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Three phase single stage inverter for Photo voltaic application Connected to a Grid

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ABSTRACT

The objective of this paper is to elucidate a single stage resonant topology for conversion of low solar PV dc voltage to high ac voltage in an islanded micro grid. In this paper, the boost- inverter architecture that achieves both boosting and inversion functions in a single-stage with pure sinusoidal output voltage is described. The working of the proposed boost inverter is shown with one leg operation corresponding to a single phase along with the state space analysis in on and off state conditions. The central idea is to show the benefits of Boost Inverter as a reliable power modulator over the conventional conjugated usage of a boost converter and a 3 phase Voltage Source Inverter. From the simulation outcomes, the functional viability of the model is determined and evaluated.

Key Words- Solar PV,

INTRODUCTION

With the advancement of science and introduction of new technology the only thing we are depending upon directly or indirectly is electricity. The use of solar energy has steadily grown over the last couple of decades. It is renewable and clean resources for electricity. Solar cell solar panel convert the light energy into electrical energy, but the electricity generated is called direct current electricity, which is not the type of electricity that powers most homes. A solar inverter, or PV inverter, converts the directcurrent (DC) output of photovoltaic solar panel into a utility frequency alternating current (AC).In order for the consumer to achieve maximum profit from their solar array, the array must produce as much usable power as possible. For the solar array to produce as much usable power as possible two main goals must be met. The first goal is that the solar array must produce its maximum power at all times. While the second goal is that the power must be in the required form (60 Hz, 120 Vrms when grid connected). However, in order to achieve the second goal and not have an adverse effect on the first, power electronics will be utilized. In order to create as much power for a solar array as possible MPPT (maximum power point tracking) will be used. Also, increasing the efficiency of the overall inverter system that is converting the input power into the required output form will further increase the consumer's profit margin. That is a reason for the single stage approach. Thus, in this paper, a single-stage resonant topology for conversion of low dc voltage to high ac voltage i.e. a 3-phase Boost Inverter is proposed where the operational strategy is of ultra-low switching frequency.

THEORY
SINGLE STAGE TOPOLOGY

In order for the consumer to achieve maximum profit from their solar array, the array must produce as much usable power as possible. For the solar array to produce as much usable power as possible two main goals must be met. The first goal is that the solar array must produce its maximum power at all times. While the second goal is that the power must be in the required form (60 Hz, 120 Vrms when grid connected). However, in order to achieve the second goal and not have an adverse effect on the first, power electronics will be utilized. In order to create as much power for a solar array as possible MPPT (maximum power point tracking) will be used. Also, increasing the efficiency of the overall inverter system that is converting the input power into the required output form will further increase the consumer’s profit margin. That is a reason for the single stage approach. The single stage approachwill be able to achieve higher efficiency due to the lower overall seen switching frequency. With the one stage approach, one converter is switching at the high switching frequency while the second stageis only switching at twice line frequency or 120 Hz. The reason for this is because the high switchingfrequency stage or the first stage will take the constant DC input voltage and create a rectified sine wave output through isolation for safety. While the line switching or Unfolding Stage will then take the rectified sine wave and unfold it into a sine wave thus the name Unfolding Stage. While this approach does not save on component count it will increase efficiency due to the lower overall switching frequency of the system as stated above. From this increase in efficiency there will be lowerlosses and thus a smaller heatsink requirement. This smaller heatsink requirement yields a smaller converter which in turn yields a high power density, while reducing the weight and cost of the converter.

COMPONENT SELECTION

INDUCTANCE

The first step in creating the inverter stage is choosing the correct components. Lf is used to filter the output current to decrease the total harmonic distortion (THD) and as a result to increase the power factor.

CAPACITANCE

There are two main capacitors that need to be selected/sized appropriately for proper operation of any Switch Mode Power Supply (SMPS). These two capacitors are Cf or the output capacitor, which will filter the output voltage, and Cpv or the input filter that is used to help regulate a constant DC bus voltage.

ADVANTAGES

1) Proposed converter extracts solar power with a greater efficiency.

2) It works based on buck boost principle and can be used whether ac output voltage be greater orlesser that of input PV voltage.

3) Circuit has lesser components making it more compact and with reduced size and cost.

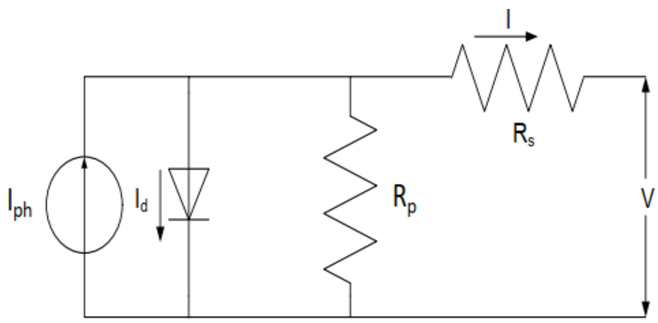
4) Reduction in the number of intermediate conversions, etc

MODEL EXPLANATION

PV array has several modules connected in series parallel combinations. The model of interest comprises of a PV array, a 3-phaseboost inverter that takes in dc voltage as input, boosts and inverts itto 3 phase ac. A simple Perturb and Observe MPPT algorithm has been chosen to track the maximum power point (MPP). The tracker raises or reduces the voltage at the Maximum Power Point (MPP) byrepeatedly regulating the duty cycle.

SOLAR PV MODULE -MATHEMATICAL ANALYSIS

Solar cell One-diode model



I ph = photon generated current

The following equation describes the mathematical

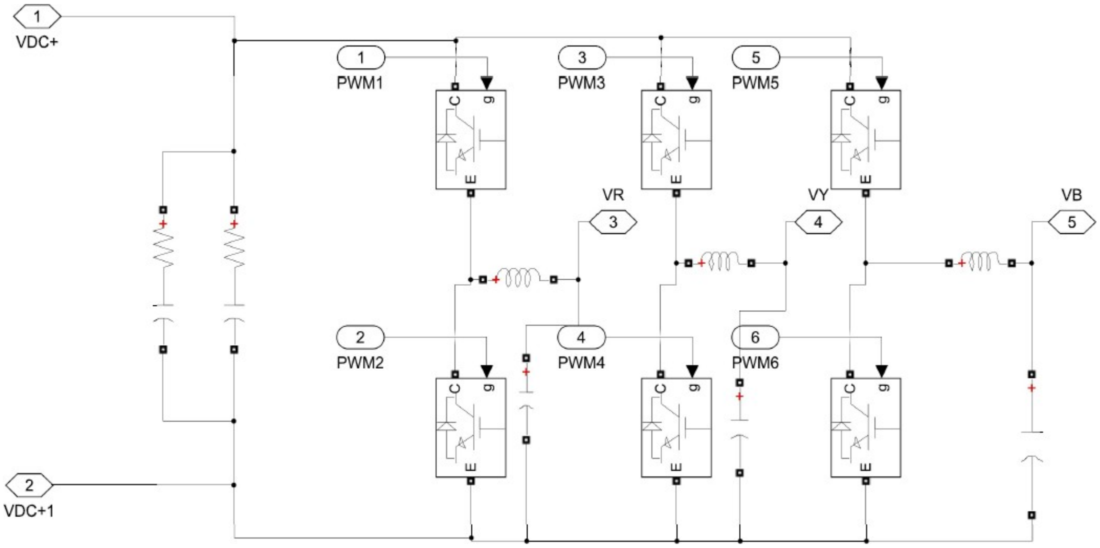
$$\boxed{I=N_{ph}I_{ph} - N_pI_p \left(e^{(qv_{pv}/kTAN_s)} -1\right)}$$

Ns* and *Np are the number of series and parallel cells respectively as used in the PV module to obtain the desired output.

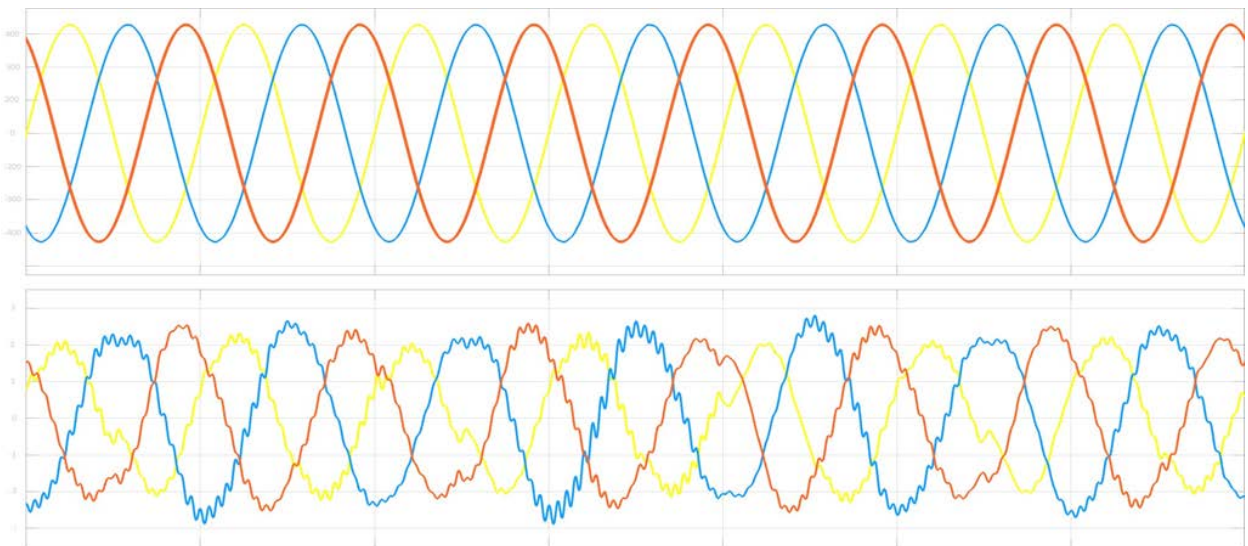
Rs* and *Rp are the intrinsic series and parallel resistances associated with the panel

Below lists the specifications of the PV module used in the simulation

$$\boxed{P=VI=N_{ph}I_{ph}\ [(qV\ /\ KTAN_s\ )-1]}$$



RESULT ANALYSIS



CONCLUSION

The model has a successful results having good results, the model serves it's purpose inverting the DC voltage coming from the panel. The operation of MPPT is as expected. The operation of the Control Units is as expected. The incoming current to the grid surely has much harmonics then expected, the calibration of the inverter has been done many times as to check the optimum results. The following results is the best that the model could offer. The model is also having much less operating power. as we creating this model to remove the transformer it can be used in much less power requiring units, like domestic purpose where the power rating is of order 1KW- 5KW. Above this power rating it is wise to use a single stage bridge type inverter as there will be less harmonics. The single staging also creates safety issues as the presence of transformer adds a safety net for the panel in case of cease of operation or fault. The single staging is also not advisable in high power requirement of order 100KW and more. This model is quite efficient and cost friendly for domestic purpose

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