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A Systematic Approach To Design Single Phase Transformer less Inverter For PVG System With Reactive Power Control

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Abstract: *There has been an increasing interest in transformer less inverter for grid-tied photovoltaic (PV) system due to low cost, high efficiency, light weight, etc. Therefore, many transformer less topologies have been proposed and verified with real power injection only. Recently, almost every international regulation has imposed that a definite amount of reactive power should be handled by the grid-tied PV inverter. According to the standard VDEAR-N 4105, grid-tied PV inverter of power rating below 3.68KVA, should attain power factor (PF) from 0.95 leading to 0.95 lagging. In this paper, a new high efficiency transformerless topology is proposed for grid-tied PV system with reactive power control. The new topology structure and detail operation principle with reactive power flow is described. The high frequency common mode (CM) model and the control of the proposed topology are analyzed. The inherent circuit structure of the proposed topology does not lead itself to the reverse recovery issues even when inject reactive power which allow utilizing MOSFET switches to boost the overall efficiency. The CM voltage is kept constant at midpoint of dc input voltage, results low leakage current. Finally, to validate the proposed topology, a 1 kW laboratory prototype is built and tested. The experimental results show that the proposed topology can inject reactive power into the utility grid without any additional current distortion and leakage current.*

Keywords: *component; Common mode, converter, high efficiency, leakage current, reactive power, transformer less.*

I. Introduction

Due to the increasing the energy demand the new energy sources requirement is increasing day by day. Now a day's fossil fuels are the main energy sources for generating energy but they can not sustain for longer change. These fossil fuels give rise to the emission of harmful gasses such as carbon dioxide and methane gas into the atmosphere and thus creating environmental pollution. These are the non- renewable energy sources. Renewable sources such as wind , hydro-electricity and solar power cooled replace fossil fuels.

Wind power is currently widely used in the hilly areas which can compensate more energy in generation of 2000 MW of electric power. Similarly PV system had gain more attention over the years as the best renewable energy sources.

Some of the advantages of PV is that It has long life , low maintenance charges, ease of installation and no need of fuel. Generally grid connected transformer less inverter are can be divided into two groups; single stage inverter and two stage inverter.

In two stage inverter a DC to DC converter connect the PV panel converts sun light to the DC electricity with low output voltage. A DC to DC boost converter is used this DC voltage can be further converted into the AC voltage with power electronic system (Inverter).

PV devices:- Several energy sources are therefore energy conversion including batteries fuel cells and wind generation each energy source is connected to inverter through specific integration technique.

A PV panel creates DC power which is link to a inverter directly or through a DC to DC converter. This is decreasing the total cost. Essentially a PV cell has a semiconductor PN junction diode cell that can converts the lights into electricity. Different cell arrangements such as series parallel and parallel –series creates a PV model that has a specific power capacity.

DC-DC power converter:- DC-DC power converter are basically used in the PV system to change the output voltage. This converter specifically can be used either as the boost converter or buck converter or a combination of both converter may be have depending on the desired capacity or the size of the output voltage to provide appropriate input voltage for the inverter with the DC voltage stabilization and regulation capacity.

II. Methodology

- A transformer less inverter for grid connected hybrid system was simulated using MATLAB/SIMULINK tool.
- This three-phase transformer inverter was capable of obtain a maximum possible power from solar and wind module. Incremental conductance MPPT technique was used.
- Therefore, the PV string can be of different electrical parameters and working conditions. Transformer less condition of the inverter helped the system to convert maximum output power from the hybrid system to the gird by limiting pulsating power.
- Leakage Current was reduced by placing LC filter across the output of the inverter. LC filter also reduced the harmonics produce at inverter output voltage.
- Output power was subjected to active and reactive power compensation. Three phase output voltage of 320 V, 20 A was obtained. A 1kW prototype of PV and 7 W of wind was built and tested through simulation. The control scheme of transformer less inverter topology was described, and its detailed analysis was provided.

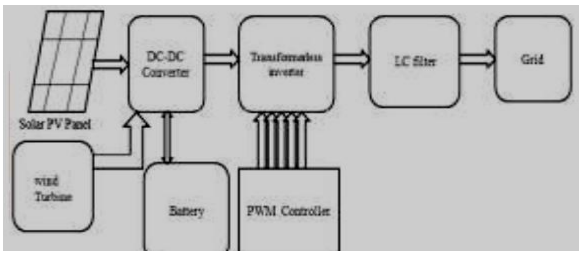


Fig 1. Block diagram of proposed system

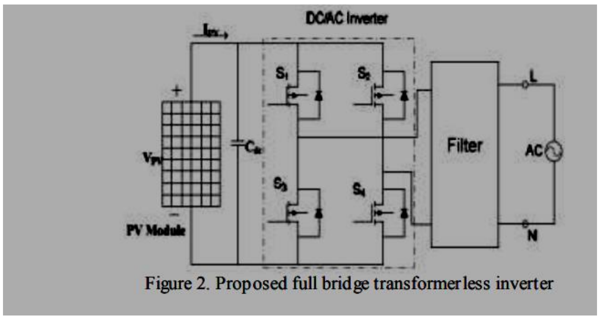


Fig2. Full bridge transformer less inverter

III. Objective

The objective of this Project is to provide a dynamic formulation for the single-phase PV inverter and reveal the origin of some of the problems discussed.

The dynamic modeling provides a powerful tool for deterministic control-system design and system-interaction and stability analyses of the interconnected systems.

The basic principles presented in this thesis can be used to analyze various control practices emerging in the field of PV inverters and other renewable energy technologies based on power electronics.

The scientific contribution of this Project can be summarized as

• Explicit formulation of photovoltaic inverter modeling.

• Effect of photovoltaic generator on a single-phase VSI-type inverter dynamics.

• Design rule for the minimum input capacitance of a VSI-type photovoltaic inverter based on input-voltage-control stability.

• Explicit formulation of the effect of multiplier-based grid synchronization causing negative output impedance.

• Invention and development of a current-fed semi-quadratic buck-boost-type converter topology suited for transformer less modular photovoltaic.

IV. Proposed Work

The PV module generates an electrically chargeable surface area which faces a grounded frame. In case of such configuration, a capacitance is formed between the PV module and the ground. Since this capacitance occurs as an undesirable side effect, it is referred as parasitic capacitance. Due to the loss of galvanic separation between the PV module and the grid, a CM resonant circuit can be created. An alternating CM voltage that depends on the topology structure and control scheme, can electrify the resonant circuit and may lead to higher ground leakage current. In order to analyses the CM characteristics, an equivalent circuit of the proposed topology.

In order to illustrate the CM model at switching frequency, could be replaced for the bridge-leg. The grid is a low frequency (50–60 Hz) voltage source; thus the impact of grid on the leakage current can be neglected. The DM capacitor Co can also be removed since it has no effect on the leakage current.

A) Control of the proposed topology

In order to control the grid current, several existing control methods such as conventional PI controller, repetitive controller (RC), proportional resonant (PR) controller, and deadbeat (DB) controller can be adopted due to the capability of tracking reference signal without steady state error.

Since the PR controller has better performance of tracking the reference signal if compared to the normal PI and RC controller, it is selected to control the output current of the proposed topology. The block diagram of the PR controller with harmonic current compensator, where Gc(s), Gh(s), and Gd(s) are the transfer function of fundamental current controller, harmonic compensator, and inverter respectively.

The dynamic response of the system when it is subject to 750W load to 1000W load step change. It can clearly be seen that fast and effective response under the changes of active power reference are achieved with the proposed topology. Therefore, it can be concluded that the proposed topology can inject real power into utility grid with low leakage current and low THD at output.

B) Verification with Real Power Injection

The proposed topology is verified with 1 kW power injection. The experimental gate drive signals for the proposed topology. It can be seen that the switching signals are fully matched with the proposed PWM scheme, and the gate drive voltages are kept constant at the desired level.

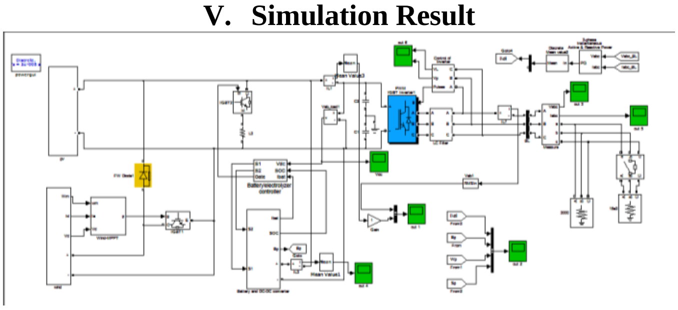
The waveforms of CM characteristics. It is clear that the voltages V1N, V2N, V3N, and V4N are clamped at 200V during the freewheeling period of positive and negative half cycle. As a result, the CM voltage is kept constant at 200V for the whole grid cycle except a small fluctuation during grid zero crossing instant as witnessed. Consequently, the leakage current flows through the system are well reduced. During zero crossing instant, a small spike can be observed due to the fluctuation of CM voltage

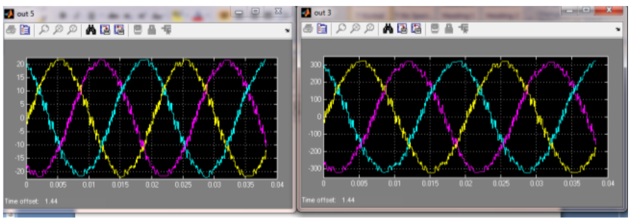
C) Report Generation

A new high efficiency transformer less topology for grid-tied PV system is presented. The main advantages of the proposed topology can be summarized as: The inherent circuit configuration of the proposed topology does not lead itself to the reverse recovery issues which allow utilizing MOSFET switches even though when inject reactive power.

Therefore, without compromising the overall efficiency, proposed topology can inject reactive power into the utility grid. The CM voltage is kept constant at the mid-point of dc bus voltage; as a result, low leakage current flows through the system which is lower than the H6-type topology. PWM dead time is not required for the proposed topology that reduces the THD at the output.

V. Simulation Result





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