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RESEARCH ARTICLE OPEN ACCESS

AN INNOVATIVE MULTILEVEL SELF-BOOSTING INVERTER FOR GRID-CONNECTED PHOTOVOLTAIC SYSTEM

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Abstract:

This article, has an rising demand for electricity and the depletion of fossil fuels, Systems that use renewable energy are currently acknowledged is the primary substitute power source. One type of renewable energy source that is expanding quickly is the photovoltaic (PV) system. PV systems are integrated with the utility grid through the use of inverters. The most popular option for solar applications is multilayer inverters because to their reduced total harmonic distortion (THD), switching stress, and electromagnetic interference. This work introduces a five-level grid-connected inverter at a low cost. Six unidirectional switches, one diode, and one switched capacitor are used in the suggested inverter. It also does away with the need for several separate independent DC sources. An appropriate switching pulse for the inverter is produced using a straightforward modulation method. The MATLAB/Simulink simulation results are used to demonstrate the efficacy of the suggested multilevel inverter.

Keywords —: Five level inverter, Cascaded H-bridge inverter, SPWM, Solar PV array.

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I. INTRODUCTION

One of the energy sources that is expanding the fastest is solar energy. The design and use of photovoltaic (PV) devices for solar energy harvesting have advanced significantly in recent decades. Solar energy and other renewable energy sources don't contaminate the environment when they are produced or used, in contrast to fossil fuels. In PV systems, the outputs must be connected to the electrical grid via voltage source inverters that are placed between the PV cells and the grid. It is possible to connect these inverters to the grid with or without a transformer. Owing to their many benefits, including reduced common mode voltage, less voltage stress on power switches, and a lower dv/dt ratio to deliver fewer harmonic contents in output voltage and current, multi-level inverters have drawn a lot of attention in the application fields of medium voltage and high power. When comparing two-level inverter topologies with equivalent power ratings, multi-level inverters also have the benefit of having switching frequencies that lower the harmonic components of line-to-line voltages supplied to the load. This study proposes a grid-connected solar cascaded H-bridge five-level inverter. The SPWM controlled method and two cascaded inverters are features of the inverter with five levels topology. Two cascaded IGBT H-Bridges connect two separate PV arrays to the grid. The suggested inverter's performance is confirmed using thorough simulation results on the MATLAB Simulink platform.

II.LITERATURE SURVEY

An E-type inverter with five levels for grid-connected uses [1]. Switched capacitor inverter with five levels for solar power applications [2]. An innovative asymmetric multilayer inverter topology

appropriate for variable irradiance solar PV applications[3]. T-Type solar multilayer inverter harmonics mitigation using a new multicarrier modulation technique[4]. Design and management of a medium-voltage multilevel converter for direct photovoltaic system[5]. Considerations for the design and hardware implementation of a modified multilayer cascaded H-bridge inverter for solar power systems[6]. Grid-connected applications using a modular cascaded H-bridge multilevel photovoltaic inverter with distributed MPPT[7].

III.PROPOSED SYSTEM

MODIFIED MULTILEVEL INVERTERS

Nowadays, MLIs are employed in power networks due to their lower levels of electromagnetic interference and harmonic distortion, as well as their capacity to meet power quality and power rating requirements. A solar grid integration application is ideally suited for the Cascade Multi Level Inverter, one of these ML I types. Multilevel inverters have been the subject of several modulation and control methods, such as selective harmonic elimination, sinusoidal PWM, and space vector PWM (SVM), and similar variants of the three primary algorithms. Due to its ability to reduce harmonics by employing several carrier signal phase shifting choices, the SPWM control approach is highly favoured in industrial applications.

CONFIGURATION OF CASCADED H-BRIDGE FIVE LEVEL INVERTER

Flow A sequence of H bridge cells in five level inverters is used to combine two independent DC sources (SDCSs), such as fuel cells, PV arrays, or batteries, to create the desired voltage. These characteristics of cascade inverters enable precise control of the inverter through the application of several pulse width modulation (PWM) techniques. For solar grid-connected systems, the cascade H Bridge five level inverter is therefore the most appropriate option.

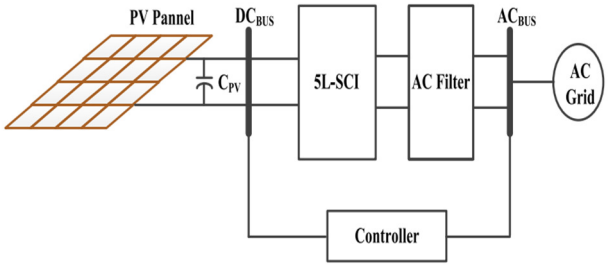

Fig. 1. The proposed scheme.

A schematic representation of the proposed system is shown in Fig. 1. PV panel, 5-L inverter, grid, AC filter, and suitable controller make up the system. The PV panel, which is DC in nature, receives solar radiation as the system's input source. The steady DC voltage at the inverter side's input is maintained via a DC bus. The DC voltage is fed into the 5-level inverter and AC filter in order to transform it into AC voltage and lower the total harmonic distortion (THD). To maintain a steady power supply across it, the voltage and current are controlled via a control algorithm.

This work introduces a new five-level PV inverter structure that can lower switch stress voltage and component counts, hence improving grid-connected system efficiency. PV panel, 5-L inverter, grid, AC filter, and suitable controller make up the system. The PV panel, which is DC in nature, receives solar radiation as the system's input source. The steady DC voltage at the inverter side's input is maintained via a DC bus. In order to convert the DC voltage into AC voltage and reduce the overall harmonic distortion (THD), this voltage is injected into the 5-level inverter and AC filter. The voltage and current are regulated by a control algorithm. An asymmetrical CHB-based MLIs topology is the suggested solution to the aforementioned problem; however, for high-level applications, there are a lot more power semiconductor devices, which raises the control complexity.

Furthermore, at the output terminal, the grid-tied arrangement produces a 5-L waveform. Reducing the size and cost of the filter, the impact of

dv/dt, and total harmonic distortion would all be achieved by doing this. Additionally, by utilising the peak current controller (PCC) technology in conjunction with a small inductor-based filter, it is possible to offer a tightly regulated injected current with a fast and dependable dynamic response that can sustain the grid's active and reactive power.

MATLAB / Simulink is used to design and modify the grid-connected solar PV system, and its performance is tested with simulation results to reflect claims.

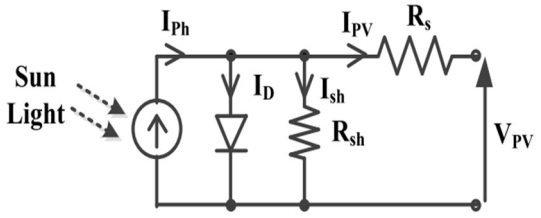

Fig. 2. Equivalent circuit.

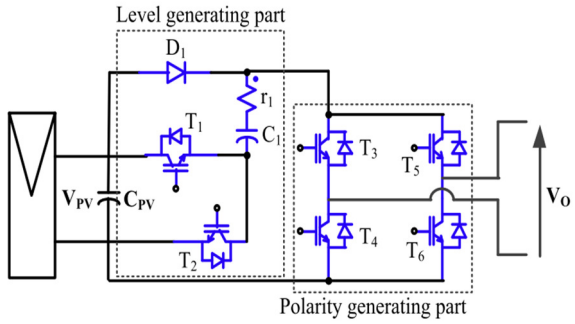

Fig. 3. Proposed topology.

Table 1
Switching states of 5-L SC inverter.

Mode	Conducting Switches	Capacitor	Output
1	T_3, T_5, T_2, and D_1	Charging	0
2	T_4, T_5, T_2, and D_1	Charging	V_{dc}
3	T_4, T_5, and T_1	Discharging	$2V_{dc}$
4	T_4, T_6, T_2, and D_1	Charging	0
5	T_3, T_6, T_2, and D_1	Charging	$-V_{dc}$
6	T_3, T_6, and T_1	Discharging	$-2V_{dc}$

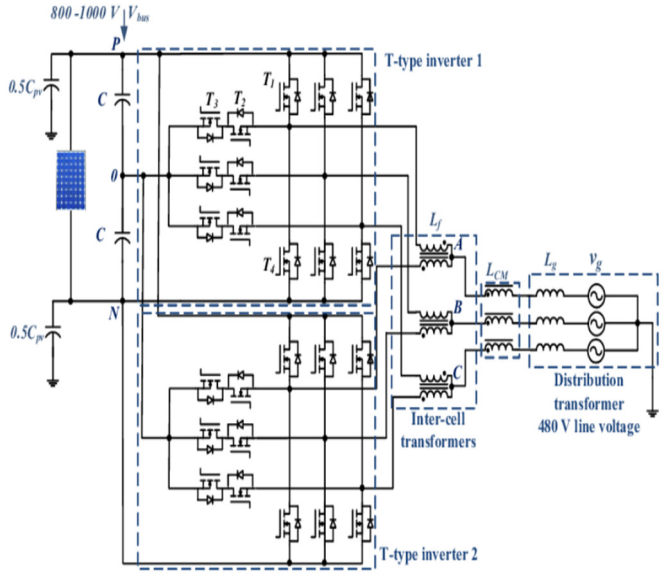

Fig 4. 5-L Inverter operating modes.

IV. RESULTS AND DISSCUSSION

This section examines how a MATLAB/Simulink environment controls the operation of a 5-L SCI with a grid-connected system. Maximum PV power extraction is guaranteed by the closed-loop control technique. Using the Matlab software, the five-level inverter is evaluated. and contrasting the simulated voltage waveform of the H bridge inverter with that of a typical Inverter with cascaded single phase. Control strategy based on SPWM topology is hence a fairly basic grid integration technique. A solar PV array integrated into the grid only takes two to four milliseconds. The voltage level and phase angle between the voltage and the current are as follows.

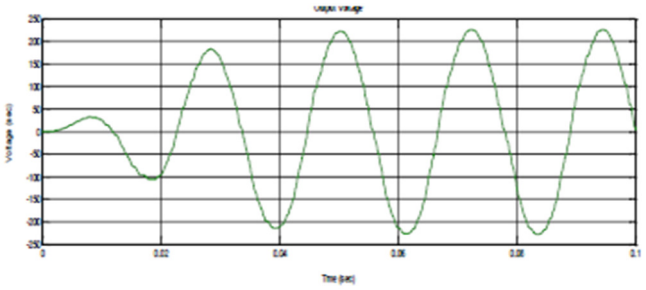

Fig 5. Output Voltage of inverter

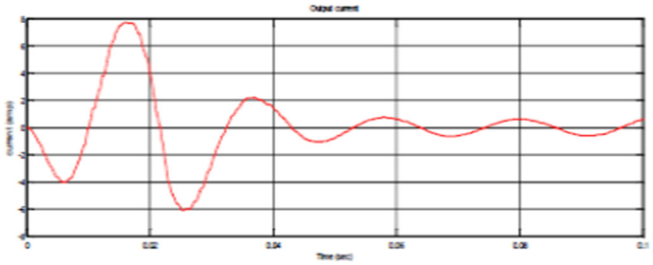

Fig 6. Output current of inverter

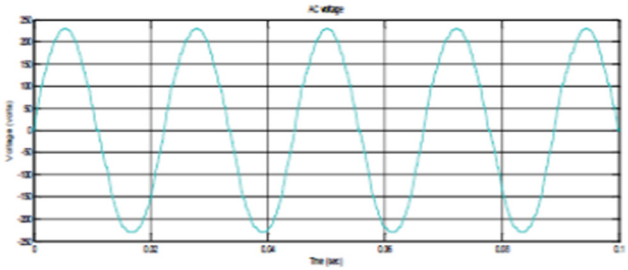

Fig 7. Grid Voltage

V. CONCLUSION

The purpose of this paper's brief overview of multilevel inverters is to draw attention to the necessity of developing new inverters or altered inverter combinations for grid-connected and photovoltaic systems. MLIs have been described in detail in a number of areas, including classifications, benefits, drawbacks, and how well they can improve energy conversion in contemporary energy systems. In light of this review, standard MLIs should be used in a modified strategy that uses MLIs at various levels in order to minimise the number of switches. In terms of size, affordability, reduced THD, and high efficiency energy conversion, modified MLIs are a potential option for PV and other renewable energy systems. In addition, this paper addressed the most modern MLIs grid-connected PV systems as well as techniques for minimising current leakage suppression.

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