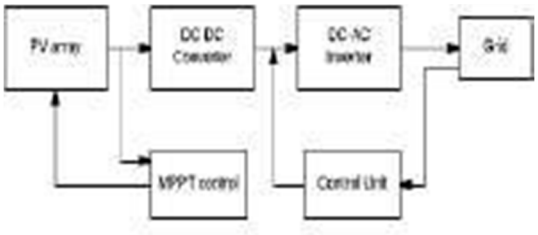


Fig:1. Block Diagram of a Basic Grid +Connected PV System

A. MPPT

The P&O algorithm is one of the most popular MPPT methods due to its simplicity and reliance on engineering intuition for tracking the MPP. The P&O algorithm can be implemented in two fashions: (a) Searching for the MPP while checking the sign of the differential coefficient of the power (P), with respect to the current (I), according to the P−I characteristic curve of the PV module (dP/dI method), or (b) Searching for the MPP while checking the sign of the differential coefficient of the power (P), with respect to the voltage (V), according to the P−V characteristic curve of the PV module (dP/dV method). The P&O method tracks the MPP by repeatedly updating the operating voltage of the PV. A wide range of solar irradiance levels and can more effectively hedge against dynamic environmental conditions that affect the MPP of the PV modules.

B. ZSI Power Injection Control Scheme

This part of the control system has three goals: regulating the PV voltage to provide by the PV side MPPT system by properly adjusting the inverter gain, controlling the ratio of active/reactive power injected to the grid (power factor control) according to the specific application requirements, and minimizing the voltage stress on the switches. The proposed control system accomplishes the three mentioned goals by generating M, D, and the phase angle of the inverter voltages. The generated values will be used by the simple-boost modulator to produce proper switching signals for controlling the inverter. The inverter gain generated by the PI controller can be used along with the desired power factor of the operation to calculate the phase angle of the inverter voltages the inverter system.

III. Z SOURCE INVERTER

The Z-network is responsible for boosting and also tracking the MPP. The ST duty cycle T_0/T can be increased or decreased depending on the change in power absorbed by the inverter from the DC source (P&O method). This process is identical to MPP tracking in the traditional VSI boost topology. The duty cycle at MPP absorbs all the power from the PV panel hence matching the PV panel with the ZSI.

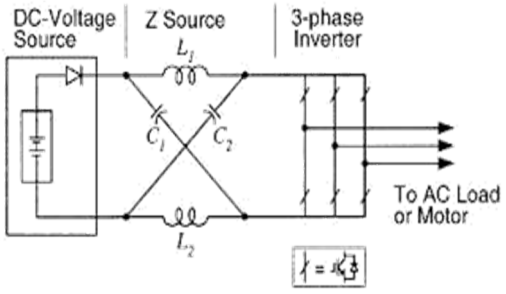


Fig: 2.Three phase z source inverter

A. Operation

The ZSI can be classified into three operation modes as given below:

1) Mode 1: Inverter bridge is operating in one of the six active states and the brigde can be seen a s an equivalent current source During this mode the DC source voltage appears across the 'inductor and the capacitor'. Capacitor is charged and energy flows to the load via the inductor. The inductor discharges in this mode.

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2) *Mode 2:* Inverter bridge is operating in one of the two zero states as the bridge 'short circuits the load through either the upper or lower three switching devices. During this mode the bridge can be viewed as an 'open-circuit' (current source with zero current flowing, shown in 2(i)). Voltage of the DC source appears across the 'inductor and the capacitor', except that no current flows to the load, from the DC source.
3) *Mode 3:* Inverter bridge is operating in one of the seven different ways of ST. The bridge is viewed as a 'short circuit' from the DC link of the inverter as shown in Fig.3(ii).during this mode , no voltage appears across the load the dc voltage of the capacitor is boosted to the required value according to the ST duty raito. The ST interval (To) is boost the voltage level.

This section presents the predictive modeling of the grid side filter and the PV side impedance network. The dynamic model of the grid side filter is given by,

$$\frac{d}{dt}i_L(t) = \frac{1}{L}(v_i(t) - v_g(t) - i_L(t)R_{esr})$$

(1)

$$\frac{d}{dt}v_c(t) = \frac{d}{dt}v_g(t) = \frac{1}{C}(i_L(t) - i_g(t))$$

(2)

Where iL(t) is the inductor current, vi(t) is the
output voltage of the inverter, vg(t) is the ac grid voltage, L and C are the filter's inductance and capacitance values, and Resistance is the equivalent series resistance of the inductor. By applying the Euler forward approximation method to they can be discretized,

$$\tilde{i}_L(k+1) = \frac{T_s}{L}(v_i(k) - v_g(k) - i_L(k)R_{esr}) + i_L(k)$$
$$\tilde{v}_C(k+1) = \frac{T_s}{C}(i_L(k) - i_g(k)) + v_C(k)$$

(3)

Where Ts is the sampling period.

One of the main characteristics of ZSI is its shoot-through mode for flexible boosting of the input (PV) voltage. In this mode, both switches in one leg of the inverter are simultaneously turned ON. The equivalent circuit model of the ZSI in Fig.3 for shoot-through mode and non-shoot-through modes (active states) are illustrated (a) and (b). Using these equivalent circuits and Euler forward approximation, the predictive model of the Z source network can be developed. The predictive equations for the inductor L1 current and capacitor C1 voltage in a non-shoot-through mode are,

$$\tilde{I}_{L1}(k+1) = I_{L1}(k) + \frac{T_s}{L_1}(V_{in}(k) - V_{C1}(k) - R_{L1}I_{L1}(k))$$
$$\tilde{V}_{C1}(k+1) = V_{C1}(k) + \frac{T_s}{C_1}(I_{L1}(k) - I_{inv}(k))$$

(4)

While the same equations for a shoot-through state are,

$$\tilde{I}_{L1}(k+1) = I_{L1}(k) + \frac{T_s}{L_1}(V_{C1}(k) - R_{L1}I_{L1}(k))$$
$$\tilde{V}_{C1}(k+1) = V_{C1}(k) - \frac{T_s}{C_1}I_{L1}(k)$$

(5)

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The second order general integrator (SOGI) is used to determine the in-phase and quadrature component (αβ) of grid voltage and current. Thus, by using the instantaneous power analysis and the αβ component of grid voltage and current, the predictive equations for the active and reactive power can be determined as

$$\bar{P}(k+1) = \frac{T_S}{L}\begin{pmatrix} v_{i\alpha}(k)v_{g\alpha}(k) + v_{i\beta}(k)v_{g\beta}(k) \\ -v_{g\beta}^2(k) - v_{g\alpha}^2(k) \end{pmatrix} + P(k)$$

$$\bar{Q}(k+1) = \frac{T_S}{L}\left(v_{i\alpha}(k)v_{g\beta}(k) - v_{i\beta}(k)v_{g\alpha}(k)\right) + Q(k)$$

(6)

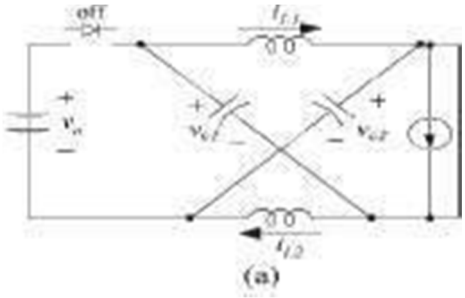


Fig:3(a). Equivalent Circuit in Shoot - Through mode

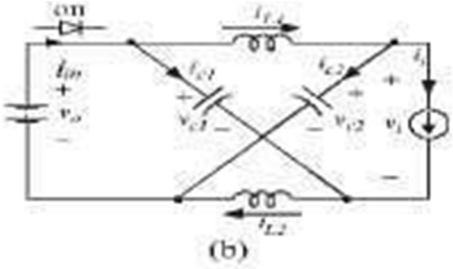


Fig:3(b).Equivalent Circuit In Non Shoot - Through mode

The z source inverter normally based on the shoot through mood condition. Its used to boost the voltage of the PV system. PWM generator generate the pulse to the generator. The square wave output is convert into sine wave with the help of LC filter. PI control use to correct the error of real and reactive power values. The accurate result of the voltage value will be proposed by the system . And also to calculate the grid voltage and grid current level to be caluculated by the matlab simulation method.

IV. SIMULATION RESULT

The simulation result of transformerless Z source inverter using grid connected PV system is simulated using MATLAB/SIMULINK environment. The output of real and reactive power, three phase AC grid voltage and AC grid current waveform simulation results are shown below.

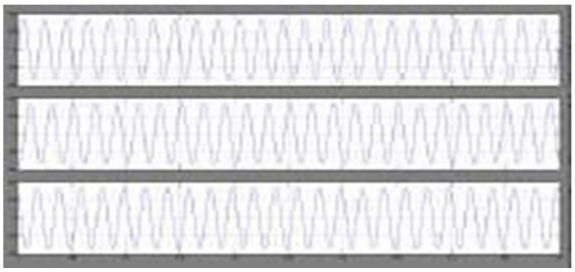


Fig: 4. Output of Three phase AC grid voltage waveform

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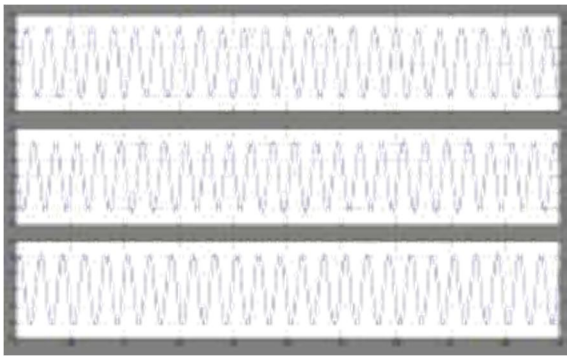


Fig: 5. Output of Three phase AC grid current wave form

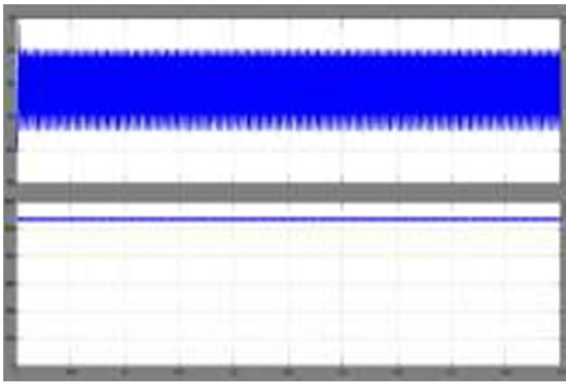


Fig: 6. Output of real and Reactive power wave from

V. CONCLUSION

The paper has presented the analysis of the traditional Z-source inverter. The first part of this work presents a new control scheme for a grid-tied ZSI based PV energy harvesting system based on the concept of MPPT technique that maximizes the energy harvest performance under dynamic conditions. . In this paper based on the mode of operation (MPPT), the power components are adjusted through control of P and Q. During the normal grid condition operation, the reference for active power (Pref) is determined by the MPPT unit. But the output of the result voltage will be not in accurate while to be used PI controller in this techniques.

REFERENCE

[1] H. T. Do, X. Zhang, N. V. Nguyen, S. S. Li, and T. T. T. Chu, "Passive-Islanding Detection Method Using the Wavelet Packet Transform in Grid-Connected Photovoltaic Systems," IEEE Transactions on Power Electronics, vol. 31, pp. 6955-6967, 2016.

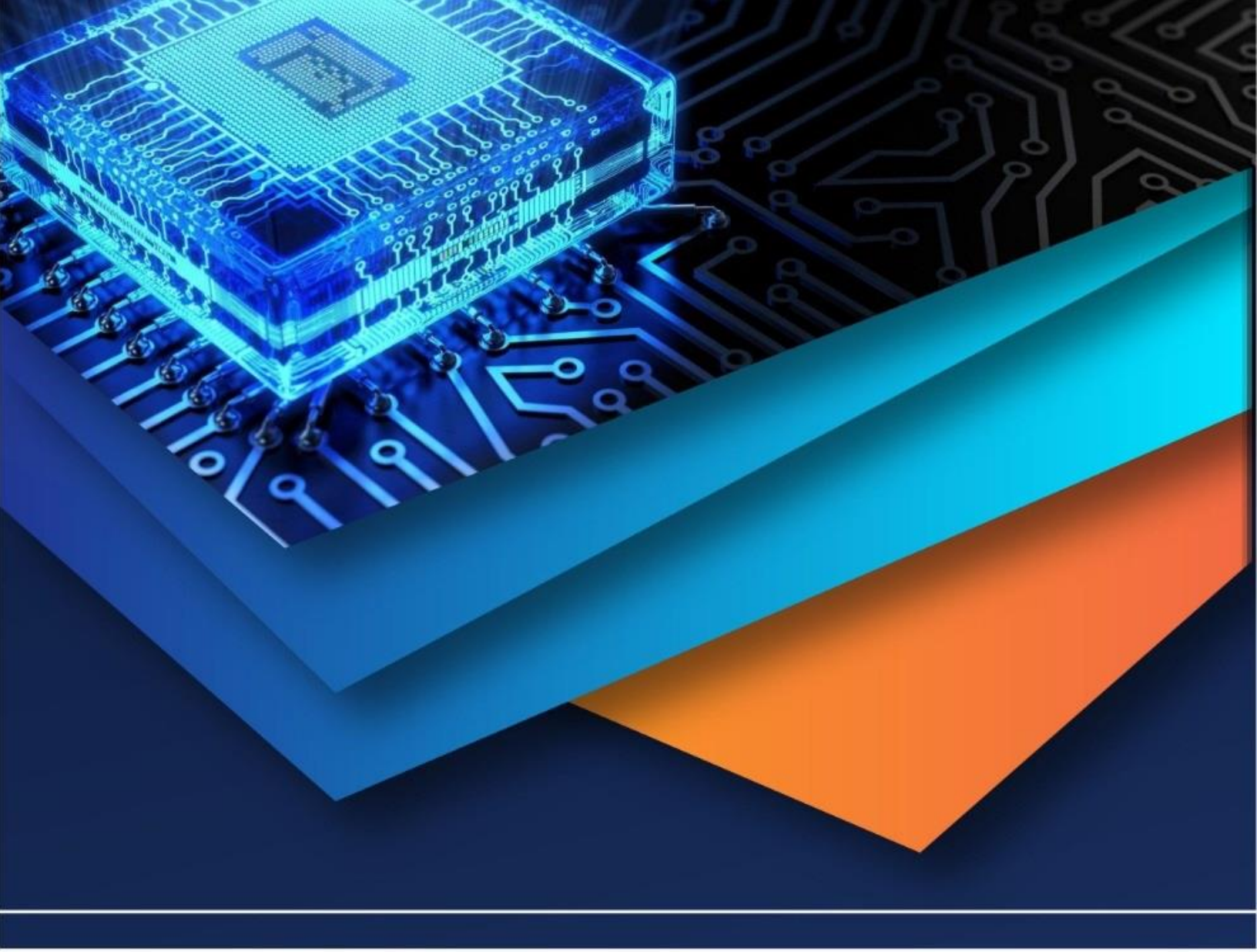
[2] Y. Shi, B. Liu, and S. Duan, “Low-frequency input current ripple reduction based on load current feed forward in a two-stage single- phase inverter,” IEEE Trans. Power Electron., vol. 31, no. 11, pp. 7972–7985, Dec. 2016.

[3] H. An and H.Cha, “Second harmonic current reduction by using a resonant circuit in a single– phase battery charger,” in Proc. IEEE Energy Conv. Cong. Expo, 2013, pp. 1409–1413.

[4] S. Kouro, J. I. Leon, D. Vinnikov, and L. G. Franquelo, "Grid-Connected Photovoltaic Systems: An Overview of Recent Research and Emerging PV Converter Technology," IEEE Industrial Electronics Magazine, vol. 9, pp. 47-61, 2015.

[5] Q.-C. Zhong; and T. Hornik;, "Cascaded current–voltage control to improve the power quality for a grid-connected inverter with a local load," IEEE Transactions on Industrial Electronics, vol. 60, pp. 1344-1355, 2013.

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