Study Report Efficient Power Control of Active and Reactive Power in Grid Connected Multi Level PV System using Fuzzy Approach

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Abstract - grid-connected Large-scale photovoltaic (PV) systems significantly contribute renewable energy to worldwide the growth and penetration, which has inspired the application of cascaded modular multilevel converters due to their unique features such as modular structures, enhanced energy harvesting capability, scalability etc. [2] Addresses challenge on output voltage overmodulation when considering the varied and nonuniform solar energy on segmented PV arrays issue and propose a decoupled active and reactive power control strategy to enhance system operation performance. We proposed method significantly controls the voltage from input to output including reactive and active power and reduces the problems mentioned above in [1] the simulation waveforms clearly show the effectiveness of the proposed method for PV based distribution system. This work presents comprehensive study of the performance enhancement of a Grid Connected Multi Level PV System using fuzzy logic.

Keywords – PV System, Cascaded Structure, Fuzzy Logic, over modulation, Active and Reactive Power.

I. INTRODUCTION

The need for a cleaner environment and the continuous increase in energy needs makes decentralized renewable energy production more and more important. This continuously-increasing energy consumption overloads the distribution grids as well as the power stations, therefore having a negative impact on power availability, security and quality. One of the solutions for overcoming this is the Distributed Generation (DG) system. DG systems using renewable energy sources like solar, wind or hydro, have the advantage that the power is produced in close proximity to where it is consumed. This way the losses due to transmission lines are not present.

In the last decade solar energy technologies have become less expensive and more efficient, which have made it to an attractive solution, being cleaner and more environmentally friendly energy resource than traditional ones like fossil fuels, coal or nuclear. Nevertheless, a PV system is still much more expensive than traditional ones, due to the high manufacturing costs of PV panels, but the energy that drives them -the light from the sun- is free, available almost everywhere and will still be present for millions of years, long after all non-renewable energy sources have been depleted.

One of the major advantages of PV technology is that it has no moving parts. Therefore, the hardware is very robust; it has a long lifetime and low maintenance requirements. And, most importantly, it is one solution that offers environmentally friendly power generation . Nowadays, PV panels are not only used in space applications, but they are present in everyday life: powering wrist watches, small calculators, supplying loads in remote sites and, last but not least, they are connected to the public grid, generating the green power of the future.

One classification for grid-connected inverters is based on their internal topology. As can be seen in Fig. 1.3, grid-connected inverters for PV panel application are divided into the following categories:

- Current Source Inverter (CSI), or
- Voltage Source Inverter (VSI).

The standard voltage source inverter or current source inverter are the trivial choices to provide single stage DC-AC conversion. Figure 1.1(a) illustrates the standard voltage source inverter topology. The VSI is fed from a DC-link capacitor which is connected in parallel with PV panels. Figure 1.1(b) presents the topology of a standard current source inverter [8]. The inverter is fed from a large DC-link inductor.

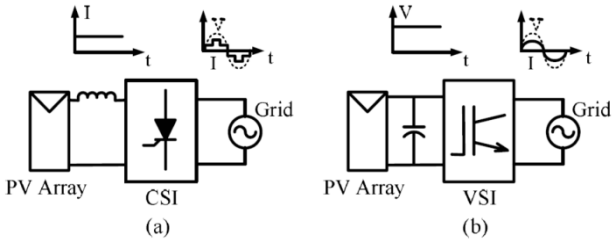

Figure 1.1 Different topologies of grid-connected PV systems: (a) current source inverter, and (b) voltage source.

A. Inverter Configurations

Generally, there are several classifications for inverter configurations with respect to the number of power stages. According to this classification, all the configurations can be divided into three classes

- Single-stage inverters,
- Dual-stage inverters, or
- Multi-stage inverters.

For single-stage inverters, the maximum power point tracking and control loops (current and voltage control loops) are handled all in one stage refer to figure 1.2. For dual-stage inverters, the maximum power point tracking is handled by additional DC-DC converter in between the PV panels and inverter, and control loops are applied to the inverter. For multi-stage inverters, a DC-DC converter takes care of the maximum power point tracking control of each string and one control inverter handles the control loops.

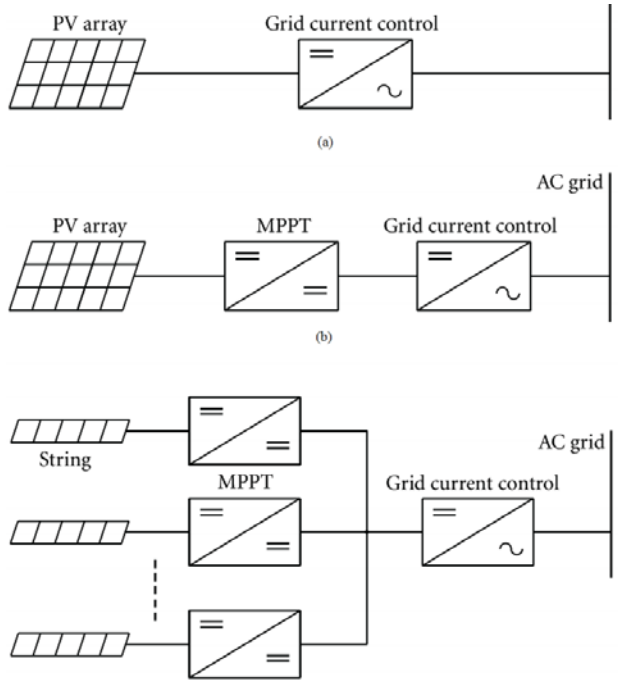

Figure 1.2 Different configurations of inverters: (a) single-stage inverter, (b) dual-stage inverter, and (c) multi-stage inverter.

There are some advantages and disadvantages in using each of these configurations. As mentioned earlier, since the efficiency of commercial PV modules is not high (< 20%), extracting and delivering the most achievable power to the utility grid is one of the most important factors in grid-connected PV systems. To reach this goal, the inverter (converter) is designed to achieve high power conversion efficiency. Additionally, the inverter (converter) cost per watt is as important as efficiency of the inverter (converter) because these two factors (efficiency and manufacturing cost) directly influence final price of the generated power.

To design a grid-connected PV system, in addition to grid standards, other demands and constraints is preferably required. These constraints can be divided into the following three categories:

Demands defined by the grid,

Demands defined by the PV modules, and

Demands defined by customers.

II. LITERATURE REVIEW

This research about predominantly concentrates on the expansive scale grid configured photovoltaic (PV) systems different control methodologies have been proposed on grid-associated PV systems.. Although these control strategies can achieve the same goals, their performances are quite different. Three noteworthy controllers have been broadly researched in the course of the most recent couple of decades: hysteresis controllers, the benefits of hysteresis controllers are their straightforwardness, quick element reaction, and heartiness. The significant disadvantage of this sort of controller is an uneven and arbitrary switching recurrence design, because of the variety of current reference or DC-interface voltage, which makes the sifting of output waveform very costly.

L. Liu, H. Li, Y. Xue and W. Liu,[2] Extensive scale grid-associated photovoltaic (PV) systems essentially add to overall renewable energy development and entrance, which has enlivened the utilization of fell measured multilevel converters because of their extraordinary elements, for example, secluded structures, improved energy collecting ability, adaptability et cetera. In any case, control dissemination and control in the fell PV system confronts extreme test on output voltage overmodulation while considering the differed and nonuniform solar energy on portioned PV clusters. Thisexploration addresses this issue and proposes a decoupled dynamic and responsive power control technique to improve system operation execution. The relationship between output voltage segments of every module and power generation is investigated with the assistance of a recently determined vector chart which outlines the proposed control conveyance guideline. On top of this, a successful control system including dynamic and responsive segments extraction, voltage appropriation and synthesization, is created to accomplish autonomous dynamic and receptive power conveyance and relieve the

previously mentioned issue. At last, a 3-MW, 12-kV PV system with the proposed control procedure is displayed and recreated in MATLAB and PSIM cosimulation stage. A downscaled PV system including two fell 5-kW converters with proposed control technique is likewise executed in the research facility. Reproduction and test results are given to exhibit the viability of the proposed control methodology for substantial scale grid-associated fell PV systems.

L. Nousiainen et al.,[3] A photovoltaic (PV) generator is inside a power-constrained nonlinear current source having both steady present and consistent voltage-like properties relying upon the working point. This work examines the dynamic properties of a PV generator and exhibits that it profoundly affects the operation of the interfacing converter. The most vital properties an info source ought to have with a specific end goal to imitate a genuine PV generator are characterized. These properties are imperative, since a power electronic substitute is frequently utilized as a part of the approval procedure rather than a genuine PV generator. This exploration likewise qualifies two business solar exhibit test systems for instance regarding the characterized properties. Examinations are based on broad useful estimations of genuine PV generators and the two business solar cluster test systems interfaced with dc-dc and also three-and single-stage dc-air conditioning converters.

D. Meneses, F. Blaabjerg, Ó García and J. A. Cobos,[4] This literature presents a complete survey of venture up single-stage non-confined inverters reasonable for air conditioning module applications. Keeping in mind the end goal to think about the most doable arrangements of the evaluated topologies, a benchmark is set. This benchmark is based on a common air conditioning module application considering the necessities for the solar boards and the grid. The chose arrangements are planned and mimicked conforming to the benchmark getting latent and semiconductor parts evaluations keeping in mind the end goal to play out an examination as far as size and cost. A discourse of the dissected topologies seeing the acquired evaluations and in addition ground streams is displayed. Suggestions for topological arrangements agreeing to the application benchmark are given.

J. Mei, B. Xiao, K. Shen, L. M. Tolbert and J. Y. Zheng,[5] This literature proposed an enhanced phase disposition pulse width modulation (PDPWM) for a modular multilevel inverter which is used for Photovoltaic grid connection. This new modulation strategy is based on particular virtual circle mapping, to accomplish dynamic capacitor voltage adjust without the assistance of an additional pay signal. The idea of virtual submodule (VSM) is initially settled, and by changing the circle mapping connections between the VSMs and the genuine submodules, the voltages of the upper/lower arm's capacitors can be all around adjusted. This strategy does not requiring sorting voltages from most astounding to least, and just distinguishes the MIN and MAX capacitor voltage's list which makes it reasonable for a secluded multilevel converter with countless in one arm. Contrasted with bearer phase-moved PWM (CPSPWM), this strategy is all the more effectively to be acknowledged in field-programmable door cluster and has much more grounded element direction capacity, and is helpful for the control of coursing current. Its attainability and legitimacy have been checked by reproductions and analyses.

Y. Zhou, L. Liu and H. Li, [6] this exploration introduces a solitary phase grid-associated photovoltaic (PV) module-incorporated converter (MIC) based on filter semi Z-source inverters (qZSI). In this system, each qZSI module serves as a MIC and is connected with one PV board. Because of the fell structure and qZSI topology, the proposed MIC includes low-voltage pick up prerequisite, single-stage energy transformation, upgraded unwavering quality, and great output control quality. Moreover, the upgrade mode gallium nitride field-impact transistors (eGaN FETs) are utilized in the qZSI module for proficiency change at higher exchanging recurrence. It is found that the qZSI is exceptionally appropriate for the utilization of eGaN FETs due to the shoot-through ability. Enhanced module configuration is created based on the determined qZSI air conditioning proportionate model and power misfortune diagnostic model to accomplish high productivity and high influence thickness. A plan case of qZSI module is introduced for a 250-W PV board with 25-50-V output voltage. The simulation and result comes about demonstrate the legitimacy of the scientific models. The last module model outline accomplishes up to 98.06% productivity with 100-kHz switching frequency.

M. Abolhassani, [7] another way to deal with enhance the power nature of high-power medium voltage multilevel drives is introduced. A measured transformers methodology in conjunction with secluded power hardware 3D shapes is produced. By applying this innovation, the info current music declines to well underneath the necessity of IEEE 519-1992 while the measure of capacitance introduced in the drive is altogether lessened. Moreover, by utilizing measured transformers innovation and proficient cooling, control thickness of the drive is expanded by 15%. The info control element of drive is likewise made strides. This literature details the new approach, analyses, and test results.

J. Ebrahimi, E. Babaei and G. B. Gharehpetian, [8] in this exploration, another topology of a cascaded multilevel

converter is proposed. The proposed topology is based on a cascaded relationship of single-phase submultilevel converter units and full-associate converters. Contrasted with the ordinary multilevel converter, the quantity of dc voltage sources, switches, establishment region, and converter cost is essentially lessened as the quantity of voltage steps increments. With a specific end goal to ascertain the sizes of the required dc voltage sources, three techniques are proposed. At that point, the structure of the proposed topology is streamlined with a particular true objective to utilize a base number of switches and dc voltage sources, and deliver a high number of output voltage steps. The operation and execution of the proposed multilevel converter is checked by reenactment comes about and contrasted and test aftereffects of a solitary phase 49-level converter, as well.

III. COMPARISONS AND RESULT ANALYSIS

Implementation and simulation of the proposed grid connected fuzzy logic based system has done on Matlab ISE outcome and result discussion has given below.

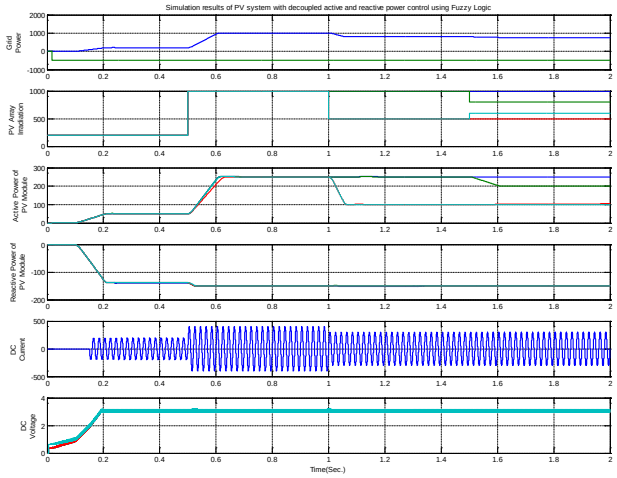

Figure Simulation Results of Proposed Decoupled Multilevel Grid Connected PV System of Single Phase (phase a) [1].

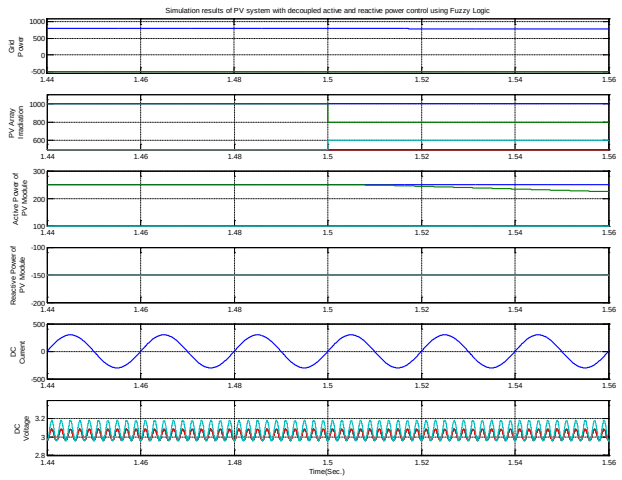

Figure Simulation Results of Proposed Decoupled Multilevel Grid Connected PV System of Single Phase (Zoomed at 1.5 sec.). [1]

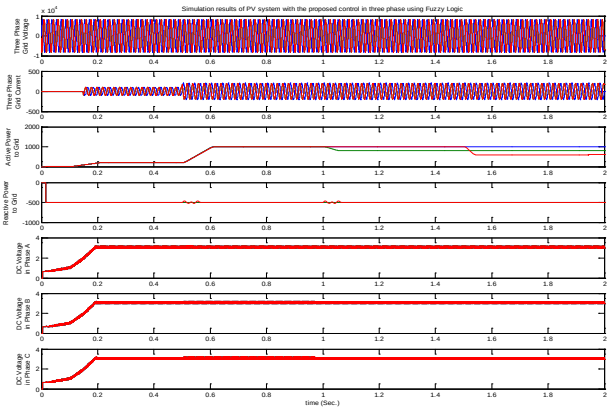

Figure Simulation Results of Proposed Decoupled Multilevel Grid Connected PV System of Three Phases [1].

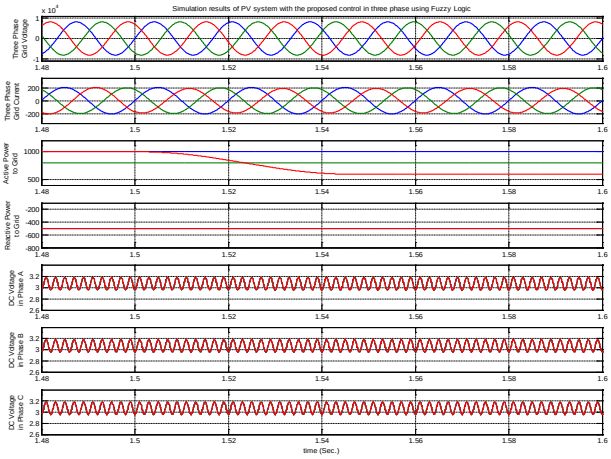

Figure Simulation Results of Proposed Decoupled Multilevel Grid Connected PV System of Three Phases (Zoomed at 1.5 sec.). [1].

IV. CONCLUSION

This work describes the comprehensive study and analysis of the proposed work [1] with existing work [2] This proposal has examined the exhibitions of some control mechanisms and algorithms for power converters utilized as a part of a photovoltaic power plant for the transformation of solar energy into Alternating current voltage that can be utilized to power AC burdens, for example, home machines, lighting and power devices and for conceivable joining into a micro grid. The PV control plant contains a photovoltaic generator (solar exhibit), a SEPIC converter for interfacing the solar cluster, a bidirectional dc-dc converter for interfacing the reinforcement energy stockpiling system, and a DC-AC converter for producing the fundamental ac output and for interfacing to the small scale grid. The performance of the

proposed work using Fuzzy Approach [1] is comparatively batter as compared to existing [2] approach.

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