A Buck and Boost Based Grid Connected PV Single Phase Inverter Using Proportional Integral

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Abstract: *A single-phase grid connected transformer less photo voltaic (PV) inverter which can operate either in buck or in boost mode, and can extract maximum power simultaneously from two serially connected sub arrays while each of the sub array is facing different environmental conditions, is presented in this paper. As the inverter can operate in buck as well as in boost mode depending on the requirement, the constraint on the minimum number of serially connected solar PV modules that is required to form a sub-array is greatly reduced. As a result, power yield from each of the sub array increases when they are exposed to different environmental conditions. In this paper PI-controlled buck –boost dc to dc converter for multi PVA system are developed the complete control system has been developed.*

Keywords: PV Array, MPPT, Buck-Boost Converter, phase lock loop, Three Phase inverter, PI controller, MATLAB.

Introduction

Power electronics application broadly includes converters', inverters, choppers etc. The AC to DC converter (rectifier) is one of the most popular power electronics devices which are an efficient and convenient source of DC power. A great portion of electrical and electronic devices currently in use is designed to operate using direct current (DC) power while, for reasons of distribution efficiency, most power is ultimately delivered to such devices as alternating current (AC) power. Therefore, the AC-DC front-end converter is needed to converter the AC power to the DC power in many electrical and electronic devices. Two-stage approach is widely used in the AC-DC front-end converters for high power application. Because of its continuous input current and simplicity, Continuous Conduction Mode (CCM) boost topology is the most popular for the power factor correction (PFC) stage. The major concern of a photo voltaic (PV) system is to ensure optimum performance of individual PV modules in a PV array while the modules are exposed to different environmental conditions arising due to difference in insolation level and/or difference in operating temperature. The presence of mismatch in operating condition of modules significantly reduces the power output from the PV array [1]. The problem with the mismatched environmental conditions (MEC) becomes significant if the number of modules connected in series in a PV array is large. In order to achieve desired magnitude for the input dc link voltage of the inverter of a grid connected transformer less PV system, the requirement of series connected modules becomes high. Therefore, the power output from a grid connected transformer less (GCT) PV system such as single phase GCT (SPGCT) inverter-based systems derived from H-bridge and neutral point clamp (NPC) inverter-based systems [4], get affected significantly during MEC. In order to address the problem arising out of MEC in a PV system, various solutions are reported in the literature. An exhaustive investigation of such techniques has been presented in . Power extraction during MEC can be increased by choosing proper interconnection between PV modules [6], or by tracking global maximum power point (MPP) of PV array by employing complex MPP tracking (MPPT) algorithm . However, these techniques are not effective for low power SPGCT PV system. Similarly, reconfiguration of the PV modules in a PV array by changing the electrical connection of PV modules is not effective for SPGCT PV system due to the considerable increment in component count and escalation in operating complexity. In order to extract maximum power from each PV module during MEC, attempts have been made to control each PV module in a PV array either by having a power electronic equalizer or by interfacing a dc to dc converter Schemes utilizing power electronic equalizer require large component count thereby increasing the cost and operation complexity of the system. The scheme presented in uses generation control circuit (GCC) to operate each PV module at their respective MPP wherein the difference in power between each module is only processed through the GCC. Scheme presented in uses shunt current compensation of each module as well as series voltage compensation of each PV string in a PV array to enhance power yield during MEC. The schemes based on module integrated converter use dedicated dc to dc converter integrated with each PV module. However, the efficiency of the aforesaid schemes are low due to the involvement of large number of converter stages, and further in these schemes the component count is high and hence they face similar limitations as that of power electronic equalizer-based scheme. Instead of ensuring MPP operation of each and every module, certain number of modules are connected in series to form a string and the so formed strings are then made to operate under MPP in. Even then there is not much reduction in overall component count and control complexity in order to simplify the control configuration and to reduce the component count, schemes reported in combine all the PV modules into two sub arrays, and then each of the sub array is made to operate at their respective MPP. However, the reported overall efficiency of both the schemes is poor.

II. Proposed Work

2.1 DUAL BUCK-BOOST INVERTER AND ITS OPERATION

The schematic of the proposed Dual Buck & Boost based Inverter (DBBI) which is depicted in Fig.3.1 V is comprising of a dc to dc converter stage followed by an inverting stage. The dc to dc converter stage has two dc to dc converter segments, CONV1 and CONV2 to service the two sub-arrays, PV1 and PV2 of the solar PV array. The segment, CONV1 is consisting of the self-commutated switches, S1 along with its anti-parallel body diode, D1, S3 along with its anti-parallel body diode, D3, the freewheeling diodes, Df1, Df3 and the filter inductors and capacitors, L1, Cf1, and Co1. Similarly, the segment, CONV2 is consisting of the self-commutated switches, S2 along with its anti-parallel body diode, D2, S4 along with its anti-parallel body diode, D4, the freewheeling diodes, Df2, Df4 and the filter inductors and capacitors, L2, Cf2, and Co2. The inverting stage is consisting of the self-commutated switches, S5, S6, S7, S8, and their corresponding body diodes, D5, D6, D7 and D8 respectively. The inverter stage is interfaced with the grid through the filter inductor, Lg. The PV array to the ground parasitic capacitance is modeled by the two capacitors, Cpv1 and Cpv2.

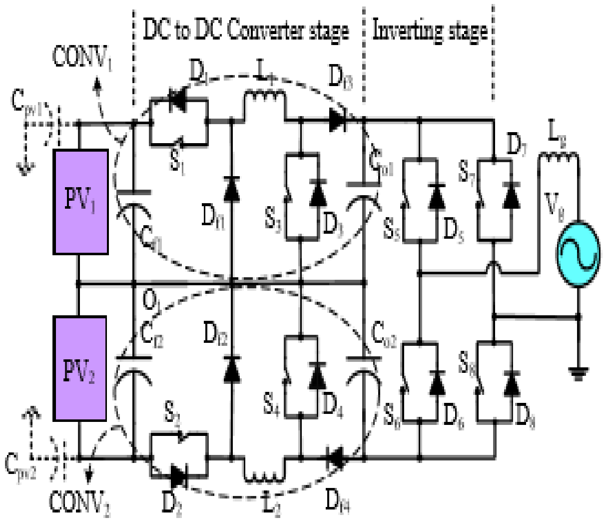

Fig 2.1: Dual Buck & Boost based Inverter (DBBI)

2.2 PROPORTIONAL-INTEGRAL CONTROL SYSTEM

Proportional-integral-derivative controllers find wide application in industrial control systems due to the reduced number of parameters to be tuned. They also provide control signals that are proportional to the error between the reference signal and the actual output i.e. proportional action, to the integral of the error i.e. integral action and to the derivative of the error i.e. derivative action. The consequent equation is given as:

$$u(t) = K_p e(t) + K_i \int_0^t e(t)dt + K_d \frac{d}{dt} e(t) \quad (2.1)$$

III. Simulation Result and Discussion

The complete design related to the project is created in MATLAB& Simulation using Sim Power System Toolbox and thereby analysis the different solar radiation.

3.1 Two PVA Buck boost converter single phase grid connected inverter with PI controller.

3.1 SIMULATION PARAMETER

PARAMETERS	VALUES
Irradiation	1000 W/m²
Temperature constant	35° C
Inductance L1 and L2	0.6 mH
Capacitance Co1 and Co2	0.5mH
Ac voltage source	220V
Frequency	50HZ
PWM switching frequency	1000
Duty cycle	0.5
MPPT algorithm	Incremental conductance
PI controller	10 and 0.05

Table 3.1: When Two PVA Buck boost converter single phase grid connected inverter.

The proposed inverter a PV array consisting of two PV subarrays while each of the subarray having four series connected modules considered. The MPPT parameters of each are as follows: Vpv1 = Vpv2 = 107 V, Ipv1 = Ipv2 = 10 A and Ppv1 = Ppv2 = 1070 W. The parameters which are used to simulate the proposed inverter are indicated in Table I. MatlabSimulink platform is utilized to simulate the performance of the proposed inverter.

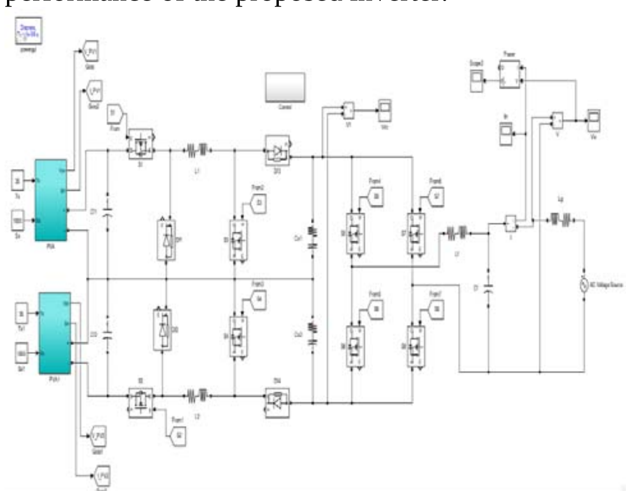

Fig 3.1: Two PVA Buck-Boost converter single phase grid.

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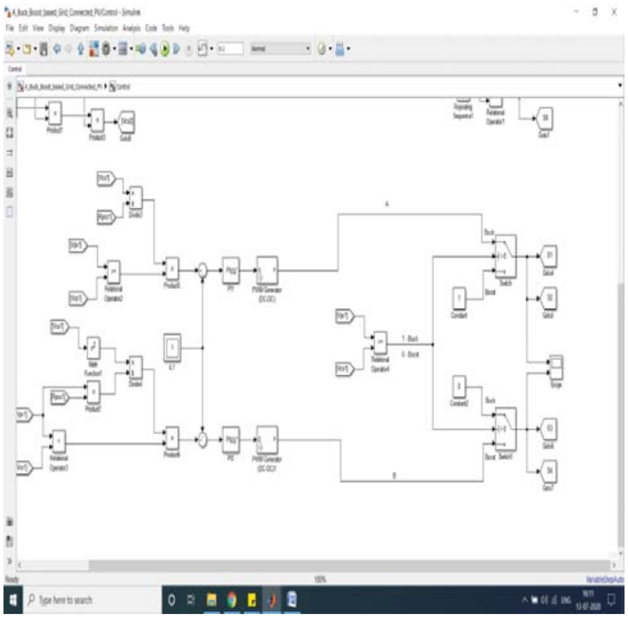

Fig 3.2: DC voltage control with PI controller.

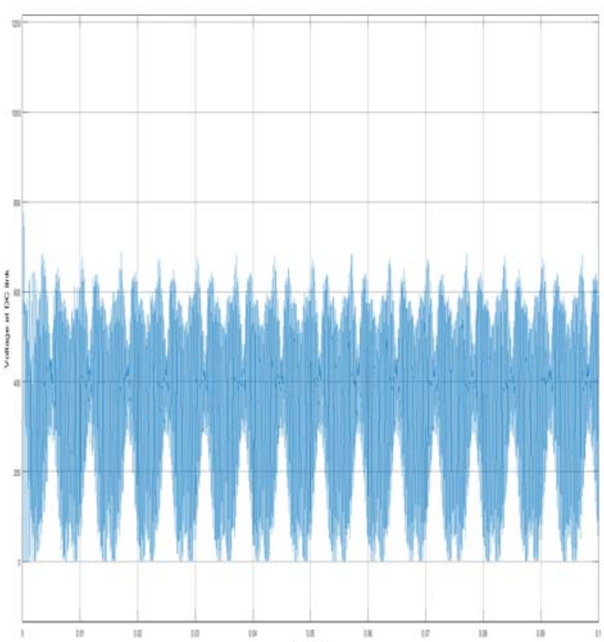

Fig 3.3: DC voltage output of buck boost converter.

3.2 Behavior of different solar irradiation of pv system When considering a PV1 solar irradiation is a 500 and another pv2 solar irradiation is a1000. The output is shown in figure.

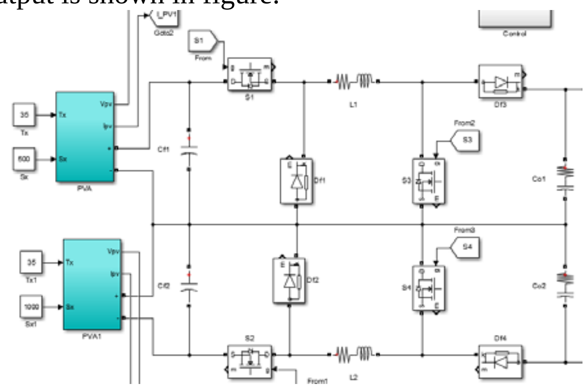

Fig 3.4: Proposed circuit with different solar irradiations on PVA due to shading.

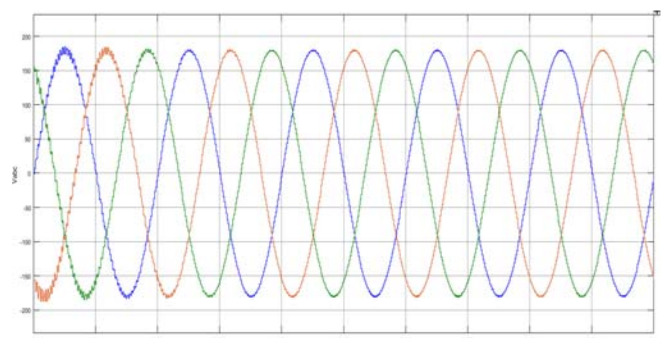

Fig 3.5: Inverter output voltage.

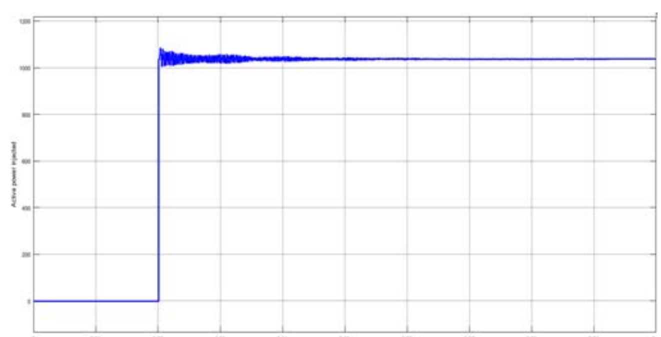

Fig 3.6: Active power injected from PVA to grid during shading effect.

IV. Conclusion

A single-phase grid connected transformer less buck and boost based PV inverter which can operate two sub arrays at their respective MPPT was proposed in my paper. Here two pv sub array are two different located so that output should be maintain in the power injection from single phase inverter is stable Single-phase power is 2kW. With the use of PI controller, the DC link voltage is stable and has reduced ripple. The voltage amplitude is maintained at 400V for the PI controller.

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