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Efficiency Improvement of PV system by using coupled-inductor single-stage boost inverter (CLSSBI) and NSPWM method

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ABSTRACT

In comparison to photovoltaic (PV) power systems with transformers, the transformer-less systems are more affordable, smaller in size, and more efficient. The safety issue of the leakage current brought on by common mode voltages, conducting in the loop with parasitic capacitors between the solar panel and the ground, is one of the technological difficulties. . An impedance network with a coupled inductor at the front-end of the inverter bridge is introduced by the proposed coupled inductor single-stage boost inverter (CL-SSBI). While LCD might be seen as a snubber, the construction is straightforward.

Keywords –Coupled Inductor, PV Cell, CL-SSBI, NSPWM, Invertor,

1. INTRODUCTION

The converter steps up the bus voltage by storing and transferring energy within the special impedance network using shoot-through zero vectors. It is also possible to optimise the boost gain by adjusting the connected inductor's turns ratio inside the impedance network. As a result, the ac output voltage may be adjusted throughout a large range and increased. The drawback of inverters of this sort is that larger boost gain would be necessary, which would need more power loss and lesser efficiency. The equivalentswitching frequency as seen from the impedance network can be six times the switching frequency of the inverter bridge, which will significantly reduce the power density and cost of the inverter. Shoot-through zero vectors are vectors that are evenly distributed among the three phase legs during a switching period. This letter outlines a CLSSBI-based technique for reducing the leakage current of a transformer-free grid- connected PV system. To stop the leakage current loop when in the active vectors and open-zero vectors, a diode is placed to the front of the topology. Additionally, the leakage current induced in the transient stages of switching from and to open-zero vectors is reduced by using the near-state PWM (NSPWM) approach with one-leg shoot-through zero vectors. Additionally, because NSPWM's modulation index remains in the high modulation region, the leakage current may be efficiently controlled without reducing the maximum magnitude of the output reference voltage.

- **EXISTING SYSTEM-** Higher power loss and lower efficiency would be unavoidable if higher boost gain is required, which is the disadvantage of inverters of this type. As shoot-through zero vectors evenly

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distributed among the three phase legs during a switching period, because conventional system switching frequency is low.

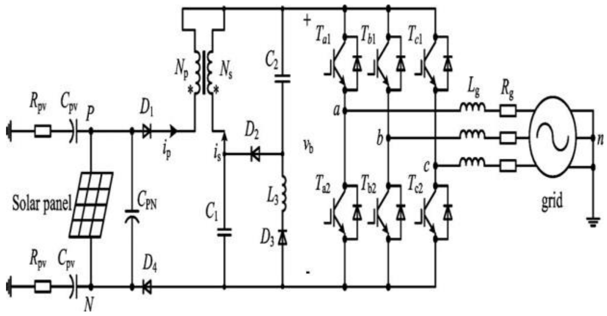

Fig. 1. Transformer less grid-connected PV system based on CL-SSBI.

These converters may be used to regulate the voltage and current at the load, to control the power flow in grid connected systems and mainly to track the maximum power point (MPP) of the device.

2. PROBLEM STATEMENT

The drawback of inverters of this sort is that larger boost gain would be necessary, which would need more power loss and lesser efficiency. Because the switching frequency in a typical system is modest, shoot- through zero vectors are frequently distributed equally throughout the three phase legs during a switching period. To minimise leakage current across the conduction route during the transition from and into open- zero vectors, the proposed system uses the near state pulse width modulation (NSPWM) approach with one-leg shoot-through zero vectors. The magnitude of common-mode voltages can be lowered while simultaneously reducing the leakage current brought on by other transitions.

3. OBJECTIVES

The "Modified Coupled Inductor Single Stage Boost Inverter Based Grid-Connected Photovoltaic (PV) System" is being suggested with the following goals:

1. Decreasing the magnitude of reference common mode voltages without lowering the leakage current induced by common mode voltages in grid-connected photovoltaic (PV) systems.

2. Increase the boost gain to regulate a wide variety of output voltages while reducing power loss and boosting system effectiveness.

4. METHODOLOGY

- **SINGLE-PHASE INVERTER-** The dc to ac converters more commonly known as inverters, depending on the type of the supply source and the related topology of the power circuit, are classified as voltage source inverters (VSIs) and current source inverters (CSIs).

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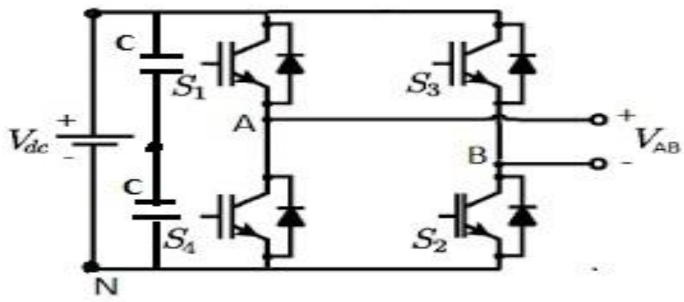

Fig 2 Single Phase Half Bridge Inverter

- **SINUSOIDAL PWM IN THREE-PHASE VOLTAGE SOURCE INVERTERS**

As in the single phase voltage source inverters PWM technique can be used in three-phase inverters, in which three sine waves phase shifted by 120° with the frequency of the desired output voltage is compared with a very high frequency carrier triangle, the two signals are mixed in a comparator whose output is high when the sine wave is greater than the triangle and the comparator output is low when the sine wave or typically called the modulation signal is smaller than the triangle. This phenomenon is shown

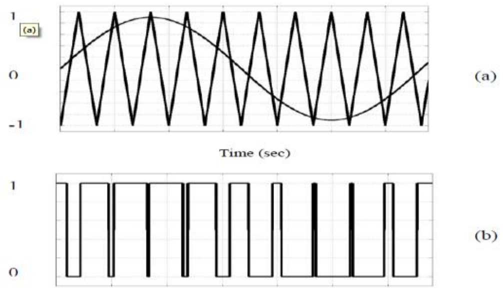

Fig 3 PWM illustration by the sine-triangle comparison method (a) sine-triangle comparison (b) switching pulses

- **SINGLE-STAGE BOOST INVERTER WITH COUPLED INDUCTOR**

Single-stage topologies, which integrate performance of each stage in a multistage power converter, are becoming the focus of research. Though they may cause increased control complexity, they may offer higher efficiency, reliability, and lower cost. It is observed that many single-stage voltage source and current source inverters have been proposed. A Z-source inverter (ZSI) proposed in is able to overcome the problems in conventional VSI and conventional current source inverter. It can provide a wide range of obtainable voltage and has been applied to renewable power generation systems.

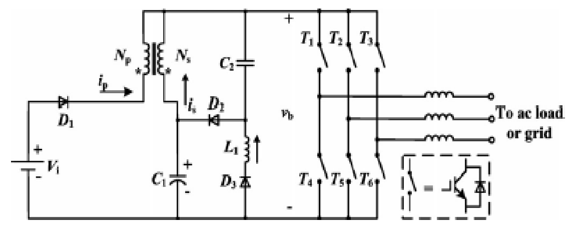

Fig 4 Topology of single stage boost inverter with coupled inductor

- **OPERATION PRINCIPLE, BOOST FEATURE ANALYSIS, AND CONTROL STRATEGY**

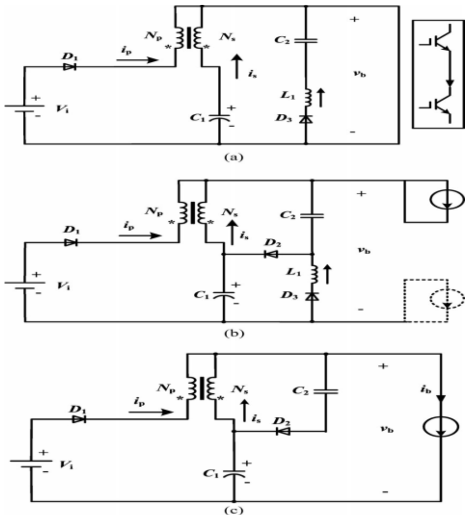

Fig 5 Equivalent circuit under three switching states. (a) Shoot-through zero state. (b) Open-zero state. (c) Active state

5. SIMULATIONS AND RESULTS

- **CL-SSBI BASED GRID CONNECTED PV SYSTEM WITHOUT USING NSPWM TECHNIQUE**

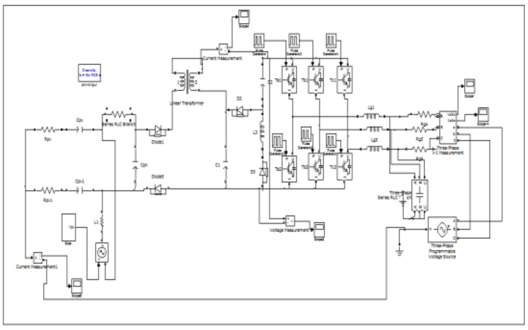

Fig 6 Simulation block diagram of coupled-inductor single-stage boost inverter based grid-connected PV system without using NSPWM technique.

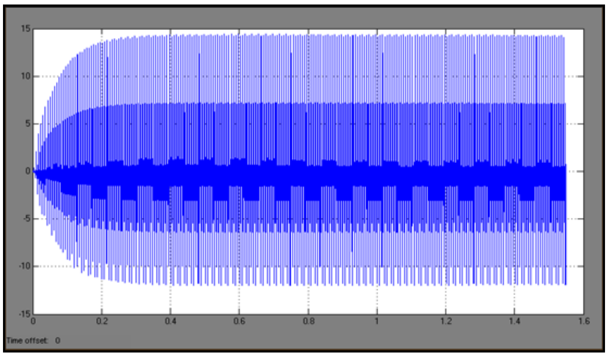

Fig 7 Simulation result of Leakage current flowing between solar panel and Ground

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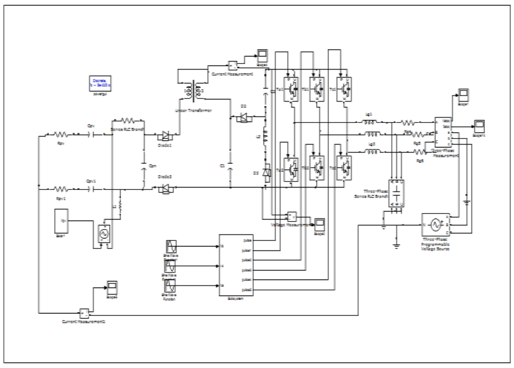

Fig 8 Simulation block diagram of coupled-inductor single-stage boost inverter based grid-connected PV system by using NSPWM technique.

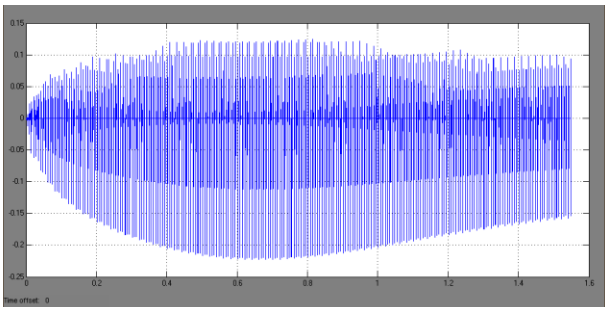

Fig 9 Simulation result of Leakage current flowing between solar panel and Ground

6. CONCLUSION

A transformer less grid-connected PV system based on a coupled inductor single-stage boost three phase inverter. Diode D4 is added in the front of the topology together with D1, to block the leakage current loop during the active vectors and open-zero vectors. The leakage current caused in the transient states of changing from and to shoot-through zero vectors is also reduced by using the NSPWM technique with one-leg shoot-through zero vectors, when open-zero vectors are omitted. Simultaneously, the leakage current caused by other transitions can be further reduced due to the magnitude reduction of the common mode voltages. The common mode voltages and the caused leakage currents are compared between CL-SSBI with NSPWM. According to the simulation results, the amplitude and RMS value of the leakage current can be well below the threshold level, indicating an effective leakage current reduction and Improve the boost gain for the regulation of wide range of output voltage without increasing the power loss and improve the efficiency of the system.

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