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Research Paper

DESIGN AND IMPLEMENTATION OF A NOVEL MULTILEVEL INVERTER FOR GRID CONNECTED PV SYSTEMS

AMARTHAPUDI SRUTHI

M.Tech, Department of Electrical & Electronics Engineering

St. Ann's College of Engineering & Technology, Chirala

Dr. KALADHAR GADDALA (M.Tech.,Ph.D)

Associate Professor, EEE Department

St. Ann's College of Engineering & Technology, Chirala

Abstract

This paper presents the design and implementation of a novel multilevel inverter for grid-connected photovoltaic (PV) systems. The proposed inverter topology reduces the number of switches and DC sources while improving output voltage quality and reducing total harmonic distortion (THD). Conventional multilevel inverters such as diode-clamped, flying capacitor, and cascaded H-bridge topologies require a large number of components, which increases complexity and switching losses. The proposed inverter generates seven-level, thirteen-level, and twenty-one-level output voltages with reduced switching devices and improved efficiency. MATLAB/Simulink analysis confirms that the proposed topology provides lower THD and better harmonic performance for grid integration applications.

Keywords

Multilevel Inverter (MLI), Photovoltaic System (PV), Grid Connected System, THD, MATLAB/Simulink, Renewable Energy.

1. Introduction

Renewable energy systems are gaining importance due to the depletion of fossil fuels and environmental concerns. Solar photovoltaic systems are widely used because of their clean energy generation capability. Grid-connected PV systems require efficient inverter topologies to convert DC power into AC power with low harmonic distortion. Multilevel inverters are preferred in high-power applications because they generate staircase output voltages closer to sinusoidal waveforms, thereby reducing harmonics and switching losses.

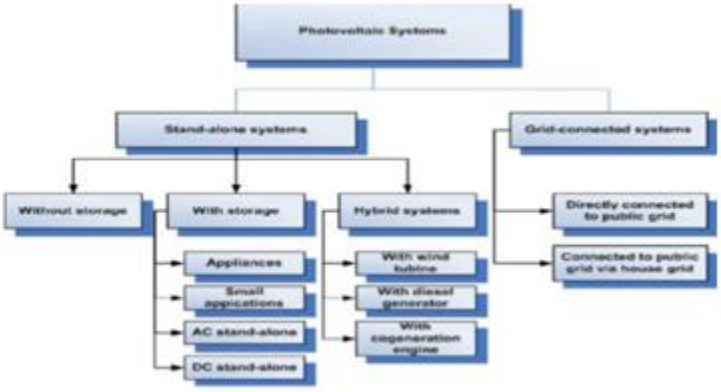


FIGURE 1 .CLASSIFICATION OF PV SYSTEM

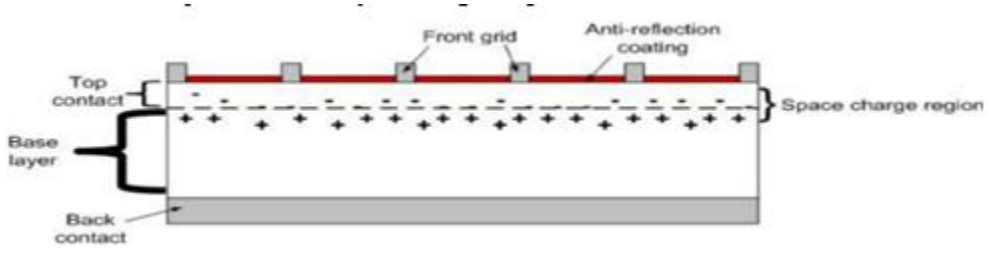


FIGURE 2. STRUCTURE OF PV CELL

2. Literature Review

Researchers have proposed several multilevel inverter topologies including diode-clamped, flying capacitor, and cascaded H-bridge inverters. Although these methods improve output quality, they require a large number of switches, capacitors, and DC sources. Recent research focuses on reducing component count while maintaining lower THD and improved efficiency.

3. Proposed Methodology

The proposed multilevel inverter consists of a cascaded structure with reduced switching devices. The inverter is designed to produce multiple voltage levels using fewer components compared to conventional topologies. The switching strategy generates seven-level, thirteen-level, and twenty-one-level outputs. The proposed system is integrated with a photovoltaic source and connected to the utility grid.

The number of output voltage levels is given by:

Number of Levels = n(n + 1) + 1

Sw1	Sw2	Sw3	Sw4	Sw5	Sw6	Load Voltage
On	On	off	off	On	off	V_{dc}
On	On	off	off	off	On	$2V_{dc}$
On	On	off	on	On	On	$3V_{dc}$
off	On	off	On	off	off	0
off	off	On	On	On	off	$-V_{dc}$
off	off	On	On	off	On	$-2V_{dc}$
off	off	On	On	On	On	$-3V_{dc}$

TABLE 1. Switching sequence for proposed seven level Inverter

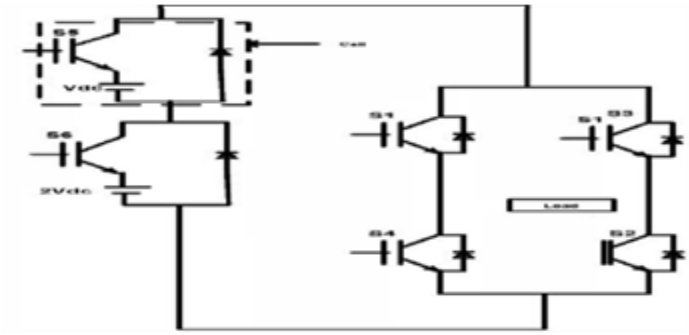


FIGURE 3. PROPOSED SEVEN LEVEL MULTILEVEL INVERTER

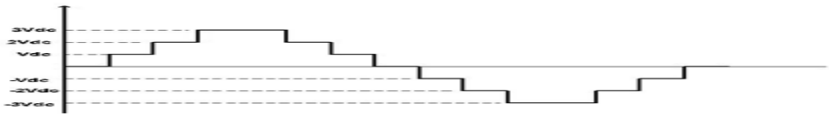


FIGURE 4.SEVEN LEVEL OUTPUT VOLTAGE WAVE FORM

Sw1	Sw2	Sw3	Sw4	Sw5	Sw6	Sw7	V_{load}
On	On	off	off	On	On	On	$6V_{dc}$
On	On	off	off	off	On	On	$5V_{dc}$
On	On	off	on	On	off	On	$4V_{dc}$
On	On	off	off	off	off	On	$3V_{dc}$
On	On	off	off	off	On	off	$2V_{dc}$
On	On	off	off	On	off	off	V_{dc}
off	On	off	On	off	off	off	0
off	off	On	On	On	off	off	$-V_{dc}$
off	off	On	On	off	On	off	$-2V_{dc}$
off	off	On	On	off	off	On	$-3V_{dc}$
off	off	On	On	On	off	On	$-4V_{dc}$
off	off	On	On	off	On	On	$-5V_{dc}$
off	off	On	On	On	On	On	$-6V_{dc}$

TABLE 2. SWITCHING SERUENCE FOR PROPOSED THIRTEEN LEVEL INVERTER

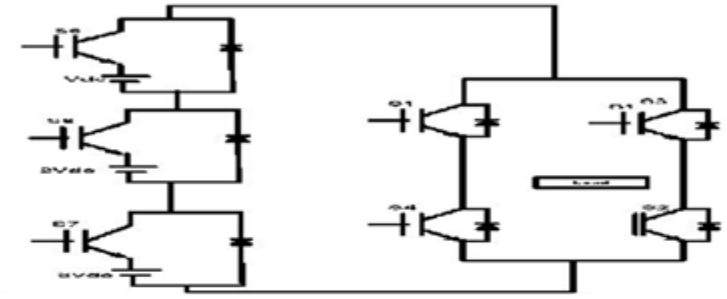


FIGURE 5. THIRTEEN LEVEL PROPOSED INVERTER

Topology	Number of switches for 7-level	Number of switches for 13-level
Diode Clamped MLI	12	24
Flying capacitor MLI	12	24
Cascaded H-bridge MLI	12	24
Proposed MLI	6	7

TABLE 3. COMPARISION BETWEEN DIFFERENT TOPOLOGIES

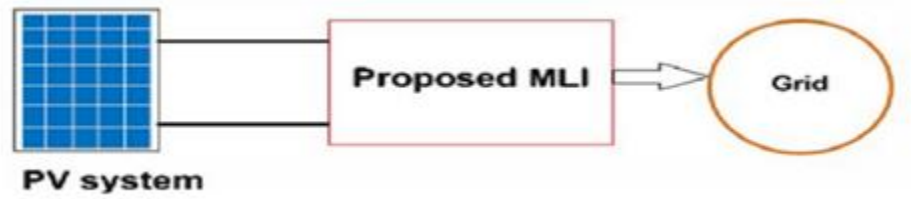


FIGURE 6. GRID TIED PHOTO VOLTAIC SYSTEM

4. Simulation Results

The proposed inverter model was simulated using MATLAB/Simulink. Simulation results show that the seven-level inverter achieved THD of 17.02%, while the thirteen-

level inverter achieved THD of 13.80%. Increasing the number of levels significantly reduces lower-order harmonics and improves power quality. The grid-connected system also demonstrated synchronization between grid voltage and current.

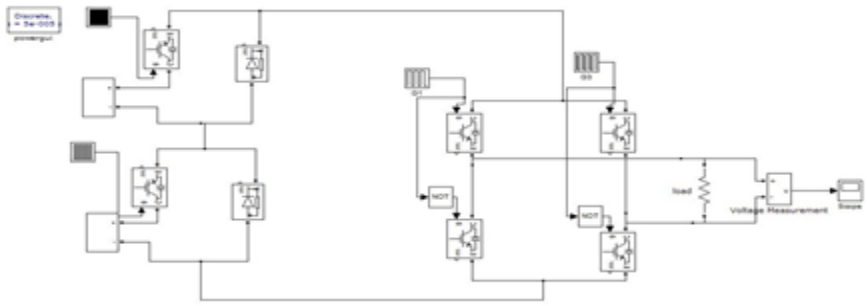
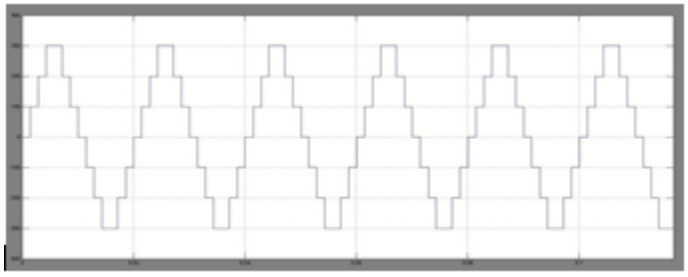


Fig.7.Matlab/Simulink diagram of proposed seven levels MLI.



FIGUGURE 8. Proposed seven level inverter output voltage.

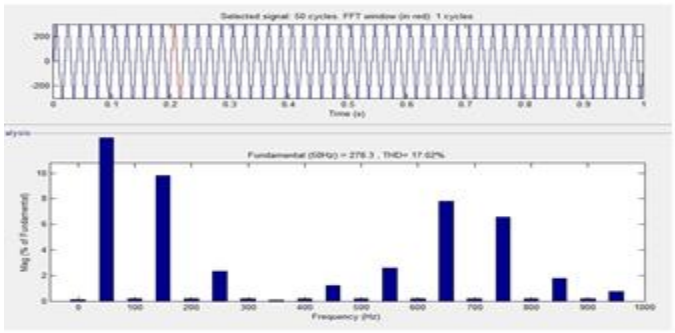


Fig.9.THDofthe7-levelproposed inverter.

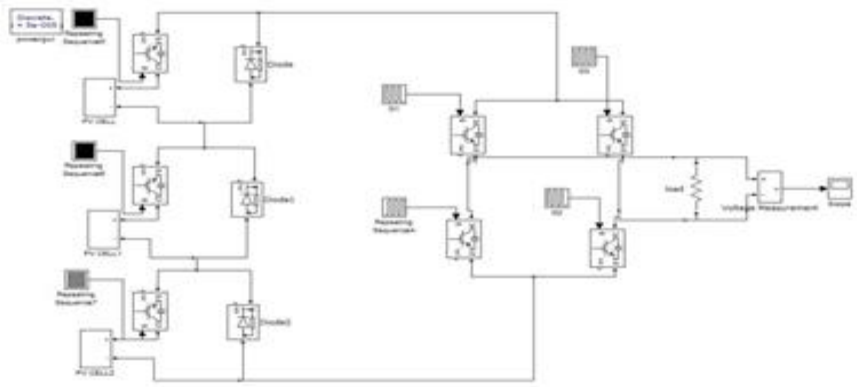


Fig10.Matlab/Simulink diagram of proposed thirteen level MLI.

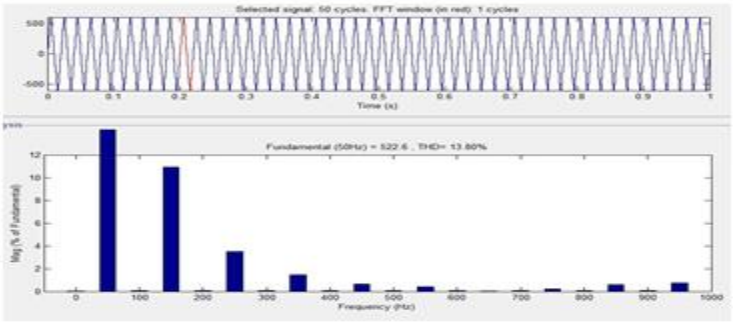


Fig.11.THD of the13-level proposed inverter.

5. Advantages of Proposed System

- Reduced number of switches and gate driver circuits.
- Lower switching losses and improved efficiency.
- Reduced total harmonic distortion (THD).
- Improved output voltage waveform quality.
- Suitable for renewable energy and grid-connected applications.

6. Conclusion

A novel multilevel inverter for grid-connected PV systems has been presented in this paper. The proposed topology reduces the number of components and improves harmonic

performance compared to conventional multilevel inverter structures. Simulation results verify the effectiveness of the proposed inverter for renewable energy applications.

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reference from the original project document should be inserted here.