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High Step-Up DC-DC Converter Soft Computing Module for PV Module

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Abstract: *The PV module demonstrates a significant market expansion as a photovoltaic (PV) power generation technology. The requirement of a high voltage gain converter exists for connecting PV modules to the power grid through a dc–ac inverter. A converter with floating active switches should be studied because it will protect PV panel users and installers by blocking power during ac module shut offs. The converter obtains high voltage gain through effective operation without requiring excess duty ratios or many turns-ratios like linked inductors; it reuses the coupled inductor leakage energy for improved efficiency. These features contribute to the module achieving remarkable efficiency performance. The paper presents analytical results for steady state operation of continuous and discontinuous and boundary conduction modes as well as a detailed description of working principles. The developed prototype circuit of the suggested converter functions with 15V input voltage, 200V output voltage, and 100W output power. The element achieves 95% efficiency under full load while reaching its highest efficiency of 95.3%.*

Keywords: *Soft computing, Simulink, PV module, electrical risks, and DC-DC converter*

I. Introduction

In distribution generation systems, photovoltaic (PV) power-producing technologies are growing in significance and prevalence. A traditional centralized PV array uses a dc–ac inverter to increase the dc-link voltage for the main electricity by connecting many panels in series. When only a small number of modules are partially shaded, the intrinsic current production is reduced and the array's generation current is prevented from reaching its maximum value, which can occasionally result in a notable reduction in the overall power produced by the PV array.

A module-based approach using ac constitutes an expected remedy to this difficulty. A low-power dc–ac utility interactive inverter functions individually on each PV module to boost maximum power output by each module independently. The maximum power point (MPP) voltage range extends from 15 to 40 volts while acting as input voltage for the ac module. Lower input voltages make it difficult for the ac module to reach maximum efficiency. The electricity output capability of an individual PV panel typically stays between 100 watts and 300 watts. The power-conversion efficiency increases when a high step-up dc–dc converter operates before the inverter. The micro inverter contains a dc–dc boost converter according to Figure 1.

The dc–dc converter requires substantial conversion steps to elevate the panel voltage to match the application requirements. To supply the dc bus with suitable voltage levels the 48 V DC needs conversion through the dc-input converter system to 380–400 V ranges. These high step-up dc–dc converters used for these applications demonstrate four key characteristics: they provide large voltage increases and these characteristics include high gain in step-up voltage. High step-up gain reaches approximately ten times to achieve this application purpose. Isolation is not necessary. Figure 1 shows that solar energy reaches the output terminal through PV panel and mini-inverter when switches are turned off. The possible variation may involve operational dangers to the facilities and workers during the ac module installation procedure. At both stages where operation is off or throughout off-grid situations a floating active switch serves to eliminate the DC current from reaching the PV panel. This isolation ensures protected operations of internal components since it blocks hazardous domestic energy from reaching input or output terminals.

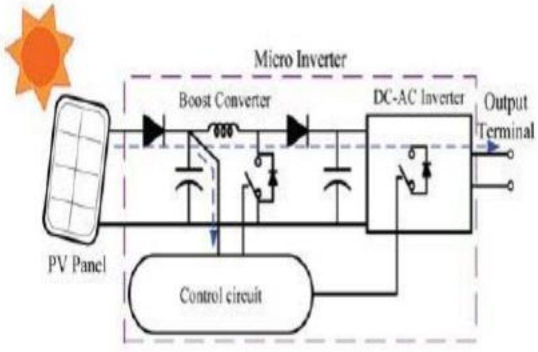

Fig 1: Block diagram of the system

II. DC-DC Converters

Figure 1 shows that solar energy reaches the output terminal through PV panel and mini-inverter when switches are turned off. The possible variation may involve operational dangers to the facilities and workers during the ac module installation procedure. At both stages where operation is off or throughout off-grid situations a floating active switch serves to eliminate the DC current from reaching the PV panel. This isolation ensures protected operations of internal components since it blocks hazardous domestic energy from reaching input or output terminals.

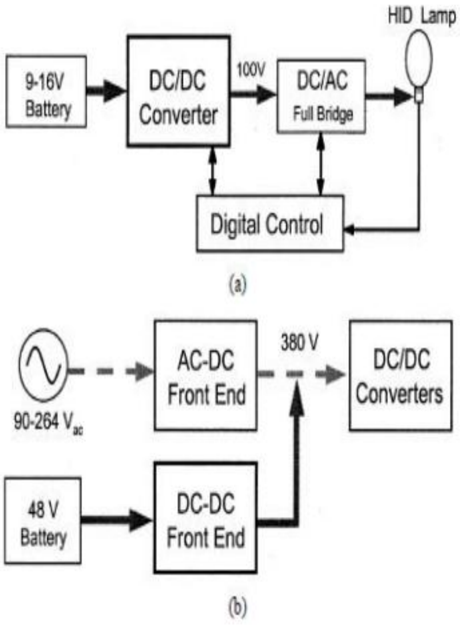

Fig 2: Applications of the dc-dc converter a) HID lamp ballast b) dual-input front –end converters

III. Converter to Reach High Performance

The proposed converter contains linked inductor T_1 as well as floating active switch S_1 based on Figure 3. The primary winding N_1 of linked inductor T_1 functions identically to boost converter standard input inductors to deliver leakage inductor energy to capacitor C_1 and diode D_1. The boost voltage becomes higher when the secondary winding N_2 from linked inductor T_1 connects to the pair of capacitors C_2 together with diode D_2 which link to N_1. C3 functions as the output capacitor that joins with the rectifier diode D3. The converter implements three critical features including enhanced voltage conversion ratio from linking two pairs of components and efficient recycling of leakage inductor energy as well as 3) an isolated active switch function. The process of obtaining maximum power from PV panels becomes straightforward when people understand panel attributes prior to connection.

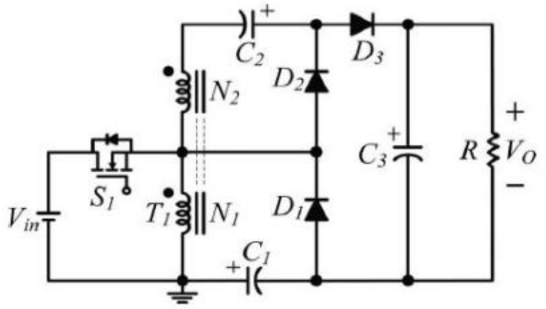

Fig 3: Proposed converter

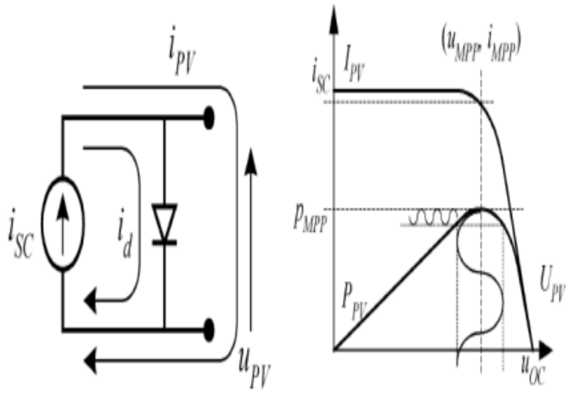

Fig 4: PV Panel model and characteristics

IV. Simulation Results

The figure 5 shows separate output results along with the simulation schematic and simulation results for both the inverter and boost converter. The document shows the parameter values in the following sections.

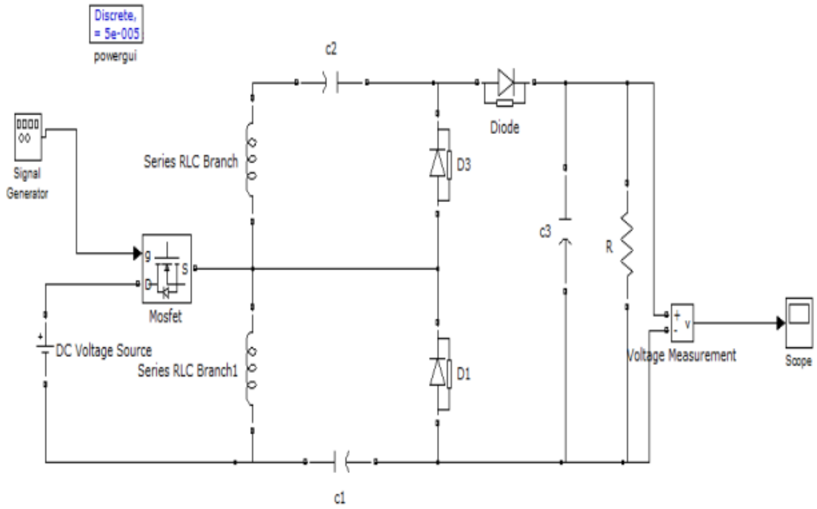

Fig 5: Simulation of Boost Converter using Matlab/Simulink

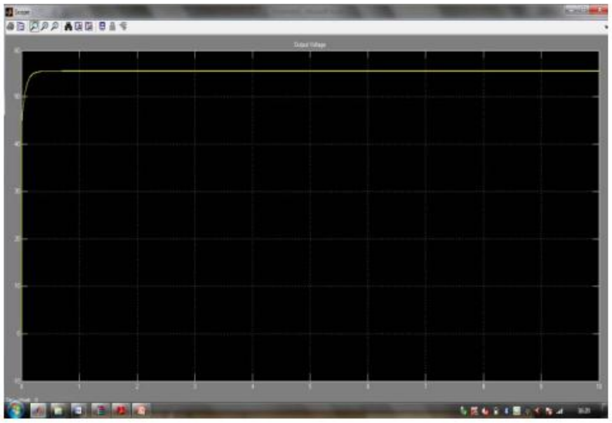

Fig 6: Output Voltage waveform of Boost Converter

MATLAB Simulink software represents a single phase full bridge inverter through Figure 7. A positive voltage of Vs exists between the nodes while S_1 and S_2 remain active while the load presents a negative -Vs from S_3 and S_4 being active. The frequency of the output voltage changes when periodic time T is adjusted. Four IGBTs exist in the circuit and form part of the RL load connection.

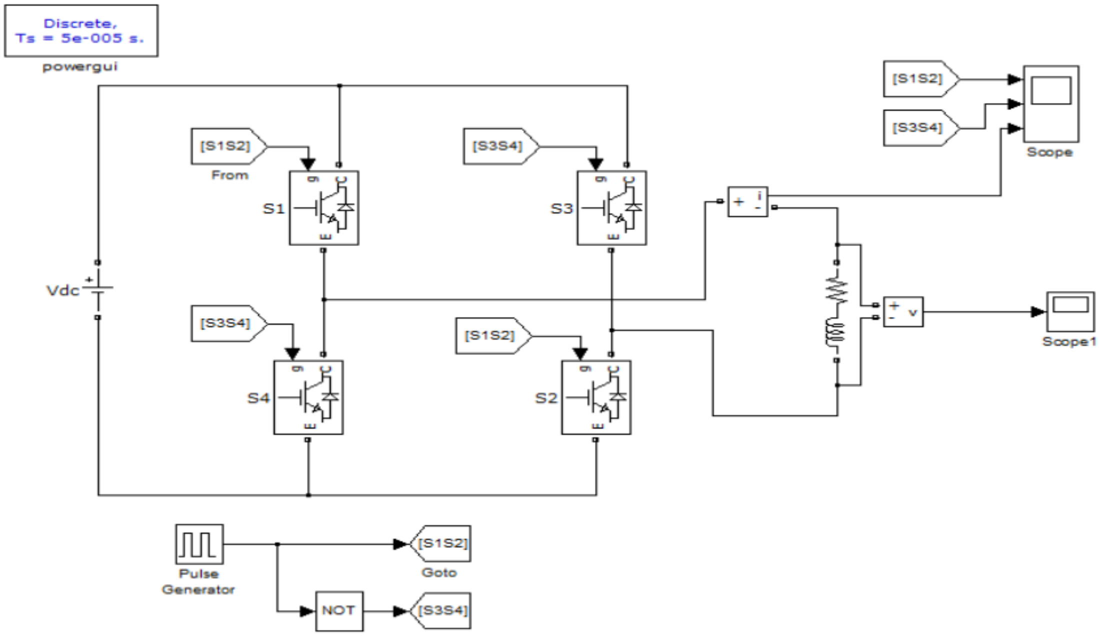

Fig 7: Simulation of Single-Phase Full Bridge Inverter using MATLAB/Simulink

An inverter performs the basic operation of changing direct current power into alternating current power with specified output voltage and frequency. The market provides two main categories of inverters. There exist two types of inverters which either use voltage sources or current sources. The circuit adopts voltage source inverters for its operation. Voltage source inverters earn this name when combined with dc source impedance that is practically zero. The input terminals of voltage source inverters operate with a steady rigid dc voltage source. The output voltage waveforms and output current waveforms appear in Figures 8 and 9.

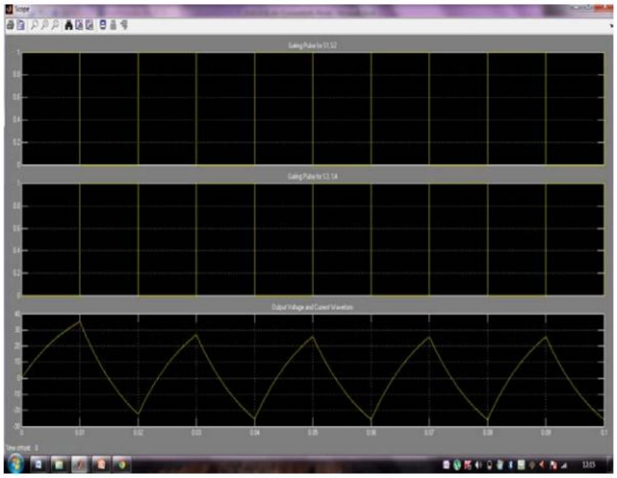

Fig 8: Pulse voltage and Output Current waveform for Single Phase Full Bridge Inverter

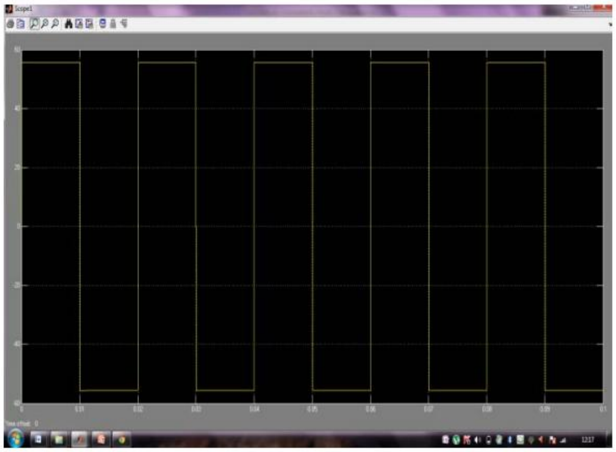

Fig 9: Output Voltage waveform for Single Phase Full Bridge Inverter

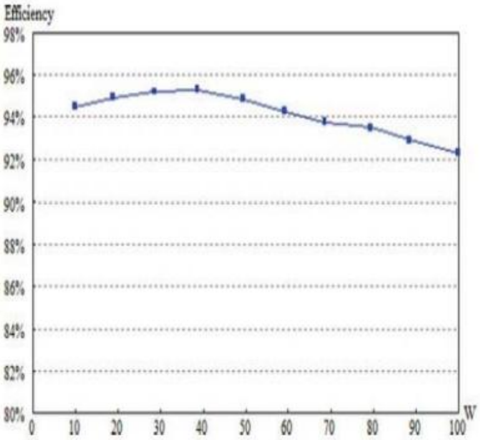

Fig 10: Maximum Efficiency of Proposed Converter

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