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# A Novel Single-Phase Multistring Multilevel Inverter Topology for Distributed Energy Resources

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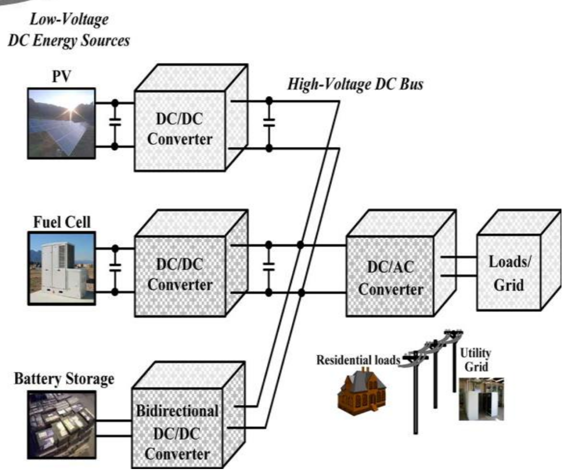
***Abstract—In the micro grid system, the distributed energy resource (DER)-based single-phase inverter is usually adopted. In order to reduce conversion losses, the key is to save costs and size by removing any kind of transformer as well as reducing the power devices. The objective of this paper is to study a novel nine-level Multistring inverter topology for DERs-based dc/ac conversion system. In this study, a high step-up converter is introduced as a front-end stage to improve the conversion efficiency of conventional boost converters and to stabilize the output dc voltage of various DERs such as photovoltaic and fuel cell modules for use with the simplified multilevel inverter. The simplified multilevel inverter requires only four active switches and eight such cascaded H-bridge multilevel inverters. The studied Multistring inverter topology offers strong advantages such as improved output waveforms.***
***Index Terms—DC/AC power conversion, multilevel inverter.***

## I. INTRODUCTION

IN LIGHT of public concern about global warming and climate change, much effort has been focused on the development of environmentally friendly distributed energy resources (DERs). For delivering premium electric power in terms of high efficiency, reliability, and power quality, integrating interface converters of DERs such as photovoltaic (PV), wind power, micro turbines, and fuel cells into the micro grid system has become a critical issue in recent years [1]–[4]. In such systems, most DERs usually supply a dc voltage that varies in a wide range according to various load conditions. Thus, a dc/ac power processing interface is required and is compliable with residential, industrial, and utility grid standards [4]–[7].
Various converter topologies have been developed for DERs[7]–[16] that demonstrate effective power flow control performance whether in grid-connected or stand-alone operation. Among them, solutions that employ high-frequency transformers or make no use of transformers at all have been investigated to reduce size, weight, and expense. For low-medium power applications, international standards allow the use of grid-connected power converters without galvanic isolation, thus allowing so called "transformerless" architectures [7], [11], [12]. Furthermore, as the output voltage level increases, the output harmonic content of such inverters decreases, allowing the use of smaller and less expensive output filters.

As a result, various multilevel topologies are usually characterized by a strong reduction in switching voltages across power switches, allowing the reduction of switching power losses and electromagnetic interference (EMI) [8], [11], [12]. A single-phase Multistring nine-level inverter integrated with an auxiliary circuit was recently proposed for dc/ac power conversion [12], [13]. This topology used in the power stage offers an important improvement in terms of lower component count and reduced output harmonics. Unfortunately, high switching losses in the additional auxiliary circuit caused the efficiency of the Multistring nine-level inverter to be approximately 4% less than that of the conventional Multistring three-level inverter [13]. In [14], a novel isolated single-phase inverter with generalized zero vectors (GZV) modulation scheme was first presented to simplify the configuration. However, this circuit can still only operate in a limited voltage range for practical applications and suffer degradation in the overall efficiency as the duty cycle of the dc-side switch of the front-end conventional boost converter approaches unity [6], [14]. Furthermore, the use of isolated transformer with multi windings of the GZV based inverter results in the larger size, weight, and additional expense [14].

To overcome the aforementioned problem, the objective of this letter is to study a newly constructed transformerless five level Multistring inverter topology for DERs. In this paper, the nine level cascaded multi level inverter is used for DER.In order to improve the conversion efficiency of conventional boost converters; a high step-up converter is also introduced as a front-end stage to stabilize the output dc voltage of each DER modules for use with the simplified multilevel inverter. The newly constructed inverter topology offer strong advantages such as improved output waveforms, smaller filter size, and lower EMI and total harmonics distortion (THD). In this letter, the operating principle of the developed system is described, and a prototype is constructed for verifying the effectiveness of the topology.




Configuration of Multistring inverter for various DERs application.

## II. SYSTEM CONFIGURATION OF OPERATION PRINCIPLES

A general overview of different types of PV modules or fuel cell inverters is given in [9] and [11]. This letter presents a Multistring multilevel inverter for DERs application. The Multistring inverter shown in Fig. 1 is a further development of the string inverter, whereby several strings are interfaced with their own dc/dc converter to a common inverter [15]. This centralized system is beneficial because each string can be controlled individually. Thus, the operator may start his own PV/fuel cell power plant with a few modules. Further enlargements are easily achieved because a new string with a dc/dc converter can be plugged into the existing platform, enabling a flexible design with high efficiency [9]. The single-phase Multistring multilevel inverter topology used in this study is shown.

This topology configuration consists of two high step-up dc/dc converters connected to their individual dc-bus capacitor and a simplified multilevel inverter. Input sources, DER module 1, and DER module 2 are connected to the inverter followed a linear resistive load through the high step-up dc/dc converters. The studied simplified five-level inverter is used instead of a conventional cascaded pulse width-modulated (PWM) inverter because it offers strong advantages such as improved output waveforms, smaller filter size, and lower EMI and THD [14]. It should be noted that, by using the independent voltage regulation control of the individual high step-up converter, voltage balance control for the two bus capacitors $C_{bus1}$, $C_{bus2}$ can be achieved naturally.

### A. High Step-Up Converter Stage

In this study, high step-up converter topology is introduced to boost and stabilize the output dc voltage of various DERs such as PV and fuel cell modules for employment of the proposed simplified multilevel inverter. The architecture of a high step-up converter initially introduces and is composed of different converter topologies:

Boost, fly back, and a charge-pump circuit.

The coupled inductor of the high step-up converter can be modeled as an ideal transformer, a magnetizing inductor, and a leakage inductor. According to the voltage–seconds balance condition of the magnetizing inductor, the voltage of the primary winding can be derived as

$$V_{pri} = V_{in} \cdot D/1 - D$$

Where, $V_{in}$ represents each the low-voltage dc energy input sources.

### B. Simplified Multilevel Inverter Stage

To assist in solving problems caused by cumbersome power stages and complex control circuits for conventional multilevel inverters, this paper reports a new single-phase Multistring topology, presented as a new basic circuitry, it should be assumed that, in this configuration, there are 8 H-bridges connected directly across the dc bus, and all switching combinations are activated in an output cycle. The dynamic voltage balance between the two capacitors is automatically controlled by the preceding high step-up converter stage.
Then, we can assume $V_{s1} = V_{s2} = V_{s3} = V_{s4} = V_s$.

This topology includes eight H-bridges the phase disposition (PD) PWM control scheme is introduced to generate switching signals and to produce nine output-voltage levels: 0, $V_S$, $2V_S$, $3V_S$, and $4V_S$.

## III. SIMULATION RESULTS

The simulation of the nine level inverter is done using MATLAB/Simulink for each H bridge voltage of 3 volts and eight such H bridges are in cascade.
The Simulink model is shown below. The parameters for the simulation are:

1. Source voltage = 3V
2. Number of Cascaded H-bridges = 8
3. Number of switches in each bridge = 4

The output voltage obtained is 8V peak in positive half cycle and 8v peak in negative half cycle. The peak to peak voltage is about 16V.

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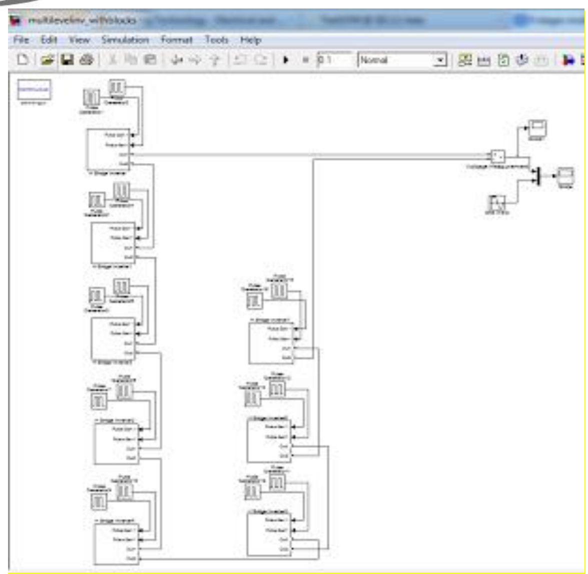
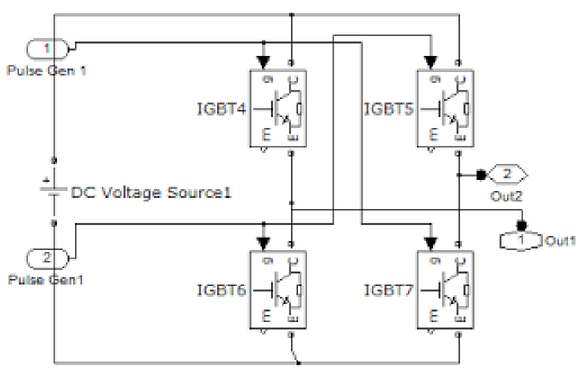
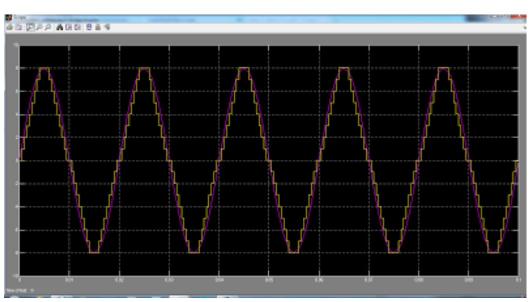


**Single-phase Multistring nine-level inverter topology.**

The single H-bridge is shown below




The simulated output voltage is shown below



## IV. CONCLUSION

This paper presents a single-phase Multistring cascaded multilevel inverter topology that produces a significant reduction in the number of power devices required to implement multilevel output for DERs. The studied inverter topology offer strong advantages such as improved output waveforms, smaller filter size, and lower EMI and THD.

## V. REFERENCES

i. *Y. Li, D. M. Vilathgamuwa, and P. C. Loh, "Design, analysis, and realtime testing of a controller for multibus microgrid system," IEEE Trans.Power Electron., vol. 19, no. 5, pp. 1195–1204, Sep. 2004.*

ii. *N. Hatziargyriou, H. Asano, R. Iravani, and C. Marnay, "Microgrids,"IEEE Power Energy Mag., vol. 5, no. 4, pp. 78–94, Jul./Aug. 2007.*

iii. *F.Katiraei,R.Iravani,N.Hatziargyriou,andA.Dimeas,"Microgridsmanagement," IEEE Power Energy Mag., vol. 6, no. 3, pp. 54–65, May/Jun. 2008.*

iv. *C. L. Chen,Y.Wang, J. S. Lai,Y. S. Lee, andD.Martin, "Design of parallel inverters for smooth mode transfer microgrid applications," IEEE Trans. Power Electron., vol. 25, no. 1, pp. 6–15, Jan. 2010.*

v. *C. T. Pan, C. M. Lai, and M. C. Cheng, "A novel high step-up ratio inverter for distributed energy resources (DERs)," in Proc. IEEE Int. Power Electron. Conf., 2010, pp. 1433–1437.*

vi. *C. T. Pan, C. M. Lai, and M. C. Cheng, "A novel integrated singlephase inverter with an auxiliary step-up circuit for low-voltage alternative energy source application," IEEE Trans. Power Electron., vol. 25, no. 9, pp. 2234–2241, Sep. 2010.*

vii. *F. Blaabjerg, Z. Chen, and S. B. Kjaer, "Power electronics as efficient interface in dispersed power generation systems," IEEE Trans. Power Electron., vol. 19, no. 5, pp. 1184–1194, Sep. 2004.*

viii. *D. G. Infield, P. Onions, A. D. Simmons, and G. A. Smith, "Power quality*

ix. *from multiple grid-connected single-phase inverters," IEEE Trans. Power Del., vol. 19, no. 4, pp. 1983–1989, Oct. 2004.*

x. *S. B. KjaSer, J. K. Pedersen, and F. Blaabjerg, "A review of single-phase*