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Minimisation of Leakage Current in Voltage Controlled Grid Connected Inverter

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ABSTRACT: Conventional power-current controlled grid-tied inverters suffer from interactive stability issues including harmonic oscillations when integrated into weak ac grids. To overcome this limitation, a power-voltage control strategy based on the capacitor voltage feedback control of LCL filter was proposed in this paper

KEYWORDS: voltage controlled grid connected inverter, leakage current

I.INTRODUCTION

Among the renewable energy sources, a noticeable growth of small photovoltaic (PV) power plants connected to low-voltage distribution networks is expected in the future. As a consequence, research has been focusing on the integration of extra functionalities such as active power filtering into the PV inverter operation. Distribution networks are less robust than transmission networks, and their reliability, because of the radial configuration, decreases as the voltage level decreases. Hence, usually, it is recommended to disconnect low-power systems when the voltage is lower than 0.85 pu or higher than 1.1 pu. For this reason, PV systems connected to low-voltage grids should be designed to comply with these requirements but can also be designed to enhance the electrical system, offering "ancillary services". Hence, they can contribute to reinforce the distribution grid, maintaining proper quality of supply that avoids additional investments. However, low-voltage distribution lines have a mainly resistive nature, and when a distributed power generation system (DPGS)is connected to a low-voltage grid, the grid frequency and grid voltage cannot be controlled by independently adjusting the active and reactive powers . This problem, together with the need of limiting the cost and size of DPGS, which should remain economically competitive even when ancillary services are added, makes the design problem particularly challenging.

II.RELATED WORKS

Opportunities for utilization of renewable energy resources and improvements in PV techniques remain a forefront topic of interest in recent researches due to their extensive use and applications. Then, it is necessary to review various strategies and their impact on society by using renewable energy techniques of solar.

III.TRANSFORMERLESS GRID CONNECTED INVERTER

Transformer less inverters offers a better efficiency, compared to those inverters that have a galvanic isolation. In this research paper conversion topology has been proposed without transformer in PV system, which is interfaced with Xilinx system generator. In this topology no common mode voltage is generated, thus changes in the behavior of the inverter in terms of high efficiency and insures that no DC will be injected into the load.

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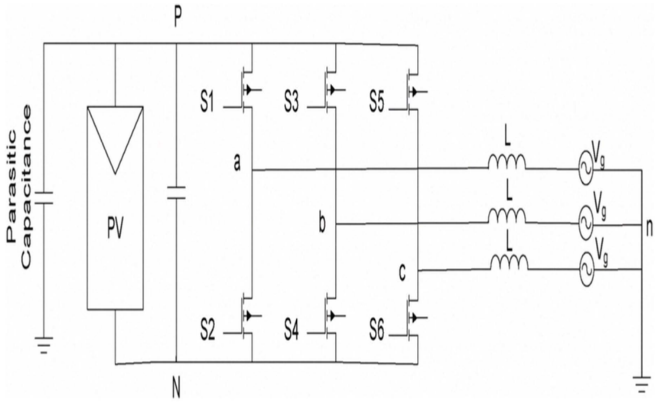

Transformerless system In figure 2.1 which consists of two stages. In this system a solar array has been constructed in PSIM by combining it into series and parallel combinations. As we now the output of solar cell is variable so we have deployed a DC-DC converter which converts variable DC into fixed DC, this is done in first stage. In second stage DC is converted into AC which will be utilized by the appliances.

IV.DC CURRENT INJECTION INTO THE NETWORK FROM PV GRID INVERTERS

The DC current injection for low voltage small grid-connected PV systems, which is one power quality requirements by the utility companies.

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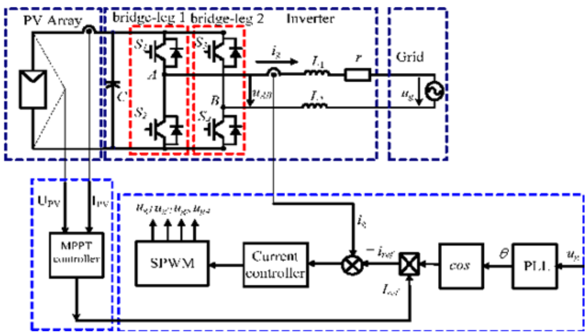

Furthermore, a grid-connected system installed in Spain has been used to perform measures about their possible DC current injection into the grid.
Thus,from the twelve single-phase inverters from the European market have been tested. Many groups of measurements were made, under different conditions. The results show that in all cases there is any DC current injection, even if a LF transformer inverter is used.Currently the management of energy sources represents a fundamental problem for the development and prosperity of any community. As a result, there exist two major problems: the energy sources and the ambient pollution from the residues from conventional sources.

It is necessary to optimize energy resources as with using alternative energy sources. The main characteristics of such sources include their renewability and small contamination contribution. Photovoltaic solar energy is in this

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category and its use also has increased notably in industry over the past few years. Common distributed generators, PV generators particularly, are increasingly being connected to utility grids to contribute electrical power to the utility grid to meet power demands and to meet electric consumers demands for alternate sources of power.

V.BENEFITS OF USING TRANSFORMERLESS INVERTER CONNAECTED TO THE INVERTER

- Usually much lighter in weight than inverters with transformers.
- Have higher efficiency ratings
- Capable of dual MPPT inputs, depending on manufacturer
- Lower cost and size

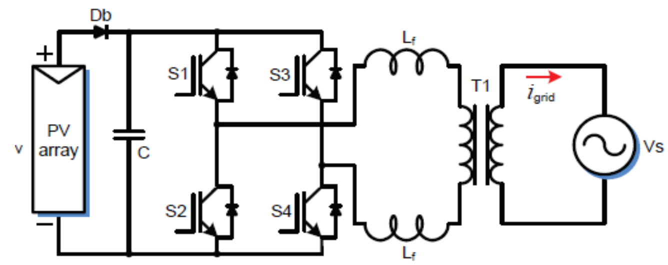
VI. CONSIDERATIONS

Transformerless inverters do not have electrical isolation between DC and AC circuits. This may raise some grounding and / or lightning protection concerns. In order for transformer less inverters to comply with NEC specifications specially designed and more expensive PV Wire must be used. Transformer less inverters have been developed for use with Grid-Tie Solar PV Systems, so Off- Gridsystems users will not necessarily achieve the same benefit yet.

VII. GRID CONNECTED INVERTER WITH TRANSFORMER

PV renewable energy has become a very important electrical energy source within the entire energy market. The growing is mainly due to the fact that these systems have been constantly improving in terms of efficiency, power, reliability, etc. On the other hand, the policies stated by the governments in many countries have allowed the spread of the PV systems. The PV system can be designed either in island or grid connected mode being the last one the most commonly used. The grid connection allows injecting the power generated into the electrical grid; in order to achieve this objective, the PV system is commonly set by using three stages: the PV array, the power inverter and the grid filter with galvanic isolation . PV stage output will be DC and inverter purpose is to convert DC voltage to AC voltage. Grid filter (Inductor) is used to filter the harmonics in AC signal. Transformer purpose is for following two things

i) Provide galvanic isolation, so that at any cause the current will not flow from load to PV array.
ii) Step up the output voltage of the inverter.



PV inverter with Low Frequency Transformer

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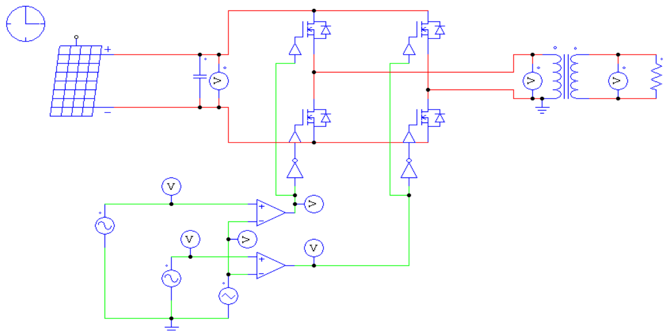
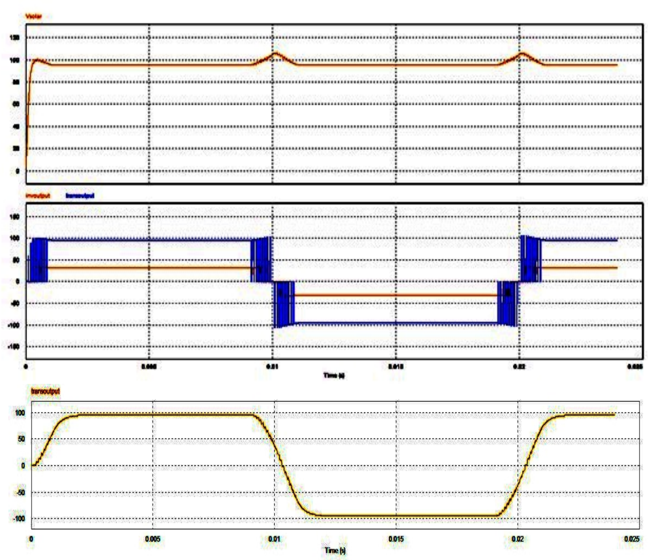
SIMULATION



Simulation of Grid Connected inverter with transformer were performed by PSIM software .To operate the MOSFET only in Cut-off mode and saturation mode we are using ON- OFF switch Controller with all 6 MOSFETs. NOT gate is used to give gate pulses in three lower transistors. This is becauseat any instance we should not TURN ON both 2 transistors in one leg to avoid short circuit. So the gate pulses given to the upper transistors are inverted by the NOT gate and will be given to the lower transistors.
Gate signals are given by comparing the sinusoidal signal and triangular signal in the comparator. Sinusoidal signal is given to the positive terminal of the comparator and triangular signal is given to the negative terminal of the comparator. So if the amplitude of sinusoidal signal is grater than triangular signal then, positive saturation voltage (which will be given to the gate of MOSFET as pulses) will be generated. So if we need to TURN ON the MOSFET for particular period then, set the magnitude of sinusoidal voltage greater than triangular voltage. If we need to TURN OFF the MOSFET for particular period then, set the magnitude of triangular volatage greater than sinusoidal voltage. If the TURN OFF period is large then output voltage will decrease and thereby we can able to control the inverter output voltage. The output of the inverter will be AC and centre pulse in both positive cycle and negative cyle will be large and so it called Centre Pulse Width Modulation (CPWM) Technique

OUTPUT WAVE FORM



a) DC Solar output
b) AC inverter Output (red color) and Transformer Stepped up AC Voltage
c) AC output voltage

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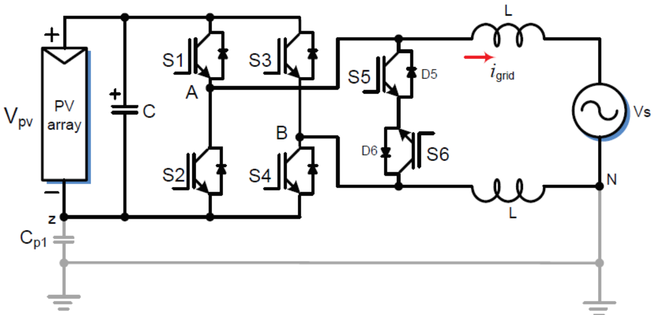
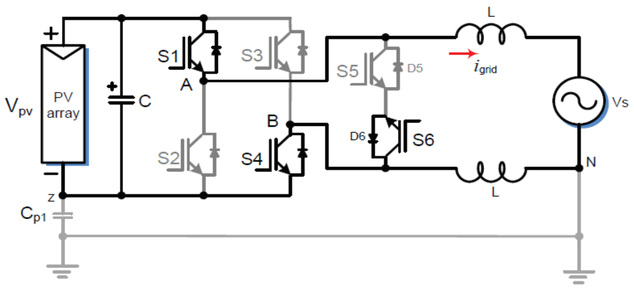
VIII.PROPOSED SYSTEM

Dc to Ac converter is known as inverter. Electrical power is usually transmitted and used in the form of alternating current.

However, some kinds of electrical generation and storage devices produce direct current, examples being PV modules and batteries. An inverter is a power electronic apparatus which converts DC to AC, allowing the DC power from these generators to be used with ordinary AC appliances, and/or mixed with the existing electrical grid. Photovoltaic generation is usually interfaced at a grid bus through a PWM inverter in which a switch signal is generated by comparing the desired sinusoidal output (i.e themodulated signal or control signal) with high frequency triangle wave (carrier signal). The points of intersection of the modulating signal and the carrier signal are the points in which the GTOs or thyristors of the inverter are switched on by turn.



The proposed topology and the circuit to generate the modulation sequence are depicted in Figure 5.1. The main idea is to generate the zero state using modified bidirectional switch on the AC side. The modulation strategy proposed to control the inverter is as follows: during the positive half-cycle, the active state is generated when S1 and S4 are ON (S3 and S2 are OFF) while S5 is OFF and S6 is ON, therefore the current flow through S1 and S4 towards the load. In this situation, as shown in Figure 4.2, there is no current flowing through bidirectional switch, due to inverse polarization of D5. In order to generate the null state, S1 and S4 must be switched OFF while S6 remains ON. In this way the current flows in the bidirectional switch through S6 and diode D5, because D5 is directly polarized due to the voltage generated by the energy stored in the inductance L; this is the freewheeling situation in the positive half-cycle as shown in Figure 4.3.



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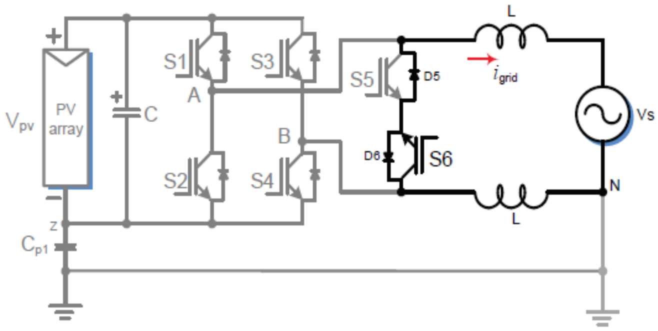
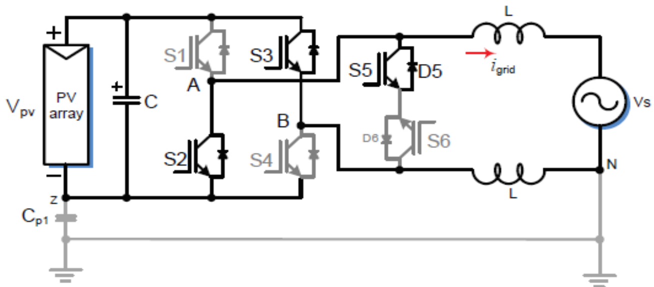
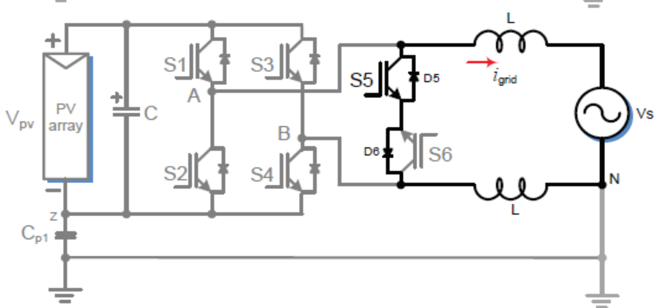


On the other hand, during the negative half cycle, the active state is generated using S2 and S3 (S1 and S4 are OFF). During this state the current flows toward the load through the switches S2 and S3 as shown in Figure 4.4. The load current does not flow through the bidirectional switch because of the inverse polarization of D6. The null state during the negative half-cycle is generated when S3 and S2 are switched OFF while S5 remains ON. Therefore the load current will flow through the bidirectional switch (S5 and D6), because D6 is directly polarized due to the voltage generated by the energy stored in the inductance L as it is shown in Figure





Thyristors and Bipolar Junction Transistors (BJT) were the only power swtches until the MOSFETs wre introduced in the late 1970s. The BJT is a current-controlled device; whereas the MOSFET is a voltage-controlled device. In the 1980s, the IGBT was introduced, which is also a voltage controlled device. The MOSFET is a positive-temperature-coefficient device whereas IGBT may or may not be a positive-temperature-coefficient device

The MOSFET is a majority carrier device making it ideal for high frequency applications. Inverters, which change DC to AC electricity, can be operated at ultrasonic frequencies to avoid audible noise. The MOSFET also has high avalanche capability compared to the IGBT. Operating frequency is important in choosing a MOSFET. The IGBT has lower clamping capability compared to the equivalent MOSFET. DC bus voltage at the inverter input, power rating , power topology and frequency of the operation must be considered when choosing between IGBT and MOSFET. An IGBT is generally used for 200V and above applications; whereas the MOSFET can be used in applications from 20V to 1000V. Newer MOSFETs have lower conduction loss and switching loss and are replacing IGBTs in medium

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voltage applications up to 600V. generally, IGBTs are used for high-current and low-frequency switching; whereas MOSFETs are used for low-current and high-frequency switching.

IX. CONCLUSION

The proposed method for transformless grid tie inverter in order to reduce the leakage current.It is shown that transformerless topologies are smaller in size and have higher efficiencies than inverters with high-frequency or low-frequency transformers.. Finally the parasitic capacitance of the PV array is discussed and measured in case of several commercial PV panels, emphasizing the safety issues regarding ground leakage currents due to varying voltages imposed over this capacitance.

Electricity is the basic necessity for the economics of a country. The industrial development and the increase of living standard of people are directly related to the more use of electricity. Solar power is connected to the National grid then increase total generation power. So, we study how to connect solar energy to the national grid. That system is very complex but solar source free from cost also, there has no environment effect and reliable. The general trends in the past decade of increasing solar cell efficiency, decreasing PV system costs, increasing government incentive programs, and several other factors have all combined synergistically to reduce the barriers of entry for PV systems to enter the market and expand their contribution to the global energy portfolio. In this paper, transformerless grid connected inverter with minimum leakage current is proposed and its leakage current is less than the maximum current leakage level 300 mA which was set by the standards DIN VDE 0126-1-1. It is very important to note that the output voltage of the inverter and output current of the inverter are in-phase. If grid is connected to the output of the inverter then, it is necessary to match the phase of inverter current with phase of the grid voltage. If not, the injected power will be totally a reactive power. Matching the phases of inverter output current and grid voltage can be done by the Phase Locked Loop (PLL).

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