Maximum Power Point Tracker Method for Grid Connected Photovoltaic System based on Hill Climbing Technique

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Abstract: This article proposes the simulation and modeling the maximum _power _point tracking (MPPT) based on Hill climbing (HC) connected in the grid. This paper primarily produces convenient model of the PV whereby the photovoltaic arrays model be acquired. This approach is utilized to follow a maximum power of the panel solar. The maximum power _point of solar panel changes with a temperature and the irradiation. A DC/DC Boost convertor and the inverter three-phase. The system is simulated utilizing Simulink/MATLAB.

Keywords: PV, Converter DC/DC Boost, Hill Climbing, Inverter DC/AC, Grid.

1. Introduction

As of late, the interest of electrical energy is expanding around the globe. It has inspired the utilization of recent renewable power sources, which has gotten more appealing, and richly accessible.

PV energy is one among the significant wellsprings of renewable power that outcomes from the immediate change of daylight into power by the methods for cells for the most part dependent on translucent silicon. In addition, the creation of that energy is non-linear and relies basically upon climatic conditions, for example, illumination and temperature.

Photovoltaic panel array utilizes a MPPT method toward constantly convey the most powerful when varieties of the irradiance, and temperature [1],[2].

The Photovoltaic system can get the panel, the DC/DC Boost convertor, the MPPT and invertor part to connect to grid. Can augmentation the efficacy of the method by augmenting the efficacy of all part. The effectiveness of the photovoltaic panel is concerned by 3 elements: the effectiveness of the photovoltaic panel, the effectiveness of the convertor Boost and the algorithm MPPT. Ameliorating the efficacy of the Photovoltaic panel also the converter isn't simple as it relies upon the accessible innovation it might necessitate best elements, which can augment radically the price of the installation. While that, increasing the pursuing of the MPP with novel control algorithm is simpler, inexpensive and can is does in manufacturing plants that were recently utilized by refreshing their control algorithms, which could prompt a quick increment in the creation of photovoltaic vitality and as a result, an easing in its cost [3],[4].

In many applications, PWM type DC-DC convertors or DC-AC invertors are used as the power connection amidst the photovoltaic panels, and the loads [5]. The exchanging duty cycle is the control changing for these types of typologies. Next, other approach [6], to MPPT depends on the connection between the power of the photovoltaic generator and the switching duty cycle. Figure. 1. shows the hill-shaped P-D connection curve, where P symbolizes the production power of the PV generator and D the duty-cycle of a DC / DC convertor in switching mode. Mathematically, the local MPP can be tracked if the $\frac{dP}{dD}$ is compelled in zero by a command. This type of MPPT technology is also specified as the method Hill Climbing (HC) [7].

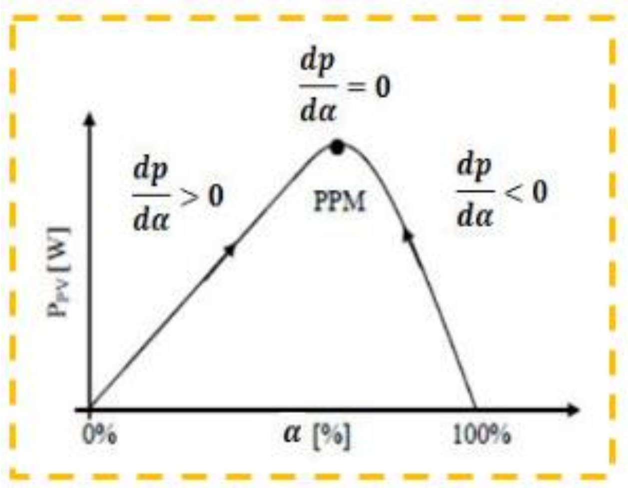


Figure 1. Relation ship between the power of GPV and duty-cycle of static converter

The method HC is broadly applied in MPPT controller because they ease and simple execution. Hill climbing procedure presents a disturbance in the duty ratio of the power convertor and is more appealing duty to the easy control build. In that article a novel methodology of method HC which utilizes a changing move of attractive voltage variation is introduced. Giving by this new control schema a nonlinear duty ratio D variation is averted [8],[9].

In this article, a simulation of MPPT Hill climbing algorithm is advanced to augment the force of the solar generate system. An remainder of the document is formatted as next. The effective system of the solar energy production is presented in Section II, III and VI. In Section IV, the Command MPPT is introduced. In Section V, a hill-climbing technique is presented. Results of simulation and conclusions is given separately by sections VII and VIII. The simulations for the total systems are effectively verified in the MATLAB.

2. Model Photovoltaic

The solar panel cell is generally a p-n semiconductor junction. When demonstrated in light, a DC current is generated. The Current produce vary linearly with a temperature and irradiance [10]. The circuit electrical equal of a perfect cell solar maybe treat as a source parallels current with an diode presented in fig. 2.

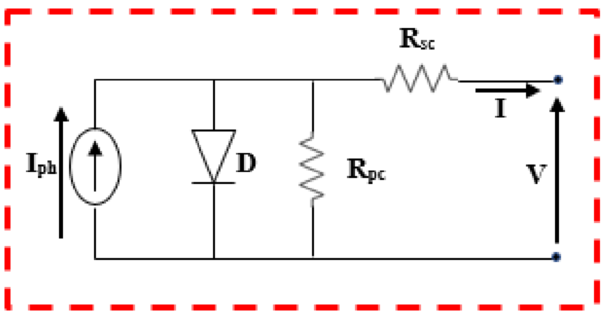


Figure 2. Electrical circuit equivalent of the solar cell

The relation between the current I [A] and the voltage V [V], the model it in the following exponential equation [11]:

$$I_D = I_s\left[\exp\left(q\frac{(V + I\ R_{sc})}{\alpha KT}\right) - 1\right] \quad (1)$$

While, the output current of the solar cell:

$$I = I_{ph} - I_D - I_{pc} \qquad (2)$$

$$I = I_{ph} - I_s \left[\exp\left(q \frac{(V + I\ R_{sc})}{\alpha KT} \right) - 1 \right] - \frac{(V + I\ R_{sc})}{R_{pc}} \qquad (3)$$

Where:

R_{sc} : Parameter of resistance of series of the cell [Ω]

R_{pc} : Parameter of resistance shunting [Ω]

α : Parameter of diode (usually α = 1;2)

T : Cellular temperature [K]

q : Load of an electron ($1.6021*10^{-19}$C)

k : Constant Boltzmann ($1.3854*10^{-23}JK^{-1}$)

I_{ph} : Photocurrent [A]

I_S : Current of saturation [A].

3. DC/DC Converter Boost

The Boost converter and a reverse of complete bridge are utilized as the power interface among the load and the PV pannel to obtain the maximum power. The output voltage of the Boost can be illustrate by $\frac{Vout}{V\,\text{int}} = \frac{1}{(1-D)}$ [12]. Functioning primarily as an inverted dollar converter [13],[14].

The DC/DC converter is an interface that permits the flexibility between the load and the PV to take out the maximum power of the panel. [15],[16]

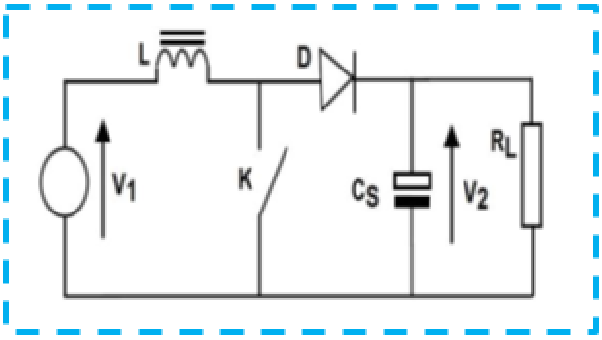


Figure 3. Electric Plan of the Boost Convertor

4. MPPT Command

The MPPT control, related with an intermediate adaptation stage, makes it possible into operate the photovoltaic system in such a way as to constantly produce the maximal of its power. Accordingly, regarding meteorological states (irradiation and temperature), the converter control puts the system at the maximum operating point.

The MPPT control produces variation the duty-cycle of the convertor so that the power provided by the panel PV is maximum in its limits. Mainly, he is instituted on the difference of the duty cycle up to have point on the MPP giving to the developments of input parameters of the convertor (VPV and IPV) [17].

In order to improve the productivity of the photovoltaic generator (PV) in other words to maximizing the power delivered to the load connected to the terminals of the generator, several criteria for optimizing the productivity of the system were applied and techniques were followed to have a good adaptation and high efficiency among these techniques, for example:

- The Perturbation & Observation (P&O) [18].
- The Incremental Conductance (IncCond) [11].
- The Fuzzy Logic (FLC) [19].
- The Hill Climping (HC).

5. HILL Climbing Algorithm

MPPT is algorithm this contained for alteration controller utilized for extract maximum accessible power of Photovoltaic modular under specific cases [20]. A voltage in this Photovoltaic modular can deliver maximum power is titled MPP. Maximum power alterations with temperature and irradiation [21], [22]

Method Hill Climbing is broadly utilized in functional PV systems due of its naivety and due it doesn't demand research or displaying of exporter characteristics and can explain qualities eroding resulting of caducity, Shading or other anomalies in work. It begins by estimating the ready worth’s of the Photovoltaic array current (I(k), and voltage (V(k). Thus, the produced power (P(k) can, be determined and contrasted with its worth determined in the past process by to the consequence the compare, the indication of a 'slop' is each complimented or remain unchanged and the duty cycle of the PWM output is modified givingly [23]. This simplified the system control structure to one control loop demonstrated inFig.4 And The method hill climbing are indicated in Fig.5.

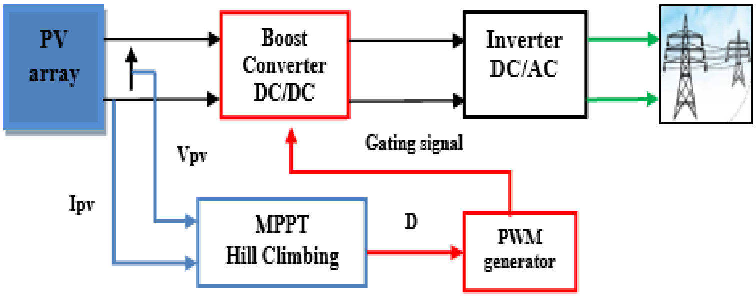


Figure 4. Structure to one control loop of the Hill Climbing control

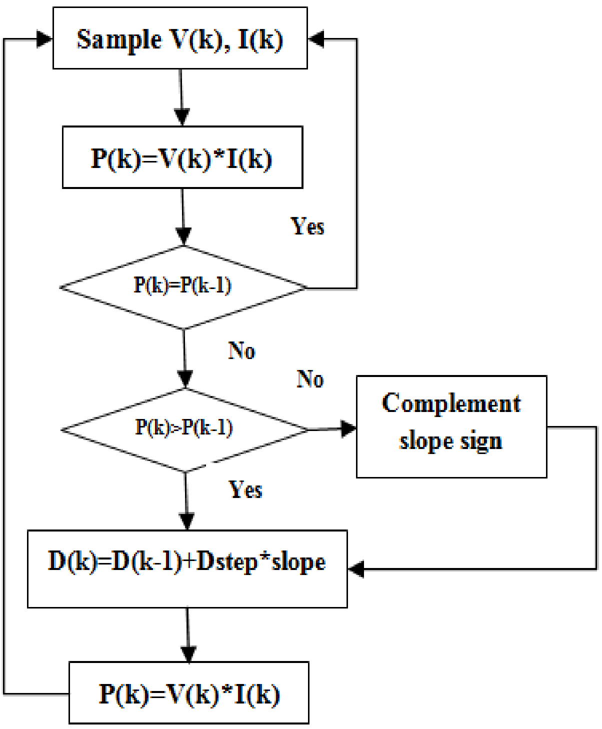


Figure 5. Flowchart hill climbing algorithm

6. Inverter

The invertors 3-phase are applied to change DC voltage in to AC voltage and supply power to load and grid via LC filter circuit. The invertor should be controlled so as to obtain a harmonious less voltage to get excellent power capacity. Various PWM technique is applied to change the inverter circuit. [24],[25]

The inverter 3-phase are applied in system PV connected to the grid. The inverter 3-phase is a 6-steps inverter. It uses a minimum of 6-devices. As communicated previously, the family of transistor devices is currently exceeding broadly used in inverter circuits. In reality, the use of IGBT in the inverter 3-phase is increasing. An capacitor connected at the input terminals aims to make constant DC input voltage.[26].

This condenser also disposes the harmonious that have returned to the source. In the inverter formula, the movement is identified as a change in fire from the IGBT to the next IGBT in the appropriate direction. For each cycle of 360, one move will be 60 times for a 6-step inverter. This suggests that the 'IGBT' will be opened at routinely intervals from the 6-stage invertor, and there are both potential commands of gating the switches.

In single model, each switch leads for 180 and in the other, each switch is driven for 120. But in two models, the trigger signals are applied and removed at 60 periods of the output voltage.

The filter type LC is applied to provide a frequency output of 50Hz to the loads of the consumers and to the electrical grid. There are various components which choose the variety of filter inductor and capacitor. Largely, so as to eliminate the higher order harmonious, the filter resonant frequency must be greater than six times the useful output frequency [27].

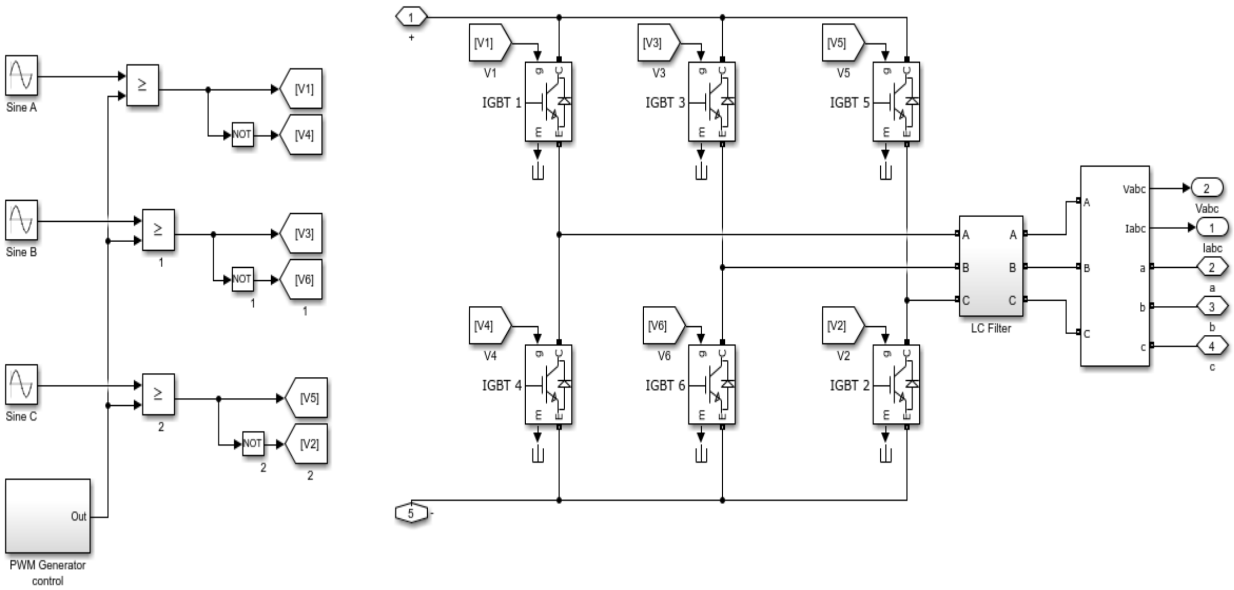


Figure 6. Simulink Model for Inverter

7. Simulation Results

The Fig. 7 illustrates the system Photovoltaic with MPPT controller, converter Boost, inverter and grid are simulated in Matlab/Simulink. The duty cycle of the convertor Boost is straight regulated utilizing algorithm HC.

The Fig. 8 shows model of Boost converter and Hill Climbing MPPT. The Photovoltaic is composed of 5 to series rows, 66 in parallel of PV array. The Table 1 demonstrate characteristics in Photovoltaic array. Fig. 9 shows V/I and V/P Characteristic for PV panel.

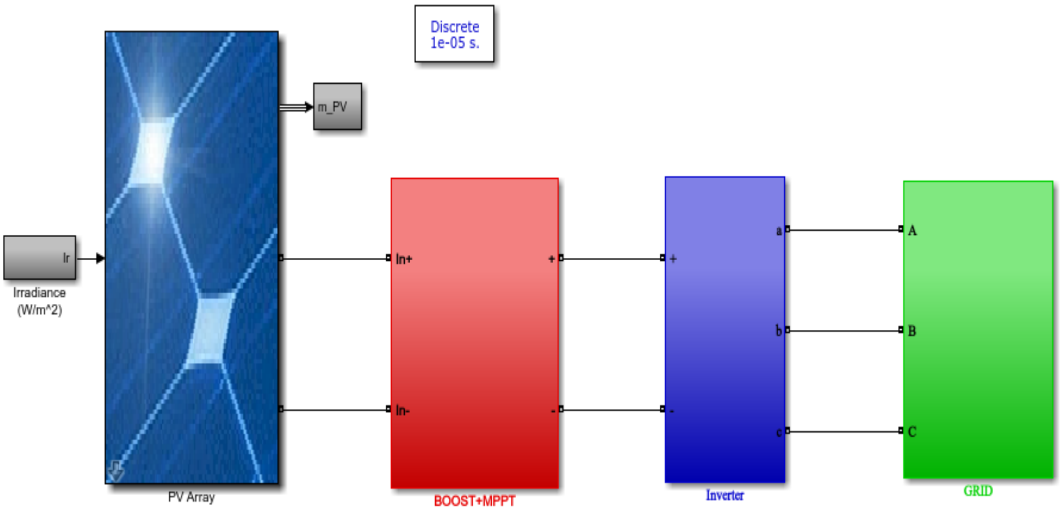


Figure 7. MATLAB model of PV system

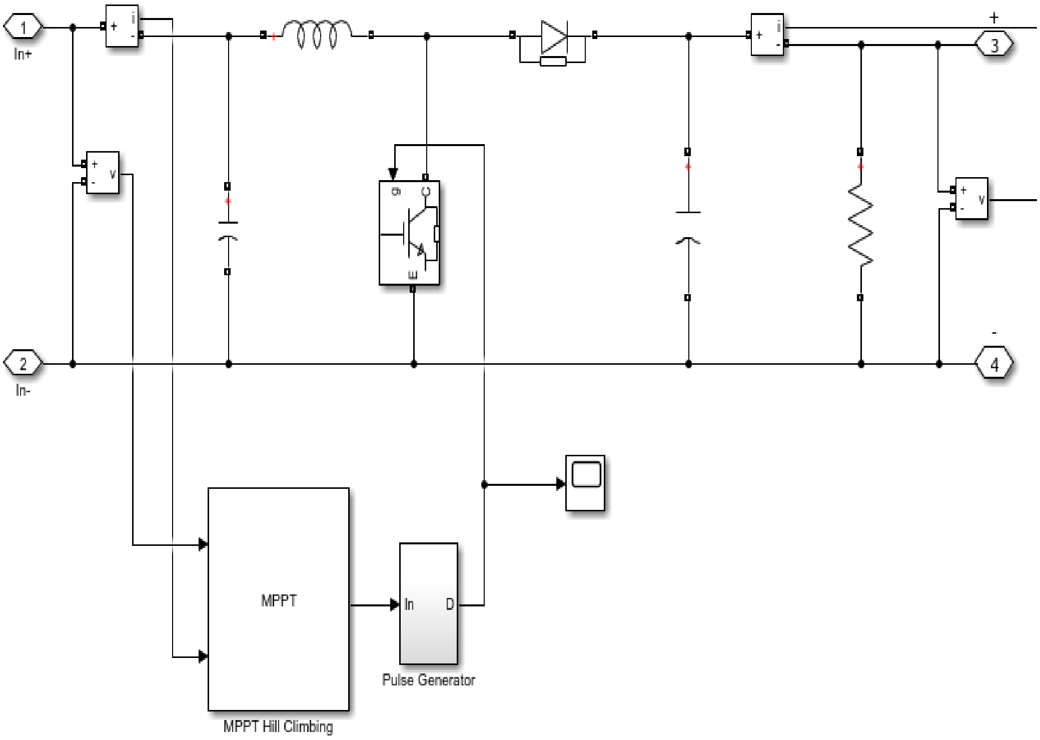


Figure 8. Simulink form of Boost converter and Hill Climbing MPPT

Table 1. Electrical characteristics for a single PV array of the SunPower SPR-305-WHT

Voc	64.2 V
Isc	5.96 A
Vmp	54.7 V
Imp	5.58 V
Isat	1.1753 e-8 A
Iph	5.9602 A
Rs	0.037998Ω
Rp	993.51 Ω

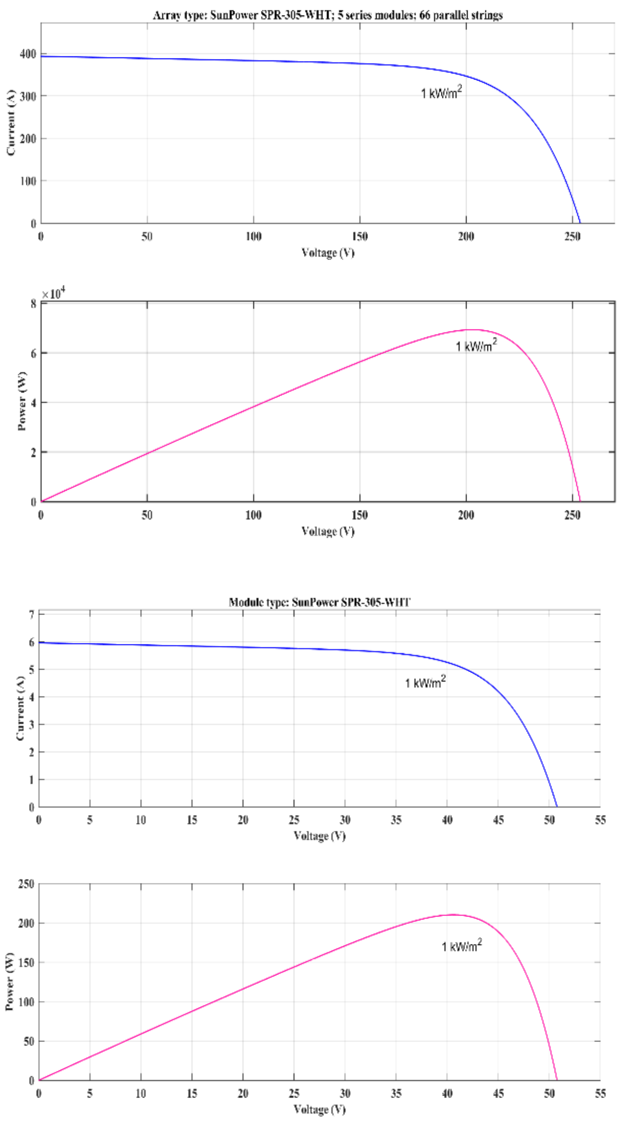
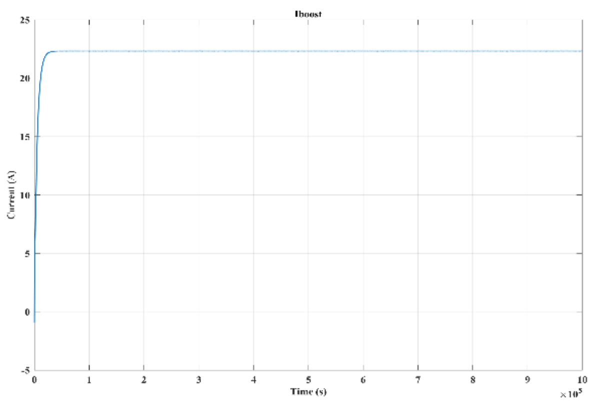


Figure 9. V_I and V_P Characteristic the PV array

The model simulation was performed using the Hill climbing algorithm. Fig 10 and Fig. 11. Presents the simulated sun waveforms, the voltage and the output current of the Control HC. Also, the voltage and the output current injected into the network. The results indicated that each MPP was quickly determined by this suggested tracking algorithm.

(a)



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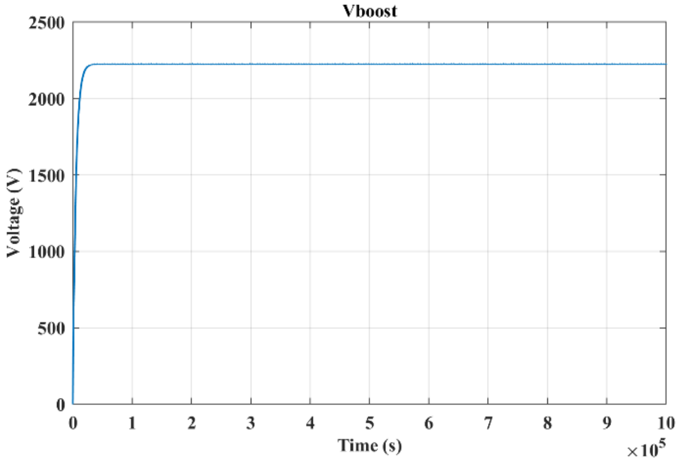

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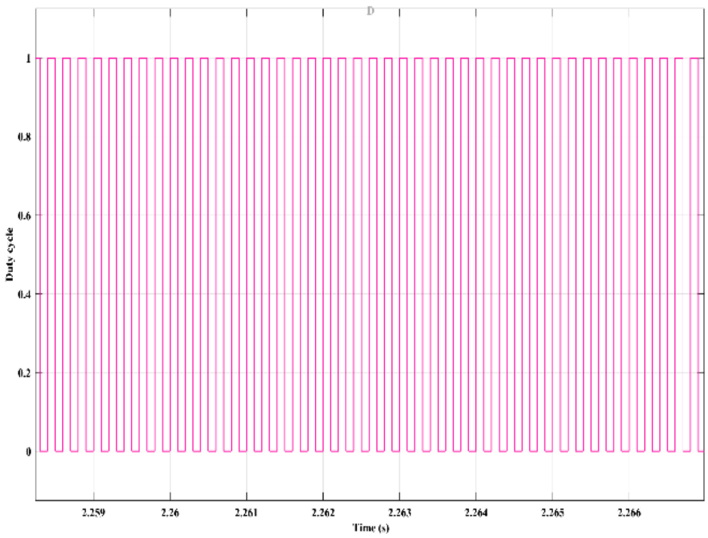

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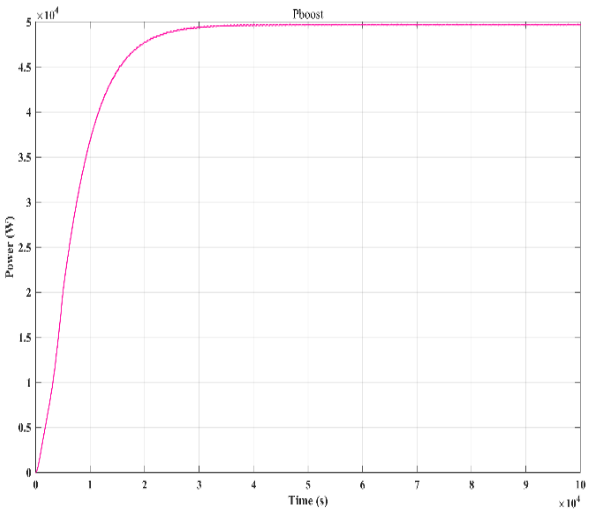
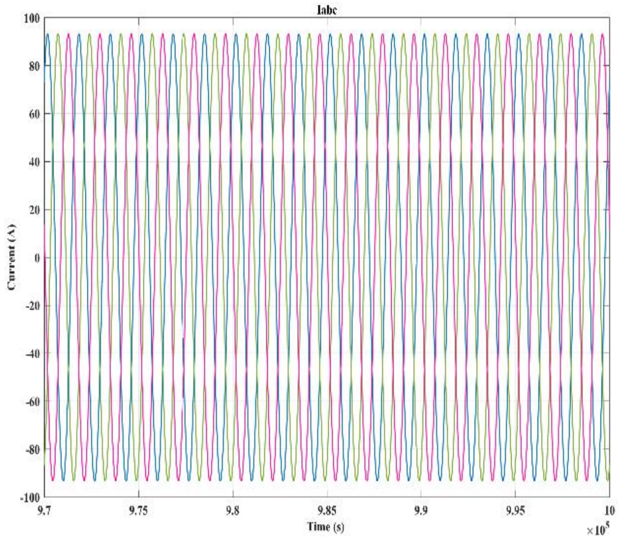


Figure 10. Output: (a) Current, (b)Voltage, (c) Duty cycle and (d) Power of Boost converter using Hill climbing algorithm



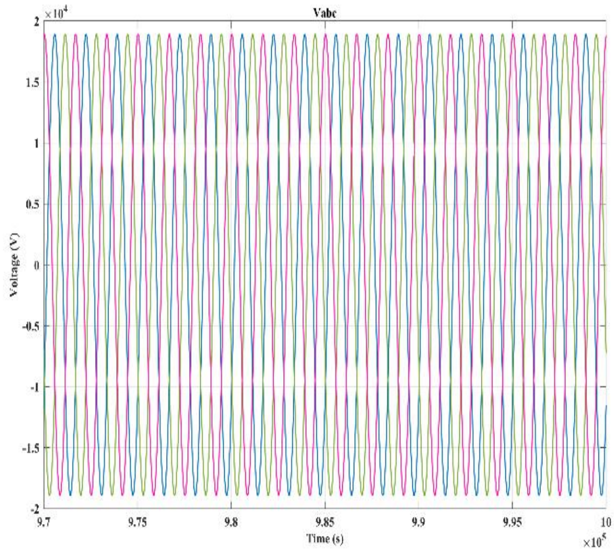


Figure 11. Voltage and Current injected to Grid

8. Conclusion

The simulation and modeling for the system Photovoltaic with method MPPT Hill climbing. MPPT has been effectively effected to the Matlab/Simulink. For this reason, it imposes the Photovoltaic system to function at near to maximum_power operating point to get maximum accessible power.

The greatest benefit of this suggested technique is the simplicity of its application, suppleness and its rapid response in steady state.

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