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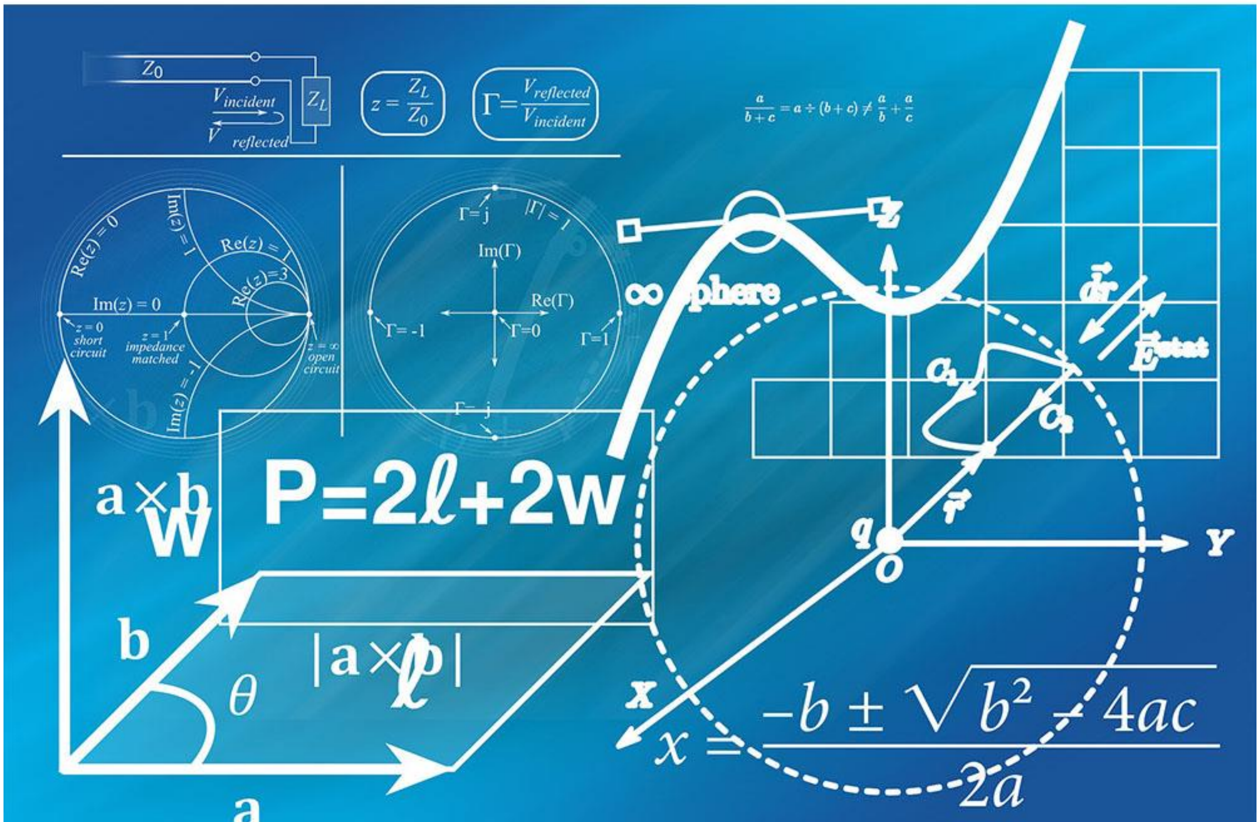

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POWER COMPENSATION METHODOLOGIES IN SOLAR BASED SYSTEM: A SURVEY

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ABSTRACT

Cascaded multilevel converter structure can be appealing for high-power solar photovoltaic (PV) systems thanks to its modularity, scalability, and distributed maximum power point tracking (MPPT). However, the power mismatch from cascaded individual PV converter modules can bring in voltage and system operation issues. This paper addresses these issues, explores the effects of reactive power compensation and optimization on system reliability and power quality, and proposes coordinated active and reactive power distribution to mitigate this issue. A vector method is first developed to illustrate the principle of power distribution. Accordingly, the relationship between power and voltage is analyzed with a wide operation range. Furthermore, a comprehensive control system with the RPCA can be designed to achieve effective power distribution and dynamic voltage regulation.

Keyword- Cascaded photovoltaic (PV) system, power–voltage distribution, reactive power compensation, unsymmetrical active power

I.INTRODUCTION

Worldwide renewable energy resources, especially solar energy, are growing dramatically in view of energy shortage and environmental concerns. Large-scale solar photovoltaic (PV) systems are typically connected to medium voltage distribution grids, where power converters are required to convert solar energy into electricity in such a grid-interactive PV system. To achieve direct medium-voltage grid access without using bulky medium-voltage transformer, cascaded multilevel converters are attracting more and more attraction due to their unique advantages such as enhanced energy harvesting capability implemented by distributed maximum power point tracking (MPPT), improved energy efficiency, lower cost, higher power density, scalability and modularity, plug-N-power operation, etc.

Although cascaded multilevel converters have been successfully introduced in medium- to high-voltage applications such as large motor drives, dynamic voltage restorers, reactive power compensations, and flexible ac transformation system devices, their applications in PV systems still face tough challenges because of solar power variability and the mismatch of maximum power point from each converter module due to manufacturing tolerances, partial shading, dirt, thermal gradients, etc. In a cascaded PV the output voltage from each converter module in one phase leg, which must fulfill grid codes or requirements, synthesizes system the total ac output voltage. Ideally, each converter module delivers the same active power to grid; hence, symmetrical voltage is distributed among these modules. In serious scenario, the synthesized output voltage may not be enough to meet the system requirement. As a result, the active power mismatch may not only result in losses in energy harvesting but also system instability and unreliability due to the inadequate output voltage or over modulation issues.

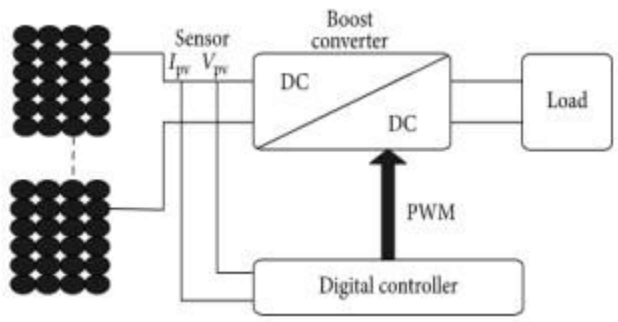

Figure1 Block Diagram of PV Generation System

II.LITERATURE REVIEW

Jie Liu et al. [1] This paper addresses these issues, explores the effects of reactive power compensation and optimization on system reliability and power quality, and proposes coordinated active and reactive power distribution to mitigate this issue. A vector method is first developed to illustrate the principle of power distribution. Accordingly, the relationship between power and voltage is analyzed with a wide operation range. Then, an optimized reactive power compensation algorithm (RPCA) is proposed to improve the system operation stability and reliability, and facilitate MPPT implementation for each converter module simultaneously. Furthermore, a comprehensive control system with the RPCA is designed to achieve effective power distribution and dynamic voltage regulation. Simulation and experimental results are presented to demonstrate the effectiveness of the proposed reactive power compensation approach in grid-interactive cascaded PV systems.

Aneesh S.L et al. [2] this paper solves the issue and proposes improved PV system with cascaded modular multilevel converters using FLC in DC-DC converter controller. A newly derived vector diagram is used to find the relation between output voltage component of each module and power generation which illustrates the proposed power distribution principle. Index Terms—cascaded photovoltaic (PV) system, power–voltage distribution, reactive power compensation, unsymmetrical active power.

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III.CIRCUIT TOPOLOGY AND DESIGN PARAMETERS

Block Diagram for large scale Cascaded PV system is shown in Fig (2). Only single phase circuit is shown in the figure.

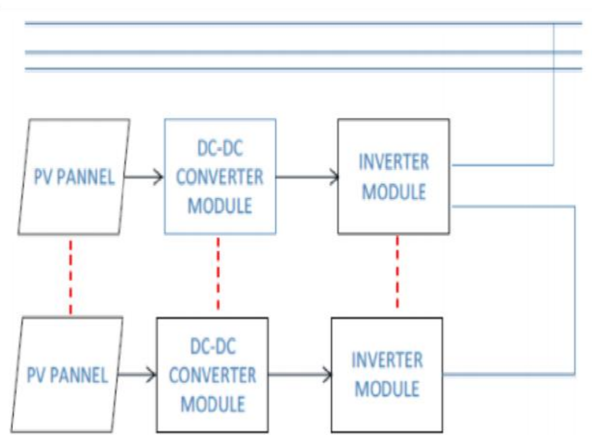

Figure 2 Block Diagram of Cascaded PV system for one phase

And the proposed large scale cascaded PV system is showed in Fig (2), which gives the three phase large scale Cascaded PV system in which two stages of power conversion takes place. In 1st stage power harvested from solar panel is given to DC-DC converter for Boost or Buck action i.e for voltage stabilization we are using Current Fed Dual Active Bridge DC-DC converters. The end of this CF-DAB DC-DC converters are connected with cascaded Modular Multilevel Inverters with High Voltage Insulation. In this configuration no need of line frequency transformers, Inverter module is directly connected to grid without any line Frequency Transformers. This is the one of the main advantage of this model compared to conventional methods. In DCDC converter module each of the individual section is connected to one PV panel this is nothing but we are achieving MPPT for each section independently so we can harvest more solar energy. This paper is focused on applying of Fuzzy Logic Control to Modular Multilevel Inverter with active and reactive power control of Grid connected Cascaded PV system.

IV.ADVANTAGES & DISADVANTAGES

A multilevel converter has several advantages over a conventional two-level converter that uses high switching frequency pulse width modulation (PWM). The attractive features of a multilevel converter can be briefly summarized as follows. Staircase waveform quality: Multilevel converters not

- Only can generate the output voltages with very low distortion, but also can reduce the dv/dt stresses; therefore electromagnetic compatibility (EMC) problems can be reduced. Common-mode (CM) voltage: Multilevel converters
- Produce smaller CM voltage; therefore, the stress in the bearings of a motor connected to a multilevel motor drive can be reduced. Furthermore, CM voltage can be eliminated by using advanced modulation strategies Input current: Multilevel converters can draw input current with low distortion.

V.METHODOLOGY

multilevel inverter modules for each phase, wh ere each inverter module is connected to one unique dc-dc converter with high voltage insulation.

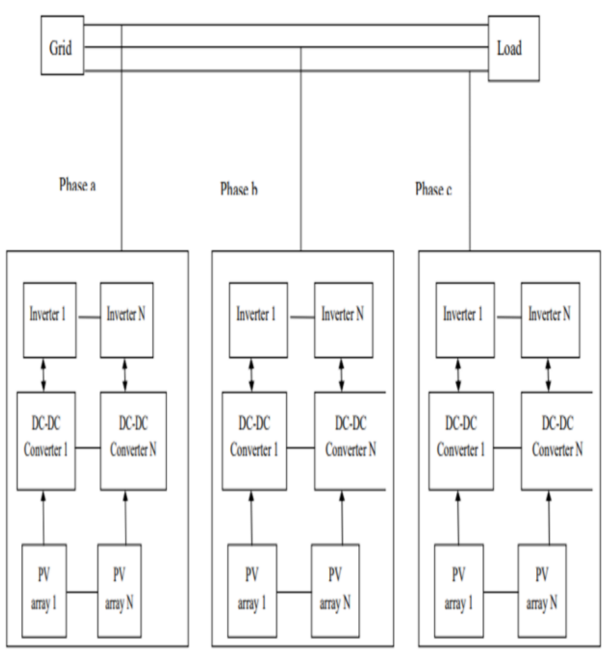

Figure 3 Block diagram of Grid-connected PV system The PV system shown in Fig.3 includes n cascaded with Cascaded PV inverters.

The dc-dc converter is interfaced with individual PV arrays and therefore the independent MPPT can be achieved. Moreover, it is immune to double-linefrequency power ripple propagation into PV arrays. It can also solve the ground leakage current and PV insulation issues. The detailed dc-dc converter design with wide range input range would be presented. Here focused on the active and reactive control of the cascaded multilevel PV inverters. The selected PV application is a 3MW/12kV PV system. The n is selected to be 4 considering the tradeoff among the cost, lifetime, capacitors and switching devices selection, switching frequency, and power quality. As a result, power rating of each inverter module is 250kW.

VI.FUZZY LOGIC CONTROLLER FOR CASCADED MODULAR MULTILEVEL INVERTER

Fuzzy controller is the robust control technique used for Multilevel Inverters and PMSM motors etc. The main parts in fuzzy system are Fuzzy Membership Functions and Fuzzy sets. The Block diagram for Fuzzy logic controller is shown in Fig(4).

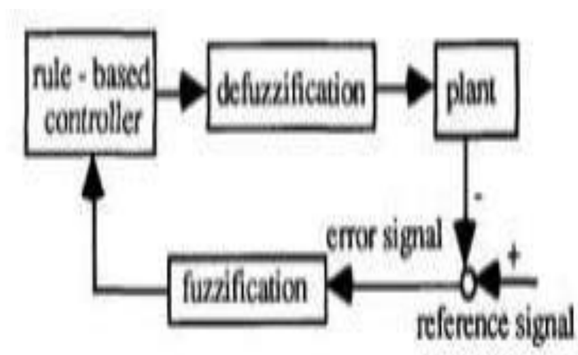

Figure 4 Fuzzy Logic Controller Block Diagram

Inputs for this fuzzification process are called crisp inputs. In this method reference signal is compared with Pulse width Modulation output and then error signal will produce. In this paper we used the double-loop dq control based on discrete Fourier transform PLL method is applied to achieve the active and reactive power distribution. If we use Fuzzy logic with this method we can get less distortion in output and improved THD. Simulink Model of Multile vel inverter control technique along with Fuzzy logic controller.

VII.MPPT CONTROL

MPPT algorithm has been proposed in the literature for maintaining constant voltage. The algorithm used to achieve maximum power point tracking is the INC methods. The INC method offers good performance under rapidly changing atmospheric conditions. However, four sensors are required to perform the computations. If the sensors require more conversion time, then the MPPT process will take longer to track the maximum power point. During tracking time, the solar power output is less than its maximum power. In order to implement the MPPT algorithm, a buck-boost dc/dc converter is used. The parameters L and C in the buck-boost converter must satisfy the following conditions the buck-boost converter consists of one switching device (GTO) that enables it to turn on and off depending on the applied gate signal. The gate signal for the GTO can be obtained by comparing the saw tooth waveform with the control voltage. The basic inverter control schemes can be broadly divided into two categories: current control and voltage control. In gridconnected PV system, the inverter operates in current control mode where the grid regulates the voltage and frequency by setting current reference for the inverter to allow exchange of real and reactive powers. The objective is to control the real and reactive power to some reference values .The power references and the voltage references are then used to set the references for the current controllers. The inverter is supplied from a DC link capacitor interconnected to the PV power system via a DC-DC converter combined with a Maximum Power Point Tracking (MPPT) controller to extract the maximum power from the PV system. In the mathematical model of the Pulse Width Modulation (PWM) inverter expressed in the d-q rotating frame there is an inherent coupling between the real and reactive components of the current which makes it difficult to regulate the power injected into the grid from the PV generation system.

VIII.CONCLUSION

This paper addressed the effect of reactive power compensation on system operation performance in gridinteractive cascaded systems. The system stability and reliability issue caused by unsymmetrical active power was specifically analyzed. Reactive power compensation and distribution was introduced to mitigate this issue. The relationship between voltage distribution and power distribution was illustrated with a wide power change range. Correspondingly, the control system with MPPT control and optimized RPCA was developed the proposed approach was demonstrated to be able to effectively enhance system operation stability and reliability, and improve power quality.

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