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High Proficiency Grid ConnectedPhotovoltaic Power Generation System

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Abstract:Solar energy hasbecomepopular nowadays and desire for clean energy. Since the solar radiation on no occasion remains constant,it keeps on insecure throughout the day. The need of the hour is to distribute a constant voltage to the grid irrespective of the deviation in temperatures and solar insolation. The inverter is designed from a boost converter along with a line frequency. The voltage from the boost converter is fedto the grid through inverter. In this proposed method high efficiency can be achievedby using only one switch functioning at high frequency at a time. The converter uses IGBT and ultra-fast reverse recovery diode. The simulation and experiment results are verified using MATLAB/Simulink software.
Index terms*:*PV cells, Renewable Energy, DC–DCConverters, Inverters

I. INTRODUCTION

Now a day's Photovoltaic power gaining more attention in supplying power to grid. Number of inverter and control schemes is used in photovoltaic applications.Single phase utility inverters are used for residential PV power generation systems. This type of residential application requires a power level lower than 5 kWand a high input voltage stack that provides a dc voltage about 400V [2]. Based on the PV panel characteristics and due to irradiation conditions, temperature variations and clouding effects the output DC voltage varies. Therefore, residential PV inverter input voltage can vary widely. For example, from 300 to 500V, and can be quite different from the desirable 400-V level. Thus, step up function, step down function or even both step up and step down function with DC-DC converter is needed before an inverter stage. Such a dc–dc converter in conjunction with a dc–ac inverter arrangement has been widely used in thePV. This PV based power is widely used in grid connected system [7]-[8]. PV offers more advantages like freely available source, pollution free and most abundant source.Figure. 1 shows the block diagram of the PV PCS. This method consists of two stage power conversion with high frequency in cascaded configuration. It also consists of DC link in the middle.

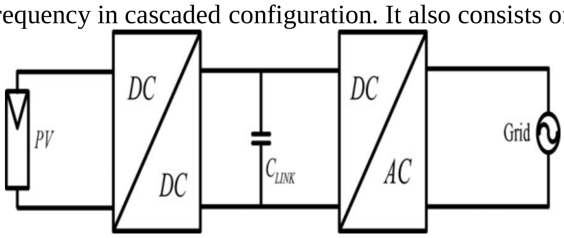

Figure 1: Conventional two-stage PV

In this arrangement, the dc-bus voltage from the PV arrayshould be boosted, and the voltage-source-type high-frequency inverter can be a dc–ac stage. Aline commutated inverter along with isolated dc-dc stage can also be used [1].

II. PROPOSED HIGH EFFICIENCY BOOST CONVERTER BASED PV INVERTER

Photovoltaic (PV) is a method that uses semiconductors to generate electric power by solar radiation, that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Materials presently used for photovoltaic include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenide/sulphide [4]-[6]. Due to the increased demand for renewable energy sources, the manufacturing of solar cells and photovoltaic arrays has advanced considerably in recent years.

In this chapter, the state-of-the-art single stage PV inverters are reviewed firstly. For these single stage PV inverters either a transformer is used for boosting the input voltage or the input voltage will be required to be higher than the peak of the grid voltage which is not good for PV application because the PV panel's characteristics changes all the time. The energy storage needs to be at the front of a single stage inverter, and it is usually implemented by electrolytic capacitors [3]. The lifetime issue of an electrolytic capacitor is introduced. And the conclusion can be drawn that although the electrolytic capacitors have limited lifetime, it can still be used by applying smaller voltage and current ripple to prolong its lifetime. Because the end of its life doesn't mean it failed, the electrolytic capacitor can work much longer than its estimated lifetime. As the capacitance also has an impact on MPPT efficiency, the larger capacitance leads to higher MPPT efficiency. After that, a boost-buck converter based inverter is proposed. It operates in either boost or buck mode; thus, it has a wide input voltage range or high efficiency can be achieved. Then, the analysis of its middle capacitor and CCM/DCM operation condition is presented. Since the common-mode voltage in this inverter is equal to the grid voltage, it changes at line frequency. Thus, the leakage current of it is very small even at an extreme case.

III. PROPOSED MODULAR DC–DC CONVERTER

To take advantage of the modular fuel cell stack, an appropriate dc–dc converter and control scheme are required. The converter should have as many independently controllable inputs as there are sections in the stack. In addition, since thepositive terminal of one section in the stack also serves as the negative terminal for the next section, the converter should provide isolation between its input and output to avoid circulating currents.

A converter meeting these specifications can be constructed by using an arrangement of isolated dc–dc converter modules, where the inputs of each module are connected across each of the sections of the stack and their outputs are connected in series in order to add the output voltages of the differentmodules, thus obtaining a higher output voltage.

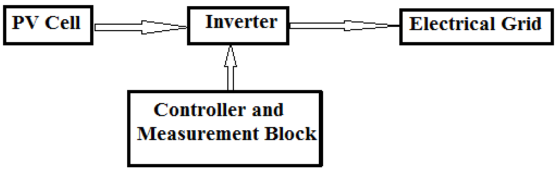

Figure 2: Proposed block diagram

Such a modular dc–dc converter is shown in Figure 2, where the converter is composed of three push–pull modules. To implement this function, each of the modules used to construct the dc–dc converter should be able to stop extracting power from the section they are connected to and set its output impedance to zero.

This function can be accomplished by removing the gating signals to the transistors. In addition, it is necessary to add a switch at the output of each module to short-circuit the output capacitor of the module and bypass it.

IV. SIMULATION RESULTS

The proposed system consists of a modular fuel cell, control system and measurement block. In a modular cell DC is converted to ac signal. Then the converted signal is given to the electric grid. Simulation model is shown in figure 3.

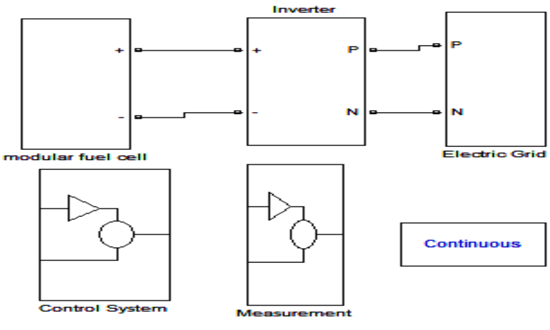

Figure 3:Simulink model for proposed system

In the figure 7, the nominal DC input voltage is given. Rated value for load R and c is selected. In figure 9 sub block of inverter is shown. It consists of Boost converter block.

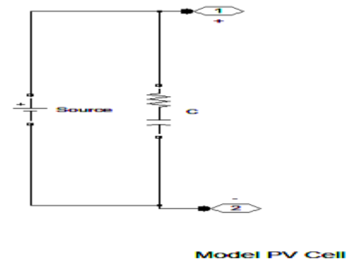

Figure 4: Simulink model for Photo Voltaic

This converter converts the signal from AC to Dc signal. The sub block system is available for boost converter. MOSFET is used as a switch in a Boost converter. Gate signal is given to the switch through closed loop.

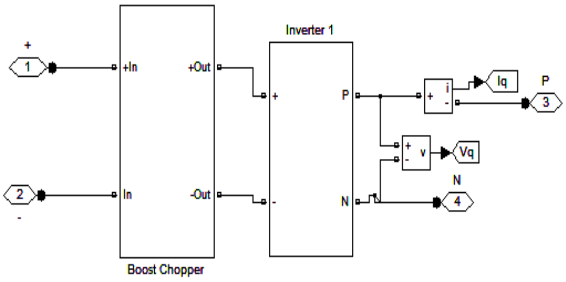

Figure 5: Simulink model Boost chopper with inverter

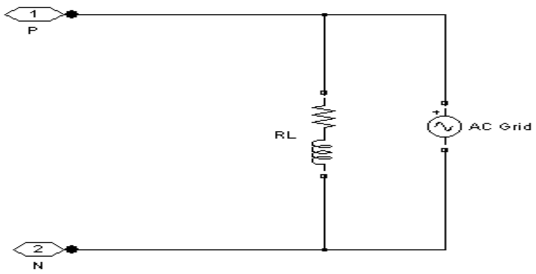

Figure 6: Simulink model of Electrical grid

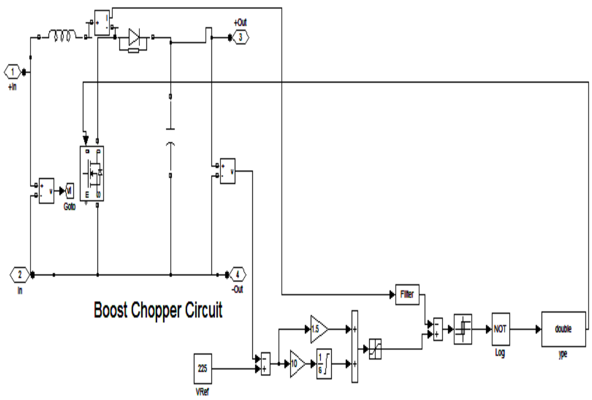

Figure 7: Simulink model of Boost converter model

The Electrical grid model is shown in the figure 6 [9]-[10]. The Boost converter controller model is shown in the figure 7. PI controller is used to extract the boost converter model. The boost converter with proposed controller gives faster response to meet the desired output.

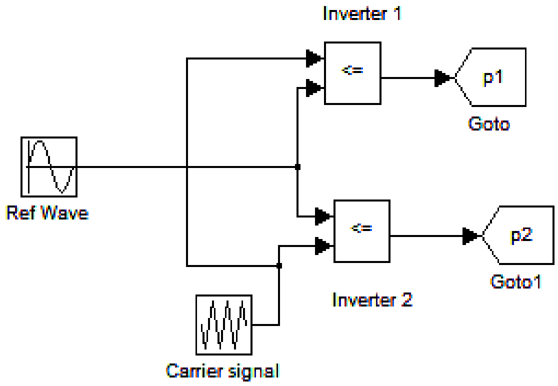

Figure 8:Simulink model for control circuit

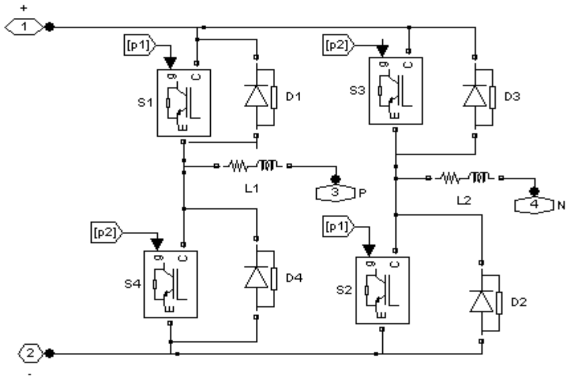

Figure 9: Simulink model of Inverter

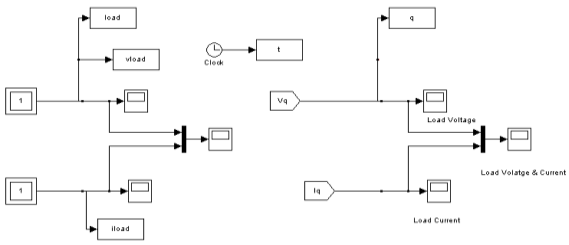

Figure 10: Simulink model for measurement Block System

V. EXPERIMENTAL RESULTS

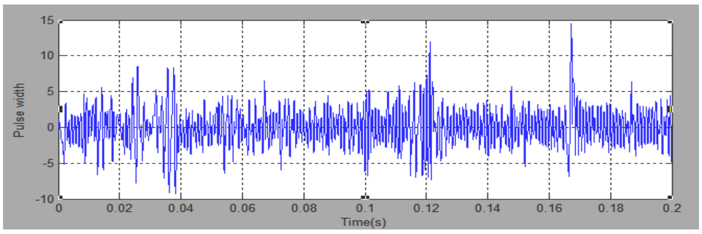

Figure 11:Pulse Width Modulation Waveform

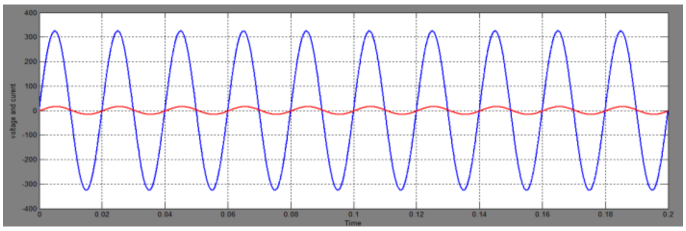

Figure 12:Input voltage and current waveform

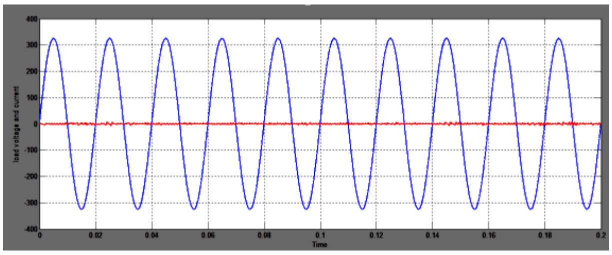
Figure 13:Load voltage and current waveform

VI. Conclusion

In this paper, a PV cell and dc–dc converter concept with inverter has been presented. Due to time constraints, MPPT algorithm is not used in boost converter.The proposed system has been shown to be fault tolerant and can continue to operate at a reduced power level under power module faults. The proposed system is capable of producing 10% additional power when compared to the traditional approach. In addition, experimental results also confirm the operation of the system under stackfailure.

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BIOGRAPHY

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