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Solar Power Tracking System Boost Converter Design with MPPT Controller

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ABSTRACT

Renewable energy sources are the best replacement for fossil fuels as a source of energy because the world's demand for electricity is increasing every day. The rising use of renewable energy sources has led to a growth in solar system utilization, which has greater advantages. This post will go over how to extract the solar array's peak power and how to produce controlled photovoltaic electricity. We will use the incremental conductance approach for MPPT to extract the solar array's maximum power point and transfer it to the boost converter, which raises the voltage to the required level it is easy to model or implement as a code the generalized algorithms that are utilized for MPPT. The MATLAB m files contain a record of the algorithms.
KEYWORDS: -MaximumPowerPoint(MPPT),Photovoltaic(PV),PVArray,Simscape,Boostconverter.

1. INTRODUCTION

One of the main issues in the power sector is the steadily rising energy demand and the lack of sufficient resources to supply it with conventional energy sources. The use of conventional systems and renewable energy sources together to meet energy demand has become more popular. The main energy sources used in this context are renewable ones like wind and solar energy. The continual burning of fossil fuels has lowered the amount of fossil fuel deposits, had a significant impact on the environment, depleted the biosphere, and contributed cumulatively to global warming.

Solar energy is widely available, making it possible to capture and effectively use it. Depending on whether a grid is available locally, solar energy can either be a solo generator or a generator that is connected to the grid. As a result, it can be utilized to power remote places without many grids. The portable functioning whenever necessary is another benefit of employing solar energy.

One must come up with an effective method of capturing energy from the sun's radiation in order to address the current energy issue. Within the last few years, the size of the power conversion systems has been drastically reduced. Power electronics and material science advancements have made it possible for engineers to create incredibly compact but powerful devices to meet the high power demand. These systems' higher power density, however, is a drawback. Utilizing converters with multiple inputs that can manage voltage swings is becoming more popular.However, these systems are scarcely able to compete in the competitive markets.

The ability to use these technologies on a bigger scale than is currently achievable would be made possible by the continuous advancement of the manufacturing technology for solar cells. The most recent power control technologies, dubbed Maximum Power Point Tracking (MPPT) algorithms, have improved the performance of solar modules, making them more successful in the field of using renewable energy sources [3], [8].LITERATURESURVEY

Numerous experts from throughout the world have studied the use of solar energy. It is well known that solar cells function with very low efficiency; therefore, a better control mechanism is needed to raise the solar cell's efficiency. Researchers have created the Maximum Power Point Tracking (MPPT) algorithms in this area.

MummadiVeeracharyhasgivenadetailedreportontheuseofaSEPICconverterinthefieldofphotovoltaic power control. In his report he utilized a two-input converter for accomplishing the maximumpowerextraction fromthesolarcell[3].

M. G. Villalva in his both reports has presented a comprehensive method to model a solar cell usingSimulink or by writing a code. His results are quite similar to the nature of the solar cell output plots [1]-[2].

P. S. Revankar has even included the variation of sun’s inclination to track down the maximum possiblepower from the incoming solar radiations. The control mechanism alters the position of the panel such thattheincoming solarradiations arealwaysperpendicularto thepanels[9].

M. Berrera has Employing two different solar irradiation functions, seven different maximum power point tracking techniques were evaluated in order to show how the output power

Ramos Hernanz has successfully depicted the modeling of a solar cell and the variation of the current-voltage curve and the power-voltage curve due the solar irradiation changes and the change in ambienttemperature [10].

2. METHODOLOGYIncrementalC onductancemethod

The incremental conductance of the PV array is used in this method to determine the sign. The algorithm recognises that the dV dVmaximum power point has been reached when dV dVdIis equal and opposite to the value of I/V (where dP = 0), at which point it stops and returns the relevant operational voltage for MPP. This method is more accurate than the P&O method for tracking rapidly varying irradiation conditions. This approach is complicated since it uses numerous sensors to function, making it less efficient economically [5] and [6].

P=V*I

Differentiatingw.r.tvoltageyields;

$$\frac{dP}{dV} = \frac{d(V*I)}{dV} \tag{5}$$

$$\frac{dP}{dV} = I*\left(\frac{dV}{dV}\right) + V*\left(\frac{dI}{dV}\right) \tag{6}$$

$$\frac{dP}{dV} = I + V * \left(\frac{dI}{dV}\right) \tag{7}$$

Whenthemaximumpower pointisreachedtheslope $\frac{dP}{dV}=0$. Thustheconditionwouldbe;

$$\frac{dP}{dV} = 0 \tag{8}$$

$$I + V * \left(\frac{dI}{dV}\right) = 0 \tag{9}$$

$$\frac{dI}{dV} = -\frac{I}{V} \tag{10}$$

ParasiticCapacitancemethod

This method is an improved version of the incremental conductance method because the voltage calculation now takes into account the parasitic union capacitance of the PV cell [5] and [6].

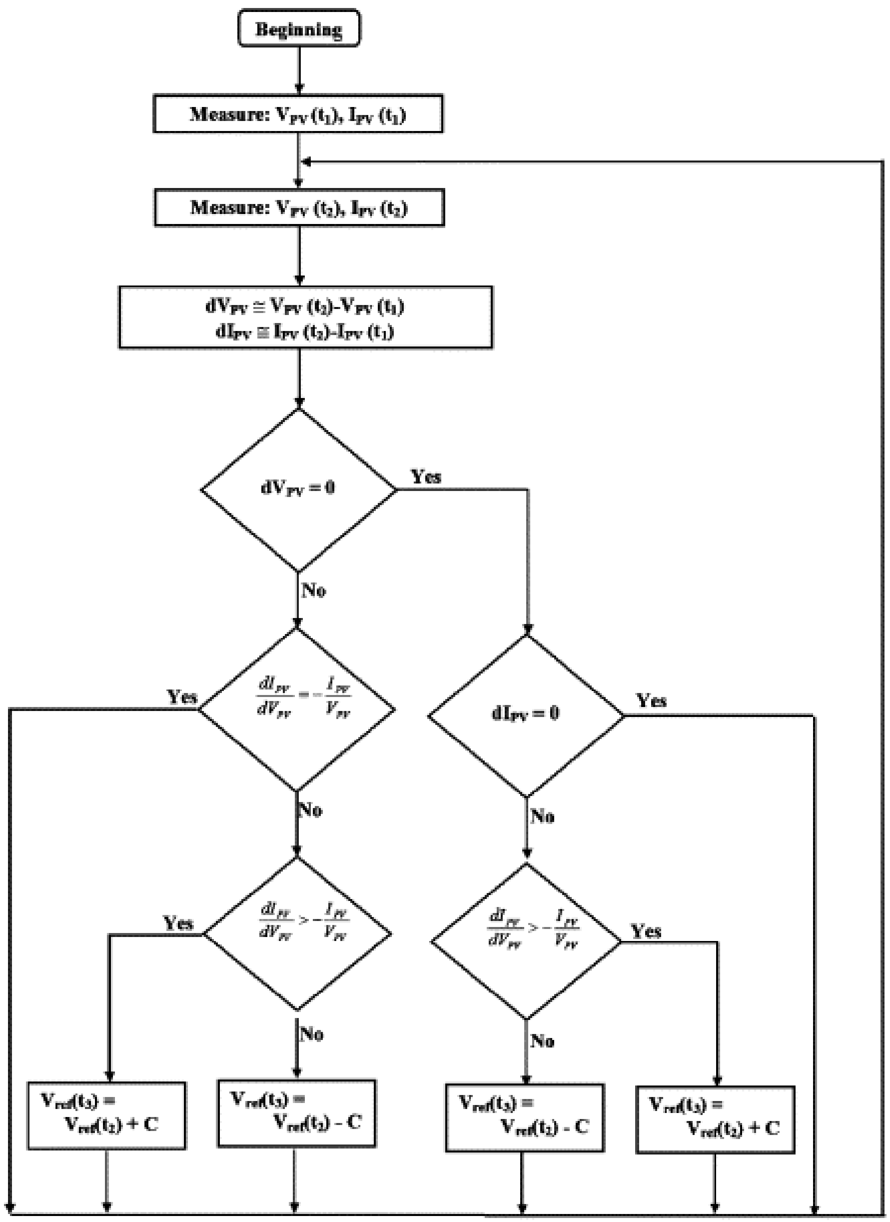
ConstantVoltagemethod

Due to operational losses, this method, which is not very popular, depends on the relationship between the open circuit voltage and the highest power point voltage. For a solar cell, the proportion between these two voltages is typically constant and hovers around 0.86. As a result, the operating voltage is set to 86% of the open circuit voltage, which was determined experimentally [8].

ConstantCurrentmethod

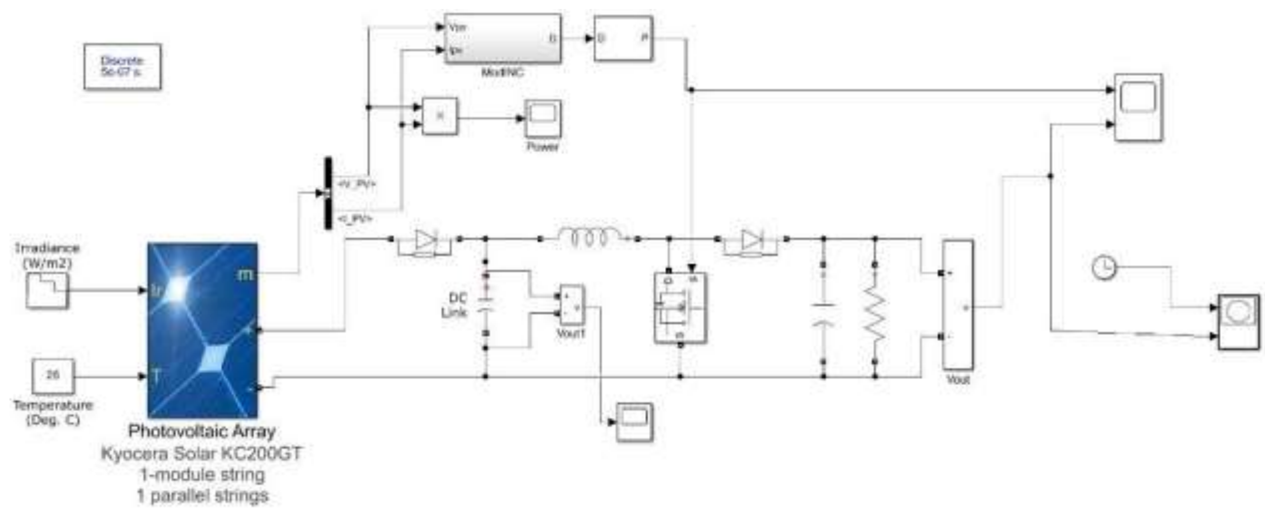
This method depends on the relationship between the open circuit current and the maximum power point current, much like the constant voltage method does. For a solar cell, the ratio of these two currents is typically constant and hovers around 0.95. Experimentally determining the short circuit current, the operating current is then set to 95% of this value [8].

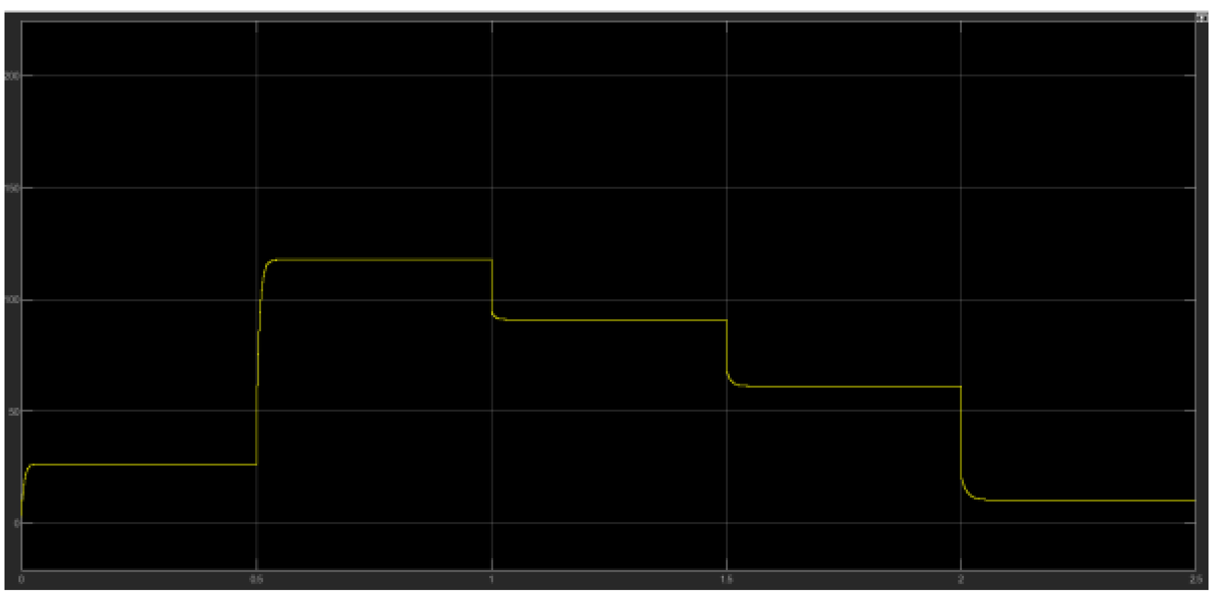
Both advantages and downsides of the methods exist. Considering the operating environment and the algorithm's requirement, a decision must be taken regarding which algorithm to use. P&O is appropriate, for instance, if the necessary algorithm is straightforward and little effort is put into reducing the voltage ripple. The IC technique is suitable, but it would make the operation more difficult and expensive if the algorithm was to provide a clear working point and limit voltage fluctuation close to the MPPT.



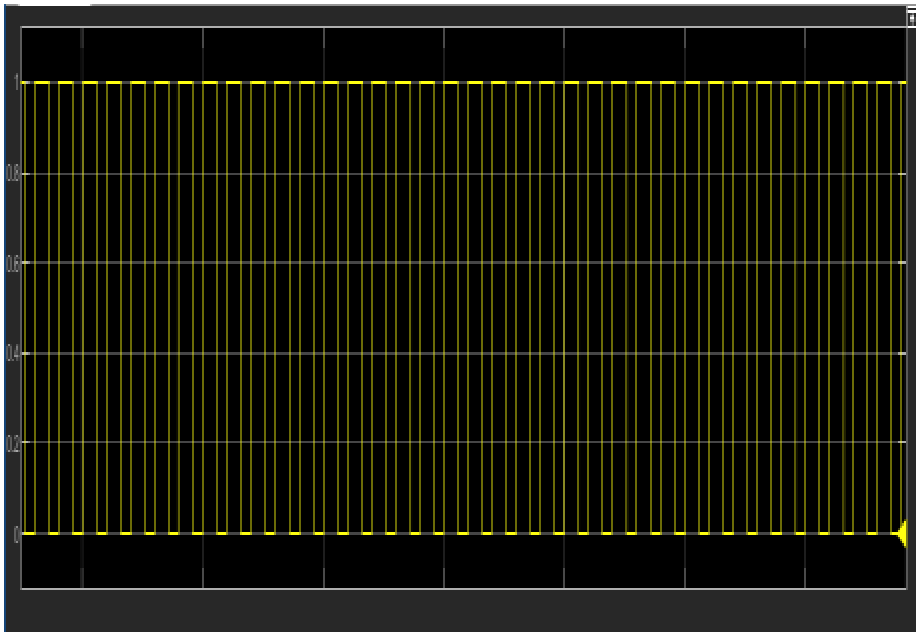
The Embedded MATLAB function of Simulink is used to implement this algorithm, and the code written inside the function block is used to change some signals in relation to the input signals.

3. SIMULATION&RESULT

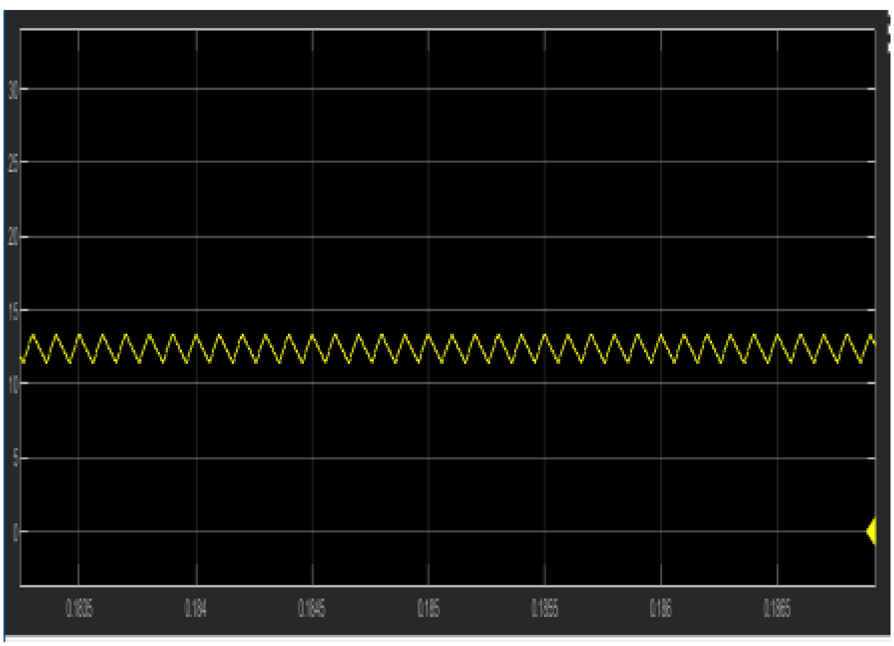




Inputwaveform



MAXIMUMPOWER OUTPUTWAVEFORM



BOOSTCONVERTEROUTPUTWAVEFORM

4. CONCLUSION&FUTUREWORK

Aresistiveloadof10ohmswasusedwiththeboostconvertertherebymakingtheoutputcurrentandvoltagesimilar.Th efrequency ofoperationwas10 KHzwhich wassetbyusingarepeatingsequence

Generator. This generator was used to produce the pulse signal, which was then compared with the signal produced by the MPPT unit to provide the switch with the gating signal.
It is not necessary to input the duty cycle while using MPPT; instead, the algorithm iterates and chooses the duty cycle on its own. However, if MPPT hadn't been used, the user would have been required to enter the duty cycle into the system. The maximum power point shifts in response to changes in solar irradiation, which also affects the duty cycle needed to run the model. But if a continuous duty cycle is employed, maximum power point cannot be monitored, making the system less effective.

Using MATLAB's plot feature, the different waveforms were obtained. Power from the solar panel side to the boost converter output side is lost slightly. This can be ascribed to the switching losses as well as losses in the boost converter's inductor and capacitor. The charts of the respective power curves demonstrate this.

Monitoring the maximum power point under shifting environmental conditions can help this project get better. Solar radiation change, changes in the surrounding temperature, or possibly both, are examples of environmental change. This is possible by doing MPPT using Simulink models rather than putting the code for it in Embedded MATLAB functions. Instead of using constant values as they are in this example, the solar irradiation and temperature can be inputs in Simulink models.

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