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Research Article

Maximum Power Point Tracking Techniques for Pv System

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Abstract

Photovoltaic systems have been used for many decades. Today, with the focus on greener sources of power, PV has become an important source of power for a wide range of applications. Improvements in converting light energy into electrical energy as well as the cost reductions have helped to create this growth. Even with higher efficiency and lower cost, the goal remains to maximize the power from the PV system under various lighting conditions. The algorithm detects the maximum power point of the PV. The computed maximum power is used as a reference value (set point) of the control system. ON/OFF power controller with hysteresis band is used to control the operation of a Buck chopper such that the PV module always operates at its maximum power computed from the MPPT algorithm.

Keywords: *Photovoltaic, maximum power point tracking, perturb and observe*

1. Introduction

Renewable sources of energy acquire growing importance due to massive consumption and exhaustion of fossil fuel. Among several renewable energy sources Photovoltaic arrays are used in many applications such as water pumping, battery charging, hybrid vehicles, and grid connected PV systems. As known from a (Power-Voltage) curve of a solar panel, there is an optimum operating point such that the PV delivers the maximum possible power to the load. The optimum operating point changes with the solar irradiation, and cell temperature. Therefore, on line tracking of the maximum power point of a PV array is an essential part of any successful PV system. A variety of maximum power point tracking (MPPT) methods are developed. The methods vary in implementation complexity, sensed parameters, required number of sensors, convergence speed, and cost.

2. PV Cell

A solar panel cell basically is a p-n semiconductor junction. When exposed to the light, a DC current is generated. The generated current varies linearly with the solar irradiance. The equivalent electrical circuit of an ideal solar cell can be treated as a current source parallel with a diode shown in figure.

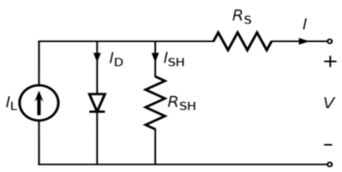

Fig.1 Equivalent electrical circuit of a solar cell

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The I-V characteristics of the equivalent solar cell circuit can be determined by following equations.

The current through diode is given by:

$$I_D = I\,[\,\exp\,(q(V + I\,R)/KT)) - 1] \qquad (1)$$

While, the solar cell output current:

$$I=I_L-I_0(e^{q(V+IRs)/KT}-1)-(\,V+IR_s)/R_{sh}$$

Where:

I - Solar cell current (A)
I_L- Light generated current (A) [Short circuit assuming no series/ shunt resistance]
I_d- Diode saturation current (A)
q - Electron charge (1.6×10-19 C)
K - Boltzman constant (1.38×10-23 J/K)
T - Cell temperature in Kelvin (K)
V - solar cell output voltage (V)
Rs- Solar cell series resistance (O)
Rsh: Solar cell shunt resistance (O)

3. Output characteristics of pv cell

The output power is depends upon the temperature and radiation (sunshine) value of the site where is the panel is placed. This may increase or decrease the output power as the result of variations of temperature and radiation level. Electrical characteristics of a PV panel with different radiation level are shown in fig.

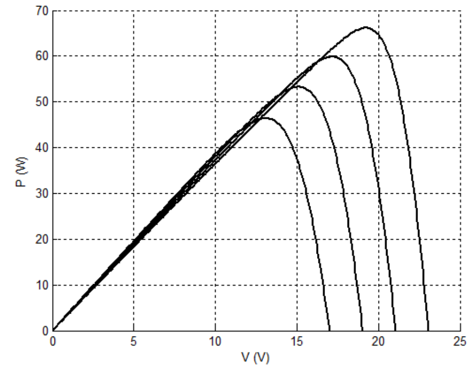

Fig.2 Pv char of solar cell

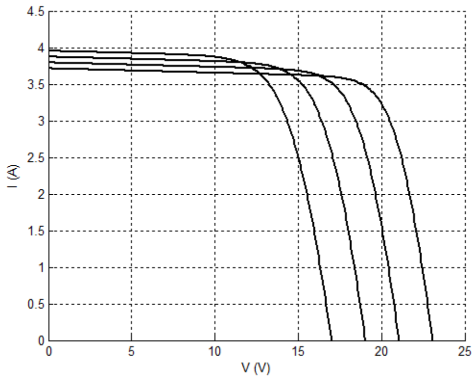

Fig.3 VI char of solar cell

MPPT

Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking harvested from the modules is then made available as increased battery charge current system that physically moves the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. Additional power

4. Commonly used MPPT techniques

The problem considered by MPPT methods is to automatically find the voltage V_{MPP} or current I_{MPP} at which a PV array delivers maximum power under a given temperature and irradiance. In this section, commonly used MPPT methods are introduced in an arbitrary order.

A. Fractional Open-Circuit Voltage

The method is based on the observation that, the ratio to its open circuit voltage V between array voltage at maximum power VOC is nearly constant.

V_{MPP}=K V_{OC}

This factor *K* has been reported to be between 0.71 and 0.78. Once the constant *K* is known, V is computed by measuring VOC periodically. Although the implementation of this method is simple and cheap, its tracking efficiency is relatively low due to the utilization of inaccurate values of the constant *k* in the computation of V_{mpp}.

Once *k*1 is known, V_{MPP} can be computed with V_{OC} measured periodically by momentarily shutting down the power converter. However, this incurs some disadvantages, including temporary loss of power. To prevent this, it can use pilot cells from which Voc can be obtained. These pilot cells must be carefully chosen to closely represent the characteristics of the PV array .Once V_{MPP} has been approximated, a closed-loop control on the array power converter can be used to reach this desired voltage. Since the relation is only an approximation, the PV array technically never operates at the MPP.

B. Fractional Short-Circuit Current

The method results from the fact that, the current at maximum power point I_{MPP} is approximately linearly related to the short circuit current I_{SC} of the PV array.

I_{MPP}=K_2 I_{SC}

Like in the fractional voltage method, k is not constant. It is found to be between 0.78 and 0.92. The accuracy of the method and tracking efficiency depends on the accuracy of K and periodic measurement of short circuit current.

An additional switch usually has to be added to the power converter to periodically short the PV array so that Isc can be measured using a current sensor. This increases the number of components and cost. It is clear that this method and the previous one have major drawbacks, the power output is not only reduced when finding *Isc* but also because the MPP is never perfectly matched.

C. Perturb and Observe

In P&O method, the MPPT algorithm is based on the calculation of the PV output power and the power change by sampling both the PV current and voltage. The tracker operates by periodically incrementing or decrementing the solar array voltage. If a given perturbation leads to an increase or decrease in the output power of the PV, then the subsequent perturbation is generated in the same (opposite) direction, So the duty cycle of the dc chopper is changed and the process is repeated until the maximum power point has been reached.

Means, the system oscillates about the MPP. Reducing the perturbation step size can minimize the oscillation. However, small step size slows down the

MPPT. To solve this problem variable perturbation size that gets smaller towards the MPP. However, the P&O method can fail under fastly changing atmospheric conditions. P&O involves a perturbation in the operating voltage of the PV array. In the case of a PV array connected to a power converter, perturbing the duty ratio of power converter perturbs the PV array current, and consequently perturbs the PV array voltage .Fig. 5 shows that the increment, or decrement of the voltage increases, or decreases the power when the operating point is on the left of the MPP, and decreases, or increases the power when being on the right of the MPP. The process is repeated periodically until the MPP is reached. The system then oscillates around the MPP. The oscillation can be minimized by reducing the perturbation step size. However, a smaller perturbation size slows down the MPPT. A solution to this conflicting situation is to have a variable perturbation size that gets smaller towards the MPP

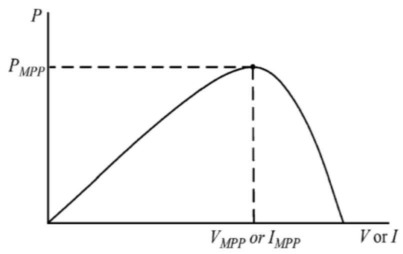

Fig.4 VI characteristics of solar cell

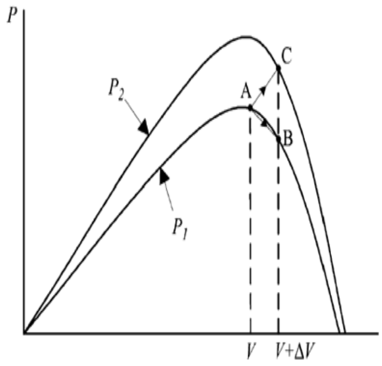

Fig.5 Divergence of p/o from MPP

However, if the irradiance increases and shifts the power curve from *P1* to *P* within one sampling period, the operating point will move from point A to C. This represents an increase in power due to the new curve P, while the perturbation is kept the same. Consequently, the operating point diverges from the MPP and will keep diverging if the irradiance steadily increases, numerous number of researches apparel in the literature recently covering not only these two methods, but also outlining other MPPT techniques.

The P&O method has been broadly used because it is easy to implement. The MPP tracker operates by periodically incrementing or decrementing the solar array voltage. If a given perturbation leads to an increase (decrease) the output power of the PV, then the subsequent perturbation is generated in the same (opposite) direction.

The P&O method presents, in some cases, two drawbacks:

- By forcing the operating point to operate near the MPP, oscillations around the MPP appear in steady state as shown in figure. Such a drawback gives rise to the waste of some amount of available energy.
- It can confuse; it moves the operating point far from the MPP instead of close to it under rapidly changing atmospheric conditions.

D. Incremental Conductance

Incremental conductance method uses two voltage and current sensors to sense the output voltage and current of the PV array. At MPP the slope of the PV curve is 0.

$(dP/dV)_{MPP}=d(VI)/dV$
$0=I+VdI/dV_{MPP}$
$dI/dV_{MPP} = - I/V$

The left hand side is the instantaneous conductance of the solar panel. When this instantaneous conductance equals the conductance of the solar then MPP is reached. Here we are sensing both the voltage and current simultaneously. Hence the error due to change in irradiance is eliminated. However the complexity and the cost of implementation increases. As we go down the list of algorithms the complexity and the cost of implementation goes on increasing which may be suitable for a highly complicated system. This is the reason that Perturb and Observe and Incremental Conductance method are the most widely used algorithms.

Conclusion

Here by using the maximum power point technique the efficiency of photovoltaic system can improve.purterb and observe method is commonly used due to its simplicity.

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