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Single- Phase Single -Stage Transformer less Grid Connected PV System

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ABSTRACT: Single- Phase, Single- stage current source inverter based photovoltaic system for grid connection without using transformer is proposed. This system is used for tracking the maximum power point and interfacing the photovoltaic array into the grid. The maximum power point tracking (MPPT) is maintained with the software controller. A proportional resonant controller to control the current injected into the grid. A double tuned parallel resonant circuit is used to attenuate the harmonics at the inverter dc side .CSI has been used to meet the grid requirements without using a high dc voltage or bulky transformer. CSI has become a preferred topology for interfacing PV system to the ac power grid, because of CSI provides a continuous dc side current. The energy stored element of CSI has a longer life time than VSI.MPPT is used to improve the system performance during normal and varying weather conditions.

KEYWORDS: current source inverter(CSI),MPPT, photovoltaic (PV).

I. INTRODUCTION

Due to the environmental issues, renewable energy source is the main thing in researchers. The most important renewable energy is a photovoltaic (PV)system, because of suitable in distributed generation, satellite system and transportation

In distributed generation applications, the PV system operated in grid connected mode is very popular. In this grid connected mode, maximum power is from the PV system to supply into the grid. A two stage grid connected PV system utilizes two conversion stages: a dc/dc converter for

Boosting and conditioning the PV output voltage and tracking the MPP, and dc/ac inverter for interfacing the PV system to the grid. In this method, high-voltage PV array is not required, because of dc voltage boosting stage. This two stage suffers from reduced efficiency, higher cost and larger size.

The conventional voltage source inverter (VSI) is the most commonly used in grid connected PV system. However, the voltage buck properties of the VSI increase the necessity of using bulky transformer or high dc voltage However, the electrolytic capacitor, which presents a critical point of failure. The three phase grid connected CSI, which affect the MPPT, reduce the PV life time and associated with odd order harmonics.Therefore, eliminating the harmonics on the dc side various techniques have been proposed to reduce the harmonics CSI PV applications.

The Nonlinear pulse width modulation (NPWM) has been proposed to improve the harmonics mitigation. The power oscillating effect is mitigated by using carrier signal on pulse width modulation(PAM) These techniques not suited in single stage grid connected system because of dc current oscillation is large, which reduces the system loss and PV life time.

In a single stage connected system, the PV system consists of single conversion unit (dc/ac inverter) to track the maximum power point (MPPT) and interface the PV system to the grid. In this paper CSI has been proposed, because dc input current is continuous and CSI voltage boosting capability allows a low voltage PV array to be grid interface without need of a transformer less or additional boost stage. A double tuned resonant is used to mitigate the harmonics at the dc side. The control structure consists of MPPT, and current loop and voltage loop. The effectiveness and robustness of the proposed system, simulation and practical implementation.

II. METHODOLOGY

A grid connected PV system consists of Single-phase Single-stage CSI is shown in FIG.1. This inverter has four insulated gate bipolar transistors (IGBT) and four diodes. Each diode is connected in series with IGBTs switch for reverse blocking capability. A double tuned parallel resonant filter is series with dc link inductor for smoothing dc link current. A C-L filter is connected in the ac side because it is used for getting the smooth the edges.

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CIRCUIT DIAGRAM

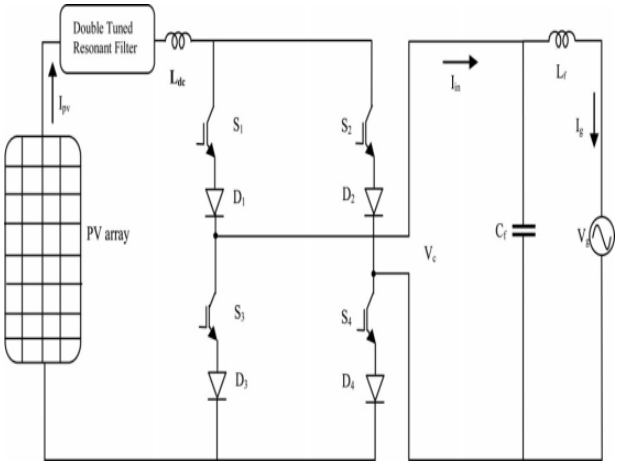
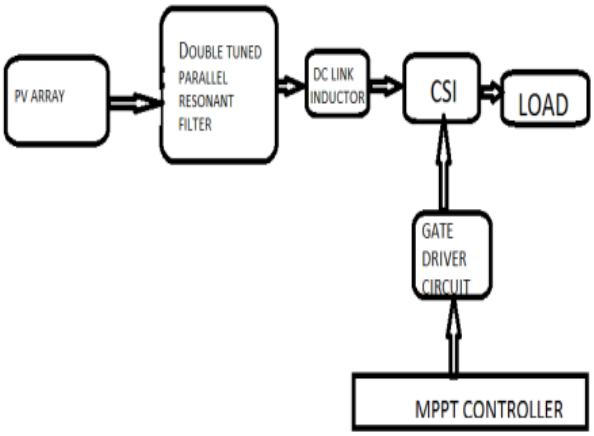


FIG1. Single phase grid connected CSI.

BLOCK DIAGRAM



DESCRIPTION:

Our aim is synchronize the PV array and the grid. The PV array produces the dc voltage depends upon the irradiation and ambient temperature. This dc voltage source shunt with diode. The ripple in dc side current is filtered and controlled by dc side inductor.

GRID CONNECTED PV SYSTEM

In the grid connected PV system, PV array and grid will be synchronized. The grid control technique is a single conversion. That is dc to ac inverter. The methodology of the system is PV array system and output parameters are analyzed by suitable controller and it produces corresponding effective PWM pulses for generation of ac voltages.

CSI BASED PV SYSTEM CONTROLLER

OPERATION OF CONTROLLER

A grid connected CSI based PV system is designed to control the dc and ac side current. The power is fed to the grid is equal to the maximum power from the PV array under normal and varying weather conditions. The phase locked loop (PLL) is used to synchronize the PWM and control of the CSI to the grid voltage also PID controller are used to process the errors between output and input current.

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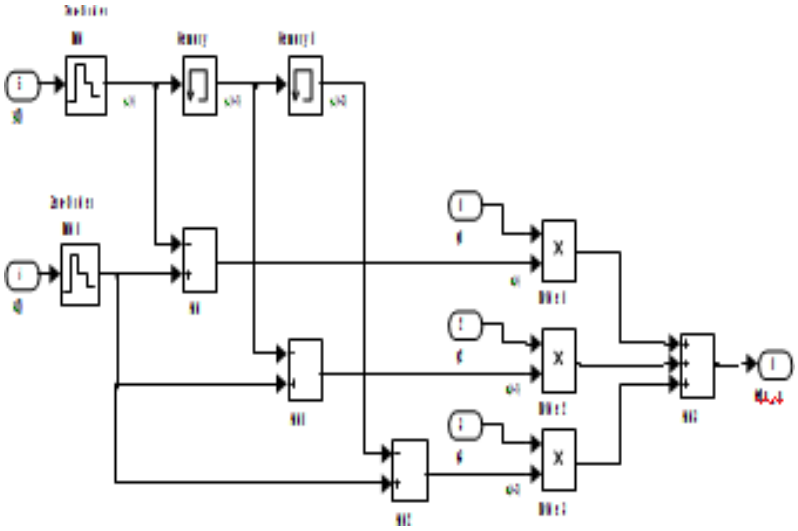
PHASE LOCKED LOOP



In the PID controller using MPPT to track the maximum power from the PV array to supply maximum power into the grid. High quality sinusoidal current is fed to the grid. PLL is used to synchronize the pulse width modulation (PWM) and control of the CSI to the grid voltage. The PID controllers are used to process the error between input and output values

III. MODELING AND ANALYSIS

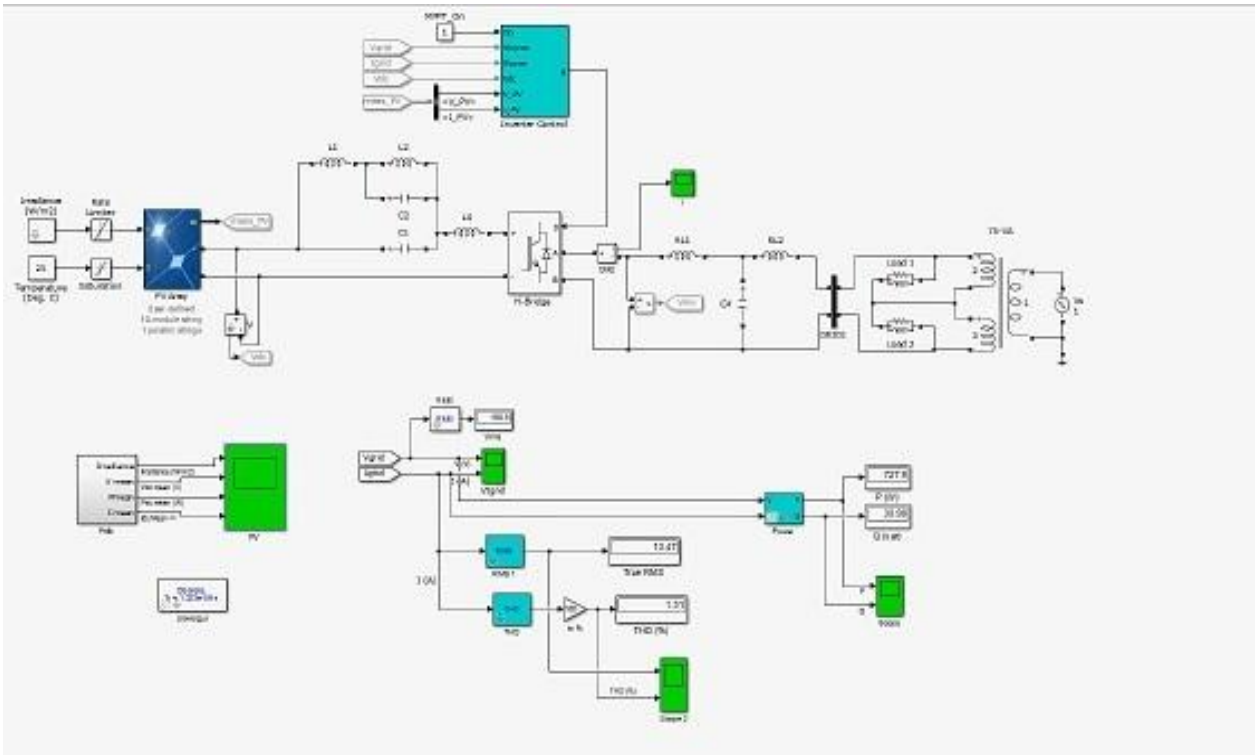


FIG. 3 Simulink model for CSI based Grid connected PV

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PV PANEL DIAGRAM

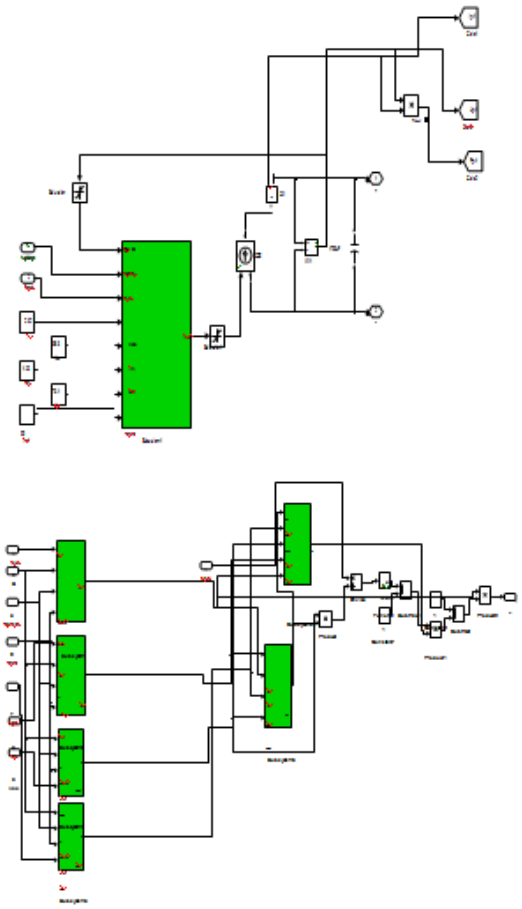

FIG. 4 Simulink model of PV array

In this FIG2.1 shows a Simulink model of Single phase single stage grid connected PV system using CSI without transformer.

FIG 2.shows a PV array is a parallel combination of PV modules. A single PV module consists of number of PV cells in series. Each PV cell is a current source with diode.

But single phase CSI, pulsating power of system frequency generates harmonics in the dc side current These harmonics reflect the ac side in the voltage and current. These harmonics reduce the PV lifetime.

The current source inverter (CSI) has preferred for this topology because of CSI provides continuous dc side current. CSI voltage boosting capability allows a low voltage PV array to be grid interface without need of transformer.

CIRCUIT PARAMETERS

Resonant filter inductor,(L1)=5mH Resonant filter inductor(L2)=10mH
Resonant filter capacitor (C1)=125microfarad Resonant filter capacitor (C2)=250microfarad DC link inductor Ldc= 5mH
AC line inductor= 1 mH
AC line capacitor= 20microfarad

SYSTEM CONTROL TECHNIQUES

To design a grid-connected PV system using a CSI, the relationship between the PV output voltage and the grid voltage is derived as follows.

By neglecting inverter losses, the PV output power is equal to the grid power.

$$V_{PV}I_{PV} = \tfrac{1}{2} * I_{g,peak} * V_{g,peak} \cos\theta \qquad (1)$$

where θ is the phase angle, V_{PV} and I_{PV} are the PV output voltage and current, respectively, while $V_{g,peak}$ and $I_{g,peak}$ are the grid peak voltage and current, respectively. The grid current is equal to the PV

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output current multiplied by the inverter modulation index M .

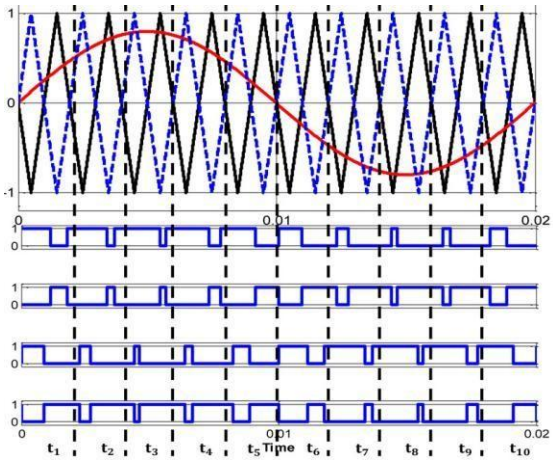
$$I_{g,\,peak} = M * I_{PV} \qquad (2)$$

Substituting (1) into (2), assuming unity power factor, the equation describing the relationship between the PV output voltage and the grid voltage is

$$V_{PV} = 1/2 * M * V_{g,\,peak}$$

Therefore, in order to interface the PV system to the grid using a CSI, the PV voltage should not exceed half the grid peak voltage.

MODIFIED CARRIER BASED PWM



Time(S)

Modified carrier based PWM is proposed to control the switching pattern for the single phase grid connected CSI. To provide a continuous path for the dc side current, at least one top switch in either arm and one bottom switch must be turned on during every switching period. In this fig. 4 shows reference and carrier waveform along with switching patterns. The carrier with solid line. The straight for upper switches while dashed line is lower switches And shifted by 180°. The switching action of each IGBT is equally distributed during every fundamental period.

IV. RESULTS AND DISCUSSION

In order to validate the theoretical analysis, closed loop operation of single phase current source inverter grid connected using photovoltaic system is simulated on MATLAB/Simulink. The simulated closed loop system has taken the circuit parameter values are shown in table III. The system control mainly consists of an Agilent modular solar array block to emulate PV system operation, a phase-locked loop (PLL) block to ensure synchronization between grid current I g and voltage V g respectively. The Double Tuned Resonant Filter to attenuate the harmonics is presented in dc side of CSI. Modified Carrier based PWM block is presented with a 4-kHz switching frequency to provide a sufficient short circuit current after every switching action and to track the maximum power point and also to interface the PV system to the grid.

The singe phase transformer-less grid connected using PV system is simulated in MATLAB/Simulink software.

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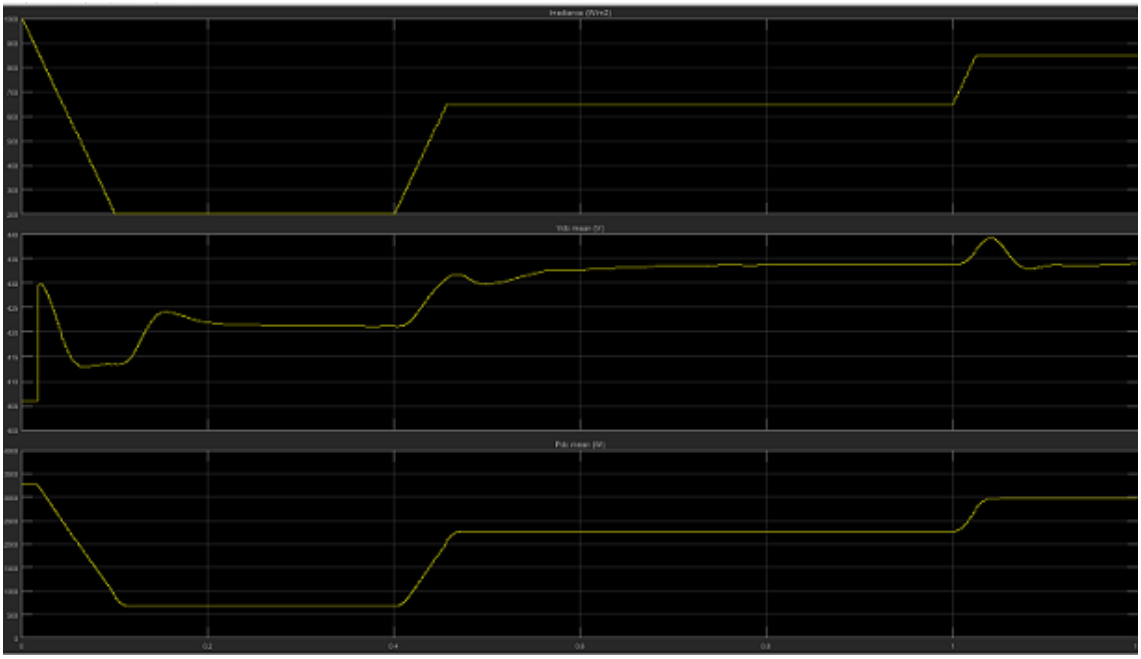
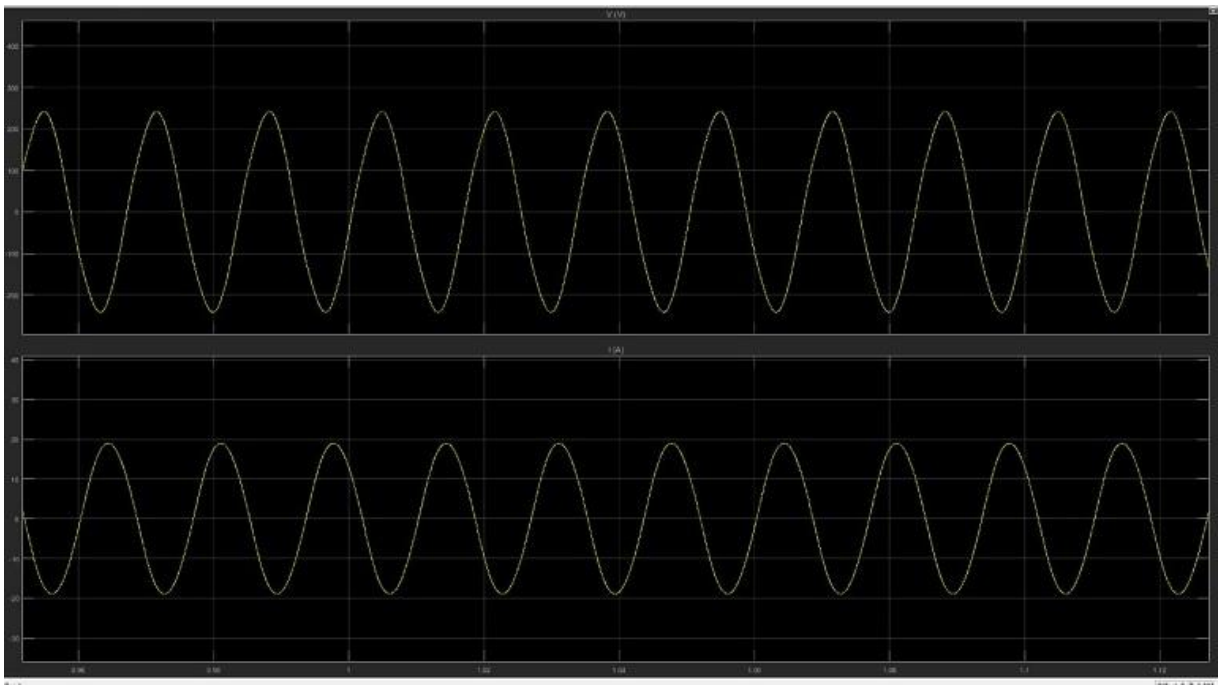


PV output waveform



Output waveforms (a) CSI output current waveform and
(b) grid voltage and grid current waveform

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TABLE DESIGN SPECIFICATION AND CIRCUIT PARAMETERS

ITEM			VALUE
PV OPEN CIRCUIT VOLTAGE	V_{OC}	(V)	80
PV SHORT CIRCUIT CURRENT	I_{SC}	(A)	15
PV ARRAY RATED POWER	P_R	(W)	500
RESONANT FILTER INDUCTOR	L1	(mH)	10
RESONANT FILTER INDUCTOR	L2	(mH)	5
RESONANT FILTER CAPACITOR	C1	(µF)	125
RESONANT FILTER CAPACITOR	C2	(µF)	250
DC LINK INDUCTOR	L_{dc}	(mH)	5
SWITCHING FREQUENCY	F_S	(kHz)	4
AC LINE INDUCTOR	L	(mH)	1
AC LINE CAPACITOR	C	(mF)	400
GRID VOLTAGE	Vgrms	(V)	110

V. CONCLUSION

A single stage single phases grid connected PV system using CSI has been meet the grid requirements without using high dc voltage or a bulky transformer. The control structure consists of MPPT to improve the system performance during normal and varying weather conditions. A single stage system, PV power is delivered to the grid with high efficiency, low cost. A modified carrier based modulation technique to provide short circuit path on the dc side. A double tuned resonant filter to proposed to suppress the harmonics with small inductance.

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