SINGLE PHASE GRID TIED TRANSFORMERLESS INVERTER OF ZERO LEAKAGE CURRENT FOR PV SYSTEM

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ABSTRACT

A new single phase transformerless Photovoltaic (PV) inverter for grid tied PV systems. The topology is derived from the concept of a charge pump circuit in order to eliminate the leakage current.It is composed of four power switches, two diodes, two capacitors and an LCL output filter. The neutral of the grid is directly connected to the negative polarity of the PV panel that creates a constant Common Mode (CM) voltage and zero leakage current. The Charge pump circuit generates the negative output voltage of the proposed inverter during the negative cycle.characterized by higher efficiency and lower cost. In this context, new topologies, modulation, and control schemes were presented to solve problems of a common-mode voltage and leakage current. This work proposes a transformerless five-level inverter with zero leakage current and ability to reduce the harmonic output content for a grid-tied single-phase PV system. The neutral of the grid links to a common on which the negative and the positive terminals of the DC-link are connected via parasitic capacitors that can eliminate the leakage current. The proposed topology, with its inherent circuit structure, leads to boost the overall efficiency. Simulation and experimental results show almost zero leakage current and a high-quality output when maintaining balanced capacitor voltages on the DC-link input. The experimental results show 1.07% THD and 96.3 % maximum efficiency when injecting a power of 1.1 kW that verify the performance of the proposed inverter with PV source

Keyword : - *Grid tied inverter , Leakage current elimination, Transformerless inverter*

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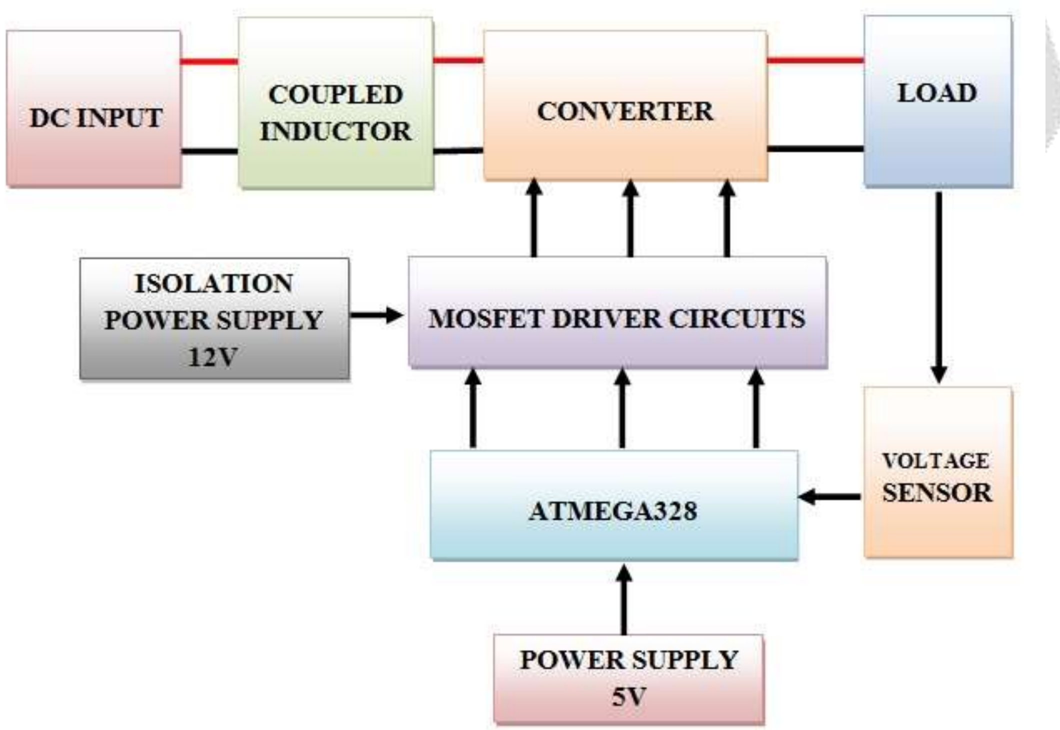
1. INTRODUCTION

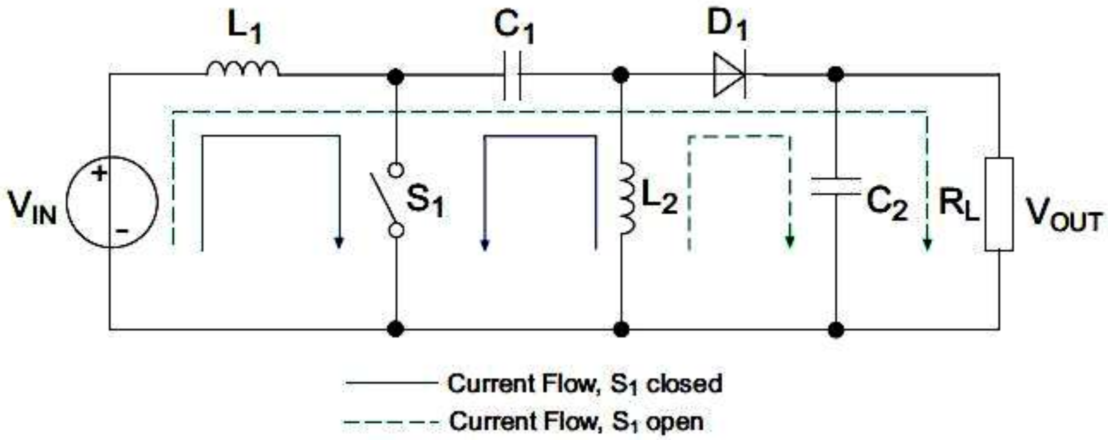
Nowadays, the invention and development of new energy sources are being continuously enhanced which in turn makes renewable energy sources to become a more important contributor to the total energy consumed in the world. Traditional power generations that are on a basic of fossil fuel resource are considered to be unsustainable in long term national strategies. This has been one of the main driving forces for an increasing installation of renewable energies like wind power, solar Photovoltaic (PV) power, hydropower, biomass power, geothermal power, and ocean power, etc. into the public grids [1], [2]. Among the major renewable energy resources, photovoltaic (PV) power supplied to the utility grid is gaining more and more visibility, while the world' s power demand is increasing [3]. The exclusion of transformer, and hence its isolation capability, has to be considered carefully. Because of the parasitic capacitance between the PV module and the ground, the fluctuating common mode (CM) voltage that depends on the topology structure and switching scheme can inject a capacitive leakage current [9]. Two switches and two diodes are added in the ac side of full-bridge topology to decouple the PV module from the grid during the freewheeling period [20]. As shown in Fig. the topology which has been proposed in [7] replaces the two switches freewheeling branch with one bi-directional switch and four diodes. All the topologies can achieve high efficiency and low leakage current. The dependability of these topologies will be reduced if a phase shift between the voltage and current is occurred due to the low reverse recovery issues of the MOSFETs anti-parallel diode. In this paper, a new transformerless inverter for single phase grid-tied PV system is proposed. The control system for the proposed topology is also presented in section III. It has shown that the proposed inverter can handle a certain amount of reactive power if necessary. Finally, the proposed topology is verified with a prototype of rated 1kW/50Hz for unity power factor and other than unity power factor which is shown in section IV and section V concludes the project.

2. CONVERTERS OPERATION

Inverters may have one or more stages according to a levels of power conversion. Generally single-phase systems are the most commonly used in the private sector or residential application. The majority of such PV systems can have be up to 5KW and are roof mounted with a fixed tilt and a southward orientation. Taking into consideration the presented scenario, highly efficient single-phase inverter topologies that will most likely reach a high level of efficiency at low cost are the ones established by a single-stage transformer less inverter.



BLOCK DIAGRAM



SEPIC CONVERTER

2.1 SEPIC CONVERTER

The SEPIC converter is a switching converter that operates by periodically opening and closing an electronic switching by which output DC voltage either larger or smaller than its input DC voltage with no polarity reversal, meanwhile power must be conserved, the output current is lower than the source current. In order to convert voltage from one level to other this converter exchanges the energy between inductor and capacitor.

The switch S1 controlled the amount of energy exchanged which is typically a transistor such as a MOSFET having much higher input impedance and lower voltage and do not require biasing resistors because switching is controlled by differences in voltage rather than a current. When the pulse is high the MOSFET Switch is on, input voltage charged the inductor L1 and capacitor C1 charged the inductor L2. The output is maintained by capacitor C2 when the diode is off. When the pulse is low the MOSFET is off, the capacitors are charged and the inductors output through the diode to the load. The output will be larger if the larger percentage of duty cycle the pulse is low. This is because the longer the inductors charge, the larger their voltage will be. However, the converter will fail, if the pulse lasts too long and the capacitors will not be able to charge.

In a boost converter the output voltage is always greater than input voltage. A boost converter has consisted a power MOSFET as a switch. The Circuit operation can be divided into two modes. Mode 1 begins when transistor Q1 is switched on at t = 0, the input current rises. Flows through inductor L and transistor Q1. Mode 2 begins when transistor M1 is switched off at t = t1. The current that was through the transistor would now flow through L,C and Load. The inductor current falls until transistor M1 is turn on again in the Next cycle. The energy stored in inductor L3 is transferred to the load. A boost converter can step up the output voltage without any transformer. Due to a single transistor it has a high efficiency. The input current is continuous. However a high peak current has to flow through the power transistor. The output is very sensitive to change in duty cycle and it might be difficult to stabilize the regulator. The average output current is less than the average inductor current. Power can also come from DC sources such as batteries, solar panels, rectifiers and DC generators. A process that changes one DC voltage to a different DC voltage is called DC- DC conversion. A boost converter is a DC- DC converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it " steps up" the source voltage. Since power must be conserved, the output current is lower than the source current. For high efficiency, the simple mode of power switch must turn on and off quickly and have low losses.

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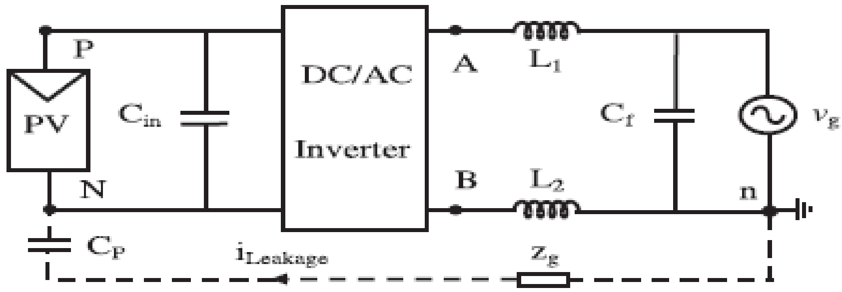
3.SINGLE PHASE GRID TIED TRANSFORMERLESS INVERTER

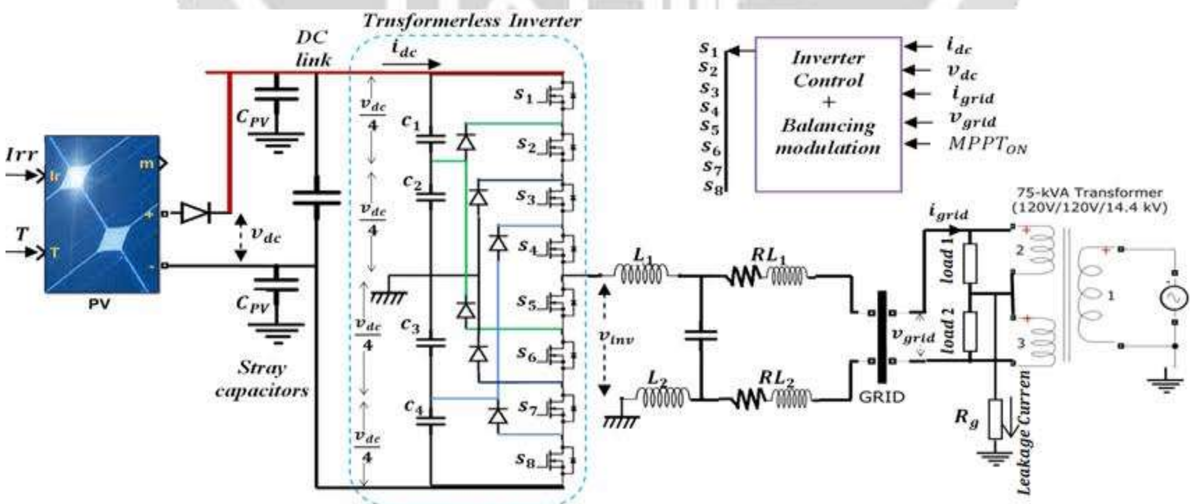


Block diagram of a single phase grid connected transformerless inverter with leakage current path

Fig. :illustrates a single-phase grid tied transformerless inverter with Common mode current path, where P is positive terminal and N is negative terminals of the Photovoltaic, respectively.
In order to eliminate the leakage current, the Common mode voltage (CMV) must be kept constant during all operation modes according to it.

4. CONTROL SCHEME

The control strategy of a proposed grid-tied single-phase inverter contains the two cascaded loops the first loop is an inner control loop, which has to generate a sinusoidal current and the outer control loop is implemented for the current reference generation, where the power is controlled. A proportional resonant (PR) controller provide an infinite gain at a resonant frequency and can be eliminate the steady state error when tracking a sinusoidal signal, which is an index of the power quality. Due to these features, the PR controller is selected instead of the PI controller in the current control loop in this topology.



CIRCUIT DIAGRAM

5. CONCLUSIONS

Based on the results that has been done through simulation and experiment of a modified DC-AC converter with high static gain, it can be concluded that modified converter topology able to increase the voltage of 12V to 240 V with full load condition. Thereby, the gain of converter is equal to 20 times. The average efficiency of the modified converter is 91.46%. In addition, proposed controller based PI is effectively working to maintain the output voltage of the converter and can be applied for photovoltaic Applications.

6. REFERENCES

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