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A Review on Solar Based Multilevel Inverter with Three Phase Grid Supply

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Abstract: The world demand for electric energy is constantly increasing and conventional energy resources are diminishing and are at the edge of extinction, moreover their prices are rising. For all these reasons, the need for alternative energy sources has become necessary and solar energy in particular has proved to be a very promising alternative because of its easy availability and pollution-free nature. Due to increasing efficiency, decreasing cost of solar panels and improvement of the switching technology used for the power conversion, we are interested in developing a multilevel inverter powered by pv panels that could supply three phase grid. Multilevel inverter as compared to single level inverters have advantages like minimum harmonic distortion, reduced EMI/RFI generation and can operate on several voltage levels.

Keywords: Three-phase; grid connected; photovoltaic systems; Multilevel Inverter; Power Components

Literature Survey:

Abdelaziz Fria et al. (2013) presented a comparative study in the Matlab/Simulink environment between three topologies of three-phase multilevel inverter MLI (five-level). We will consider the Flying Capacitor Multilevel Inverter (FCMLI), the Neutral Point Clamped Multilevel Inverter (NPCMLI), and the Cascaded H-Bridge Multilevel Inverter (H-bridge MLI). The comparison between these inverters is based on some criteria: the spectral quality of the output voltage, the complexity of the power circuits and the cost of implementation. Each inverter is controlled by the same type of control which is the multi-carrier sinusoidal pulse width modulation (SPWM). Voltage sources supplying the inverters cells are simulated by a DC voltage representing photovoltaic panels (PV). We have chosen the 5L inverter because it is the most widespread. In literature, there is works dealing on a single topology with several levels, or developing a new topologies, or achieving a sophisticated control dedicated to very specific topologies. This study focuses on a comparison of three topologies bases. These topologies are simpler and easily controlled in an analog or digital manner. This study shows, on the one hand, that the total harmonic distortion (THD) is approximately 32% for NPCMLI and PWM H-Bridge topologies, and it is about 36% for the FCMLI topology. Moreover, the distortion factor (DF) of the FCMLI is smaller (0.94) than the NPCMLI and H-bridge (0.951). In addition, the rays spectrum are concentrated on the switching frequency (2500Hz) for the three topologies. On the other hand, the H-bridge MLI topology has fewer components compared to the others. Our study confirms that the most promising topology for photovoltaic systems is the PWM H-bridge one in view of the spectral quality, the phase shift ($2\pi/3$) between voltages, the waveform of the composed output voltage and the cost.

Aarti Gupta et al. (2013) proposed in any PV based system, the inverter is a critical component responsible for the control of electricity flow between the dc source, and loads or grid. This paper presents a solar PV generation system integrated to the grid. The results of matlab modelling of the system detail the comparative operation of inverter topologies which are the conventional two level inverters and multilevel inverter topology to reduce total harmonic distortions in grid voltage and electromagnetic interference. The proposed control scheme to mitigate the power quality issues for power quality improvement in grid integrated DER simulated using MATLAB/ SIMULINK in power system block set.

Bijo Reji et al. (2014) proposed distributed energy systems and industrial motor drives multilevel converters and inverters are the emerging trends. Single phase inverter is widely used for stand-alone systems and micro-grid application. The major limitation faced by multilevel inverters are, number of switches required large which leads to higher switching losses. A novel solar powered extended simplified multilevel inverter is proposed, in which a single phase multilevel output can be attained using less number of switches. This paper observers the feasibility of the proposed topology using Matlab/Simulink software. A seven level output voltage is obtained with less harmonic content and reduced switching losses.

K.S. Srikanth (2014) Photovoltaic energy is a wide kind of green energy. A high performance on these systems is needed to make the most of energy produced by solar cells. Also, there must be a constant adaptation due to the continuous variation of power production. Control techniques for Power Converters like the MPPT algorithm (Maximum Power Point Tracking) present very good results on photovoltaic chains. Nevertheless, losses on power elements reduce global performance and

the voltage/current adaptation is not always possible. This paper presents a single-phase 11-level (5 H-bridges) cascade multilevel DCAC grid-tied inverter. Each inverter bridge is connected to a 200 W solar panel. OPAL-RT lab was used as the hardware in the loop (HIL) real-time control system platform where a Maximum Power Point Tracking (MPPT) algorithm was implemented based on the inverter output power to assure optimal operation of the inverter when connected to the power grid as well as a Phase Locked Loop (PLL) for phase and frequency match. A novel SPWM scheme is proposed in this paper to be used with the solar panels that can account for voltage profile fluctuations among the panels during the day. Simulation and experimental results are shown for voltage and current during synchronization mode and power transferring mode to validate the methodology for grid connection of renewable resources.

D.Madhurisrilatha et al. (2014) presented the use of the renewable energy sources increasingly, application of the distributed generation (DG) in the distribution system acquired more attention. The DG systems are powered by micro sources such as fuel cells, photovoltaic (PV) systems, and batteries. Photovoltaic (PV) inverters become more and more widespread within both private and commercial circles. These grid-connected inverters convert the available direct current supplied by the PV panels and feed it into the utility grid. Micro grid concept acts as a solution to integrate large amounts of micro generation without disrupting the operation of utility grid. The uniqueness of the proposed modeling and control includes a complete model's details of micro-grid set up with PV system, power conditioning devices and load model, the utilization of an MPPT and feedback controller to control the output voltage and current and interfaced to grid system using 2-level & 3-level inverter topology. The dynamic analysis of proposed converter strategies is evaluated with the help of Matlab/Simulink platform and results are conferred.

Renato M. Nakagomi et al. (2015) presented an approach to generate three phase multi-level AC voltage output using a switching matrix device and photovoltaic (PV) panels. The approach is based on the dynamic reconfiguration of PV panels distributed in a matrix. The principle is similar to methods used in multi-level inverters related to the technique of matrix reconfiguration. The concept is to switch in and out solar panels in series to create a higher three phase voltage level. The focus of the project is optimizing the PV array usage and improving the output current while generating three-phase multi-level waveforms.

Kelam Bhargav et al. (2016) proposed solar energy is a renewable energy that is found abundantly in nature. It is green energy that can be utilized throughout day, therefore maximum energy has to captured from the panel. MPPT algorithm is incorporated to capture maximum energy. A multilevel inverter is a power electronic converter that synthesizes a desired output voltage from several levels of dc voltages of dc voltages as inputs. With an increasing number of dc voltage source, the sinusoidal waveform is obtained by the output voltage, while using a fundamental frequency-switching scheme. The advantage of multilevel inverter is very small output voltage, results in higher output quality and lower switching losses. This paper proposes a MPPT controller based solar power generation system, which consist of dc/dc converter and a new nine-level inverter.

M. Venkatesan et al. (2016) proposed a comparative study of three phase grid connected photovoltaic (PV) inverter using Proportional-Integral (PI) controller and Fuzzy logic controller (FLC) is presented in this paper. Proposed three phase inverter with single DC source employing three phase transformer for grid connected PV system controlled by using space vector pulse width modulation (SVPWM) technique. PI and FLC are used as current controller for regulating the current. Perturb and observe maximum power point technique (MPPT) is used for tracking of maximum power from the PV panel. Finally total harmonic distortion (THD) comparison made between two controllers for validation of results. Furthermore switching losses of inverter are also presented. The simulation results are obtained using MATLAB Simulink.

Edjadéssamam AKORO et al. (2017) described that three-phase inverters are widely used today as converters in many fields of application including renewable energies. Compared to single-phase inverters, three-phase inverters have a longer service life. This paper is essentially devoted to a review of the literature on the various topologies of three-phase inverters connected to the grid. The various power components of the inverters and the losses they generate have been described. Based on a few evaluation criteria, basic three-phase inverters such as Voltage source inverter, current source inverter and Z-source inverter were compared. Finally, the various three-phase inverter structures and their advantages and disadvantages are discussed.

Ada Olokpo et al. (2018) This Project Attempts To Solve The Problem Of Power Energy Using Clean Renewable Power Energy By Designing A Three Phase Five-Level Flying Capacitor Multi-Level Inverter (Fcmli) Getting Its Energy From The Sun. The System Described Was Design And Analyzed In Four Stages; The Solar Energy Harvesting, The Current/Voltage Control, The Boost Converter And The Fcmli. The Solar Energy Harvesting Described Uses Arrays Of Solar Panels In Series And Parallel To Obtain The Required Voltage And Current Of (200-240vdc And 12-17a). The Solar Panels Array Is Connected To A Current/Voltage Controller System That Measures The Current And Voltage Of The Solar Pv And

Generates An Equivalent Scaled Voltage Values For The Current Range 12-17a. The Voltage Is Scaled Between The Ranges Of 3.8v To 5v For Switching To Occur. The Boost Converter Step Up The 200-240vdc From The Solar Pv To 415vdc, Only When The Current Of The Pv Is Between 12-17a The Voltage Step Up Occurs. The 415vdc From The Boost Converter Is Fed Into The Three-Phase Five-Level Fcmli To Convert It To 415vac Using Pod Modulation Technique. The Simulation Is Done Using Simulink And The Results From The Simulations Shows That The Fcmli Generates Modified Sinewave After Filtering Using Third Order Lcl Filter A Sinewave Is Produced. The Thd When Voltage Is Not Filtered Is 22.56% And When The Voltage Of The Fcmli Is Filtered Is 16.76%; This Shows The Filtered Circuit Generates A Pure Sinewave And Less Thd, This Design Can Be Connected To Any Grid Via Transformer.

Conclusion: The use of solar energy is essential for providing solutions to the environmental problems and also energy demand. The invention of multilevel inverter has provided a numerous advantages in the power electronic field which came to replace the single level inverter in handling medium and high voltage application with less switching losses and less harmonic contents .Different type of multilevel inverter topologies has been proposed to be applied in the industry. A multi-stage inverter is being utilized for multipurpose applications, such as active power filters, static variable compensators and machine drives for sinusoidal and trapezoidal current applications. The drawbacks are the isolated power supplies required for each one of the stages of the multi converter and it's also lot harder to build, more expensive, harder to control in software.

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