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Five Level Inverter for Renewable Power Generation System

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Abstract **– Single-stage single-phase inverters used in small grid-connected photovoltaic (PV) systems have become increasingly important due to changes in the power sector and legislation promoting renewable energy. Multilevel inverters are chosen above two levels in order to increase performance. The single-stage, five-level inverter proposed in this study in relation to grid-connected PV systems. The photovoltaic (PV) array's voltage can be used to modify the inverter's output current. The SPWM topology forms the basis of this control technique. An growing number of these applications are using SPWM-based schemes that do not need the use of a phase-locked loop to interface the inverter to the grid. The Matlab platform is used to evaluate the five-level inverter's performance. The suggested scheme's feasibility is validated through simulation and outcomes validation**

Keywords **– Renewable Power, inverters, Photovoltaic.**

I. Introduction

Since fossil fuels are becoming more scarce and the greenhouse effect is happening, there has been a noticeable growth in the need for renewable energy. Thanks to advancements in power electronics technology, solar and wind energy have become highly sought-after among the different forms of renewable energy sources. Today, a lot of applications employ photovoltaic (PV) sources because of their low maintenance requirements and zero emissions. Over the past 20 years, demand for solar electric energy has continuously increased by 20% to 25% year, mostly as a result of declining costs and prices. The following variables have contributed to this decline.

- Solar cells' efficiency is higher
- Advances in Manufacturing Technology
- Economies in Scale

The main component of a PV system, the PV inverter, transforms the dc electricity from the PV modules into ac power that can be sent into the grid. Enhancing the inverter's output waveform lowers its corresponding harmonic content, which in turn decreases the amount of filter needed and the amount of electromagnetic interference (EMI) produced when the inverter switches on and off Inverter. Because multilayer inverters provide benefits over traditional three level PWM inverters, researchers and manufacturers have been more interested in them recently. They provide better output waveforms, reduced Total Harmonic Distortion (THD), smaller filter sizes, and less EMI.

The following are the three typical multilayer inverter topologies.

- Capacitor clamped (flying capacitors)
- Diode clamped (neutral clamped)
- H-bridge inverter with cascaded design.

II. Proposed Cascaded H-Bridge Five Level Inverter Configuration

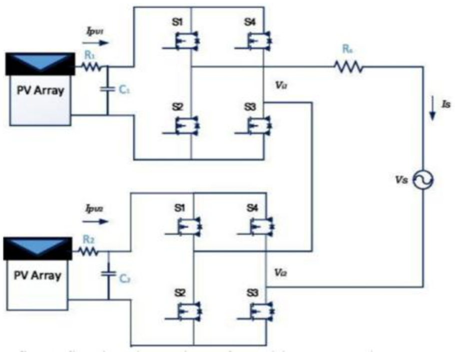

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Fig 1: Grid-connected system with five-level topology

III. SPWM CONTROL TOPOLOGY

The most used PWM control method is sinusoidal SPWM because of its numerous benefits, which include minimal switching losses, fewer harmonic outputs compared to other approaches, and ease of implementation. To create gate signals for the inverter switches in an SPWM, a triangular carrier waveform and a sinusoidal reference voltage waveform are compared. In order to lower the THD ratios, a number of multicarrier methods based on the traditional SPWM with triangle carriers have been developed

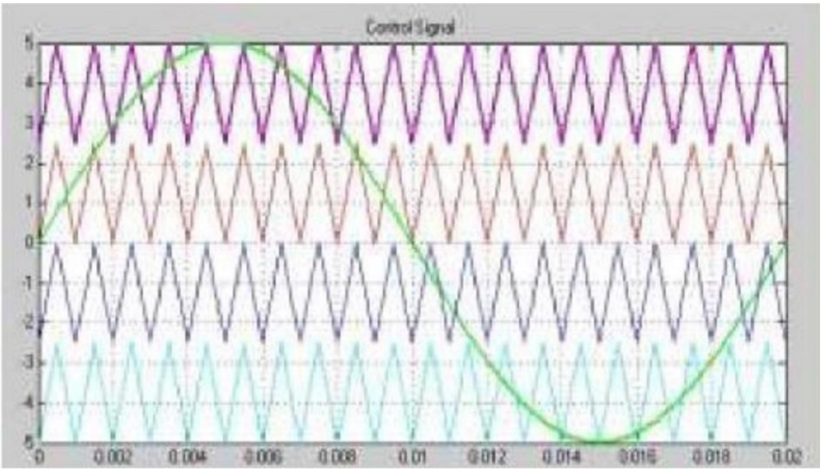

Fig. 2 Modular control strategy (control Waveform)

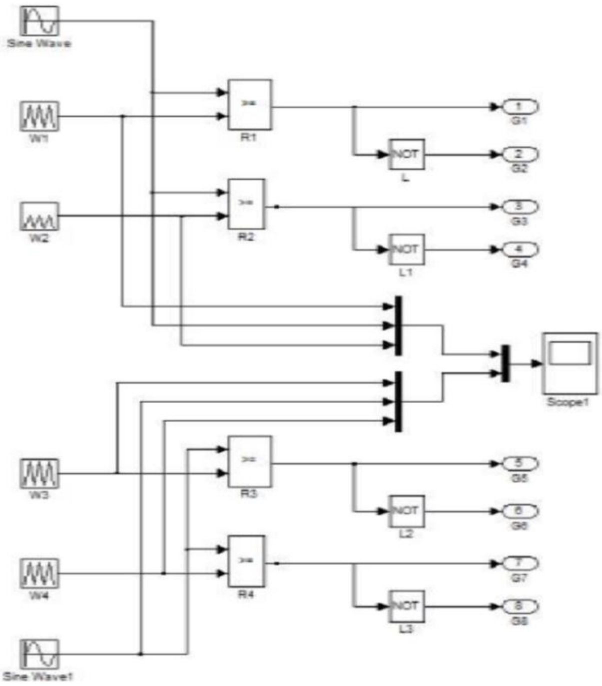

Fig. 3 Modular control strategy (Block diagram)

An analogue or logic comparator device compares a low frequency sinusoidal modulating signal with a high frequency triangular carrier signal in order to provide SPWM control. The required line voltage frequency at the inverter output is defined by the modulating sinusoidal signal's frequency. Four distinct SPWM pulses have been produced for each H Bridge by the modulation method in the SPWM modulator block.

IV. SIMULATION SETUP

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Thorough MATLAB-Simulink simulation studies are conducted to validate the performance of the proposed cascaded H-bridge five level inverter. The modular controller for the suggested system is seen in Fig. 2, and the simulation model of the proposed system is displayed in Fig. 4 using the Matlab Simulink programme.

The solar insolation of a PV array is specified to be 1000 W/m2. The PV array's output, at 1000 W/m^2 of insolation, is 115 V, which is supplied into a cascaded H-bridge inverter. Grid integration makes use of two separate cascaded H-bridge inverters. Two cascading H-bridge inverters will be directly linked to the grid utility and have an output of 230V AC. The modular control approach is used to regulate this inverter output. For each of the two inverters, there are two separate modular controllers. IGBT switches for inverter architecture in Fig. 3 display a modular controller. The following are the specific settings of the inverter used for the controller and simulation:

- Solar Insolation: 1000W/m2
- Nominal Solar array voltage: 115 Volts
- Resistance R1, R2: 1.5 Ohm, 10 Ohm
- DC link Capacitor: 2200 µf
- Grid Voltage: 230 Volts
- Fundamental frequency of the filter: 50 Hz

Figure 4 depicts the simulation model of the suggested five-level inverter fed solar grid linked system. Photovoltaic arrays and cascaded H-bridge inverters are connected by DC link capacitors C1 and C2, resistances R1 and R2, respectively.

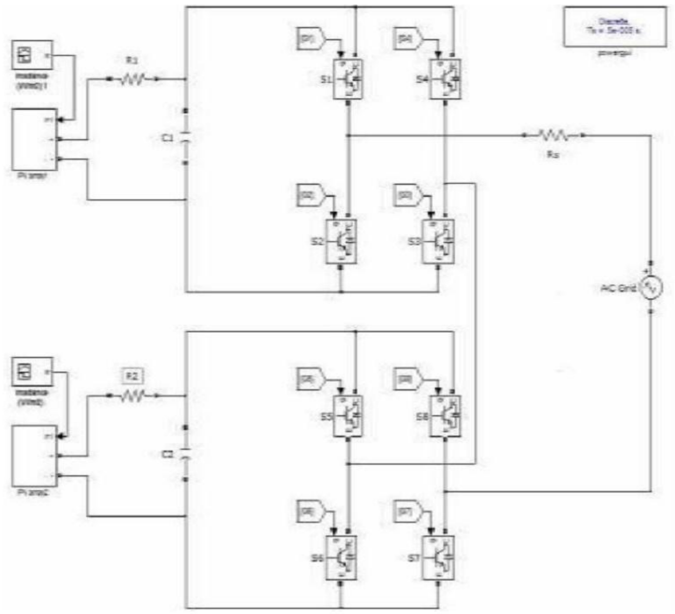

Fig. 4 Simulation model of proposed system

V. RESULTS AND DISCUSSION

A five-level inverter simulation setup in MATLAB is displayed in Figure 4. The output PV array is merged with the DC link voltage directly and is linked to the inverter. The output voltage, output current, DC link voltage, and AC grid voltage simulated waveforms are displayed in Fig. 5 through (d). One solar equivalent circuit model's output is displayed by this DC connection voltage. Fig. 6 and 7 shows the output voltage and output current of the five-level inverter after 2 to 4 msec.

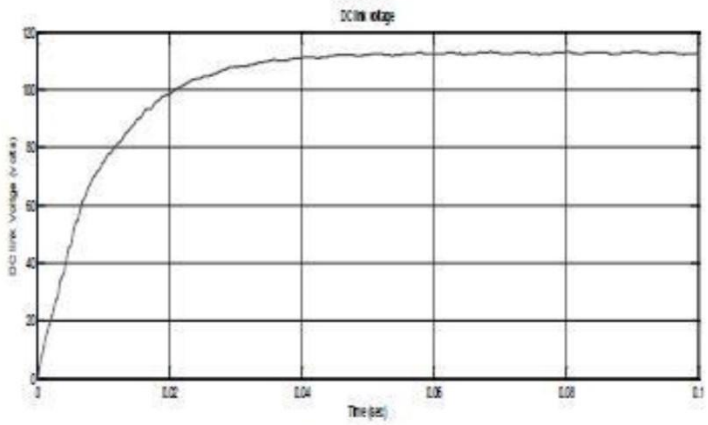

Fig. 5 DC Link Voltage

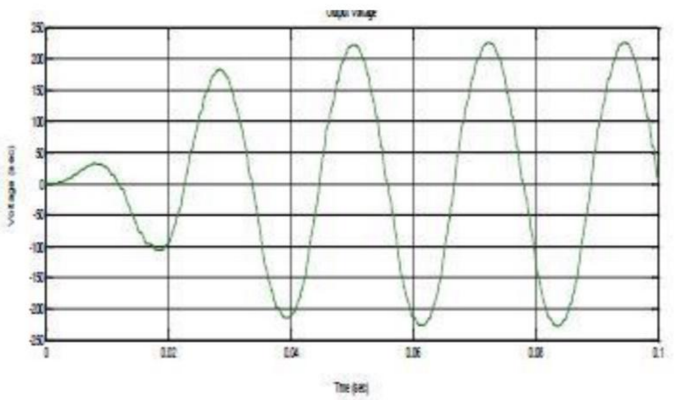

Fig. 6 Output current of Inverter

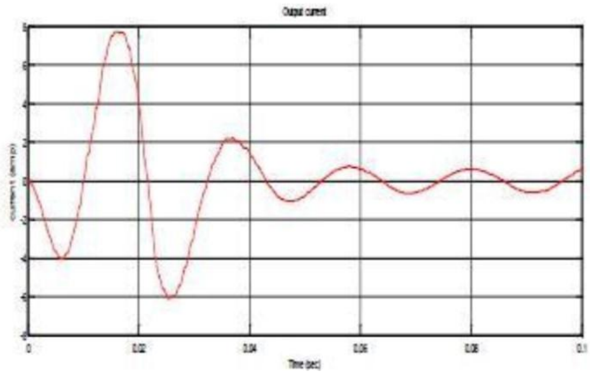

Fig. 7 Grid Voltage

For PV grid integration with single phase supply, a solar five level inverter takes two to four milliseconds. This result unmistakably demonstrates that the cascaded H-bridge inverter used in the solar grid integration is based on the SPWM control approach.

VI. CONCLUSION

An easier-to-use single-phase cascaded H-bridge five-level inverter for solar grid integration is proposed in this research. Using the Matlab software, the five-level inverter's performance is evaluated. and drawing comparisons between its simulated voltage waveform and the traditional single phase cascaded H-bridge inverter. Thus, a very basic grid integration approach is the control strategy based on SPWM topology. It takes about 2 to 4 milliseconds for a solar PV array to be incorporated into the grid. The voltage level and phase angle between the voltage and the current are the next sections.

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