

## Research Paper

# BOOST CONVERTER WITH MPPT AND PWM INVERTER FOR PHOTOVOLTAIC SYSTEM

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This paper presents boost converter with maximum power point tracking technique for photovoltaic system to extract maximum power from solar panel, and the system is connected with battery storage system, and cascaded with PWM inverter along with an RLC second order passive filter which outputs a stable AC voltage, which is not possible in traditional PV inverter system. The circuit operation principle, control strategy, and characteristics of the system are analysed in detail. Simulation results are shown to verify the theoretical analysis.

**Keywords:** Pulse Width Modulation (PWM), Maximum Power Point Tracking (MPPT), Boost converter, Passive filter (RLC), Grid

## INTRODUCTION

As people are much concerned with the environmental problems and the fossil fuel exhaustion because of the conventional power generation, Renewable energy sources are becoming widely popular, due to which the cost of renewable energy sources are dropping, and new technologies are developed to efficiently utilize renewable energy sources [2].

Apart from power generation renewable energy sources are used in transportation system also. The photovoltaic solar panel is widely used in many grid connected and stand-alone application. It has several advantages like no noise, no installation area limitation,

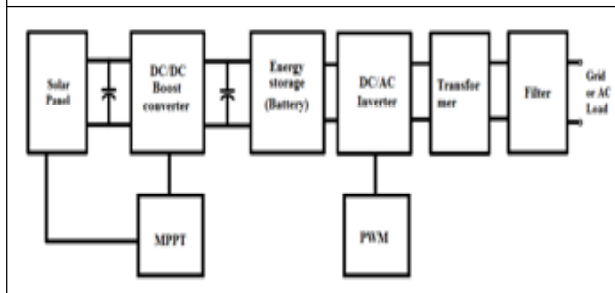
and no additional maintenance cost but its installation cost is high and low efficiency and also due to non-linear characteristic it requires maximum power point Tracking. There are many different types of MPPT algorithms based on simplicity, time taken, and stability [6]. The DC-DC boost converter can achieve high boost gain, however high gain is restricted by switches used. The PWM inverter with RLC passive filter outputs almost sinusoidal output waveform.

The output can be either used for standalone load or can be integrated with power grid. Before connecting the system with power grid the output should be synchronized with grid parameters [1].

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This paper presents boost converter controlled with MPPT and SPWM inverter with RLC second order passive filter to ensure a sinusoidal output. The benefit of this paper is to give access to a pollution free source of energy.

**Figure 1: Block Diagram of the Proposed System**



The solar panel is connected to DC/DC boost converter which is controlled by MPPT controller, the energy is stored in battery, SPWM inverter is used to convert DC to AC and filtered using RLC second order filter, the sinusoidal output can be connected to stand alone load or to grid. There are filter capacitors after each DC blocks to remove ripple contents [3]-[5].

## DESIGN AND CONTROL STRATEGY

### Photovoltaic Cell

The electrical equivalent circuit of photovoltaic cell can be expressed in many ways, the simplest circuit is as shown below.

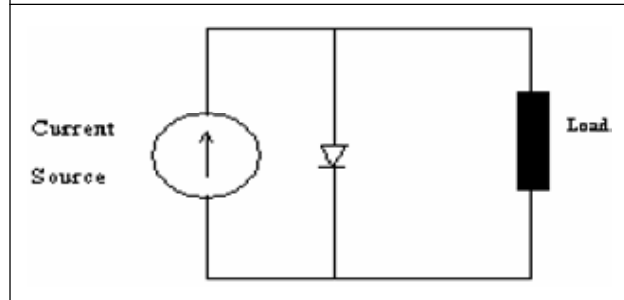
$$\text{Load current: } I_L = I_{ph} - I_D \quad \dots(1)$$

where,  $I_L$  is load current,  $I_{ph}$  is photo current and  $I_D$  is diode current. Voltage and current varies as per solar irradiance and temperature.

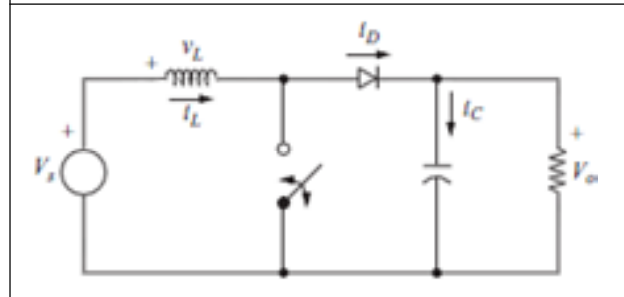
### Boost Converter

The boost converter is a switching circuit which is used to step-ups DC voltage.

**Figure 2: Electrical Equivalent Circuit of Solar Panel**



**Figure 3: Boost Converter**



$$V_o = \frac{V_s}{1 - D} \quad \dots(2)$$

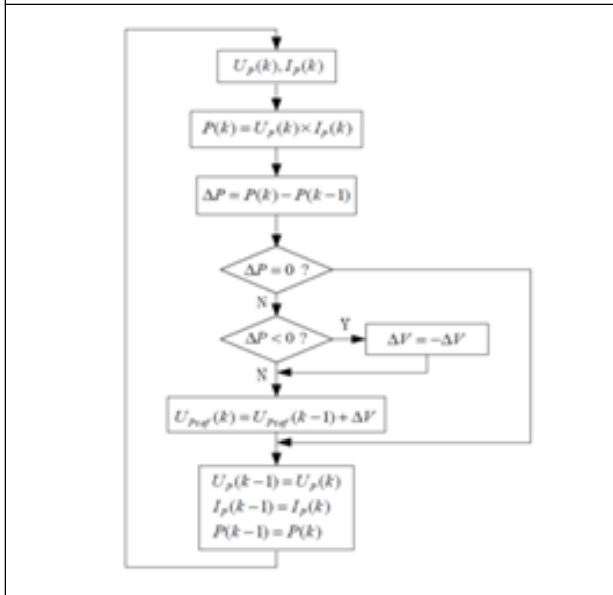
The output voltage ( $V_o$ ) depends on input voltage ( $V_s$ ) and duty cycle ratio ( $D$ ). The values of inductor and capacitor can be calculated by using below equations by choosing a constant switching frequency ( $f$ ), and  $(\Delta V_o/V_o)$  output voltage ripple should be suitably selected.

$$C = \frac{D}{R \left( \frac{\Delta V_o}{V_o} \right) f} \quad \dots(3)$$

$$L = \frac{D(1 - D)^2 R}{2f} \quad \dots(4)$$

### Maximum Power Point Tracking (MPPT)

MPPT works on Maximum power transfer theorem which states that output power will be maximum if input parameters and output parameters are matched. The principle of

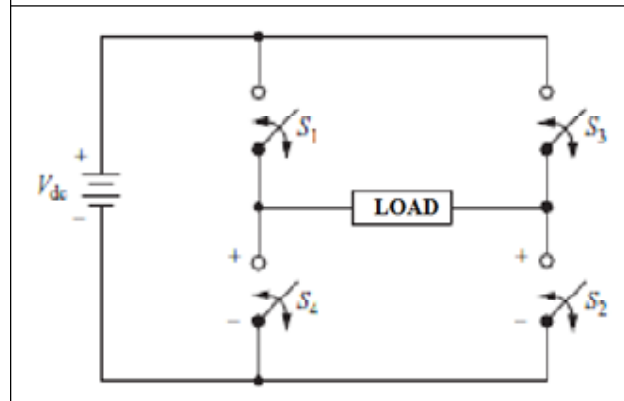
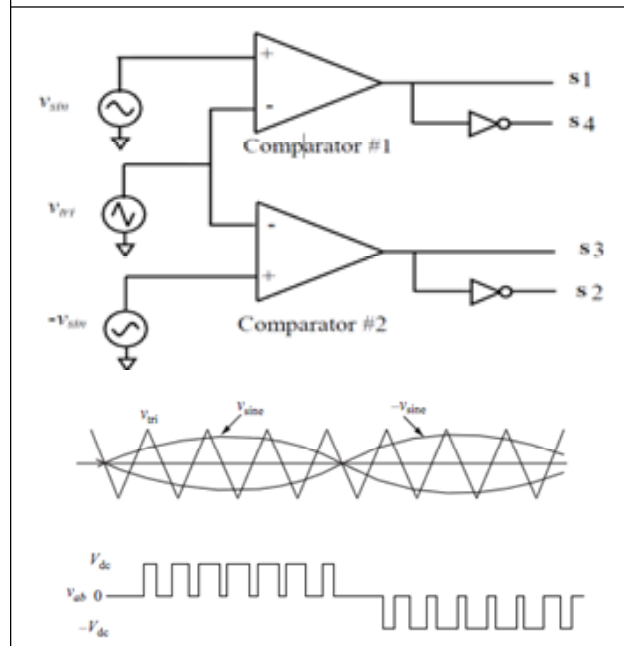
**Figure 4: Flow Chart of Perturb and Observers Method**

working is as voltage and current of PV cell will be varying based on solar parameters the MPPT will be designed in such a way that it finds maximum power point of cell for different voltage and current by estimating power and gives signal to control boost converter to work in maximum efficiency condition. There are different ways of doing so, but perturb and observer method is simplest. The flow chart for perturb and observers as shown below.

### PWM Inverter and Filter Circuit

The single phase full bridge inverter consists of four switches, controlled using PWM signals, the switches can be selected based on power rating of the circuit. The PWM signals are result of two signals merging namely reference signal and carrier signal, the two signal will be of different parameters merged to get desired PWM signal as shown below.

The generated PWM signal is given to  $S_1$  and  $S_2$ , and same signal is complimented and given to  $S_3$  and  $S_4$ , by doing so we can avoid

**Figure 5: Single Phase Inverter Circuit****Figure 6: PWM Signal Generation**

short circuit caused by improper operation of switches.

The filter used is a passive filter consisting of Resistor, Capacitor and inductor. The filter is low pass type, it is made to resonate ( $f_0$ ) close to fundamental frequency that is 4 to 5 times of fundamental frequency and values of inductor and capacitor values are calculated by keeping one constant. The resistor for lite damping should be below  $5 \Omega$ .

$$f_o = \frac{1}{2\pi\sqrt{LC}} \quad \dots(5)$$

## SIMULATION RESULT

The simulation is performed in MATLAB user interface, the circuit is built in matlab and executed, the setup is built using following parameter values as shown in the below table which are designed using above formulas, and the following results are shown.

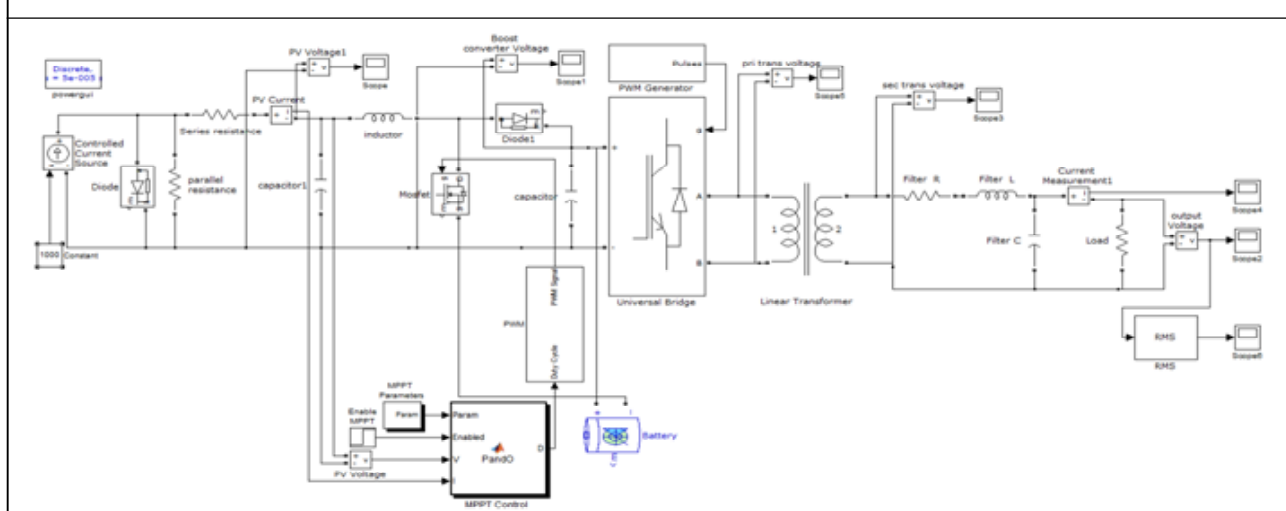
## CONCLUSION

This paper presents a photovoltaic system with boost converter controlled by MPPT circuit

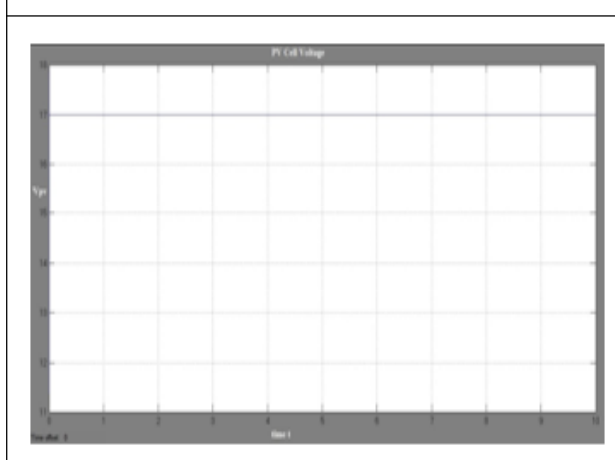
**Table 1: Specification Details**

Maximum Power	$P_o$	100 W
PV cell voltage	$V_{PV}$	17 v
Converter output voltage	$V_{OC}$	39 v
Switching frequency controller	f	25 KHz
Converter inductor and capacitor	L C	126 $\mu$ H 40 $\mu$ F
Battery	$V_{Bat}$	36 v
Filter parameters	R L C	4.7 $\Omega$ 3.3 mH 220 $\mu$ F
Output parameters	$V_p$ $V_{RMS}$	345 v 240 v

**Figure 7: Simulation Circuit**

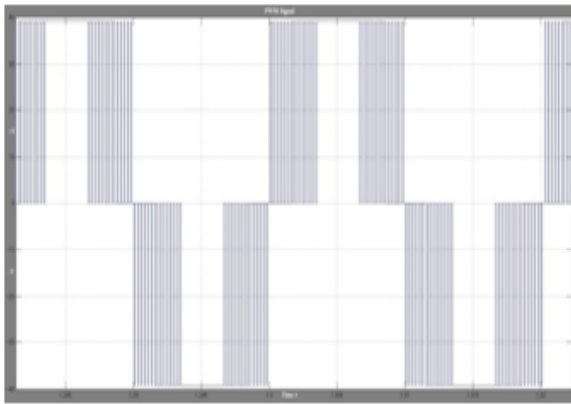
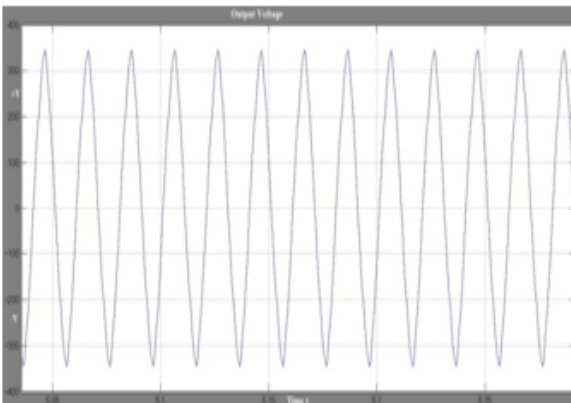


**Figure 8: Photovoltaic Cell Voltage**

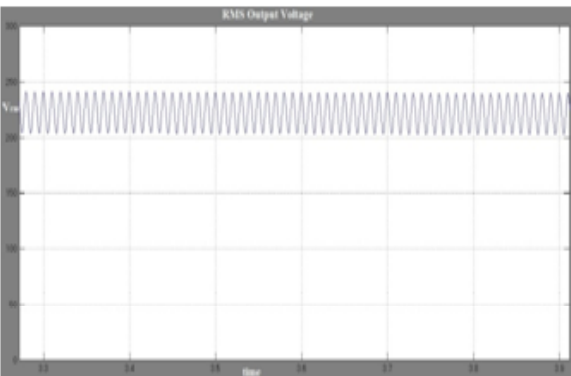


**Figure 9: Boost Converter Output Voltage**



**Figure 10: Generated PWM Signal****Figure 11: Output Voltage**

based on perturb and observer method for better efficiency and stability, single phase full

**Figure 12: RMS Output Voltage**

bridge PWM Inverter which performs inversion, by designing passive filter properly we get stable sinusoidal output voltage. The output can be used for stand-alone load or for connecting to grid after synchronising with grid parameters.

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