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Review on Grid Connected PV System using Transformerless Inverter with Virtual DC Bus Concept

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Abstract: *The photovoltaic based power generation systems are popular nowadays. For low power grid connected application, a single phase converter can be used. In PV application it is possible to remove the transformer in the inverter to reduce losses, cost and size. Galvanic connection of the grid and the DC sources in transformerless system can introduce additional common mode ground leakage currents due to the ground parasitic capacitance. These current reduce the efficiency of power conversion stage and affect the quality of grid current. To eliminate this common mode leakage current, virtual DC bus concept is used in this paper. By connecting the grid neutral line directly to the negative pole of the dc bus, the stray capacitance between PV panels and ground is bypassed. The CM ground leakage current can be suppressed completely.*

Keywords: transformerless system

I. INTRODUCTION

Day by day the contribution of renewable energy is increased in total energy consumed in the world. Among all renewable sources like solar, wind, hydro; the solar system or photovoltaic (PV) system is most stable and reliable energy. Now a day, the solar energy technologies have becomes more efficient and less expensive than the traditional technologies. A grid connected PV system is mainly consisting of set of PV arrays as a DC generator, inverter for power conversion and filter. Generally in grid connected PV system low frequency or high frequency transformer is placed between grid and power conversion stage. The low frequency transformer provides isolation between PV system and grid ground so that the leakage current is greatly limited. However this transformer increase size, cost and weight of PV system and reduces the efficiency. To increase efficiency, high frequency transformer is placed in DC stage of inverter. This inverter provides galvanic isolation between PV system and grid ground but again it increase size, weight and cost[1]. Now a days, transformerless PV-grid connected system is evolved which has high efficiency, low weight, low size and low cost. Due to elimination of transformer, there is galvanic connection is forms between PV panels and grid ground. As a result strong leakage current is flows between PV panels and grid ground [2-][3]. So to eliminate this common mode leakage current, it is necessary to develop power conversion stage in such a way that it must keep common mode voltage constant.

II. LITERATURE REVIEW

Transformer less photovoltaic inverter is characterized by low loss and high efficiency features. But the topology is burdened with leakage current generation problem. In order to minimize the problem, virtual DC bus concept inverter could be a good solution which is proposed in the literature. But some problem still exists with this inverter. Although it suppresses the leakage current through PV panel to ground capacitor but it cannot eliminate the leakage current through one of the inverter phase to ground capacitor. A very conventional LCL filter is used in previous literature to solve the problem but they all offers substantial amount of leakage current in the system. In order to minimize this problem, we have proposed different designed auxiliary circuit for virtual DC bus inverter. The proposed circuit can suppress the

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leakage current comprehensively and improve the output voltage quality of the inverter. To verify the advantage of the proposed circuit, simulations are carried out which demonstrates a very promising result. [1]

Transformer less inverters are widely used in grid-tied photovoltaic (PV) generation systems, due to the benefits of achieving high efficiency and low cost. Various transformer less inverter topologies have been proposed to meet the safety requirement of leakage currents, such as specified in the VDE-4105 standard. In this paper, a family of H6 transformer less inverter topologies with low leakage currents is proposed, and the intrinsic relationship between H5 topology, highly efficient and reliable inverter concept (HERIC) topology, and the proposed H6 topology has been discussed as well. One of the proposed H6 inverter topologies is taken as an example for detail analysis with operation modes and modulation strategy. The power losses and power device costs are compared among the H5, the HERIC, and the proposed H6 topologies. A universal prototype is built for these three topologies mentioned for evaluating their performances in terms of power efficiency and leakage currents characteristics. Experimental results show that the proposed H6 topology and the HERIC achieve similar performance in leakage currents, which is slightly worse than that of the H5 topology, but it features higher efficiency than that of H5 topology. [2]

In order to eliminate the common-mode (CM) leakage current in the transformer less photovoltaic (PV) systems, the concept of the virtual dc bus is proposed in this paper. By connecting the grid neutral line directly to the negative pole of the dc bus, the stray capacitance between the PV panels and the ground is bypassed. As a result, the CM ground leakage current can be suppressed completely. Meanwhile, the virtual dc bus is created to provide the negative voltage level for the negative ac grid current generation. Consequently, the required dc bus voltage is still the same as that of the full-bridge inverter. Based on this concept, a novel transformer less inverter topology is derived, in which the virtual dc bus is realized with the switched capacitor technology. It consists of only five power switches, two capacitors, and a single filter inductor. Therefore, the power electronics cost can be curtailed. This advanced topology can be modulated with the unipolar sinusoidal pulse width modulation (SPWM) and the double frequency SPWM to reduce the output current ripple. As a result, a smaller filter inductor can be used to reduce the size and magnetic losses. The advantageous circuit performances of the proposed transformerless topology are analyzed in detail, with the results verified by a 500-W prototype. [3].

In this paper, To eliminate the common-mode leakage current in the transformerless grid-connected photovoltaic (PV) system, inspired by the newly-developed embedded-switch H5 topology and dual-buck full-bridge grid-connected inverter (GCI), a novel transformerless dual-buck full-bridge GCI with H5-type (TDFGI-H5) topology for PV systems is firstly presented. Then, the operating modes and common-mode leakage current of TDFGI-H5 modulated by unipolar sinusoidal pulse-width modulation are analyses. The analysis result shows that TDFGI-H5 has the advantages of the three-level output, no shoot-through problem, high reliability, and can completely meet the condition of eliminating common-mode leakage current. Aim at the problem of the common-mode leakage affected by the switches' junction capacitances, the effect of switch's junction capacitance is explored in detail when TDFGI-H5 is in the transient process that converts from non-decoupling states to decoupling states. Finally, the results of experiment verify the correctness of the theoretical analysis[4].

This paper Efficiency and leakage current are two major issues for transformerless grid-connected inverters (TLI). Soft-switching technologies can reduce switching losses and be applied in TLIs. Herein, a zero-voltage-transition H5 type (ZVT-H5) inverter with soft turn-on and turn-off transitions of high-frequency main switches is derived from basic resonant tanks. Compared with the hard-switching H5 (HS-H5) inverter, the conversion efficiency of ZVT-H5 is significantly improved. Moreover, the reverse recovery problem of freewheeling diodes is alleviated under the operation of the auxiliary resonant network. Meanwhile, a diode clamping branch is employed to achieve constant common-mode characteristic for the ZVT-H5. The construction process of the proposed topology is described, and the operation principle of the auxiliary resonant network is analyzed. Moreover, the resonant parameter design of ZVT-H5 and its circuit performance are discussed in detail. Finally, the experimental results of a 3-kW prototype at 100 kHz switching frequency are provided to verify the effectiveness of the ZVT-H5. [5].

III. EXISTING SYSTEM

Exiting system withIn the traditional grid-connected PV inverters, either a line frequency or a high frequency transformer is utilized to provide a galvanic isolation between the grid and the PV panels. Removing the isolation

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transformer can be an effective solution to increase the efficiency and reduce the size and cost However, if the transformer is omitted, the common mode (CM) ground leakage current may appear on the parasitic capacitor between the PV panels and the ground . The existence of the CM current may reduce the power conversion efficiency
increase the grid current distortion, deteriorate the electric magnetic compatibility, and more importantly, give rise to the safety threats.

IV. PROPOSED METHODOLOGY

Proposed system introduces a new concept In this paper, a novel topology generation strategy called the virtual DC bus concept is proposed for the transformer less grid-connected PV inverter. In this solution, the grid neutral line is connected directly to the negative pole of the DC bus, so that the voltage across the parasitic capacitor is clamped to zero. As a result, the CM current is eliminated completely. Meanwhile, a virtual DC bus is created to help generate the negative output voltage. The required DC bus voltage is still the same as the full bridge, and there is not any limitation on the modulation strategy since the CM current is removed naturally by the circuit structure. In this way, the advantages of the full bridge and half bridge based solutions are combined together.
Based on the innovative idea above, a novel inverter topology is proposed with the virtual DC bus concept by employing the switched capacitor technology. The proposed inverter can be modulated with the unipolar SPWM and double frequency SPWM. It consists of only five power switches and a single filter inductor, so the cost of the semiconductor and magnetic components can be reduced. .

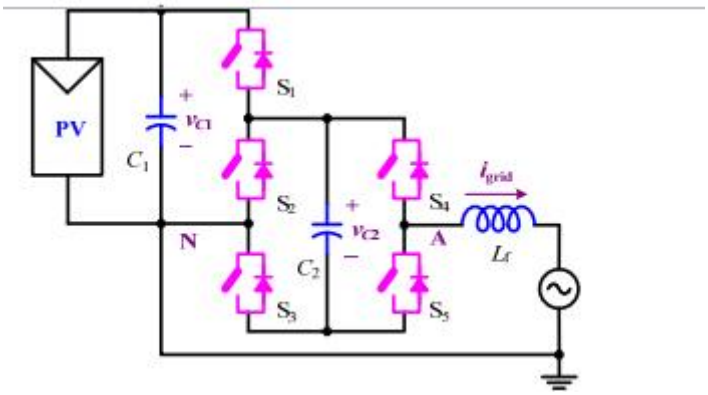

Fig 1 Proposed System

4.1 Research Objectives

- Main objective to design Transformer less inverter with virtual DC bus Concept for Cost effective PV system.
- To eliminates the Common Mode Ground current completely
- To increase the efficiency of PV grid tied system
- To Reduce harmonics using Novel topology Inverter
- To immune against transient overvoltage of the grid

4.2 Advantages of Proposed System

- Achieving high efficiency
- Economical having low cost
- No shoot through problem
- High reliability
- Can completely meet the condition of eliminating common mode leakage current

4.3 Application

1) Transformerless inverter are widely used in gri tried photovoltaic generation.
2) Transformerless inverters can be used in standalone photovoltaic generation system to run AC load.

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