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A SUPPRESSION OF COMMON MODE LEAKAGE CURRENT USING TRANSFORMERLESS INVERTER UNDER ALL ECOLOGICAL CONDITIONS

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ABSTRACT

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 transformer less topology are analyzed in detail, with the results verified by a 500-W prototype.

Index Terms: Common mode (CM) current, photovoltaic (PV) system, switched capacitor, transformer less inverter, unipolar sinusoidal pulse width modulation (SPWM), virtual dc bus.

INTRODUCTION

THE distributed photovoltaic (PV) power generation systems have received increasing popularity in both the commercial and residential areas. In most occasions, the inverters are used to feed the PV power into the utility grid. It is important for the PV inverter to be of high efficiency, due to the relatively high price of the PV panels. Small size is also strongly desired for the low-power and single-phase systems, especially when the inverters are installed indoor. In 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 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.

The CM current path in the grid-connected transformer less PV inverter system, it is formed by the power switches, filters, ground impedance Z_G, and the parasitic capacitance C_{PV} between the PV panels and the ground. According to, the CM current path is equivalent to an LC resonant circuit in series with the CM voltage. The CM voltage v_{CM} is defined by

$$v_{CM} = v_{AO} + v_{BO}2 + (v_{AO} - v_{BO})\, L2 - L1/2(L1 + L2) \quad (1.1)$$

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where vAO is the voltage difference between points A and O, vBO is the voltage difference between points B and O, and L1and L2 are the output filter inductors.

If the switching action of the inverter generates high frequency CM voltage, the CM current iCM may be exited on the LC circuit. From this point of view, the topology and modulation strategy adopted for the transformer less PV power system should guarantee that vCM is constant or only varies at low frequency, such as 50 Hz/60 Hz line frequency. A simple way to realize this goal is to use the full-bridge inverter with the bipolar sinusoidal pulse width modulation (SPWM), of which the CM voltage is fixed at half the dc bus voltage. Comparing with the bipolar SPWM, the unipolar SPWM has better performance in terms of the output current ripple and switching losses, but cannot be directly used for the full-bridge inverter in the transformer less application, because it generates the switching frequency CM voltage. For this reason, some state-of-the-art topologies, such as the H5 inverter, the HERIC inverter, etc., have been developed based on the full-bridge inverter, to keep vCM constant when the unipolar modulation is used. By inserting extra switches into the full bridge inverter either on the dc or ac side, the dc bus can be disconnected from the grid when the inverter output voltage is at zero voltage level, so that the CM current path is cut off. Such solutions need two filter inductors with independent iron cores, which may lead to a rise in the size and cost. Moreover, the dc and ac sides cannot be perfectly disconnected by the power switch because of the switch parasitic capacitance. Another kind of solution is to use the half-bridge inverter with the grid neutral line directly connected to the midpoint of the dc bus.

In this way, the voltage across the parasitic capacitor is clamped to be constant by the dc bus capacitor. However, this method has an important disadvantage that the required dc bus voltage should be doubled compared with the full-bridge topologies. For the 220 Vac systems, it can be as high as 700 V. Although the three-level neutral point clamped (NPC) circuit can help improve the performance of the half-bridge inverter, the dc bus voltage is still high. Besides the aforementioned classic circuits, there are other topologies proposed in recent literature works. The Karschny inverter and the paralleled buck inverter are derived from the buck–boost and buck circuits, respectively. These solutions have high reliability, but are not capable of supplying the reactive power to the grid. The inverter proposed in employs a capacitor voltage divider to keep the CM voltage constant, but is regarded to be of higher conduction losses.

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, the 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. Full-bridge-based topologies for the transformer less inverter structure. In this way, the advantages of the full-bridge- and half bridge-based solutions are combined together. Based on the aforementioned innovative idea, 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.

EXISTING SYSTEM

The traditional grid-connected PV inverter includes either a line frequency or a high frequency transformer is utilized to provide a galvanic isolation between a gird and the PV panels. Removing the isolation transformer can be an effective solution to increase the efficiency and reduce the size and cost.

If the transformer is omitted, a common mode ground leakage current may appear on the parasitic capacitors between the PV panels and the ground. The existence of the CM current may reduce the power conversion efficiency, affects the quality of grid current, deteriorate the electric magnetic compatibility and give rise to the safety threats. In this bipolar sinusoidal pulse width modulation technique is used but it has some draw backs.

DISADVANTAGES OF EXISTING SYSTEM

- Increases – Size, Cost, Losses
- Increases the system losses
- Reduces the grid connected current quality

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- Induces severe conducted and radiated electromagnetic interference
- Causes personal safety problems

PROPOSED SYSTEM

In my project the elimination of common mode leakage current in transformer less PV system, the concept of virtual DC bus is proposed.

Virtual DC bus is created to provide the negative voltage level for the negative AC grid current generation. The negative current charges the capacitor and thus leads to suppress the common mode leakage current and by this system THD is reduced. It is modulated with the unipolar SPWM to reduce the output current ripple. The virtual DC bus is realized with the switched capacitor technology that uses less number of elements. Therefore, the power electronic cost can be reduced. A smaller filter inductor can be used to reduce the size and magnetic losses.

PROPOSED SYSTEM BLOCK DIAGRAM

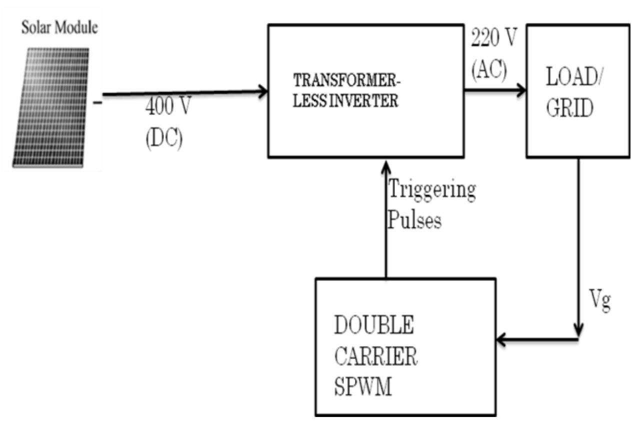

Figure 1.1: Proposed Block Diagram

BLOCK DIAGRAM DESCRIPTION

The block diagram consists of a PV panel, transformer less inverter, Double carrier SPWM and Load. In this solar module produce 400 v DC and it fed in to the transformer less inverter. The inverter converts 400 v DC to 220 v AC. The AC voltage is fed to load or grid. The grid neutral line current is directly given to the inverter by the virtual DC bus concept, by this system efficiency is increased. The double carrier sinusoidal pulse width modulation is used to generate triggering pulse to the inverter. By this SPWM can provide a higher equivalent switching frequency.

PV PANEL

A PV module is to absorb and directly covert sunlight into electricity. It is a packaged, connected assembly of a solar cells. Solar panels can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial applications.

INVERTER

Inverter is used to convert direct current (DC) to alternating current (AC). Transformer less inverters use a computerized multi-step process and electronic components to convert DC to high frequency AC. The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific circuitry. The inverter does not produce any power, the power is provided the DC sources.

DOUBLE CARRIER SPWM

The double carrier pulse width modulation signal is used to determine the output voltages. The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off there is practically no current, and when it is on and power is being transferred to the load, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero.

ADVANTAGES OF PROPOSED SYSTEM

- Transformer less Topology – Reduced Size, weight, cost and installation complexity.
- Increases efficiency.
- Achieve improved power factor.
- Improved THD.

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CONCLUSION

In this paper, the virtual DC bus is proposed to solve the CM current problem for the grid connected PV inverter. The virtual DC bus is designed by the switched capacitor technology. By this, the CM current is suppressed completely, the quality of the current at grid side, power factor, THD and the system efficiency are increased. The concept of the virtual dc bus is proposed to solve the CM current problem for the transformer less grid-connected PV inverter. By connecting the negative pole of the dc bus directly to the grid neutral line, the voltage on the stray PV capacitor is clamped to zero. This eliminates the CM current completely. Meanwhile, a virtual dc bus is created to provide the negative voltage level. The required dc voltage is only half of the half bridge solution, while the performance in eliminating the CM current is better than the full-bridge-based inverters. Based on this idea, a novel inverter topology is proposed with the virtual dc bus concept by adopting the switched capacitor technology. It consists of only five power switches and a single filter inductor. The proposed topology is especially suitable for the small-power single-phase applications, where the output current is relatively small so that the extra current stress caused by the switched capacitor does not cause serious reliability problem for the power devices and capacitors.

With excellent performance in eliminating the CM current, the virtual dc bus concept provides a promising solution for the transformer less grid-connected PV inverters. These results are clear and is individually simulated with double carrier sinusoidal pulse width modulation is better than the unipolar SPWM. In future, I will implement this in hardware.

REFERENCES

[1]. B. Yang, W. Li, Y. Gu, W. Cui, and X. He, “Improved transformer less inverter with common-mode leakage current elimination for a photovoltaic grid-connected power system, ”IEEE Trans. Power Electron., vol. 27,no.2, pp. 752–762, Feb. 2012.

[2]. B. Yang, W. Li, Y. Deng, X. He, S. Lambert, and V. Pickert, “A novel single-phase transformer less photovoltaic inverter connected to grid,” in Proc. 5th IET Int. Conf. Power Electron., Mach. Drives, Apr. 19–21, 2010, pp.1–6.

[3]. J. P. Benner and L. Kazmerski, “Photovoltaics gaining greater visibility ,”IEEE Spectr., vol. 36, no. 9, pp. 34–42, Sep. 1999.

[4]. O. Lopez, F. D. Freijedo, A. G. Yepes, P. Fernandez-Comesaa, J. Malvar, R.Teodorescu, and J. Doval-Gandoy, “Eliminating ground current in a transformer less photovoltaic application,” IEEE Trans. Energy Converse., vol. 25, no. 1, pp. 140–147, Mar. 2010.

[5]. R. W. Erickson and A. P. Rogers, “A micro inverter for building-integrated photovoltaics,” in Proc. 24th Annu. IEEE Appl. Power Electron. Conf. Expos., Feb. 15–19, 2009, pp. 911–917.

[6]. Z. Zhao, M. Xu, Q. Chen, J.-S. Lai, and Y. Cho, “Derivation of boost-buck converter based high-efficiency robust PV inverter,” in Proc. IEEE Energy Converse. Cong. S. B. Kjaer, J. K. Pedersen, and F. Blaabjerg, “A review of single-phase Expos., Sep. 12–16, 2010, pp. 1479–1484.

[7]. V. Matthias, G. Frank, B. Sven, and H. Uwe, German Patent H5-Topology,DE 102004030912 B3, Jan. 2006.

[8]. W. Cui, B. Yang, Y. Zhao, W. Li, and X. He, “A novel single-phase transformer less grid-connected inverter,” in Proc. 37th Annu. Conf. IEEE Ind. Electron. Soc., Nov. 7–10, 2011, pp. 1126–1130.

[9]. W. Yu, J.-S. Lai, H. Qian, C. Hutchens, J. Zhang, G. Lisi, A. Djabbari, G.Smith, and T. Hegarty, “High-efficiency inverter with H6-type configuration for photovoltaic non-isolated ac module applications,” in Proc.25th Annu. IEEE Appl. Power Electron. Conf. Expos., Feb. 21–25, 2010.