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Research Article

Implementation of solar based grid tied with interleaved fly back inverter

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Abstract

The main aim of this project is to improve the efficiency of the incorporate fly back inverter over a wide range, under boundary condition mode and discontinuous conduction mode .Based on the loss analysis, a new hybrid control strategy combining the one-phase discontinuous conduction mode and two-phase discontinuous conduction mode control is projected to progress the efficiency in wide load range by reducing the dominant losses depending on the load current. Furthermore, in comparison with the conventional Fly back, the energy is supplied to the secondary side not only from the magnetizing inductance, but also from the introduced series capacitor, lowering the transformer energy requirements. The proposed converter makes also the soft-transitions possible for both mosfets. For all these reasons, as a more efficient and smaller size approach, this topology shows better performances in high power density low-cost applications.

Keywords: Fly back inverter; Discontinuous conduction mode; Boundary condition mode.

Introduction

Renewable energy sources are often considered as alternative sources because, in general, maximum industrial nations do not trust on them as their main energy source. Instead, they tend to rely on non-renewable causes such as fossil fuels or nuclear power. Since the energy crisis in the United States during 1970s, the dwindling materials of fossil fuels and exposures related with nuclear power, usage of renewable energy bases for instance wind, biomass, solar, geothermal, biomass, and hydroelectric has developed (Yu et al., 2009) Renewable energy comes from the sun (considered as an "unlimited" supply) which will long last the human or other sources that can be tentatively be transformed as swiftly as they are expended (Kjaer et al., 2005). If used at a bearable rate, these sources will be obtainable for intake for thousands of years or elongated. Inappropriately, some tentatively renewable energy bases, namely biomass and geothermal, are truly being tired in some zones because the usage rate exceeds the renewal rate (Li et al., 2008).

Solar energy is the ultimate energy source. Any particle which leaves the sun mostly reaches the earth's surface, this is more than sufficient to meet the world's energy requirements. In fact, all other sources of energy, renewable and non-renewable, are basically stored forms of solar energy. The process of directly converting the solar energy to heat or electricity is measured as a renewable energy source. Solar energy characterizes an essential development on the earth. However the difficulties lie in binding the energy. Solar energy has been used for centuries to heat homes and water, and current technology (photovoltaic cells) has given a mode to harvest electricity from sunlight (Zhang et al., 2011; Jiang et al., 2012).

(Prapanavarat et al., 2002; Shimizu, 2011) studied Dc-dc converter is a method which produces a dc output voltage when the dc input is given. If we require the higher output voltage than the input voltage we go for boost converter. The boost converter can be used for step up applications because of low conduction loss, simple structure and small budget. Yet, it is not apposite for great step-up applications. (Kutkut et al., 2010) The requirement of exciting duty cycle to obtain high voltage gain is a major restriction. In order to remedy these problems, use of low frequency or high frequency power transformer has been suggested. However, there exists a need for galvanic isolation between the input and output steps of the power converters. To obtain high voltage step-up converters non isolated converters with large conversion ratios are proposed (Oun et al., 2013) where multiple stages are connected in parallel but this will lead to high module count. In applications where dc separation is not necessary, a transformer would normally be required for large voltage transformation ratio.

Though, (Wu et al., 2013; Dunisha Wijeratne et al., 2014) leakage inductance of the transformer reasons some problems as switch voltage overshoot, EMI generation. Hence a boost converter consuming switched capacitors is planned, where high voltage gain can be gained, but it is controlled to low power applications. Also great amount of capacitors was used as the multiplier and is attached in the high-voltage (output) section of the converter; the diodes were submitted to voltage stress. (Gautam et al., 2013; Rongyuan et al., 2004)Alternative topology which consists of clamp mode coupled inductor boost converters working with the advantages of high voltage improvement ratio and half output voltage pressure across the switches.

Existing System

Interleaved Fly back Inverter

The term, "micro inverter", represents the solar PV scheme compassed of a distinct low-power inverter unit for each PV panel. These systems are suitable more and more general as they reduce overall installation costs, increase safety and well maximize the solar energy harvest (Kjaer et al., 2005). Other benefits of a solar micro inverter system include: Micro inverters can be applied using a single converter, as has been demonstrated or using multiple interleaved converters. When interleaved converters are used, the secondary controls are not placed in series with the subordinate diodes of each fly back converter; instead there is a separate, low frequency converter that is used to interface the output of the fly back converters to the grid voltage. When the grid voltage is positive, a transversely opposed pair of inverter switches is on throughout the half cycle; when the voltage is negative, the other pair is on. The disadvantages in the conventional system are overcome by proposed control process. For the interleaved fly back micro inverter, the main losses with heavy load comprises of the transmission loss of the power MOSFETs and diodes, and the loss of the transformer; while the main losses with light load include the gate heavy loss, the turn-off loss of the power MOSFETs and the converter core loss (Jiang et al., 2012).

Proposed control method and operation

In the proposed control method, full bridge inverter in the conventional method is replaced by half bridge inverter, to reduce the switching losses occurring at the diodes. The switching losses occurring at the diodes is reduced in high frequency, hence the isolation transformer is used.

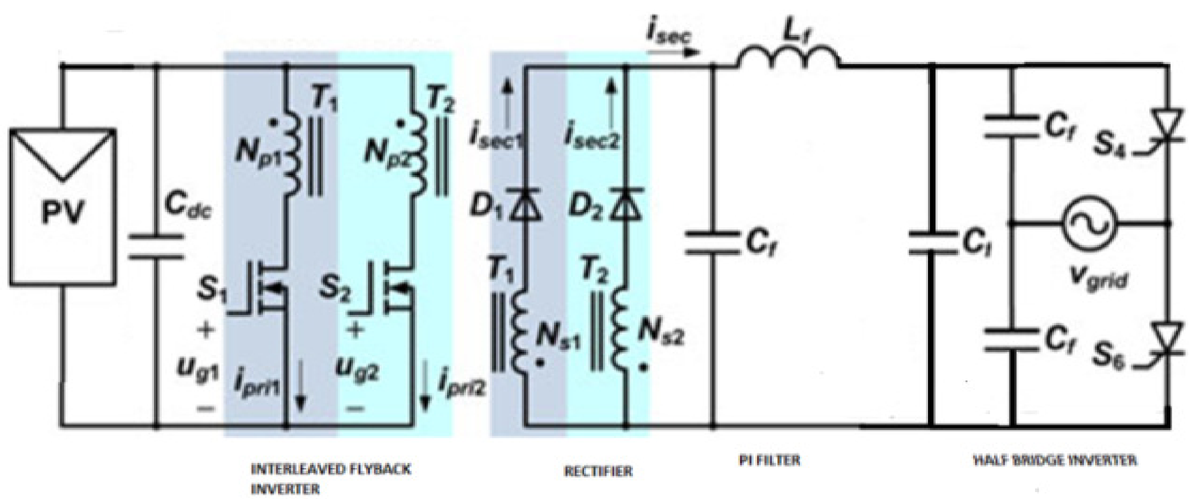

Fig.1. Circuit Diagram

Fig. 1 shows the chief circuit of the interleaved fly back inverter. The inverter includes of two-phase-interleaved fly back converters and a CSI. $S1$ and $S2$ are the main power controls; $D1$ and $D2$ are the rectifier diodes; NP 1 and NP 2 are the main windings, and $NS1$ and $NS2$ are the subordinate windings.$S3 - S6$ form the CSI to explain the rectified sinusoidal waveform into the system.$S3$ and $S6$ turn ON during the positive-half cycle.

Solar PV

In general, a large number of interconnected solar panels, known as solar PV array, are installed in an array field. These panels may be installed as stationary or with a sun tracking mechanism. It is important to ensure than that an installed panel does not cast it shadow on the surface of its neighboring panels during a whole year. The layout and mechanical design of the array such as slope view point of panels, tallness of panels, authorization between the panels etc. are carried out taking into climatic condition, ease of maintenance.

Interleaved fly back converter

The term, "micro inverter", refers to a solar PV system included of a solo low-power inverter unit for every PV panel. These systems are becoming more and more popular as they reduce overall system costs, improve safety and better exploit the solar energy harvest. Other advantages of a solar micro inverter system include: Improvement of system consistency by decreasing inverter temperatures and removing fans, Spare of old-style difficult swapping methods by soft switching techniques to increase efficiency and reduce heat dissipation and System designs can be standardized (hardware and software) to improve consistency and reduce rate.

LC Filter

A low pass LC filter is essential at the output terminal of Full Bridge VSI to reduce harmonics made by the exciting modulation waveform. While designing L-C filter, the cut-off frequency is selected such that most of the low order harmonics is eliminated. To operate as an ideal voltage source, that means no additional voltage alteration even though under the load change or a nonlinear load, the output impedance of the inverter must be kept zero. Therefore, the capacitance value should be maximized and the inductance value should be minimized. Each value of L and C component is determined to minimize the reactive power in these components because the reactive power of L and C will decide the cost of LC filter and it is selected to minimize the cost, then **it** is common that the filter components are determined at the set of a small capacitance and a large inductance and consequently the output impedance of the inverter is so high. With these design values, the voltage waveform of the inverter output can be sinusoidal under the linear load or steady state condition because the output impedance is zero. But in case of a step change of the load or a nonlinear load, the output voltage waveform will be distorted because by the slow system response as the output response is non-zero.

Single phase half bridge inverter

It consists of two semiconductor controls T1 and T2. These controls may be BJT, Thyristor, and IGBT etc with a commutation path. D1 and D2 are called Freewheeling diode or Feedback diodes because they send back the load reactive power.

In the proposed control method we are converting the full wave bridge inverter into half wave bridge inverter (Fig. 2 and 3) in order to reduce the switching losses in the diodes, to improve the efficiency of the circuit. Hence the efficiency of the circuit is improved over wide long range.

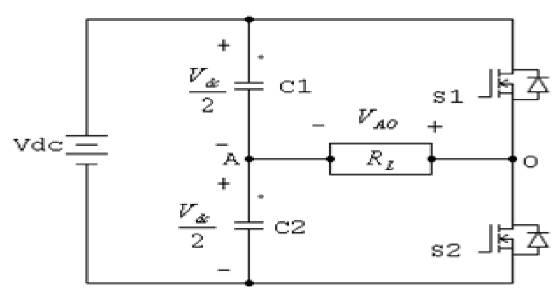

Fig. 2. Single Phase Half Bridge Inverter

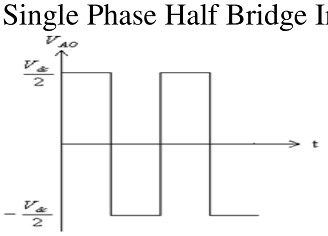

Fig. 3. Half Wave Waveform

Table 1. Switching States of Half Bridge Inverter

S1	S2	V_{ao}
ON	OFF	$V_{dc}/2$
OFF	ON	$-V_{dc}/2$

T1 is ON during the progressive half cycle of the output voltage, which makes $V_{out}=Vo/2$ and T2 is ON during the undesirable half cycle which makes $V_{out}= -Vo/2$. The both switches must operate otherwise otherwise there may be a chance of short circuiting. In case of resistive load, the current waveform follows the voltage waveform but not in case of sensitive load. The feedback diode functions for the reactive load when the voltage and current are of opposite polarities.

Results and discussion

An imitation model of the proposed control has been developed. The proposed simulation diagram is shown in the fig. 4. It consists of solar PV, interleaved fly back inverter, isolation transformer, rectifier, resonant filter and inverter.

The input voltage generated from the solar PV is given to the interleaved fly back inverter. The interleaved fly back inverter reduces the spike voltages and current sharing between the two interleaved phases. The output of the LC filter is given to the half bridge inverter circuit. The output of rectifier is given to the output resonant filter, is used to eliminate the harmonics and noises present in the voltages. Finally the output is given to the inverter, to convert the dc-ac and given to the load. In the proposed simulation method, full bridge inverter is replace by the half bridge inverter, in order to reduce the switching and conduction losses occurring at the diodes. The specifications of the interleaved boost converter are as follows: input voltage *V*dc = 12 V in Fig. 5; grid voltage *V*grid= 220 Vac; grid frequency: *f* grid = 50 Hz; transferring frequency *fs* = 100 kHz; gate energy voltage *Vg* = 15V; primary inductance: L_P= 28 μH, and the turns ratio *n* = 0.5. Fig. 6 & Fig. 7 shows the switching pulses of fly back inverter and transformer respectively. Primary and secondary voltage of transformer 1 and transformer 1 are shown in Fig. 8 and 9.

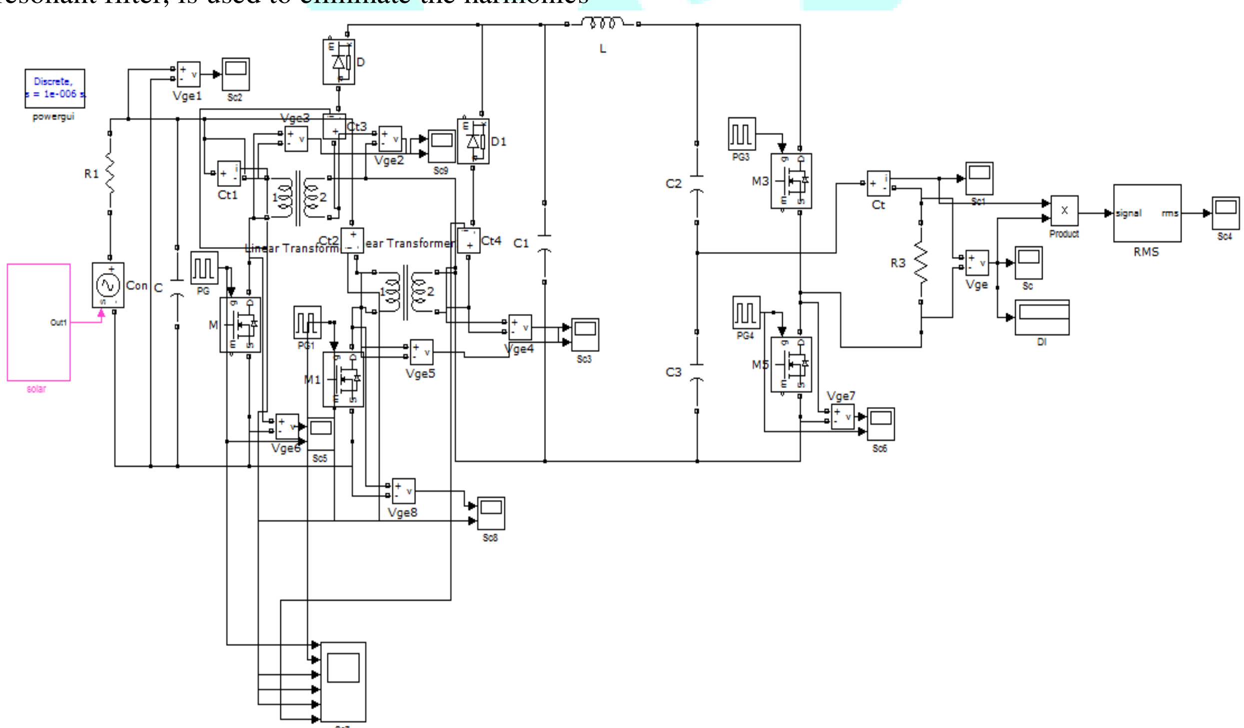

Fig. 4. Simulation diagram

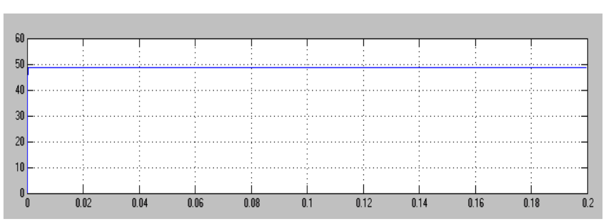

Fig. 5. Solar input voltage

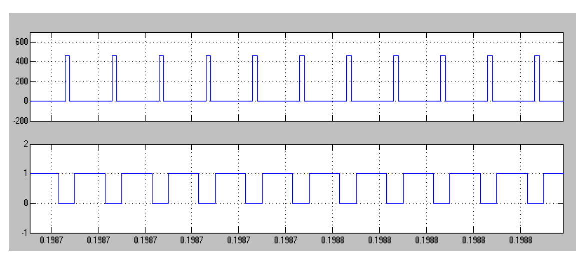

Fig. 6. Switching pulse for fly back inverter

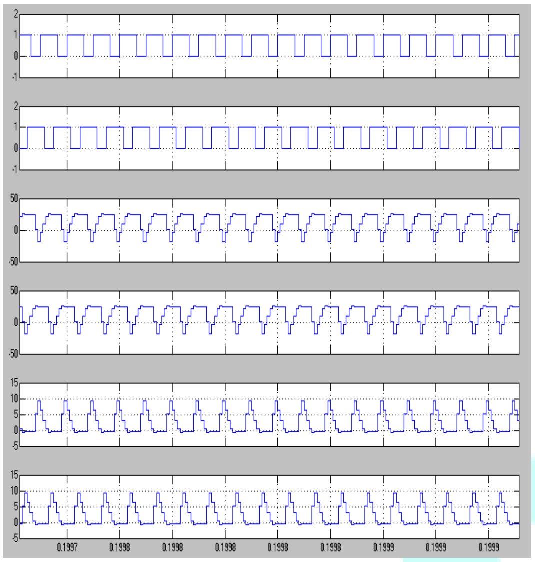

Fig. 7. Switching pulse for M1, M2 and transformer primary and secondary

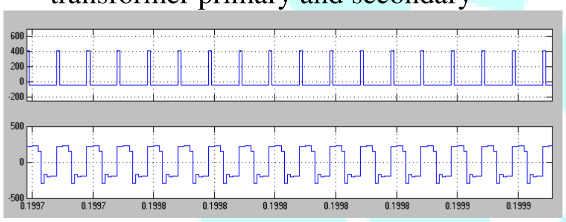

Fig. 8. Transformer1 primary and secondary voltage

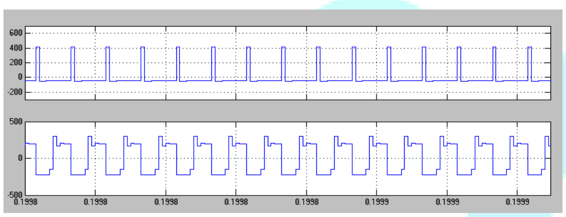

Fig. 9. Transformer2 primary and secondary voltage

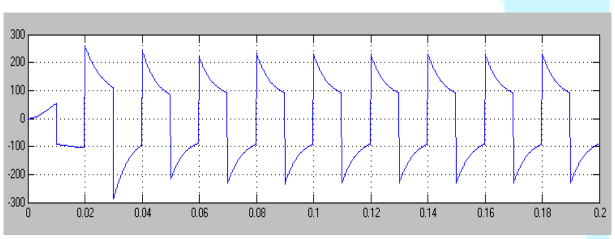

Fig. 10. Output voltage

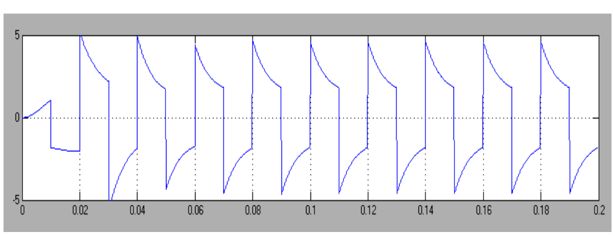

Fig. 11. Output current

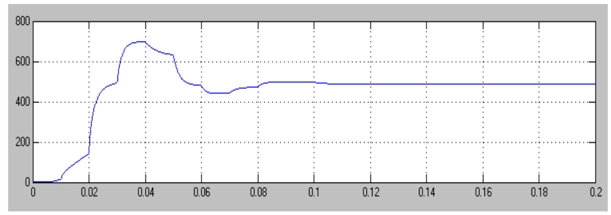

Fig. 12. Output power

Conclusions

This project has accessible Photovoltaic Grid-Tied-Interleaved with fly back micro inverter to achieve high efficiency in wide load range. The obtained outputs from simulation clearly show an acceptable covenant with the imaginary study. The tentative results confirmed the proposed control with the MPPT function. This project has proposed interleaved fly back with micro inverter where a comparative study of different stages has been done and observed that the output voltage in Fig. 10, gain and efficiency are improved by replacing full bridge inverter circuit by half bridge inverter circuit. An important characteristic that can be seen in this topology is the reduced current ripple in Fig. 11, switching losses and the total stress across each switches. With the proposed control, the efficiency is improved under light-load condition and the output power rating is increased upto700W, but the output power rating in the existing system is only 200W. Thus the efficiency and the output power rating of the system are increased over wide long range as shown in Fig. 12. Finally, we can say that as the number of stages increases the output voltage get boosted there by increasing the efficiency. Hence the proposed converter can be used in high voltage applications.

Conflict of Interest

Authors declare there are no conflicts of interest.

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