DESIGN AND ANALYSIS OF MODULAR CASCADED H-BRIDGE MULTILEVEL INVERTER FOR MPPT BASED PV CONNECTED GRID APPLICATIONS

Sk. Nawaz shareef[1], G.Tabita[2]

[1]PG Scholar, EEE, lakireddyBalireddy College of Engineering,shareef.eee786@gmail.com

[2] Asst.Professor, EEE, lakireddyBalireddy College of Engineering

Abstract— this paper reports a modular cascaded H-bridge multilevel photovoltaic (PV) inverter for single- or three-phase grid-connected applications**.** The efficiency, flexibility and stability of the system has been increased and improved by the modular cascaded multilevel technique. The MPPT technique is used for both single and three phase multilevel inverters to essence extreme power energy from the PV segments, this MPPT technique is helpful for an individual control of each dc-link voltage. Due to the unbalanced power supply to the PV cells may lead to unbalanced grid current for three phase grid coupled applications. To overcome this problem in the three phase grid tied applications modulation compensation control technique is proposed .By using nine h-bridge modules, we can built a three phase seven level cascaded H-bridge inverter (three modules per phase). 185-W solar panel is tied to each h-bridge module. Simulation results are presented.

Keywords: Cascaded multi-level inverter, distributed maximum power point (MPP) tracking (MPPT), modular, modulation compensation, photovoltaic (PV)

INTRODUCTION

Due to the conventional power generation natural fuels consumption will reduce and climatically problems will increase. Geothermal power especially solar energy at present has turn into popular. The production of solar energy has been increased 20%-25% per Annam from the last 25 years and mostly the growth occurs in grid linked applications [1].The strange growth of market in PV systems the interest also increased for grid tied configurations. At fig1 five inverter families are shown to the separate formations of the PV system [2]-[7].

Several inverters are connected in series in cascaded inverters; due to combination of number of module inverters will give high power and high voltage. it will help in this scheme for small end bulky PV systems[8]-[10].which are connected to grid. 2 types of series inverters are present in this topology. The dc-dc converter association of PV segments are shown in fig.1 (e). This process combines the features of string inverters, ac-module inverters provides the advantages of individual segment MPPT, but it has lower and the efficiency is more than the ac module inverters[11]-[12].

But, in this configuration we have two power conversation phases. Additional series linked inverter is shown in fig. 1(f),it is also a dc to ac inverter, a PV panel is connected to it., then these inverters are joined in series to get high voltage level [13]. The benefits maintained by this cascaded inverter are of "per panel one converter," such as improved operation per PV module, the ability of merge the different source, and separation of the organization. In resulting, this dc/ac series connected inverters will eliminate the requirement of the dc bus and also the central dc/ac inverter, which improver's complete efficiency.

The integrated cascaded multilevel h-bridge inverter that needs an isolated dc source for each h-bridge. Independent voltage control is possible by the division of dc links in multilevel inverter. As a result, in each PV module individual MPPT control is achieved, and

maximum energy is gathered from the PV panels. Temporarily, the low cost and the modularity of multilevel converters will place them as primary aspirant for the following generation of capable, and dependable grid tied solar power electronics.
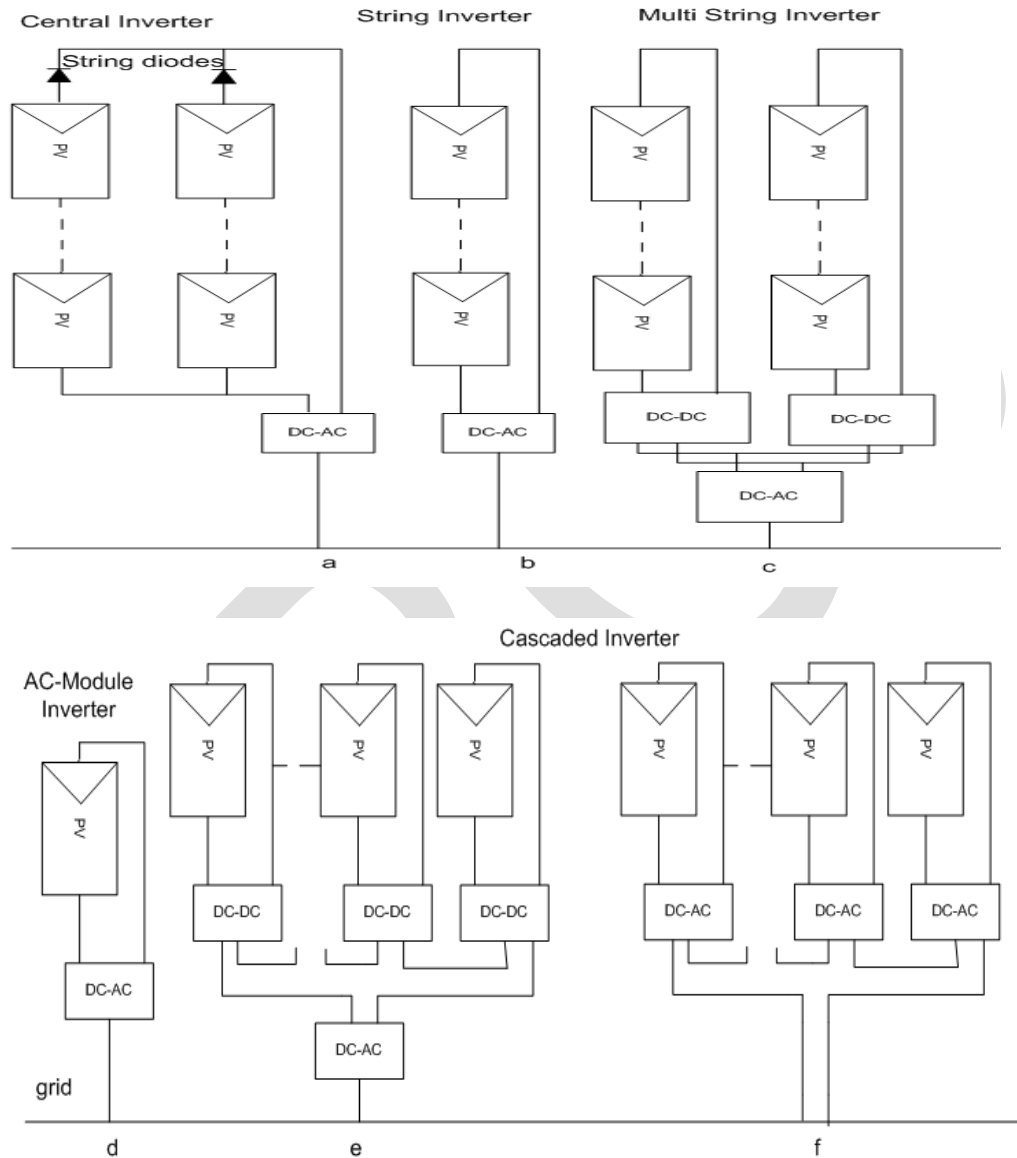

Fig. 1 PV systems configurations

In this project segmental series connected multilevel h-bridge inverter scheme for three phase or single phase grid tied PV system is offered. The panel different topics are shown to describe the requirement of independent MPPT control, and a distributed MPPT control through a control scheme is proposed. And this MPPT control technique is related to single phase as well as three phase systems. Further, individual PV segment is working at its MPP, for the offered three phase grid tied PV systems, unstable power is delivered to the three phase multilevel inverter due to the PV mismatches, leading to unbalanced injected grid current. The modulation compensation technique is additionally added to the control system to balance the three phase grid current. Modular series connected three phase multilevel inverter prototype has been assembled. 185-W solar panel is connected to each h-bridge. This modular design will reduce the cost as well as the flexibility of the system will also increase. And the model results are shown to describe the established control system.

II. EXPLANATION OF PROPOSED SYSTEM

In Fig. 2. Three phase and single phase grid tied PV schemes through modular series connected h-bridge multi-level inverters are shown. n H-bridge converters are tied in series. Through L filters series connected multilevel inverter is tied to the grid, it was used to remove the current harmonics. In each H-bridge module four switches are connected in different combinations, -vdc, 0, or +vdc are the three output voltage levels which are generated. In this type, from n input sources, 2n+1 ac output wave forms will generate. The other advantages of multilevel inverters such as reducing the voltage stresses on the semiconductor switches and it has high frequency

EXPLANATION

III. PANEL MISMATCHES

The significant matter in the PV scheme is PV mismatch. The MPP of individual PV module is diverse due to different temperatures, receiving of unbalanced irradiance and aging of PV panels. To get the better efficiency of PV system, we have to control each PV module independently. Five level two-H-bridge single-phase inverter is simulated in MATLAB/SIMULINK to show the necessity of the individual MPPT control.185-W PV panel is tied as an isolated dc source to each H-bridge. According to the requirement of industrial PV panel, PV panel is modeled from astrometry CHSM-5612M. let an working condition for the each PV panel having various irradiation conditions from the sun; let us consider panel 1 irradiance S = 1000 W/m2 and and panel 2 irradiance is S =600 W/m2. And if the panel 1 is traced and its MPPT controller decides the average voltage of both panels, the power outlet from both the panels P1 is 133W and P2 is 70W as shown in the Fig. 3. The total power harvested from the entire PV system is 203W without individual MPPT control.

PV variance may cause more difficulties in three phase grid tied PV system. By the introducing of unstable power supply to the 3 phase grid tied systems overall efficiency may decreases. Input power individual phase will be different if there are PV mismatches among the phases. Since unbalanced currents will formed in the grid due to the differences in input power but grid voltage is balanced. To resolve the PV mismatch issues, independent MPPT control and modulation compensation are suggested in this paper.

IV CONTROLTECHNIQUES

A. Distributed MPPT Control

To increase the effectiveness of a PV scheme and to remove the opposing effect of the misalliances the PV segments essential to work at various voltage levels to increase the consumption per PV segment. The individual voltage control is feasible by the isolated dc links in the series connected H-bridge multilevel inverter. To realize the each single MPPT control in each PV segment the control technique proposed is reorganized for this application. The three-phase cascaded H-bridge inverter of distributed MPPT control is shown in Fig. 5. An MPPT controller technique is added to produce dc-link voltage references in individual H-bridge module. Single dc-link voltage is matched to their equivalent voltage reference and to determine the current reference then sum of all the mistakes are measure over the voltage controller. The reactive current reference can be set to zero, Iq ref can also be assumed by a reactive current calculator. To find out the phase angle of the grid voltage the synchronous reference frame phase-locked loop (PLL) has been used. The grid currents in abc organizes are modulated to coordinates with the classic control system in three phase system and to produce the modulation index in the coordinates they are measured through proportional integral (PI) controller, which is then changed back to three phases.

For single phase system the distributed MPPT control technique is almost same. The magnitude of the active current reference values given by the total voltage controller, and phase angle and frequency of the active current reference value is provided by the phase-locked loop. Current control loop gives the value of variation index. To make every single PV module work on its own MPP the voltages v_{dca2} to v_{dcan} are managed independently through n-1 loops. In phase a modulation index proportion of single H-bridge module is given by voltage controller. Modulation indices can be acquire by multiplying modulation index of phase a and n-1. The control techniques are same for both b and c phases. Through PI controller, dc-link voltages are regulated. a phase-shifted sinusoidal pulse width modulation switching technique is used to command the switching devices of each H-bridge. Out of N modules there is only one H-bridge module whose modulation index is get by subtraction. The implementation and development of many MPPT techniques have done. We used incremental conductance technique is used in this project.
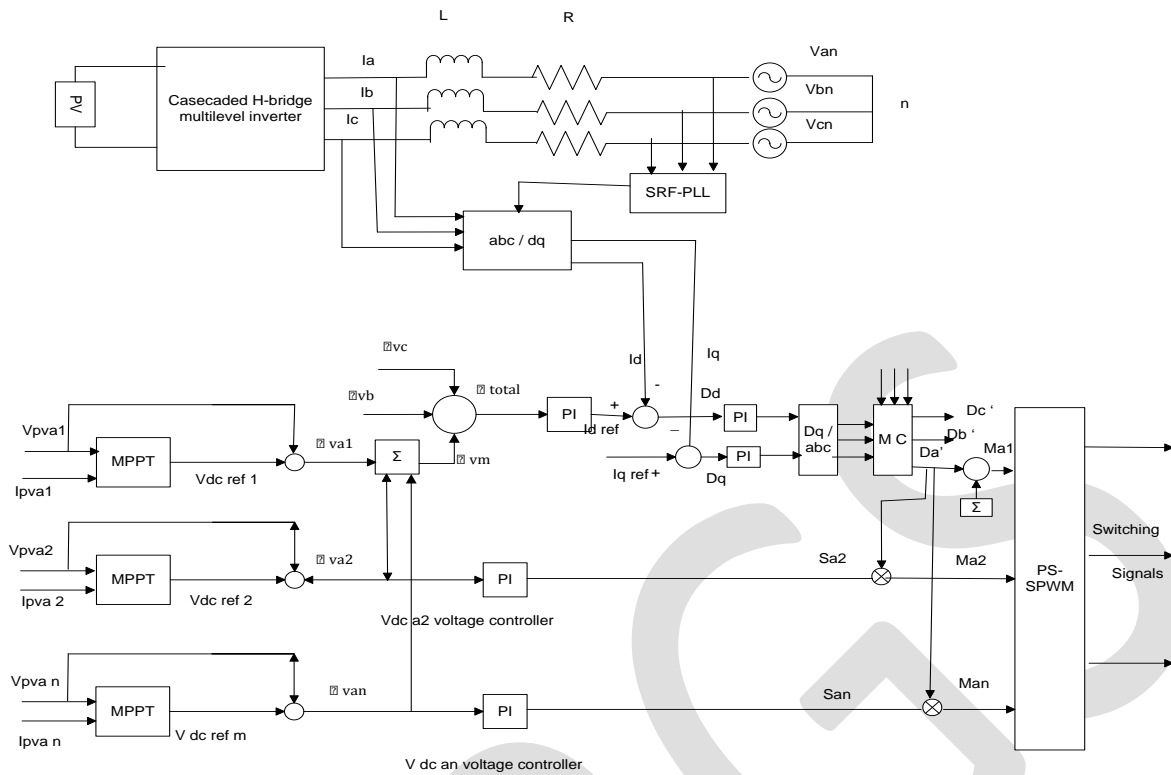
Fig. 3 three-phase modular cascaded H-bridge multilevel PV inverter

B. Modulation Compensation

PV problems may cause many troubles to a three-phase multilevel PV inverter, which brings unstable current to the grid. Zero sequence voltage is inflicting the phase legs in order to strike the current flowing in each phase. Unbalanced current is proportional to output phase voltages, to get the balanced current. Without increasing the difficulty of the control system is used to improve the modulation index of each individual phase. Is the ratio of unbalanced power weight .Where is the phase a, phase b, phase c input powers. The average output power is denoted by Then, a zero sequence modulation index is injected it will be

$$r_j = \frac{P_{inav}}{P_{inj}}$$

Where d_j *the modulation index of phase is* a, phase b, phase c. and these are decided by the current controller.

$$d'_j = d_j - d_0$$

In this scheme easy calculations are needed which are not increases the complications of the control system. To explain the modulation compensation technique, one example is presented in below figure. Here the input powers of each phase is assumed to be unequal.
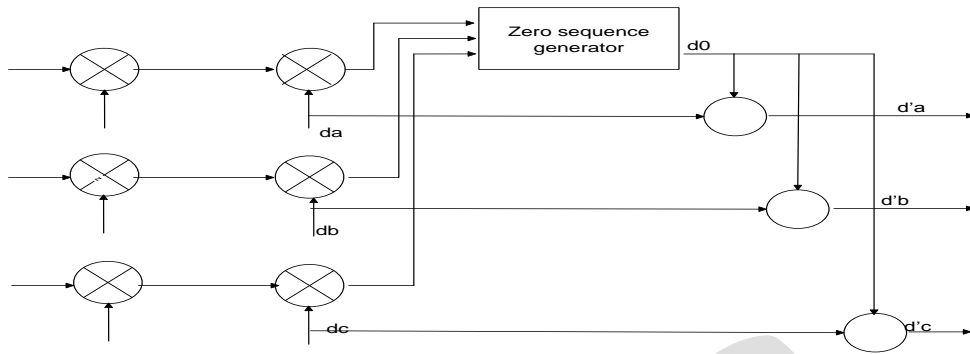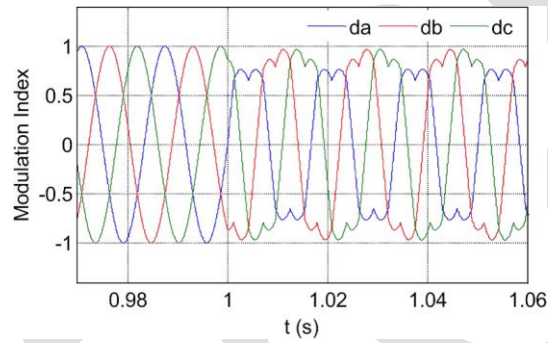
Fig. 4 Modulation compensation scheme

Fig. 5 before and after modulation compensation of modulation indices
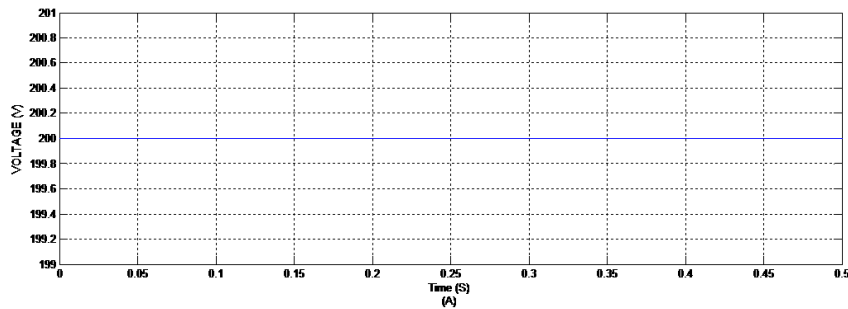
V. SIMULATION RESULTS

Fig 6. DC-link voltages
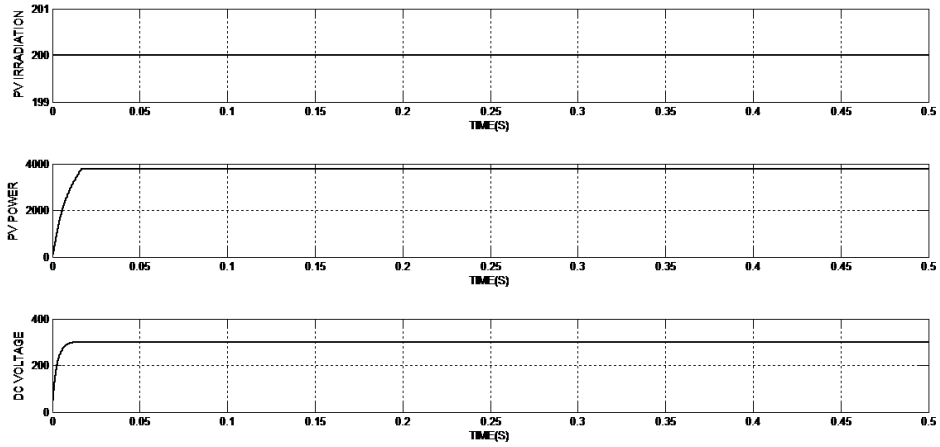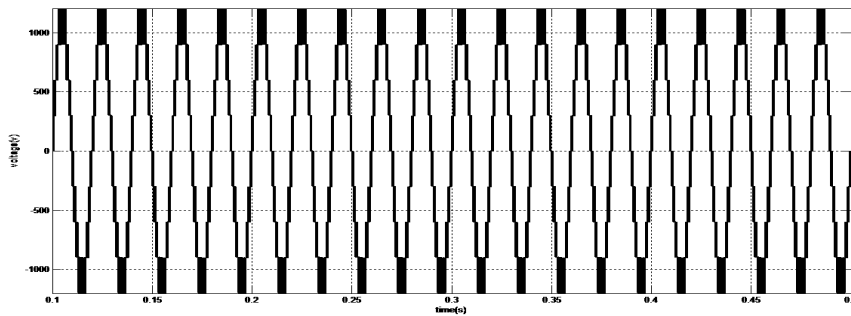
Fig 7. Power outlet from PV panels

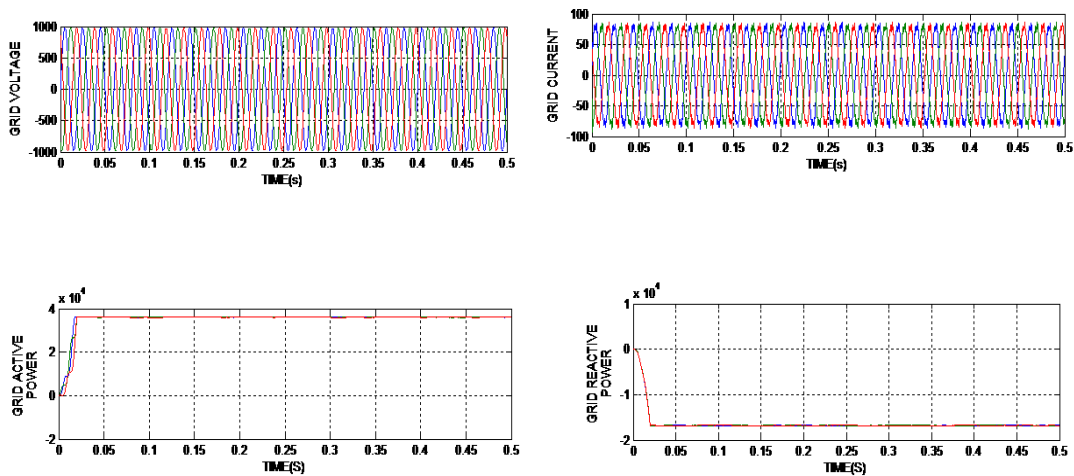Fig 8. Phase A inverter output voltage waveforms

Fig 9. Power introduced to the grid connected PV system Vs Is PQ

VI. CONCLUSION

This project presents a modular cascaded h-bridge multilevel inverter for grid connected PV applications. Each dc link voltages are controlled individually. And PV module utilization will increases by the multilevel inverter topology. By adding the distributed MPPT control scheming for single and three phase PV system, the overall efficiency is increased. In three phase PV systems, PV mismatches may lead to cause unstable supplied power, which result in unstable grid current. So, a modulation compensation technique is used to balance the grid current. It will not increase extra power losses and the difficulty of the control system

REFERENCES:

[1] J. M. Carrasco *et al.*, "Power-electronic systems for the grid integration of renewable energy sources: A survey," *IEEE Trans. Ind. Electron.*, vol. 53, no. 4, pp. 1002–1016, Jun. 2006.

[2] S. B. Kjaer, J. K. Pedersen, and F. Blaabjerg, "A review of single-phase grid connected inverters for photovoltaic modules," *IEEE Trans. Ind. Appl.*, vol. 41, no. 5, pp. 1292–1306, Sep./Oct. 2005.

[3] M. Meinhardt and G. Cramer, "Past, present and future of grid connected photovoltaic- and hybrid power-systems," in *Proc. IEEE PES Summer Meet.*, 2000, vol. 2, pp. 1283–1288.

[4] M. Calais, J. Myrzik, T. Spooner, and V. G. Agelidis, "Inverter for singlephase grid connected photovoltaic systems—An overview," in *Proc. IEEE PESC*, 2002, vol. 2, pp. 1995–2000.

[5] J.M. A.MyrzikandM. Calais, "String and module integrated inverters for single-phase grid connected photovoltaic systems—A review," in *Proc. IEEE Bologna Power Tech Conf.*, 2003, vol. 2, pp. 1–8.

[6] F. Schimpf and L. Norum, "Grid connected converters for photovoltaic, state of the art, ideas for improvement of transformerless inverters," in *Proc. NORPIE*, Espoo, Finland, Jun. 2008, pp. 1–6.

[7] B. Liu, S. Duan, and T. Cai, "Photovoltaic DC-building-module-based BIPV system—Concept and design considerations," *IEEE Trans. Power Electron.*, vol. 26, no. 5, pp. 1418–1429, May 2011.

[8] L. M. Tolbert and F. Z. Peng, "Multilevel converters as a utility interface for renewable energy systems," in *Proc. IEEE Power Eng. Soc. Summer Meet.*, Seattle, WA, USA, Jul. 2000, pp. 1271–1274.

[9] H. Ertl, J. Kolar, and F. Zach, "A novel multicell DC–AC converter for applications in renewable energy systems," *IEEE Trans. Ind. Electron.*, vol. 49, no. 5, pp. 1048–1057, Oct. 2002.

[10] S. Daher, J. Schmid, and F. L. M. Antunes, "Multilevel inverter topologies for stand-alone PV systems," *IEEE Trans. Ind. Electron.*, vol. 55, no. 7, pp. 2703–2712, Jul. 2008.

[11] G. R. Walker and P. C. Sernia, "Cascaded DC–DC converter connection of photovoltaic modules," *IEEE Trans. Power Electron.*, vol. 19, no. 4, pp. 1130–1139, Jul. 2004.

[12] E. Roman, R. Alonso, P. Ibanez, S. Elorduizapatarietxe, and D. Goitia, "Intelligent PV module for grid-connected PV systems," *IEEE Trans. Ind. Electron.*, vol. 53, no. 4, pp. 1066–1073, Jun. 2006.

[13] F. Filho, Y. Cao, and L. M. Tolbert, "11-level cascaded H-bridge grid tied inverter interface with solar panels," in *Proc. IEEE APEC Expo.*, Feb. 2010, pp. 968–972