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Elimination of Common Mode Leakage Current in Transformerless Inverter Grid-Connected P.V Power Systems

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Abstracts

To eliminate common mode leakage current approaching technique is photo voltaic grid connected power system by using inverse sine carrier pulse width modulation (ISPWM). To eliminate the common-mode leakage current in the transformer less photo voltaic grid-connected system, an improved single-phase inverter topology is presented. The improved transformerless inverter can sustain the same low input voltage as the full bridge inverter and guarantee to eliminating common-mode leakage current. The inverse sine carrier pulse width modulation (ISPWM) control strategy can be applied to implement the presented inverter. The lower total harmonic distortion and higher fundamental output voltage are obtained by using the inverse sine carrier pulse width modulation (ISPWM). The maximum power point tracking (MPPT) is used to extract the maximum power from PV panel. The high efficiency and convenient thermal design are achieved thanks to the decoupling of two additional switches connected to the dc side of the inverter.

Keywords: Photovoltaic (PV) system, Inverse sine carrier pulse width modulation (ISPWM), Improved transformer less inverter, Maximum power point tracking (MPPT)..

Introduction

Renewable energy sources become a more and more important contribution to the total energy production in the world. Today the energy production from solar energy compared to the other renewable energy sources is very low, but the PV systems are one of the fastest growing in the world. The price of PV system components, especially the PV modules are decreasing and the market for PV is expanding rapidly. Solar power will be dominant because of its availability and reliability. Photo voltaic inverters become more and more widespread within both private and commercial circles. These grid-connected inverters convert the available direct current supplied by the PV panels and feed it into the utility grid. According to the latest report on installed PV power, during 2012, there has been a total of 69.3 GW of installed PV systems in the world out of which the majority (35.8%) has been installed in Germany. The gird-connected photovoltaic (PV) systems, especially the low-power single-phase systems, call for high efficiency, small size, light weight, and low-cost grid connected inverters. Most of the commercial PV inverters employ either line frequency or high-frequency isolation transformers. However, line-frequency transformers are large and heavy, making the whole system bulky and hard to install. Topologies with high frequency transformers commonly include several power stages, which increases the system complexity and reduces the system efficiency [1], [2]. The improved transformerless inverter to minimize the common-mode leakage current and improve the efficiency, weight, and size of the whole PV grid-connected power system. In this paper, an improved grid-connected inverter topology for transformerless PV systems is presented, which can sustain the same low input voltage as the full-bridge inverter and guarantee not to generate the common-mode leakage current

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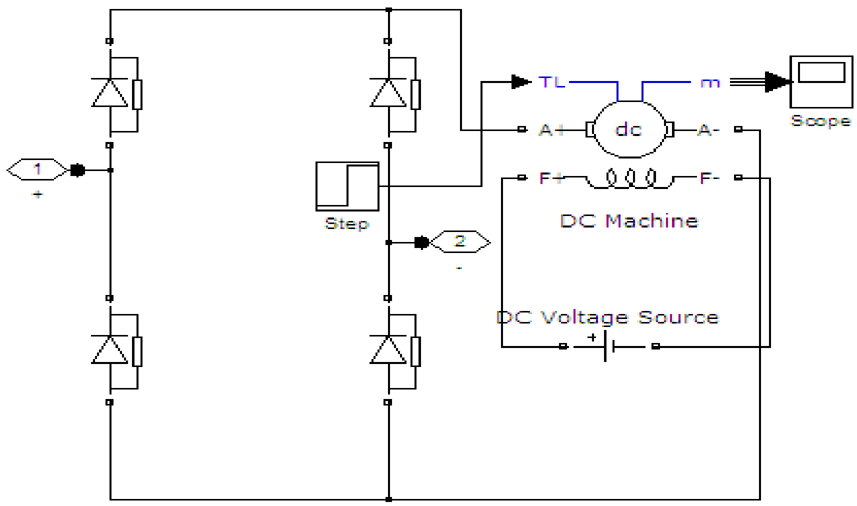

Fig 1.0 Block Diagram of the system

Condition to eliminate leakage current

Without an isolated transformer in the PV grid-connected power systems, there is a galvanic connection between the grid and the PV array, which may form a common-mode resonant circuit and induce the common-mode leakage current. The simplified equivalent model of the commonmode resonant circuit has been derived in as shown in the Fig. 2, where CPV is the parasitic capacitor, LA and LB are the filter inductors, icm is the common-mode leakage current.

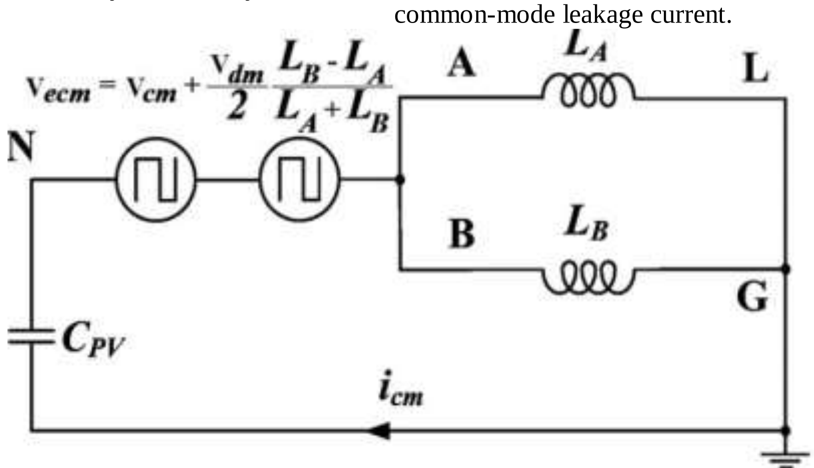

Fig 2.0 converting the diagram of common mode

The voltage and current of the PV panel are measured after one perturbation and the power is calculated. This is then compared with the previous value of power and the difference ΔP (ΔP =P k –Pk-1) is calculated. If ΔP is positive, perturbation is continued in the same direction. For negative values of ΔP, the direction of perturbation is reversed.

ISPWM technique

The modulation strategy employed in this paper is the inverted sine PWM (ISPWM) technique. In the conventional PWM method, triangular wave is used as carrier where in they are replaced by inverted sine carrier waves in this model in Fig. 3.

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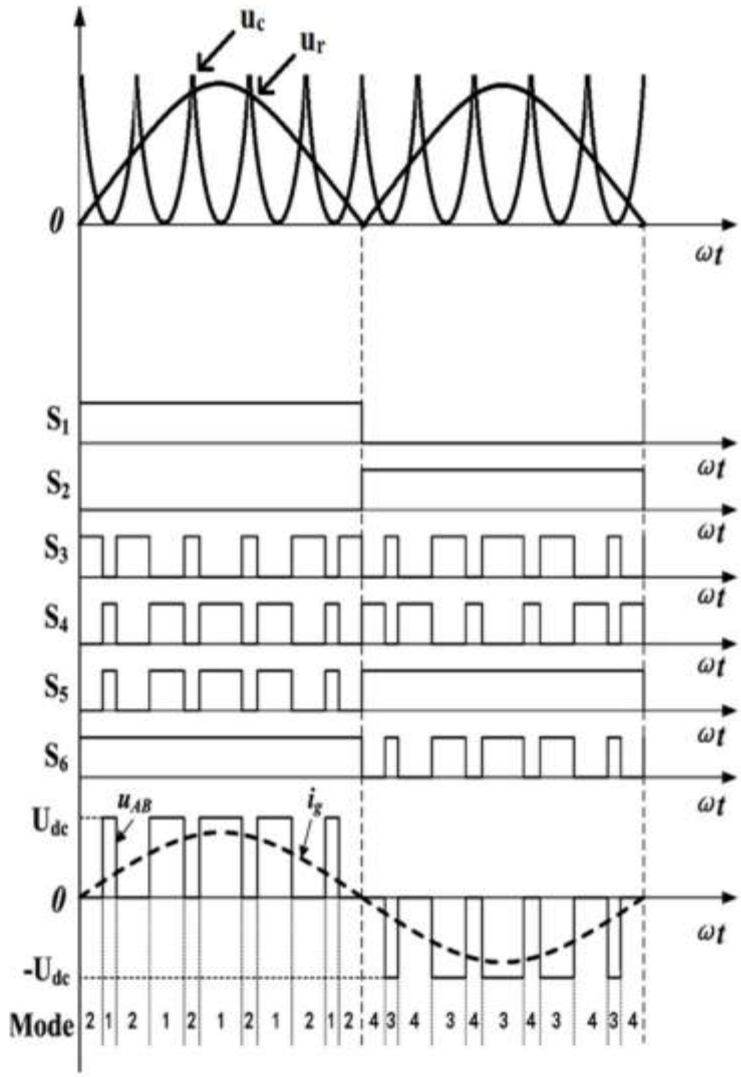

The inverse sine carrier pulse width modulation (ISPWM) technique has a better spectral quality and a higher fundamental component compared to the conventional sinusoidal PWM without any pulse dropping. Also, there is a reduction in the total harmonic distortion (THD). An inverted sine wave of high switching frequency is taken as a carrier wave and is compared with that of the reference sine wave. The pulses are generated whenever the amplitude of the reference sine wave is greater than that of the inverted sine carrier wave [10]. PIC microcontroller is used to obtain the gating pattern for the individual IGBTS. The total harmonic distortion for the different values of switching frequencies is obtained and is found to be lesser than the conventional method. By employing this new modulation technique it has been proved that the fundamental voltage is improved throughout the working range and is greater than the voltage obtained using conventional method which employs triangular carriers for modulation.

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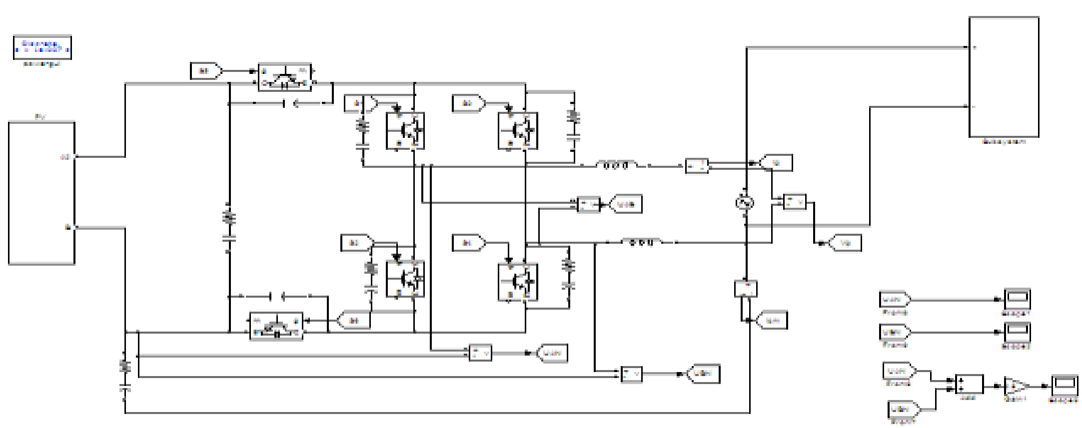
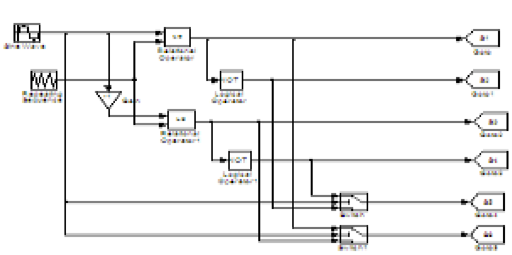
Table I
Parameters of improved transformerless inverter topology

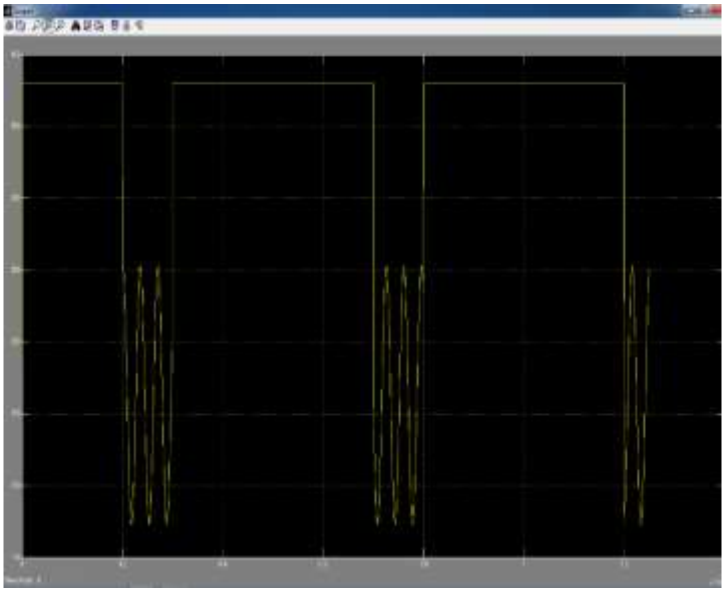
SI.no	Parameter	Value
1	Input voltage, V_{dc}	220 V
2	Input capacitor, C_{dc}	940 μF
3	Filter inductor, Lf	1 mH
4	Parasitic capacitor,CPV	75 nF
5	Power switches, S1-S6	IRGB4056DPbF
6	Junction capacitors of the switches, C1–C5	29 pF
7	Grid voltage, U_g	220 V
8	Grid frequency, f_g	50 Hz
9	Switch frequency, fs	20 kHz

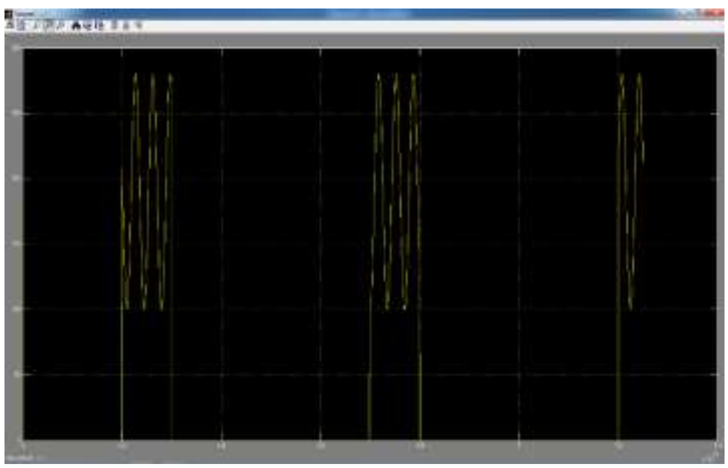
Simulation

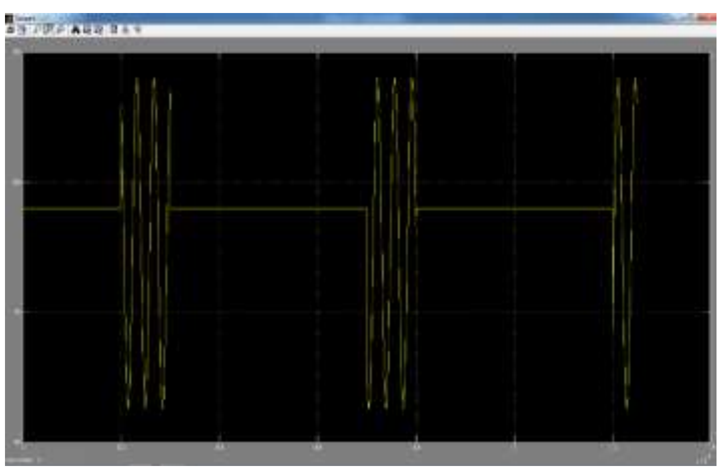




Results







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Conclusion

This paper presented an improved grid-connected inverter topology for transformer less PV systems. The inverse sine carrier pulse width modulation control strategy can be applied to implement the presented inverter, which can guarantee not to generate the common-mode leakage current because the condition of eliminating common-mode leakage current is met completely. The high efficiency and convenient thermal design are achieved thanks to the decoupling of two additional switches connected to the dc side of the inverter. Moreover, the lower total harmonic distortion(THD) and higher fundamental output voltage are obtained by inverse sine carrier pulse width modulation(ISPWM). The smaller filter inductors are employed and the copper losses and core losses are reduced accordingly.

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