Design and Implementation of a Grid Connected Solar Micro Inverter System

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***Abstract*-A new control strategy has been proposed for the interleaved fly back inverter. The proposed method consists of two control strategies, they are active clamp control and phase control. Based on the output power of the PV module each converter phase of an ILFI is controlled. due to the active clamp control method the energy in the leakage inductance can be fully recycled. The concept of interleaving reduces the ripple and reduces the usage of capacitors. .simulations are done using MATLAB. The parameters are analyzed without PV and with PV. The explanations, theories and results are discussed further.**

Keywords: Interleaved fly back inverter, active clamp, photovoltaic, Harmonics, Synchronization induction motor drive.

I. INTRODUCTION

Nowadays the standby power loss and efficiency of the power supply are of major concern .the average efficiency instead of full load efficiency is important for external power supplies such as adaptors. the challenge for the power supply design is created by the light load and full load efficiency. For offline applications fly back converters are used generally due to its simplicity and low cost.to dissipate the leakage energy when the switch is off an RCD clamp circuit is used. To minimize the voltage spikes across the switch becomes difficult with the presence of well coupled transformer with minimized leakage inductance. This results in usage of a labor Intensive manufacturing process.by reducing the leakage inductance energy loss the efficiency can be improved. The concept of interleaving enables these converter topologies to operate at increased power levels. The benefits of interleaving include Reduced RMS current in the input capacitors enabling the use of less expensive and fewer input capacitors Ripple current cancellation in the output capacitor, enabling the use of less expensive and fewer output capacitors Reduction of peak currents in primary and secondary transformer windings. Improved transient response as a result of reducing output filter inductance and higher output ripple frequency Separation of heat generating components allowing for reduced heat sink requirements. Improved form factor for low profile solutions Reduced EMI as a result of reduced peak currents.

II. PROBLEM STATEMENT

- Harmonic problems occurs due to the presence of electronic switches.
- Conduction losses occur in switchers
- Develop synchronization between the inverter and grid

III. OBJECTIVE

- To design an interleaved active clamped flyback converter to boost the panel voltage
- To regulate output voltage of PV panel with effective ripple filtering by estimating the value of decoupling capacitors.
- To develop a sophisticated control system to drive the **power switches and system islanding**

IV. GENERAL BLOCK DIAGRAM

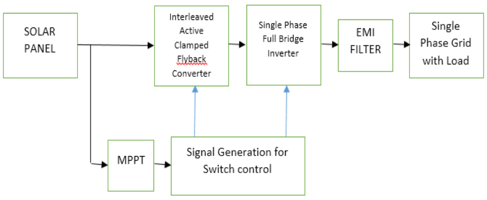

Fig.1. General Block Diagram

To meet the requirements i.e. low cost and higher efficiency the maximum power developed by the panel is fed to the H bridge inverter through interleaved fly back converter. Fig.1.8. shows the block diagram of the proposed system. This topology is derived from the conventional fly back micro inverter by interleaving two fly back cells, Block diagram consider of mainly five blocks, in which PV source is applied to the fly back converter fed to the full bridge unfolding inverter. There is low pass filter block after the inverter to reduce harmonics in the output current. The control block is used to perform two important control jobs. For the first job, it should be regulate proper DC input PV current and PV voltage. For the second job, it should be provide control to convert DC current into AC current at the grid interface for the low injection. The purpose of interleaving of winding reduces the amount of leakage flux and improve coefficient of coupling so the transformer can transfer more power from one side to another side.

V. ILFI STRUCTURE & MODES OF OPERATION

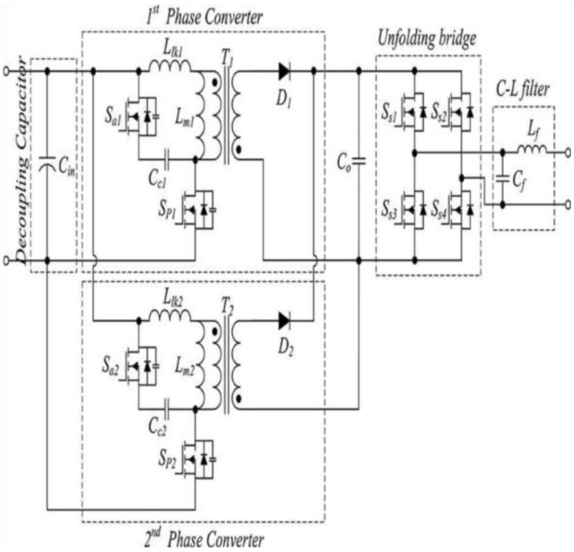

Fig.2. ILFI structure

The ILFI is designed for a PV AC module system. A decoupling capacitor, first phase converter, second phase converter, unfolding bridge, and C-L filter are present in the proposed inverter. The maximum power point tracking is essential for the generation of peak power in the PV AC module system. Constant PV voltage and PV current are required for MPPT control. The 120 HZ harmonic frequency which distorts the PV voltage and PV current are removed by the decoupling capacitor. there are main switches, diodes, transformers, in each phase. The voltage spikes across the main switch is reduced by the clamp circuit. the isolation between the PV module and the grid line is produced by the transformer .it also boosts the voltage. the connection between the AC power produced by the transformer and grid line is employed by the unfolding bridge.

The steady state operating stages are given below.

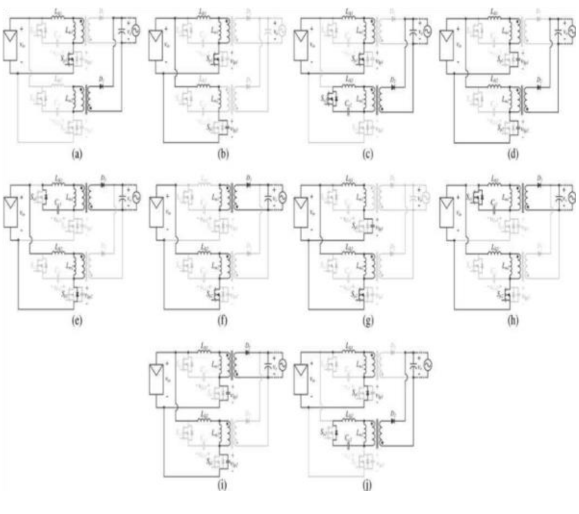

Fig.3. Equivalent circuits in steady-state operation

(a) Mode 1 [t0 –t1]. (b) Mode 2 [t1 –t2]. (c) Mode 3 [t2 –t3]. (d) Mode 4 [t3 –t4]. (e) Mode 5 [t4 –t5]. (f) Mode 6 [t5 –t6]. (g) Mode 7 [t6 –t7]. (h) Mode 8 [t7 –t8]. (i) Mode 9 [t8 –t9]. (j) Mode 10 [t9 –t10].

Due to the simplicity of control the discontinuous mode is considered. The main switches are provided with two gate signals of 180degree phase shift.sp1 and sp2 are the main switches.sa1 sa2 are the active clamp switches. The gate signals of the clamp switches are applied for short time to reduce the conduction loss of the switches. The ILFI activates a single phase converter without the active clamp circuit using the phase control method and the active clamp control method because the output power of the PV module is higher than half of the PV module maximum power and the voltage spike across main switch Sp1 is smaller than the Sp1 voltage rating. Therefore, the second-phase converter loss and clamp circuit loss can be removed. In Fig. 3(b), the ILFI activates a single-phase converter with the active clamp circuit using the phase control method because the output power of the PV module is smaller than half of the PV module maximum power and the voltage spike across the Sp1 is larger than the Sp1 voltage rating. Therefore, the second-phase converter loss can be eliminated. When the output power of the PV module is larger than half of PV module maximum power and the voltage spikes across main switch Sp1 , and Sp2 is larger than the Sp1 ,and Sp2 voltage rating, the ILFI is fully activated as represented.

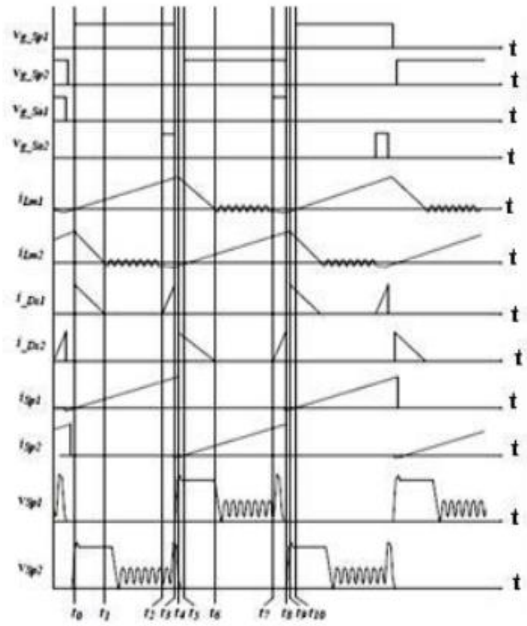

Fig.4. Steady state operation waveform of ILFI

A. ACTIVE CLAMP CONTROL METHOD

Solar irradiance and atmospheric temperature influence the output power of the PV module. based on the irradiance values of the weather conditions the efficiency of the ILFI has to be improved. the active clamp circuit reduces the voltage spikes across the main switch. ILFI is made of two phases. The losses are reduced by controlling each phase of the ILFI the sp1 voltage without the clamp circuit. the sum of input voltage vin through the PV module ,the feedback voltage, spike voltagevsp1 forms the voltage across sp1 when sp1 is turned off.sp1 is failed when the vsp1 is above the switch rating voltage VRT .thus active clamp circuits have been used in fly back inverter for reducing voltage across main switch. The waveform of the main switch when the clamp circuit is used. Clamp capacitor Cc1 absorbs the energy in the Llk1 of the transformer. This reduces the voltage spike across the main switch. Thus a new active clamp control has been used to reduce the conduction loss , switching loss of the clamp circuit.

VI. MAXIMUM POWER POINT TRACKING

MPPT charge controller MPPT charge controller is a maximum power point tracker which is an electronic DC to DC converter which takes the DC input from the solar panels, changes it to high frequency AC and converts it back to a different DC current to match with the batteries.

A. P and O TECHNIQUE FOR MPPT

If the operating current or, in other words, the current drawn from the PV array is perturbed in a given direction and if the power drawn from the PV array increases, the operating point becomes closer to the MPP and, thus, the operating current should be further perturbed in the same direction. If the current is perturbed and this results in a decrease in the power drawn from the PV array, this means that the point of operation is moving away from the MPP and therefore, the perturbation of the operating current should be reversed.

Fig.5. Flow chart of the P&O technique

TABLE1 DESIGN PARAMETER OF ILFI

PARAMETER	VALUE	UNIT
Grid Frequency f_{grid}	50	Hz
Input Capacitance C_{in}	11	mF
DC link Capacitance C_o	136	nF
Leakage Inductance L_{lk1},L_{lk2}	0.21	µH
Transformer Turns Ratio	1:6	-
Magnetizing Inductance L_{m1},L_{m2}	8.28	µH
Filter Capacitance C_f	25	µF
Filter Inductance L_f	3	mH

VII. SIMULATION AND RESULTS

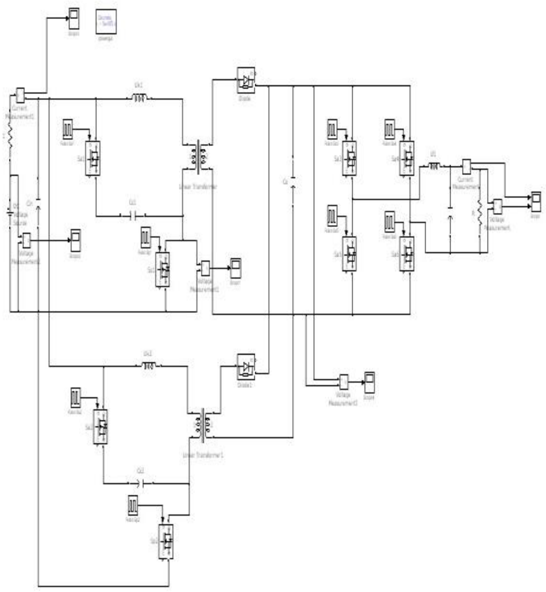

Fig.6. ILFI Simulink model

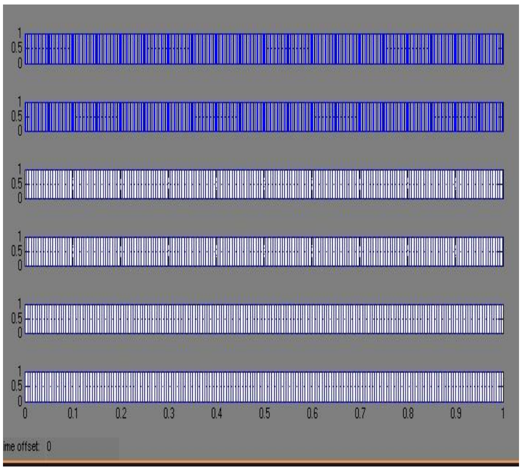

Fig.7. pulse generation

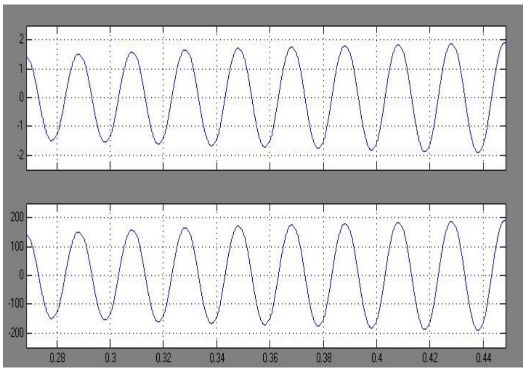

Fig.8. output current and voltage waveform

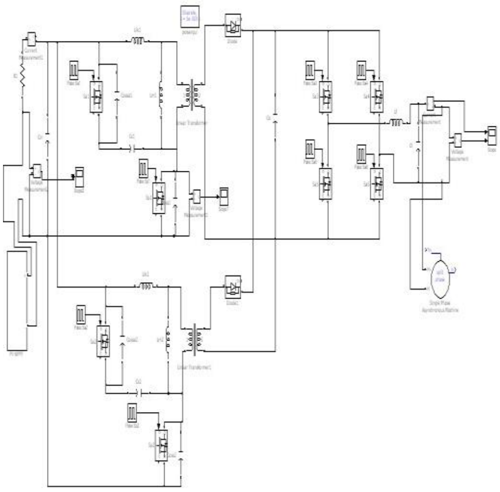

Fig.9. Simulink model with PV

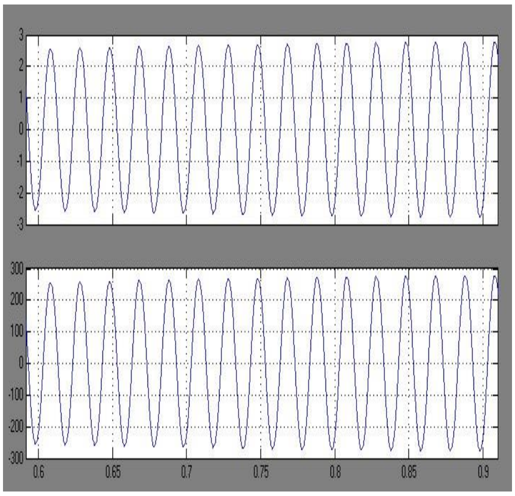

Fig.10. output current and voltage waveform

VIII. CONCLUSION

Thus the interleaved fly back inverter has been simulated using MATLAB. Active clamp control method has been proposed to reduce the switching loss of the interleaved fly back inverter. The proposed inverter is simulated using PV.

IX. FUTURE SCOPE

This paper can be further improved by using other forms of renewable energy sources.

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