

MODIFIED COUPLED-INDUCTOR SINGLE-STAGE BOOST INVERTER BASED GRID-CONNECTED PHOTOVOLTAIC (PV) SYSTEM

[PAPER ID ICITER-D199]

MR. GAURAV ASHOK BONGALE

ME Student at Ashokrao Mane Group of Institutions, Wathar, Kolhapur

PROF MR. P.D.PANGE

PG Dean Ashokrao Mane Group of Institutions, Wathar, Kolhapur

ABSTRACT:

Different advantages with grid connected Photovoltaic (PV) Power System has been attracting more and more attention for its lower cost, smaller volume, as well as higher efficiency. One of the technical challenges and we can also say that important factor is the safety issue of the leakage current caused by the common mode voltages (CMV) conducting in the loop with parasitic capacitors between the solar panel and the ground. A coupled inductor single stage boost inverter (CL-SSBI) will be introducing an impedance network, including coupled inductor in the front end of Inverter Bridge. Using coupled inductor single stage boost inverter (CL-SSBI) with near state pulse width modulation (NSPWM) which can reduce leakage current of the grid connected PV system. One of the main advantages is that there is no transformer in the system. The proposed transformer less grid connected photovoltaic (PV) system on the CL-SSBI modulated by NSPWM will be simulated in MATLAB/SIMULINK.

INTRODUCTION:

As mention earlier there is no transformer in the system because of that the transformer less photovoltaic (PV) power system has been attracting more and more attention for its lower cost, smaller volume, as well as higher efficiency, compared to the ones with transformer. One of the technical challenges and we can also say that important factor is the safety issue of the leakage current caused by the common mode voltages (CMV) conducting in the loop with parasitic capacitors between the solar panel and the ground. A coupled inductor single-stage boost inverter (CL-SSBI) is proposed in, which introduced an impedance network, including coupled inductor in the front-end of the inverter bridge. Whatever the converter uses in that system that converter shoot-through zero vectors to store and transfer energy within the unique impedance network, for step up the bus voltage. As shoot-through zero vectors evenly distributed among the three phase legs during a switching period, the equivalent switching frequency viewed from the impedance network can be six times the switching frequency of the inverter bridge,

which will greatly reduce the power density and cost of the inverter. One more important semiconductor device is used here(diode) is added in the front of the system to block the leakage current loop when in the active vectors and open-zero vectors. And the leakage current can be reduced effectively without lowering the maximum magnitude of the output reference voltage, for the modulation index.

LITERATURE REVIEW:

Below is a literature review of works carried out in last few years for detecting modulation technique for the modified coupled-inductor single-stage boost inverter (CLSSBI) based grid-connected photovoltaic (PV) system.

a) HIGH EFFICIENCY SINGLE PHASE TRANSFORMER LESS INVERTERS:

By S.V .Araujo and P.Zacharias: This paper talks about the H-Bridge with a new AC bypass circuit consisting in diode rectifier and a switch with clamping to the DC midpoint to acquire higher efficiencies combining with very low ground leakage current.

b) TRANSFORMER LESS INVERTER FOR SINGLE PHASE PHOTOVOLTAIC SYSTEM:

By R.Gonzalez presented at Mar 2007: This paper talks about when no transformer is used in a grid connected photovoltaic(PV) system a galvanic connection between the grid and PV array exists. In these conditions dangerous leakage currents can appear between PV array and ground. Avoid these leakage current, different inverter topologies that generate no varying common-mode voltages such as half-bridge and the bipolar pulse width modulation full-bridge topologies.

c) SINGLE STAGE BOOST INVERTER WITH COUPLED INDUCTOR:

by Y. Zhou and W. Huang: By introducing impedance network, including coupled inductor into the three phase bridge inverter and adjusting the previously forbidden shoot-through zero state, The converter can realize a high boost gain and output a stable ac voltage.

As in power systems distributed generation units often experience big changes in the inverter input voltage due to fluctuations of energy sources. Often a front end boost converter is added to step up the dc voltage when energy resources are at a weak point.

d) GRID CONNECTED SINGLE PHASE PHOTOVOLTAIC INVERTERS:

by I.Patro: Need of a high input voltage represents an important drawback of the half bridge, the bipolar PWM full bridge requires a lower input voltage but exhibits a low efficiency.

e) BOOST-CONTROL METHODS FOR THE Z-SOURCE INVERTER:

Which can obtain maximum voltage gain at any given modulation index without producing any low-frequency ripple that is related to the output frequency and minimize the voltage stress at the same time. Thus, the Z-network requirement will be independent of the output frequency and determined only by the switching frequency.

f) ELIMINATING LEAKAGE CURRENTS IN NEUTRAL POINT CLAMPED INVERTERS FOR PHOTOVOLTAIC SYSTEM BY:

M. C. Cavalcanti: The main contribution of this paper is the proposal of new modulation techniques for three-phase transformer less neutral point clamped inverters to eliminate leakage currents in photovoltaic systems without requiring any modification on the multilevel inverter or any additional hardware. The modulation techniques are capable of reducing the leakage currents in photovoltaic systems by applying three medium vectors or using only two medium vectors and one specific zero vector to compose the reference vector. In addition, to increase the system utilization, the three-phase neutral point clamped inverter can be designed to also provide functions of active filter using the $p-q$ theory.

g) GRID-CONNECTED PV SINGLE-PHASE CONVERTER:

It is possible to adopt converter topologies without galvanic isolation between the photovoltaic (PV) panels and the grid. The absence of a high- or line-frequency transformer permits us to reduce power losses, cost, and size of the converter. On the other side, in the presence of a galvanic connection, a large ground leakage current could arise due to parasitic PV panel capacitance. Leakage currents cause electric safety problems, electromagnetic interference increase and consequently, a reduction of the converter power quality.

METHODOLOGY:

CIRCUIT DIAGRAM:

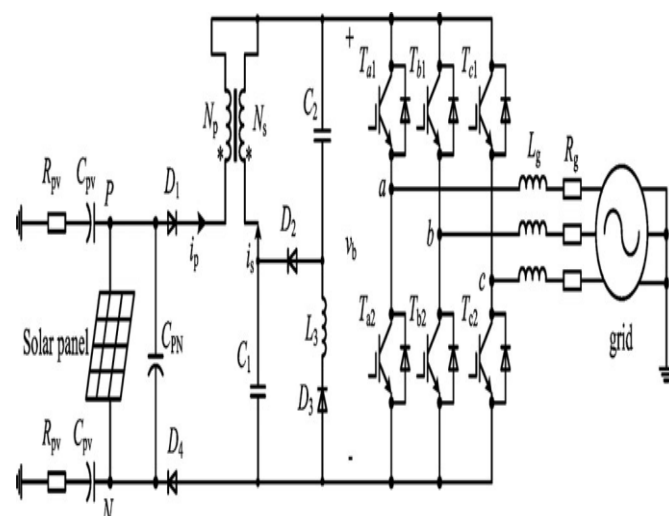


Fig-1 Three Phase Inverter

THREE-PHASE INVERTER:

We know the definition of the inverter which is dc to ac converters or commonly known as inverters, there are mainly two type of inverter depending on the type of the supply source and the related type of the power circuit, are classified as voltage source inverters (VSIs) and current source inverters (CSIs). And depending on the supply we can say inverter is classify in the single-phase inverters & three phase inverter. We explained here three phase inverters. Three-phase counterparts of the single-phase half and full bridge voltage source inverters are shown in below figures. Single-phase VSIs cover low-range power applications and three-phase VSIs cover medium to high power applications. The main purpose of these type is to provide a three-phase voltage source, where the amplitude, phase and frequency of the voltages can be controlled. There are different application of three-phase dc/ac voltage source inverters are extensively being used in motor drives, active filters and unified power flow controllers in power systems and uninterrupted power supplies to generate controllable frequency and ac voltage magnitudes using various pulse width modulation (PWM) strategies. The standard three-phase inverter shown in Figure 1 has six switches the switching of which depends on the modulation scheme. The input dc is usually obtained from a single-phase or three phase utility power supply through a diode-bridge rectifier and LC or C filter.

There are again two type of three phase inverter which are used in the system one is Three phase half bridge inverter and another one is Three phase full bridge inverter.

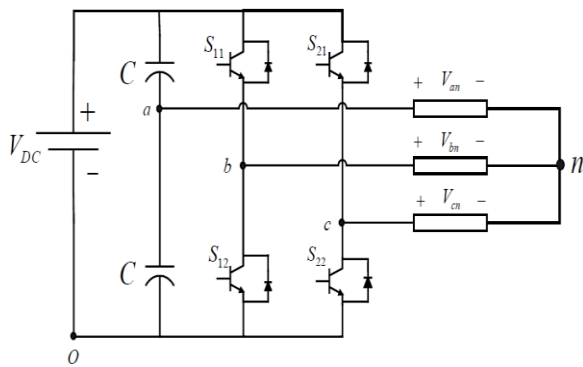


Fig.2 Three-Phase Half Bridge Inverter

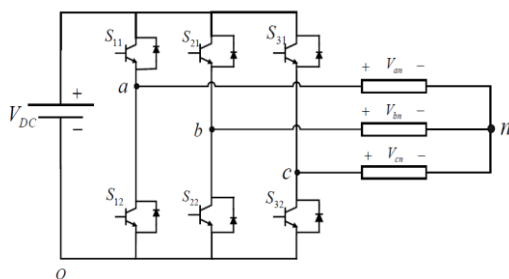


Fig3. Three-phase Full -Bridge Inverter

The inverter has eight switch states given in below table as explained earlier in order that the circuit satisfies the KVL and the KCL, both of the switches in the same leg cannot be turned ON at the same time, as it would short the input voltage violating the KVL. Thus the nature of two switches in the same leg is complementary.

$$S_{11} + S_{12} = 1 \quad \text{-----(1)}$$

$$S_{21} + S_{22} = 1 \quad \text{-----(2)}$$

$$S_{31} + S_{32} = 1 \quad \text{-----(3)}$$

Table-The Switching state in the three phase inverter

S_{11}	S_{12}	S_{31}	V_{ab}	V_{bc}	V_{ca}
0	0	0	0	0	0
0	0	1	0	$-V_{DC}$	V_{DC}
0	1	0	$-V_{DC}$	V_{DC}	0
0	1	1	$-V_{DC}$	0	$-V_{DC}$
1	0	0	V_{DC}	0	$-V_{DC}$
1	0	1	V_{DC}	$-V_{DC}$	0
1	1	0	0	V_{DC}	$-V_{DC}$
1	1	1	0	0	0

In the above table two switches from them produce zero ac line voltage at the output. In this case, the ac line currents freewheel through either the upper or lower components. The remaining states produce no zero ac output line voltages. For the operation of inverter I generate a given voltage waveform, the inverter switches from one state to another. Thus the resulting ac output line voltages consist of discrete values of voltages, there are three value of voltage is given which are $-V_{DC}$, 0, and V_{DC} .

The selection of the states in order to generate the given waveform is done by the modulating technique that ensures the use of only the valid states.

$$\frac{V_{DC}}{2} (S_{11} - S_{12}) = V_{an} + V_{no} \quad \text{-----(4)}$$

$$\frac{V_{DC}}{2} (S_{21} - S_{22}) = V_{bn} + V_{no} \quad \text{-----(5)}$$

$$\frac{V_{DC}}{2} (S_{31} - S_{32}) = V_{cn} + V_{no} \quad \text{-----(6)}$$

$$\frac{V_{DC}}{2} (M_{11}) = V_{an} + V_{no} \quad \text{-----(7)}$$

$$\frac{V_{DC}}{2} (M_{21}) = V_{bn} + V_{no} \quad \text{-----(8)}$$

$$\frac{V_{DC}}{2} (M_{31}) = V_{cn} + V_{no} \quad \text{-----(9)}$$

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 required by the VDE0126-1-1 standards, indicating an effective leakage current reduction.

REFERENCES:

- i. R. Gonzalez, J. Lopez, P. Sanchis, and L. Marroyo, "Transformer less inverter for single-phase photovoltaic systems," IEEE Trans. Power Electron., vol. 22, no. 2, pp. 693–697, Mar. 2007.
- ii. H. Xiao and S. Xie, "Transformer less split-inductor neutral point clamped three-level PV grid-connected inverter," IEEE Trans. Power Electron., vol. 27, no. 4, pp. 1799–1808, Apr. 2012.
- iii. S. V Araujo, P. Zacharias, and R. Mallwitz, "High efficiency single-phase transformer less inverters for grid-connected photovoltaic systems," IEEE Trans. Ind. Electron., vol. 57, no. 9, pp. 3118–3128, Sep. 2010.
- iv. M. C. Cavalcanti, K. C. de Oliveira, A. M. de Farias, F. A. S. Neves, G. M. S. Azevedo, and F. Camboim, "Modulation techniques to eliminate leakage currents in transformer less three-phase photovoltaic systems," IEEE Trans. Ind. Electron., vol. 57, no. 4, pp. 1360–1368, Apr. 2010.
- v. J. M. Shen, "Novel transformer less grid-connected power converter with negative grounding for photovoltaic generation system," IEEE Trans. Power Electron., vol. 27, no. 4, pp. 1818–1829, Apr. 2012.
- vi. O' . Lo'pez, F. D. Freijedo, A. G. Yepes, P. Fern'andez-Comesa'na, J. Malvar, R. Teodorescu, and J. Doval-Gandoy, "Eliminating ground current in a transformer less photovoltaic application," IEEE Trans. Energy Convers., vol. 25, no. 1, pp. 140–147, Mar. 2010.
- vii. F. Bradaschia, M. C. Cavalcanti, P. E. P. Ferraz, F. A. S. Neves, E. C. dos Santos, Jr., and J. H. G. M. da Silva, "Modulation for three-phase transformer less Z-source inverter to reduce leakage currents in photovoltaic systems," IEEE Trans. Ind. Electron., vol. 58, no. 12, pp. 5385–5395, Dec. 2011.
- viii. X. Guo, M. C. Cavalcanti, A. M. Farias, and J. M. Guerrero, "Single-carrier modulation for neutral point-clamped inverters in three-phase transformer less photovoltaic systems," IEEE Trans. Power Electron., vol. 28, no. 6, pp. 2635–2637, Jun. 2013.
- ix. I. Patrao, E. Figueres, F. Gonzalez-Espin, and G. Garcera, "Transformer less topologies for grid-connected single-phase photovoltaic inverters," 1046 IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 29, NO. 3, MARCH 2014 Renewable Sustainable Energy Rev., vol. 15, no. 7, pp. 3423–3431, Sep. 2011.