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A Kind of Maximum Power Point Tracking Method Based on Improved Observation Technique

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Abstract. The operation of photovoltaic cells is influenced by the environmental temperature, irradiance and other factors, showing a typical non-linear characteristics in different external conditions. This paper studies the working characteristic of photovoltaic panels. This paper analyses the impact the temperature and light intensity put on the output current, output voltage and output power of photovoltaic battery. Photovoltaic cells are able to run on different and unique maximum power point. This paper compares and analyzes four useful MPPT methods, points out the advantage and weakness of every method in detail. This paper presents a calculation method of input and output capacitors and inductors of BOOST circuit.

Keywords: maximum power point, MPPT, oscillation.

1 Introduction

Photovoltaic power generation is a way of the development and utilization of solar energy, photovoltaic power generation uses photovoltaic cells converting solar energy into electricity. And with the advance of technology, photovoltaic power generation has the potential to be one of the most promising power generation technologies. However, photovoltaic cells show a typical nonlinear operating characteristic. In a photovoltaic power generation system, the photovoltaic cell should be made to work in its optimal condition to convert maximum solar energy into electrical energy. The traditional MPPT methods can be divided into closed-loop MPPT methods and opening-loop MPPT method basing on different judgment methods and criterions. Open-loop MPPT methods are based on the output characteristic curves of photovoltaic cells. Closed loop MPPT methods include perturbation and observation method, incremental conductance method, etc. Every method has its advantages and disadvantages, so we do a simple comparison of these methods, and give the applicable occasions of each method. In the end, this paper proposes an improved MPPT method. We make a simulation of the new method. The simulation results show the feasibility of the method, the method can improve the conversion efficiency[1-3].

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2 Comparison of maximum power tracking method

2.1 Constant Voltage Control Method (CVT)

(1) principle Voltage of the maximum power point is at both sides of a fixed voltage value, which can be see from the output P-U curve principle of photovoltaic cells. CVT control method is controlling the output voltage of the photovoltaic cells in the vicinity of voltage of the maximum power point. In this case the photovoltaic cells will approximately work in the maximum power point.

(2) the advantages and disadvantages The advantage of using CVT control method is that the control method is simple and fast; the system is in high stability. But its drawback is that it ignores the impact of external conditions ,it changes the voltage of photovoltaic Maximum operating point . Constant voltage tracking method is generally used in less demanding low prices and simple system.

2.2 Short-circuit current proportional coefficient method

(1) principle There is also approximately a linear relationship between current of maximum power point of photovoltaic cells I_m and short-circuit current of photovoltaic battery I_{SC}, namely

$$I_m \approx k_2 - I_{SG} \quad . \tag{8}$$

Where, the value of the coefficient k_2 depends on the characteristics of the particular photovoltaic cells.

(2) the advantages and disadvantages The main advantage of Short-circuit current proportional coefficient method is simple and easy to implement. The disadvantages are that the photovoltaic cells are not working in the real maximum power point.

2.3 perturbation and observation method (P&O)

(1) principle The basic idea is: First, add an disturbance to the output voltage(or current)of photovoltaic cells, then observe changes in power output of photovoltaic cells, therefor change the direction of the disturbance of voltage (or current)according to the trend of the chang of the output power and the direction of the disturbance to make the system work in the maximum power point of photovoltaic cells finally.

(2) the advantages and disadvantages Perturbation and observation method has the advantages of simple control, few measured parameters. But its drawback is that the disturbance and observation method has oscillation and false judgement problem, what’s more the initial value of the voltage and the step of disturbance voltage have great influence on the tracking accuracy and tracking speed.

2.4 incremental conductance method (INC)

(1) principle There is dP/dU=0 at the maximum power point, which can be seen from the

P－U curves of photovoltaic cells. So consider using total differential of power to approximatly lternative dP, the following formult can be draw from dP = UdI + IdU at the maximum power point:

$$dI/dU = I/U \quad . \tag{9}$$

Therefore, the formula (9) can be a basis for determining whether a photovoltaic cell are working at the maximum power point, do the corresponding control to the system, which can achieve the maximum power point.

(2) the advantages and disadvantages The advantages of INC method is a good control effect, the stability of the control method is high, and the method is not affected by the power time curve. But its drawback is that the control algorithm is complex,and has higher requirements on the control system.In addition, the incremental conductance method has misjudgment problems.

3 Improved variable step perturbation and observation method

In summary, the existing methods can not resolve the misjudgment and oscillation problems of maximum power point tracking at one time. Now we introduce a new method of maximum power point tracking. This new method is simple and fast compared to other methods, it is very good to solve the oscillation problem, and has the effect of inhibiting the misclassification problem.

In the U−I characteristic curves of photovoltaic cells, area range ratio of the region of class current source and the region of class voltage source is about 4:1. The perturbation and observation method with variable step size is always hoping a long step in similar constant current source region in order to improve the tracking speed, a short step size in similar constant voltage source area in order to improve the tracking accuracy. Concrete steps are: first, detect the change of the current and the voltage,judge the working area the photovoltaic cells is located in : In the class constant current source region, current changes little, in the class constant voltage source region, current changes big; then, in different work areas we set different steps. This can reduce the amount of calculation,and speed up the process of tracking maximum power point. U1 is the voltage changed at the frist time, P_1 is its corresponding output power. U is the current voltage, P is its corresponding output power.

When increasing the reference voltage U (U_1=U+⊿U), if P_1>P, it indicates that the current working point is located in the left side of the maximum power point. The system should keep increasing reference voltage,namely U_2=U_1+⊿U, where U_2 is the voltage adjusted at the second time.

When increasing the reference voltage U (U_1=U+⊿U), if P_1<P, it indicates that the current working point is located in the right side of the maximum power point. At this

point we should change the direction of system disturbance, reducing the reference voltage, namely $U_2=U_1-\Delta U$, where U_2 is the voltage adjusted at the second time.

When decreasing the reference voltage U ($U_1=U-\Delta U$), if $P_1>P$, it indicates that the current working point is located in the right side of the maximum power point, At this point we should change the direction of system disturbance, increasing the reference voltage, namely $U_2=U_1+\Delta U$, where U_2 is the voltage adjusted at the second time.

When decreasing the reference voltage U ($U_1=U-\Delta U$), if $P_1<P$, it indicates that the current working point is located in the left side of the maximum power point, The system should keep decreasing reference voltage,namely $U_2=U_1-\Delta U$, where U_2 is the voltage adjusted at the second time.

When the change of output power is very small ,stop the disturbance, so this method can solve the problem of system of oscillation well.

4 Conclusion

It is verified by simulation that improved and observation perturbation method avoids the problem of oscillation existing in the process of tracking. The method has fast tracking speed, high precision, can filter oscillation in the process of tracking, can accurately trace the maximum power point. The method provides reference and feasibility to the maximum power point of PV power.

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