PHOTO-VOLTAIC POWER COMPENSATION WITH REVERSIBLE SUPPLY TO GRID

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Abstract – *This paper proposes an implementation of solar energy management with reversible supply to national grid or power station by using Simulink and core controller. The goal of the project is controlling boost-buck converter for the incoming voltages of PV module through PWM technique applied through VHDL programming and display the results of power management which we required. It includes the control of the chopper circuits and displaying the values of the current sensor and voltage sensor as well as compare with the pre-scale value of present and previous power duty cycle values. It is also known as Hill climbing method, because it depends on the rising curve of power against voltage below the maximum power point, and the fall above that point. This developed hardware has the merits of reversible supply from household savings to grid with high accuracy with constant solar irradiance value. The proposed MPPT (Maximum Power Point Tracking) technique has been detailed in this paper.*

Keywords – Photovoltaic, FPGA, SEPIC converter, OTG supply, boost/buck converter

I. INTRODUCTION

'Solar energy' is a vital part in today's energy consumption of our country. In perturb & observe (P&O) method the controller adjusts the voltage by a small amount from the array and measures power (^P). If power increases high, further adjustments in that direction are tried until power no longer increases. It is also known as **Hill climbing** method, because it depends on the rising curve of power against voltage below the maximum power point, and the fall above that point. If ^P is positive, it is closer to MPP. Thus further voltage perturbations in same direction. The PV array has a highly non-linear current-voltage characteristic varying with the irradiance and temperature that substantially affects the array power output in efficient way.

Design ofS-E-P-I-C Converter

Single Ended Primary Inductor Converter is essentially a boost converter followed by a buck converter, through CAN (controller area network) network which is similar to a traditional buck-converter.

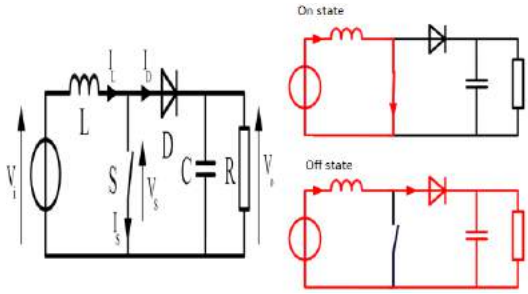


Figure 1.1 Boost converting mechanism

DC-DC converter allowing electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The SEPIC output is controlled by the duty cycle(D) of the control transistor.

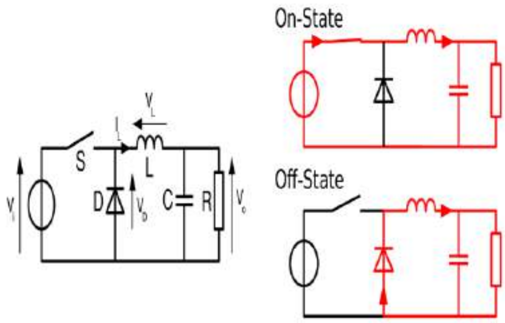


Figure 1.2 Buck converting mechanism

The steady-state voltage and current relations (D - duty cycle) of the converter operating in continuous current mode are given by, with respect to the duty cycle [D],

Vout / Vin = [1 / (1-D)]
D = {Vout –Vin / Vout}

II ELECTRICAL PROPOSED SYSTEM

'Solar irradiance' is the power flow per unit area produced by the sun in the form of electromagnetic radiation.

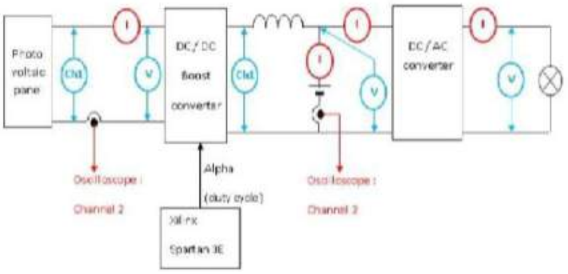


Figure 2.1The Proposed System

PV output voltage(volts)	Boosted output(volts)	Inverter voltage
12.225	60.21	59.12
11.571	80.41	81.40
12.770	85.05	85.93
12.013	90.17	91.02

Table 2.1 - Electrical characteristics

Input voltage (Vin)	12V
Input current	4.1A
Output Voltage	80V (no load)
Output current	26.66 A(no load)
Maximum Power output (P)	52.9W
Switching frequency (f)	16.86kHz

Table 2.2 -Specification of SEPIC converter

III FIELD PROGRAMMABLE GATE ARRAY

Thecontrolalgorithm andprogrammable interconnect is proposed by means of CHIP SELECT(in), DRIVER-IN(out) which is indicated by corresponding LED blinking mechanism at FPGA.

FPGA voltage regulators

The PV sources deliver variable power which depends on solar radiation which is 1000 W/m2 during day time. In order to extract maximum power from PV source, solar power regulator has been incorporated which regulates the voltage to respective Maximum power point.

Pulse generator in proposed system

Pulse Width Modulation is a technique for getting analog results with digital manner. Performed PWM technique which provide average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast rate. The longer the switch is on compared to the off periods, the higher the total power supplied to the load. is sensed by the voltage regulators of FPGA.

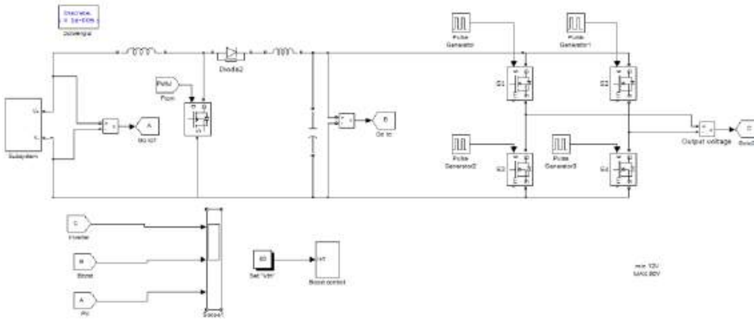
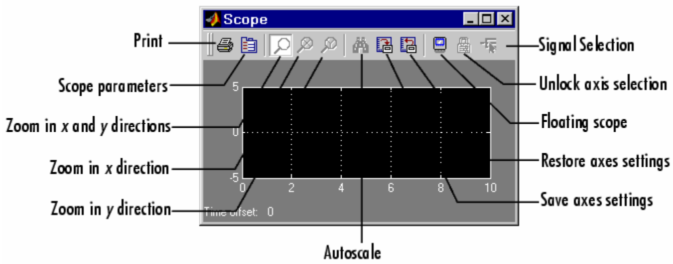


Figure 3.1 The overall proposed system

The system consists of a solar array, buck converter, XILINX (FPGA) Board, Battery, inverter. Its electrical characteristics can be up to 90 volts. The maximum electrical characteristics obtained during our unrepeatable tests.

IVINTERFACING FPGA WITH CONVERTER

The whole digital design has been implemented in VHDL using Xilinx software, to beable to use the Spartan3E FPGA. It was necessary to study the Xilinx development tool. The whole project was divided into "black boxes", whichalso consist of different smaller black boxes. By doing this, we could reuse subpartsmultiple times and reduce the complexity of each part. We divided it into 3 big parts.



The first one is the measurement part, used to convert the measured currents and voltages to digital signals, using an A/D converter. The display part uses a predesignedblock and a self-made part to display these values on the small 8-digit display on the FPGA card. Three switches are used to select which value is displayed. The control part controls the chopper in open loop.

V EXPERIMENTAL RESULTS

Thewhole proposed system separated into parts which are constricted and integrated by MATLAB Simulink environment.The proposed setup has been tested at different time durations in a day (T1, T2, T3) to ensure the testing is done in different environmental working conditions in the manner.

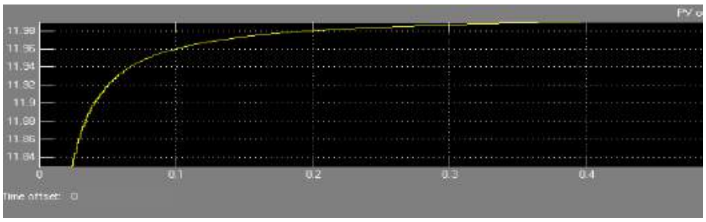


Figure 5.1PV panel voltage = 12 volts during time T1

At time T1, PV panel incoming voltage by the help of 'solar irradiance a's well as solar constant(air mass constant 1.5 to 2) is around 1000 in a range(36 cells solar module).While varying solar cells range, its gain should be high (without any load). From figure-1, 11.99 volts is reached through PV panel with respective time offset scale at a day.

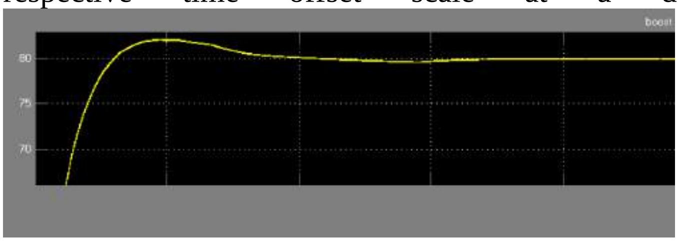


Figure 5.2 Boosting voltage = 80 volts during time T2

From this figure, SEPIC converter acts into step-up (boosting) mode for increasing 12V PV panel incoming voltage value. While connecting load with the battery output, it produce slight variations in the duty cycle period. ($I_{battery}$> 0 is known as battery in active generator mode with respect to time).

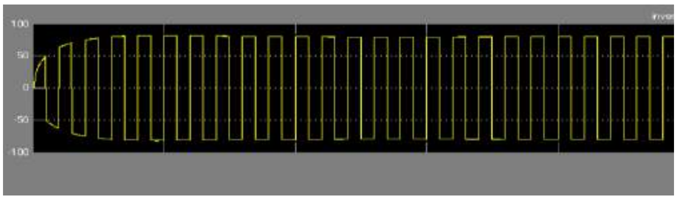


Figure 5.3 Inverter output voltage (dc to ac)= 80 volts during time T3

Normally 'inverter' used to change DC voltage & current into AC voltage & current within particular half cycle. Because DC voltage is unidirectional and so we can't use this in household appliances .When converting 80 DC voltage into AC voltage within time period (T3) to shown as AC sinusoidal pulses.

VI CONCLUSION

This novel proposal represents electricity from solar supply which providesand howefficiently control the boost-buck converter through FPGA with MPPT tracking to feed a load which consumes energy from that battery directly connected to panel. Therefore, making proposed system to compared output results with expected output values in efficient manner.It checks output power of the array and compares its range which varies perturbation of the operating voltages of the array itself. Using these different methods like perturb & observe method, incremental conductance method which has been analyzed by simulating temperature and insolation parameters. Hybrid PV converter system back up with standby source proposed in this study for rural home based applications is considered as appropriate design for developing countries where power cut happens very frequently and it provide the sufficient back up supply in good manner.

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