

A Review Paper on Maximum Power Tracking for Photovoltaic Power System for Performance Evaluation

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Abstract

Solar Radiation and Temperature plays an important role in electric power supply by Photovoltaic Power Generation. Maximum Power Operating Point tracking makes the system efficient. Three weight comparison methods help in avoiding oscillation problem of the perturbation and observation algorithm, which is used to track the maximum power point. For this a nano technology based system consisting single chip unit is designed to adjust the output voltage of a solar cell array.

Finally, this study confirms the superior performance of the photovoltaic power generation

Keywords: *Photovoltaic; cell array; oscillation; perturbation and observation algorithm; maximum power point tracking..*

I. INTRODUCTION

PV generation is playing an important role as a renewable source as it involves no fuel cost, requiring little maintenance and above all not being polluting among others. But they have relatively low conversion

efficiency. For which control of MPPT for solar array is very essential to improve PV system.

Amount of power generated by PV depends on operating voltage of the array. MPP of

PV varies with solar insulation and temperature. At MPP, the PV operates at its highest efficiency.

In MPPT, P&O (perturbation and Observation) technique is widely used to control the PV power generation as it is comparison method – by utilizing a Boost Converter to adjust the output voltage of the PV to approach MPP.

The rest of this paper is organised as follows. Section II introduces the basic principle of PV system. Section III describes the traditional P&O. Section IV explains the ‘Three Point Weight Comparison’ method. Section V discusses experimental results as illustrations.

Conclusion is finally drawn in the last Section.

II. MATHEMATICAL MODEL

In solar cell, PV array are the building block, which is basically a p-n semiconductor junction shown in Figure1. V-I characteristics of a solar array is given by Equation (1)[4].

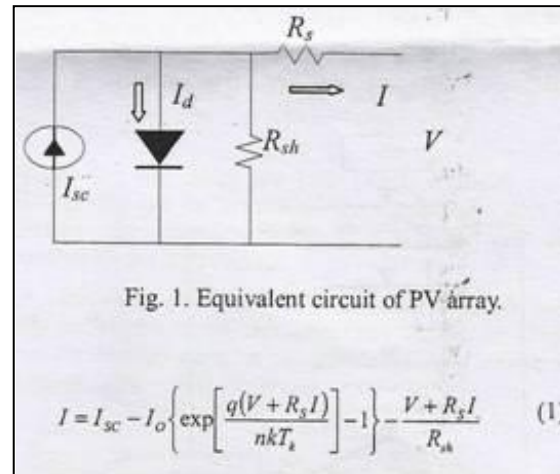


Figure: 1

Where V & I represents the output voltage and current of the PV respectively; R_s and R_{sh} are the series and shunt resistances of the cell; q is the electronic charge; I_{sc} is the light generated current; I_o is the reverse saturation current; n is a dimensionless factor; k is the Boltzmann's constant and T_k is the temperature in OK.

Computer simulations use Equation (1) to obtain output characteristic of solar cell as shown in Figure2. The output characteristics of solar cell are Non-Linear and are influenced by solar radiation, temperature and load condition. MPP is present in each curve at which the solar array operates most efficiently.

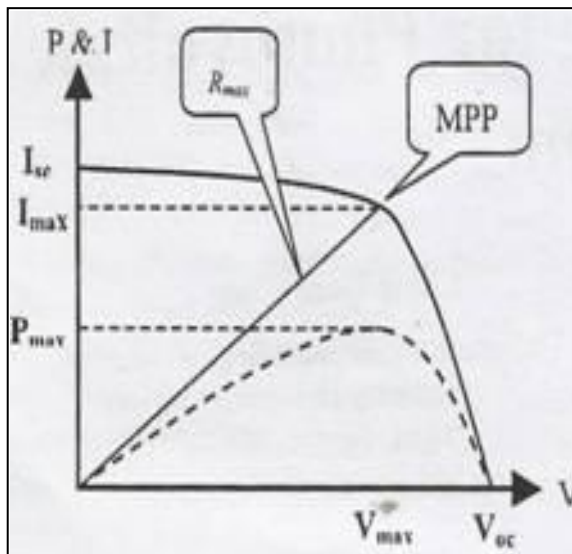


Figure: 2 V-I characteristic of a solar cell.

III. MAXIMUM POWER POINT TRACKING

All The P&O method has been broadly used as it is easy to implement. Control flow chart of the P&O algorithm is shown in Figure3. The MPP tracker operates by periodically incrementing or decrementing the solar array voltage. If the output power of the PV increases (decreases) at a given perturbation, then the subsequent perturbation is generated in the same (opposite) direction, the $Duty^+$ and $Duty^-$ represent the subsequent perturbation in the same or opposite direction respectively.

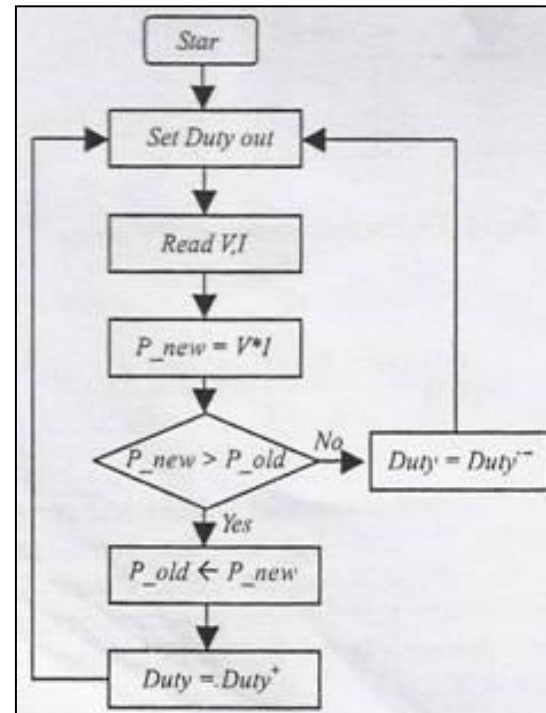


Figure: 3 Flow chart of the P & O algorithm

IV. THREE POINT WEIGHT COMPARISON METHOD

Generally P&O algorithm compared only two points, which are the current operation point and the subsequent perturbation point to observe the change and thus decide whether increase or decrease the solar array voltage.

The P&O algorithm oscillates around the MPP which results in a loss of PV power, especially in cases of rapidly changing solar radiations. Therefore, three points weight comparison method is proposed to avoid this rapid change in operating point in cases

when the solar radiation varies quickly. MPPT can be traced accurately when the solar radiation is stable and power loss is low.

The three point weight comparison algorithm runs periodically by perturbing the solar array terminal voltage and comparing the PV output power on three points of the V-P curve. Three points are:-

- 1) Current Operation Point (A)
- 2) Point (B), perturbed from point(A)
- 3) Point(C), with doubly perturbed in opposite direction from point (B)

The nine possible cases are shown in Figure4.

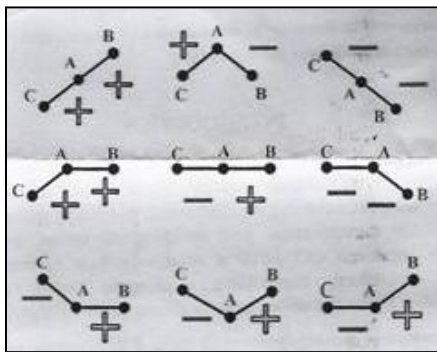


Figure: 4 possible states of the three perturbation points.

In these cases, for the point A and B, if the Wattage of point B is greater than or equal to that of point A, the status is assigned a positive weighting. Otherwise, the status is assigned a negative weighting. And, for the

point A and C, when the Wattage of point C is smaller than that of point A, the status is assigned a positive weighting. Otherwise, the status is assigned a negative weighting. Of the three measured points, if two are positively weighted, the duty cycle of the converter should be increased.

On the contrary, when two are negatively weighted, the duty cycle of the converter should be decreased. In the other cases with one positive and one negative weighting, the MPP is reached or the solar radiation has changed rapidly and the duty cycle is not to be changed. Figure 5 presents a flow chart of the three-point weight comparison algorithm.

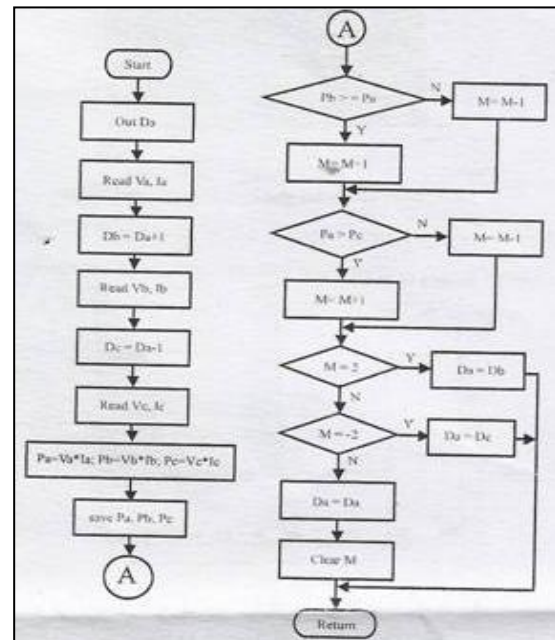


Figure: 5 Algorithm for the three-point weight comparison

V. CONFIGURATION OF PV SYSTEM

Figure 6 shows the system configuration of the proposed PV system.

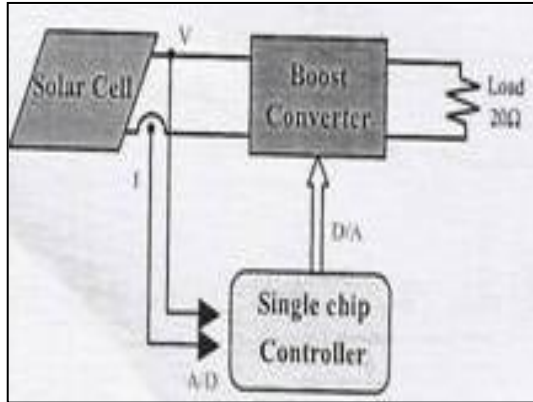


Figure: 6 Configuration of the PV System

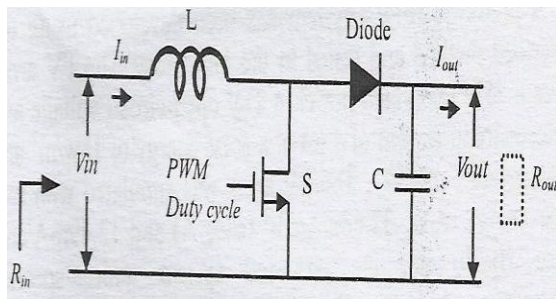


Figure: 7 Circuits of the boost converter.

This system consist of a solar array with an open voltage of and a short circuit current, an A/D and D/A converter, a resistor as the load , and a control unit on a single chip Figure 7 depicts the circuits of the boost converter connected from the output of the solar cell. The power flow is controlled by varying the on/off duty cycle of the

switching. The average output voltages are determined by the Eq. (2)[10].

Where V_{out} and V_{in} are the output and input voltage of the converter. The input power of the converter is equal to the output power of the converter if the converter is ideal, yielding the following equations.

From Eq. (4), when the load (R_{out}), is fixed, the input resistance R_{in} can be controlled by varying the duty cycle. Therefore, the operating point of the solar cell can becontrolled by the duty cycle.

CONCLUSION

A single and robust algorithm for MPPT is proposed in the paper to avoid the oscillations problem in the traditional P&O algorithm, three point weight comparison method was developed. The system include a Boost converter and a microcontroller on a single chip unit which control the converter directly according to the PV array output power measurement.

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