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Transformer Less Inverter with Virtual DC Bus Concept for Cost-Effective Grid –Connected PV Power System

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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.*

Keywords: MPPT, Common mode noise , Photovoltaic (PV)

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. WORKING PROCESS

2.1 VIRTUAL DC BUS CONCEPT:

The concept of the virtual dc bus is depicted in Fig. 6. By connecting the grid neutral line directly to the negative pole of the PV panel, the voltage across the parasitic capacitance *C*PV is clamped to zero. This prevents any leakage current flowing through it.

With respect to the ground point N, the voltage at midpoint B is either zero or+*V*dc, according to the state of the switch bridge. The purpose of introducing the virtual dc bus is to generate the negative output voltage, which is necessary for

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the operation of the inverter. If a proper method is designed to transfer the energy between the real bus and the virtual bus, the voltage across the virtual bus can be kept the same as the real one. As shown in Fig. 6, the positive pole of the virtual bus is connected to the ground point N, so that the voltage at the midpoint C is either zero or $-V$dc. The dotted line in the figure indicates that this connection may be realized directly by a wire or indirectly by a power switch. With points B and C joined together by a smart selecting switch, the voltage at point A can be of three different voltage levels, namely $+V$dc, zero, and $-V$dc.

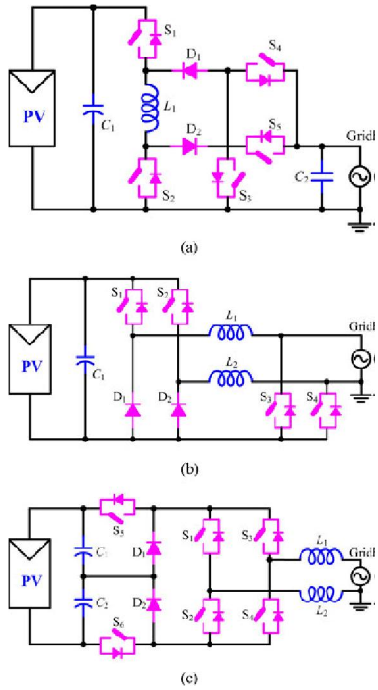

Fig. 1. Other transformerless inverter topologies: (a) Karschny inverter ;
(b) paralleled-buck inverter ; (c) H6 inverter with capacitor voltage divider

Since the CM current is eliminated naturally by the structure of the circuit, there is not any limitation on the modulation strategy, which means that the advanced modulation technologies such as the unipolar SPWM or the double-frequency SPWM can be used to satisfy various PV applications

2.2 DERIVED TOPOLOGY AND MODULATION STRATEGY

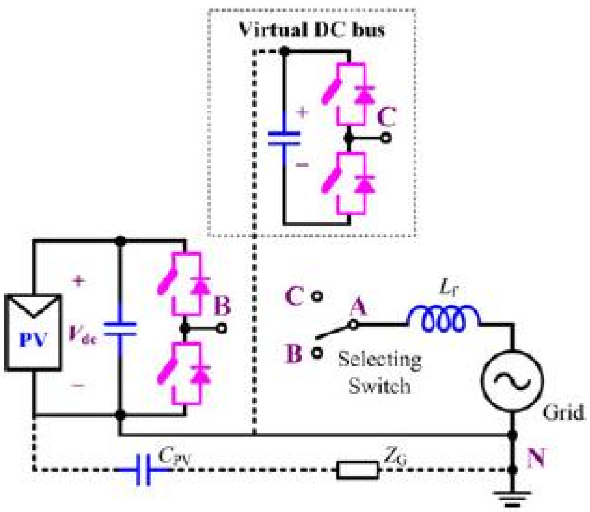

Fig:2 Virtual DC bus Concept

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Based on the virtual dc bus concept, a novel inverter topology is derived as an example to show the clear advantages of the proposed methodology, which is shown in Fig. 7. It consists of five power switches S1–S5 and only one single filter inductor Lf . The PV panels and capacitor $C1$ form the real dc bus while the virtual dc bus is provided by $C2$ .With the switched capacitor technology, $C2$ is charged by the real dc bus through S1 and S3 to maintain a constant voltage. This topology can be modulated with the unipolar SPWM and double-frequency SPWM. The detailed analysis is introduced as follows.

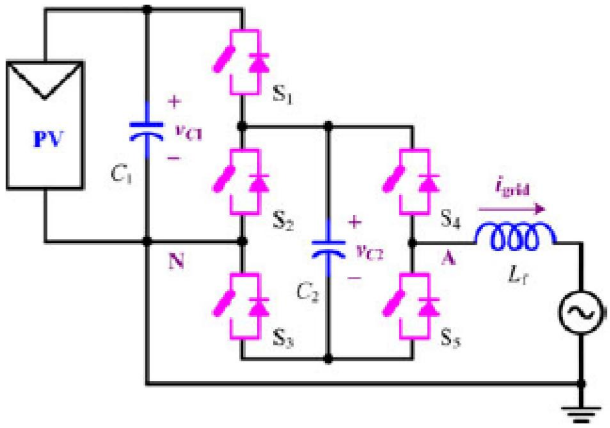

Fig3 : Proposed System

III. SIMULATION AND RESULT

The principle and operation of proposed system is presented using MATLAB/SIMULINK. The simulation waveforms observe in MATLAB Simulink

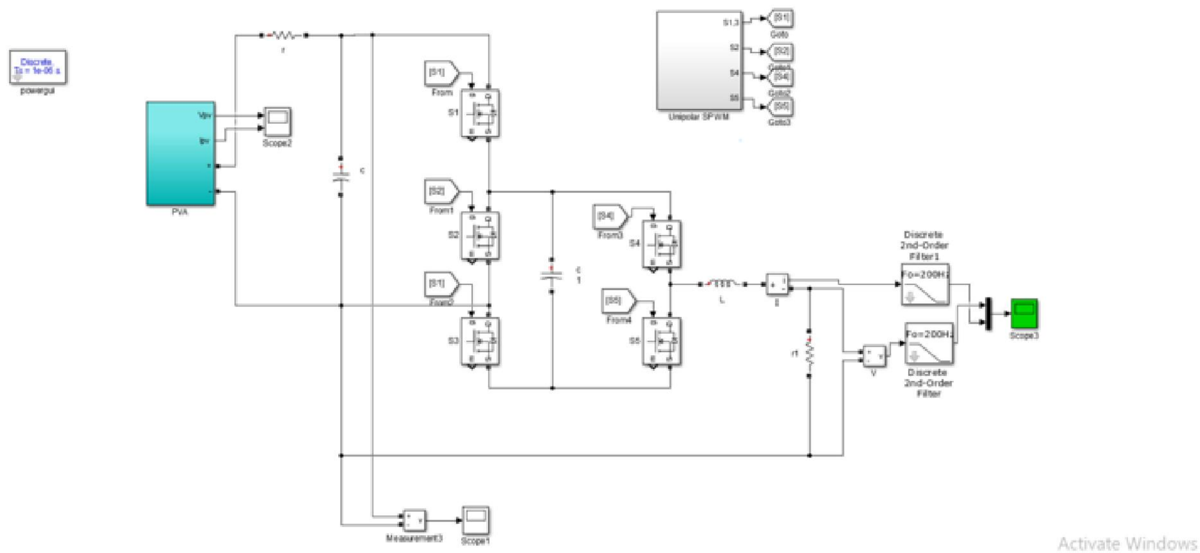

Fig. 4: Simulink model of proposed system

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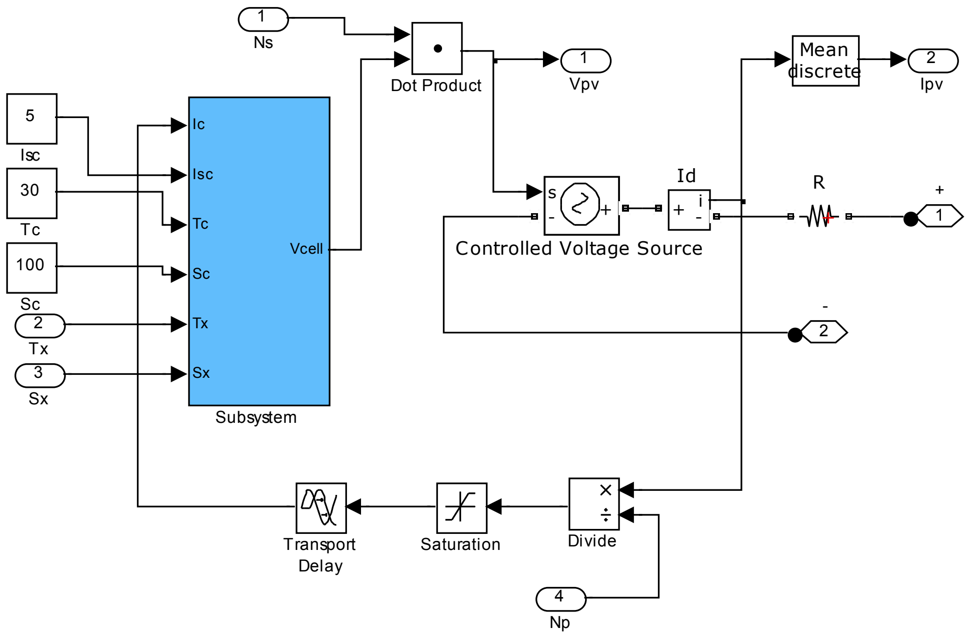

Fig 5: PVA modelling

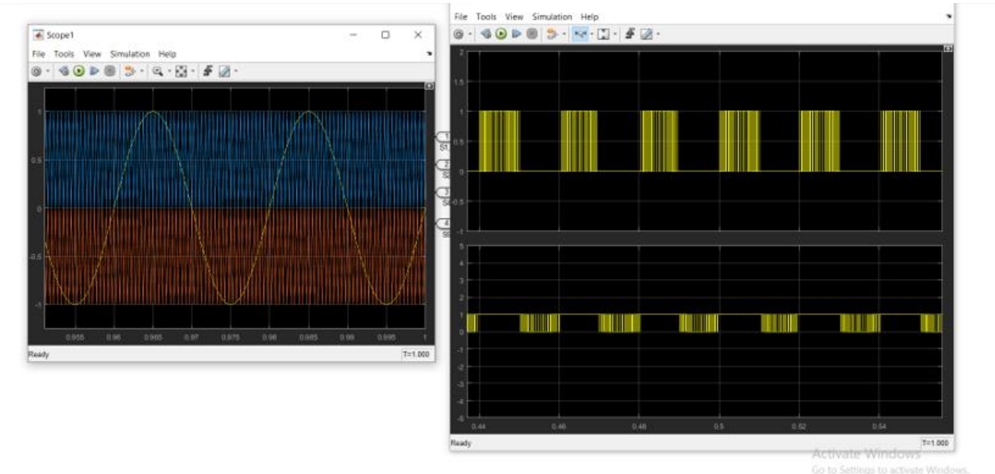

Fig. 6: SPWM for proposed topology

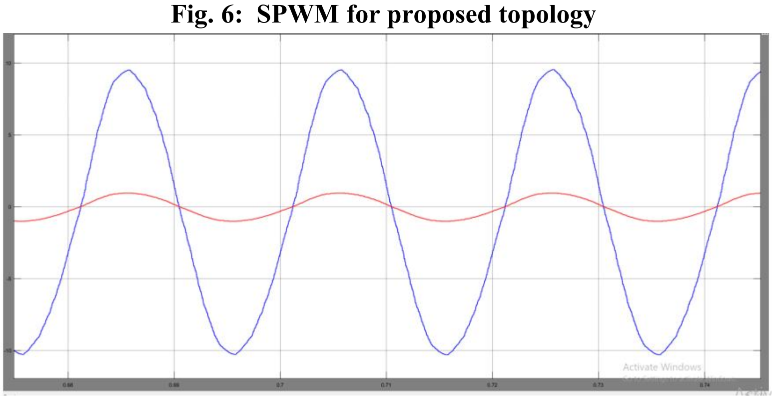

Fig. 7: Load voltage and current

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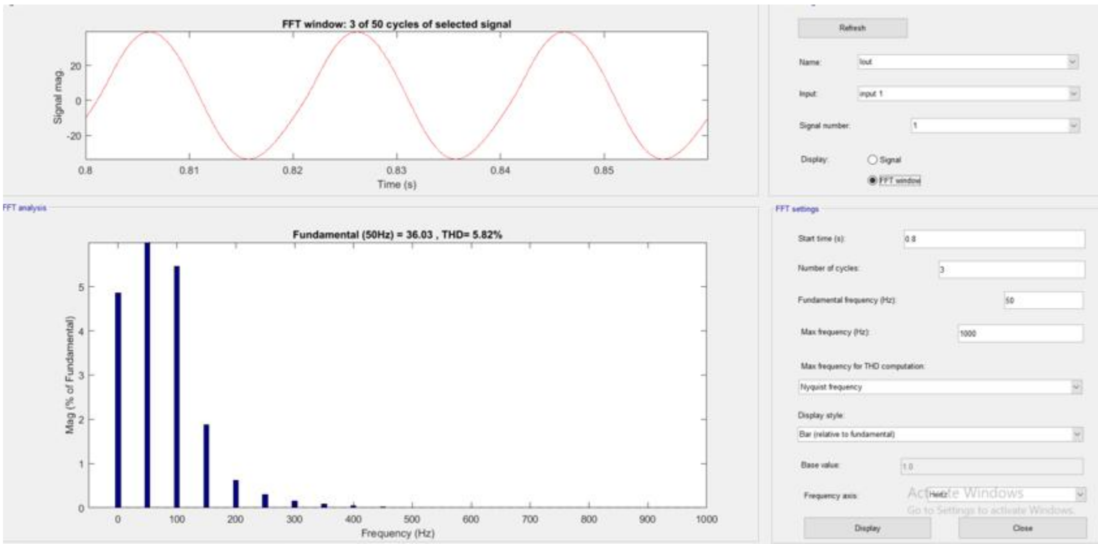

Fig. 8: Total Harmonic Distortion

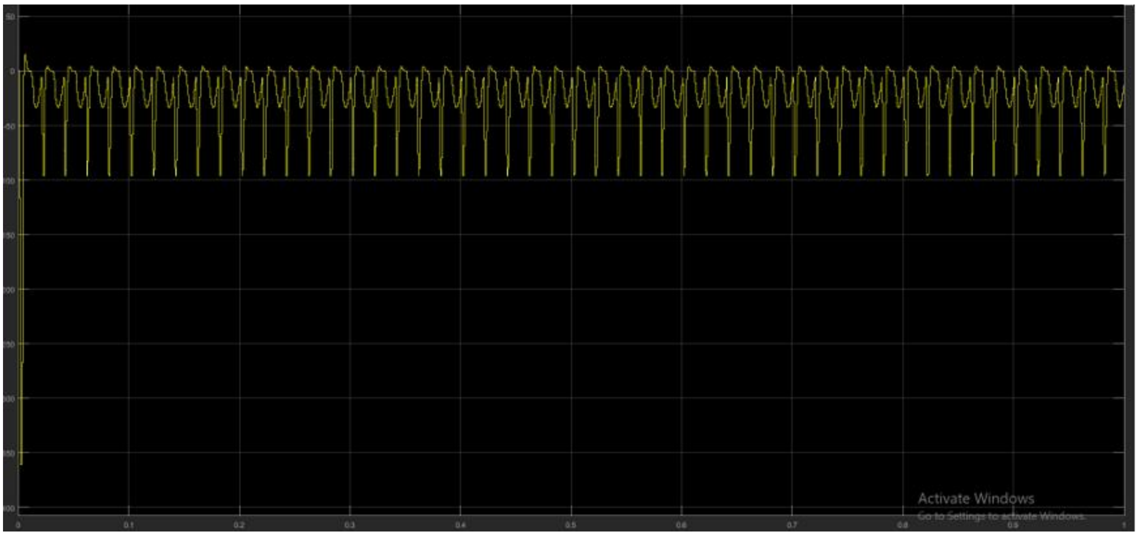

Fig 9: common mode noise

In this chapter Different simulating results diagram shown. observe THD of proposed system is 5.68 % also observed common mode noise and ouput voltage and current

IV. CONCLUSION

The concept of the virtual DC bus is proposed to solve the CM current problem for the transformerless 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 transformerless grid-connected PV inverters.

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