INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 2 ISSUE 2 (2016) PAGES 725-729
RECEIVED : 22/03/2016. PUBLISHED : 29/03/2016
March 29, 2016

A SINGLE PHASE INVERTER BASED ON STEP UP SWITCHED CAPACITOR USING THIRD ORDER HARMONIC INJECTION METHOD

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Abstract:
In the microgrid system, single-phase inverter is usually used for the distributed energy resource (DER). To reduce conversion losses, Removing the transformer and reducing power devices will bring down the cost and zise of the converter. The objective of this paper is to build simulation of seven level multi string inverter topology for DERs based DC to AC system. In this paper, a high step-up converter isused as front-end stage to improve the conversion efficiency of conventional boost converters and to stabilize the output DC voltage of various DERs such as PV and fuel cell modules for use with the simplified multilevel inverter. Seven level inverter requires only six active switches instead of the eight required in the conventional cascaded H-bridge inverter. In addition, two active switches are operated under line frequency. The simulated seven level string inverter topology offers strong advantages such as improved output waveforms, small filter size, and low magnetic interference and harmonic distortion. Simulation results show the effectiveness of the proposed solution.

Keywords: DC/AC power conversion, multilevel inverter.

1. INTRODUCTION

In light of public concern about global warming and climate change, much effort has been focused on development of environmentally friendly distributed energy resources (DERs).For delivering premium electric power in terms of high efficiency, reliability, and power quality, integrating inter face converters of DERs such as photovoltaic, wind power, micro turbines, and fuel cells into the microgrid system has become acritical issue in recent years [1]-[4

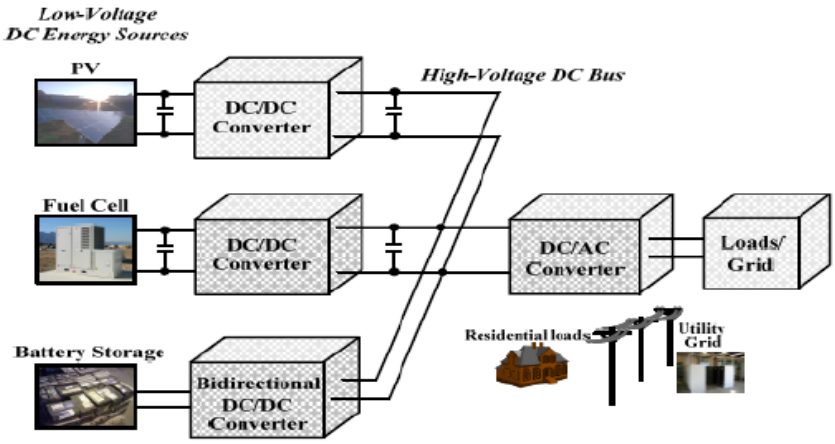

Fig. 1 Configuration of multistring inverter for various DERs application

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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 ―transformer less ‖architectures [7], [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]. A single-phase multistring five-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 five-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 application sand 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 above-mentioned problem, the objective of this paper is to study a newly- constructed transformer less five-level .

2. SYSTEM CONFIGURATION

A general overview of different types of photovoltaic (PV) modules or fuel cell inverters is given in [9]. This paper presents a multi string multilevel inverter for DERs application. The multi string 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.

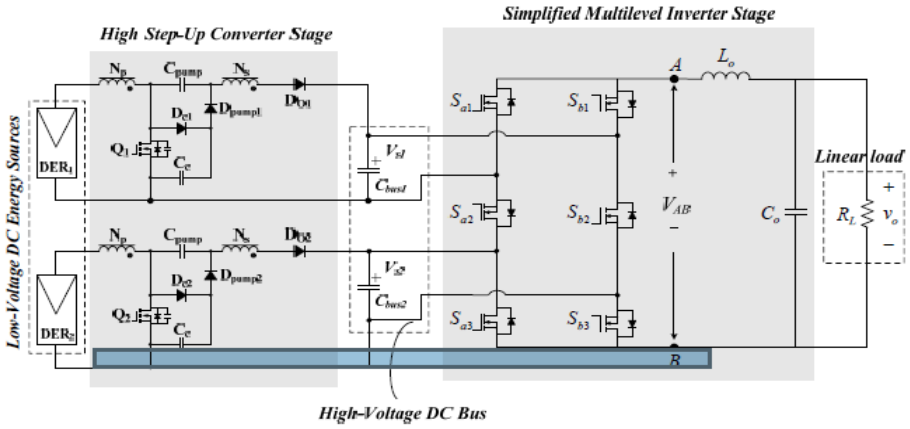

Fig.2. Single-phase multistring five-level inverter topology

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This topology configuration consists of two high step-up DC/DC converters connected to their individual 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 multi string multilevel inverter topology used in this study is shown in Fig. 2. 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.

3. COMPARISON WITH CCHB INVERTER

The studied simplified five-level inverter is used instead of a conventional phase disposition (PD) pulse width modulated (PWM) inverter because it offers strong advantages such as improved output waveforms, smaller filter size, and lower electromagnetic interference and THD. 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 Cbus1, Cbus2 can be achieved naturally. The average switching power loss Ps in the switch caused by these transitions can be defined as where tc(on) and tc(off) are the turn-on and turn-off cross over intervals, respectively; VDS is the voltage across the switch;and Io is the entire current which flows through the switch. Compared with the CCHB circuit topology , the voltage stresses of the eight switches of the CCHB inverter are all equal to Vs. For simplification, both the proposed circuit and CCHB inverter are operated at the same turn-on and turn-off cross over intervals and at the same load Io. Then, the average switching power loss Ps is proportional to VDS and fs as According to Eq. (8), the switching losses of the CCHB inverter from eight switches can be obtained as Similarly, the switching power loss of the proposed single phasefive- level inverter due to six switches can also be obtained as Because switches Sa2, Sb2 can only be activated twice .

4. SIMULATION RESULTS

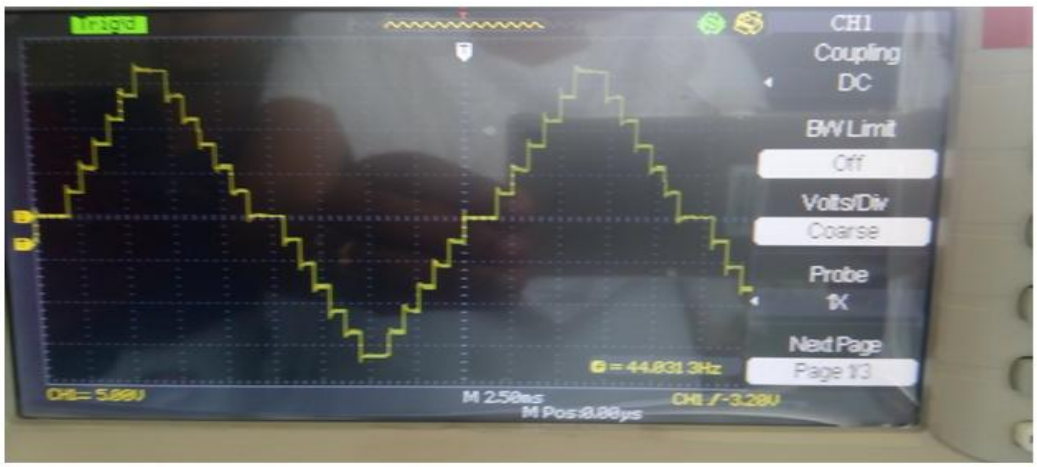

Fig.3.Waveform Analysis

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To facilitate understanding of the operating principle and as verification, a Simulation system with a high step-up DC/DC converter stage and the simplified multilevel DC/AC stage are built with the corresponding parameters listed. The specifications of the two preceding high step-up DC/DC converters are (a) input voltage 30V; (b) controlled output voltage 100V; and (c) switching frequency 85kHz. The corresponding specifications of the simplified multilevel DC/AC inverter stage are (1) output power,

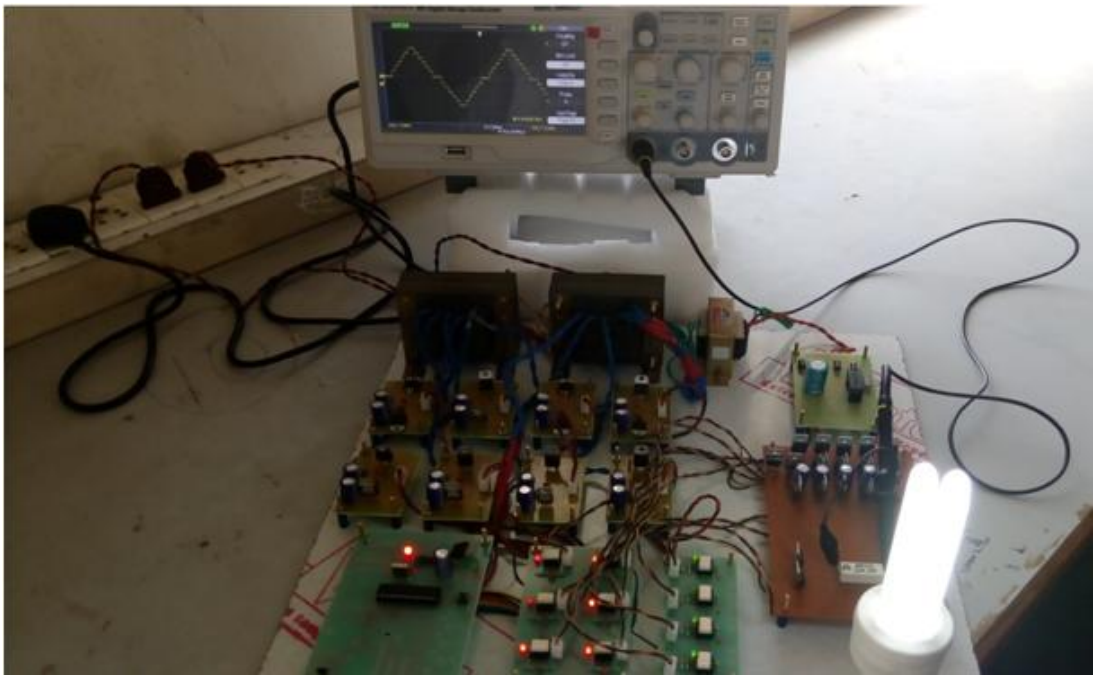

Fig.4.Exprimental Setup

Po=230W; (2) input voltage, Vs=100V; (3) output voltage, vo=110Vrms; (4) line frequency, fm=60Hz; (5) switching frequency, fs=40kHz; and (6) peak modulation index, mpeak=0.76.For better understanding, the guidelines and considerations of the DC-link capacitance. To calculate the relationship between capacitance and voltage limits, the net power flowing into the bus capacitor, i.e. DC link capacitor, is expressed as where PDER is the total output power of the DER modules, and Vo and Io are the peak AC-side quantities.

CONCLUSION

This work reports a newly-constructed single-phase multistring 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. Simulation results show the effectiveness of the proposed solution.This paper presents a new Novel Asymmetrical Multistring multilevel converter. Here we proposed single phase and three phase multistring multilevel inverters, the proposed converter produces more voltage levels with less number of switches compared to H- bridge configuration.

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