iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VII **Month of publication:** July 2023

DOI: https://doi.org/10.22214/ijraset.2023.54669

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VII Jul 2023- Available at www.ijraset.com

Multilevel Inverter for Solar Photovoltaic Applications - A Review

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***Abstract:** This paper presents a review of Multilevel inverter for solar Photovoltaic applications. Design and Implementation of Multilevel Inverters for electric vehicles has been studied. Grid tied PV system using modular multilevel inverter is analysed. Performance analysis of Nested multilevel inverter topology for 72V electric vehicle applications is studied. Multilevel inverter for PV system employing MPPT technique is studied. Power Electronics application in renewable application in renewable energy is studied.*

***Keywords:** MPPT, Grid, Total Harmonic Distortion*

I. INTRODUCTION

The Earth grabs a significant amount of solar power, at nearly 173 terawatts. This is around ten thousand times more power than the world's population uses. As such, it is possible that one day the world could be entirely reliant on solar energy, which could present an available, clean, pollution-free, highly efficient, and long-life energy source. With the help of technology, the cost of the Solar Photovoltaic panels and associated equipment has reduced tremendously over recent decades. To interface solar energy to the grid, low voltage PV cells are aligned in a series to acquire high DC output voltage. This process needs high-rated voltage equipment for inversion and a step-up transformer, which increases the losses, cost, weight and size of the system. To overcome these issues, the transformer can be eliminated.

The multilevel inverter is the best option for the majority of electricity production in an SPV system. The traditional 2-level inverters face high switching voltage stress, less efficiency and low power quality.

II. LITERATURE REVIEW

Ali Bughneda et al., has proposed Review of Multilevel Inverters for PV Energy System Applications. This paper reviews multilevel inverters based on their classifications, development, and challenges with practical recommendations in utilizing them in renewable energy systems. Moreover, PV systems with various maximum power point tracking (MPPT) methods have been extensively considered in this paper as well. The importance and the development of a modified multilevel inverter are also highlighted in this review. In general, this paper focuses on utilizing multilevel inverters for PV systems to motivate and guide society to focus on inventing an efficient and economical multilevel inverter that has the combined capabilities of these converters reported in the literature.

C. Dhanamjayulu et al., has presented Design and Implementation of Multilevel Inverters for Electric Vehicles. This paper proposes a 53-Level multilevel inverter topology based on a switched capacitor (SC) approach. The number of levels of MLI is designed based on the cascade connection of the number of SC cells. This reduces the device count, cost, and size of the MLI. For the 17-level, 33-level, and 53-level MLI, simulation results are verified with experimental results, and total harmonic distortion (THD) is observed to be the same and is lower than 5% which is under IEEE standards. A hardware prototype is implemented in the laboratory and verified experimentally under dynamic load variations, whereas the simulations are done in MATLAB/Simulink.

Sujitha N et al., has published paper on Grid tied PV system using modular multilevel inverter. A grid tied Photovoltaic system using modular multilevel inverter topology is proposed in this paper. Basic unit structure of modular multilevel inverter used in this system is capable of converting DC power from PV array to AC power for feeding power to the household loads or utility grid. The proposed modular multilevel inverter structure has lesser power electronic devices compared to the existing multilevel inverter topologies. The proposed system generates a nearly sinusoidal signal and achieves better output profile with low total harmonic distortion. Simulation of the proposed system is carried out in MATLAB/Simulink software and the results are presented.

Narendra Kumar Muthukuri et al., has explained Performance Analysis of Nested Multilevel Inverter Topology for 72V Electric Vehicle Applications. This paper investigates the performance an advanced MLI named as nested topology for 72V electric vehicle (EV) motor drive application for 1kW/1500 RPM system.

It can generate near-sinusoidal voltages with only fundamental switching frequency, there is no electromagnetic interference (EMI) and also it gives easy operating EV and safer conditions. Furthermore, this paper inspects the analysis, benefits and control scheme for nested MLI for the use of EV motor drive applications. The simulations are carried out using Matlab/Simlink.

Xiaoqiang Guo et al., has proposed Modeling and Analysis of New Multilevel Inverter for Solar Photovoltaic Power Plant. In this paper, a novel five-level inverter is introduced for the high voltage PV power plant applications. The model of the inverter is analyzed. With the redundant switching states, a new modulation strategy is proposed to reduce the common-mode voltage and EMI. The proposed approach is able to eliminate the common-mode voltage, meanwhile it has the capability of balancing the capacitor voltages. The simulation tests with the Matlab/Simulink. The results verify the effectiveness of the proposed method.

Murali krishna et al., has proposed New multilevel inverter topology for photovoltaic system. Thirty-one level configuration of multilevel inverter reduces the value of total harmonic distortion. Comparison is made between the thirteen level inverter configuration and thirty-one level inverter configuration. The thirteen level inverter configuration has a total harmonic distortion of 13.69%. The proposed thirty-one level inverter configuration with less number of switches has a total harmonic distortion of 3.67%. Efficiency for thirteen level inverter is 95.80% and for thirty one level inverter is 98.31%.

Dilip et al., has explained, Design and Development of Multilevel Inverter for Solar Power Generation. The seven-level inverter contains only six power electronic switches, which simplifies the circuit configuration. Furthermore, only one power electronic switch is switched at high frequency at any time to generate the seven-level output voltage. This reduces the switching power loss and improves the power efficiency and also reduces the Total Harmonic Distortion (THD). The voltages of the two dc capacitors in the proposed seven-level inverter are balanced automatically, so the control circuit is simplified. Simulation results show that the proposed solar power generation system generates a seven-level output voltage and outputs a sinusoidal current that is in phase with the utility voltage, yielding a power factor of unity.

M. Thiagarajan et al., has presented Multilevel Inverter for PV System Employing MPPT Technique. A single-phase five-level PV inverter topology with dual reference modulation technique. Two reference signals identical to each other with an offset equivalent to the amplitude of the triangular carrier signals were used to generate PWM signals. Maximum Power Point Tracking (MPPT) is implementation in solar array power system with direct control method. The incremental conductance algorithm is used to track the MPP, as it performs better control under rapidly changing atmospheric condition. The Total Harmonic Distortion (THD) produced by the inverter is reduced. The proposed system is verified through simulation.

Moacyr A. G. de Brito et al., has proposed Research on photovoltaics, Review, trends, Perspectives.A briefly review, some trends and perspectives in the field of Photovoltaic energy conversion. The power electronics plays a fundamental role in this process, developing systems each times more competitive, efficient, reliable, and also reducing costs and reducing the payback time. Some trends are visible, which are the use of Silicon Carbide devices in PV inverters, the use of integrated inverter structures, the integration of power converters into the PV module or the use of few PV series connection, the development of thinner and more efficient solar cells.

Nishij Ganpatrao Kulkarni et al., has presented Power Electronics and its application to Solar Photovoltaic Systems in India. Out of many renewable energy resources, solar energy is one of the conspicuous sources of energy which can supply the increasing demand of energy. As of May 2014, India has an installed PV capacity of 2.5 GW. The solar photovoltaic project includes power electronics with high quality performance devices, incorporated with smart energy management principles. Power electronics is used to improve the energy efficiency of apparatus, and help the generation of environmentally clean energy. In this article the explanation of role of power electronics and the discussion about similar and future concepts in solar photovoltaic systems related to reliability and advancement of each technology in India has been presented.

Yogendra .V. Kulkarni et al., has ejected Power Electronics Application in Renewable Energy. Over the last few decades there has been a considerable depletion of non-renewable energy resources and it has produced green house gases. To reduce the impact on environment and meet the increasing power demand it is important to shift focus on renewable energy. Use of distributed generation in the grid has accelerated momentum. This paper focuses on the use of solar energy for meeting the power demands; also it emphasizes the role of power electronics for its stability.

III. CONCLUSION

This paper presents the application of Power Electronics in Renewable energy. The proposed study reviews the application of multilevel inverter in solar photovoltaic systems. The study also presents multilevel inverter for PV system employing MPPT technique. According to the study, Total Harmonic Distortion produced by the inverter is reduced. Efficiency of multilevel inverter is increased than conventional inverters.

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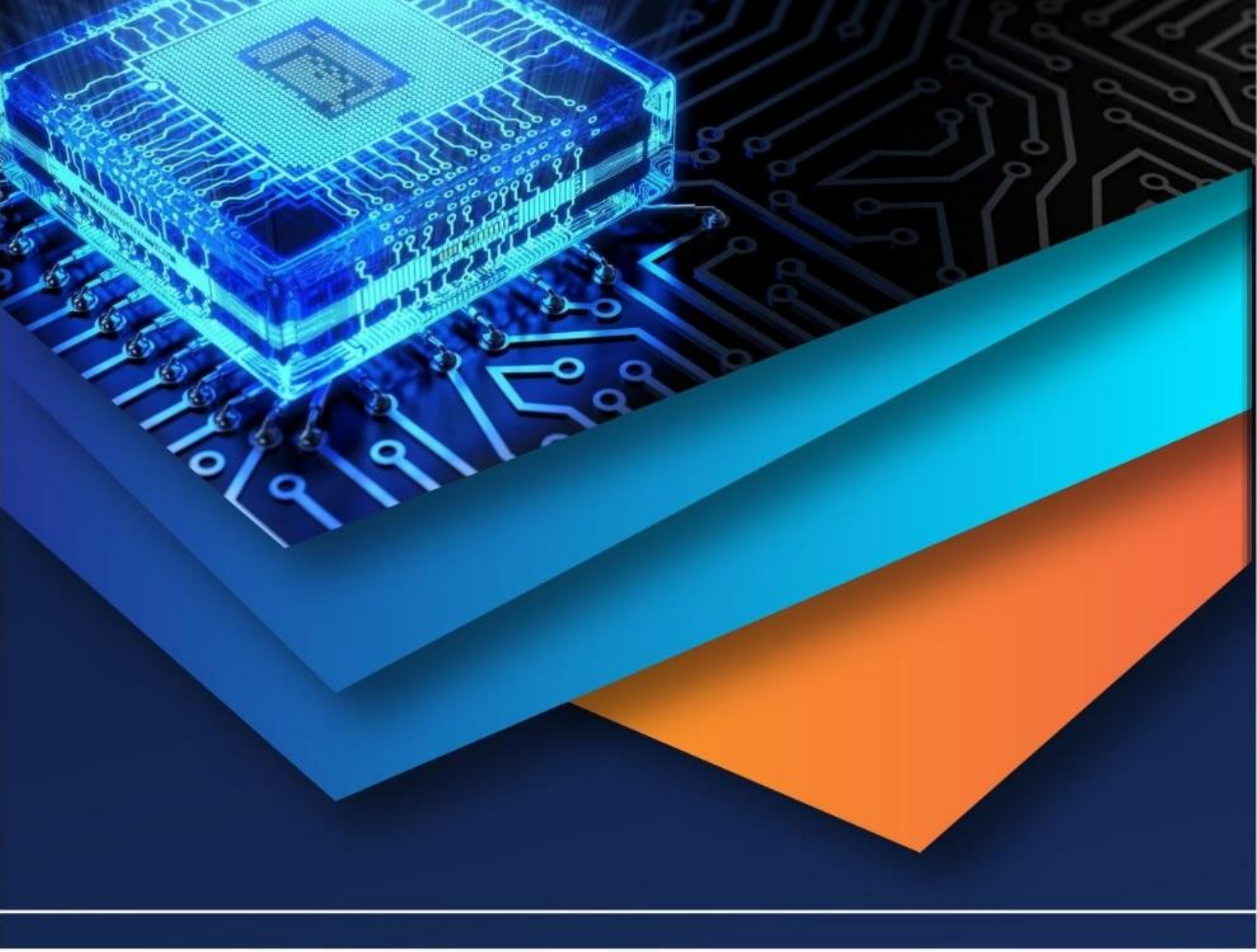

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