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Three-phase Alternating Parallel Perturbation Variable Step Length Apply to MPPT Solar Controller

Qiang TONG[1,a,*], Bin WANG[1], Zhao-Wei SHAO[1], Xiang LI[2] and Yong-Qing WANG[2]

HeBei Mutian Solar Energy Scientech Co.Ltd., Baoding 071000, China

Electronic Information Engineering College, Hebei University, Baoding 071000, China

[a]184977735@qq.com

*corresponding author

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Abstract. In order to improve the charging efficiency of photovoltaic power generation, Photovoltaic controller adopts STM32F103 as the main chip, Hardware IGBT power (IKW40N120H3), Three-phase alternating BUCK/BOOST circuit in parallel, The variable step disturbance observation Maximum Power Point Tracking (MPPT), Combining the open circuit voltage method and average sliding filter AD conversion technology, Through 3 kW photovoltaic controller product certificate, On the charging control for the stable operation, Implements the disturbance of the MPPT algorithm optimization.

Introduction

In the photovoltaic power generation system, the maximum power point tracking (MPPT) is critical to improving the charging efficiency of the PV system. At present, there are many researches on MPPT control strategy both at home and abroad. The commonly used control methods include fixed voltage method, disturbance observation method, incremental conductivity method and fuzzy control method [1]. Which disturbance observation method to control simple, easy to implement and widely used algorithm [2]. But there are also many deficiencies. In this paper, the control method is optimized by variable step perturbation, open circuit voltage method and average sliding technique, so that the charging control can be more stable and efficient.

Hardware Circuit

The system uses the IGBT-based three-phase interleaved BUCK / BOOST circuit shown in Figure 1

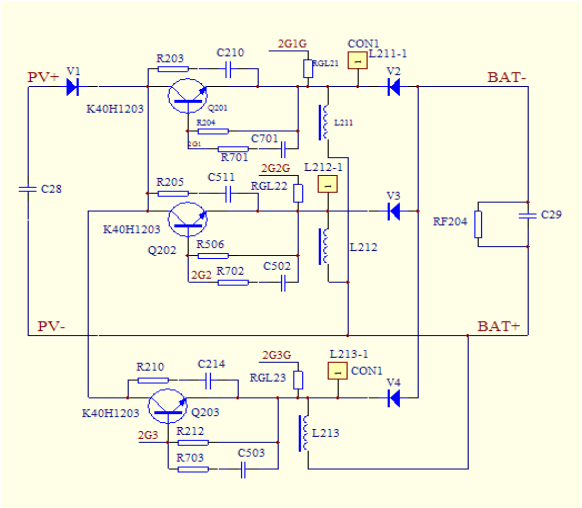

Fig. 1 Three-phase Interleaving BUCK / BOOST

Principle of Disturbance Observation

By disturbing the output voltage of the photovoltaic cell, observe the change of the output power, and determine the next disturbance direction according to the change trend of the output power, and so on until the photovoltaic cell reaches the maximum power point.

First, assume that the temperature, light intensity remains unchanged, P-U curve shown in Figure 2, it is a single peak curve. P is the output power, corresponding to the output voltage and current of photovoltaic cells are U, I, U1, I1 for the current photovoltaic cell voltage and current detection value, P1 for its corresponding output power, ∆ U for the voltage adjustment step. The specific process is as follows:

When the reference voltage (U1 = U+∆ U) is increased and P1> P is present, the current operating point is on the left side of the maximum power point (A, B, and C points in Fig. 2) and the next disturbance voltage direction.

When the reference voltage (U1 = U+∆ U) is increased, P1>P, the current operating point is on the right side of the maximum power point (D, E, F in Fig. 2),

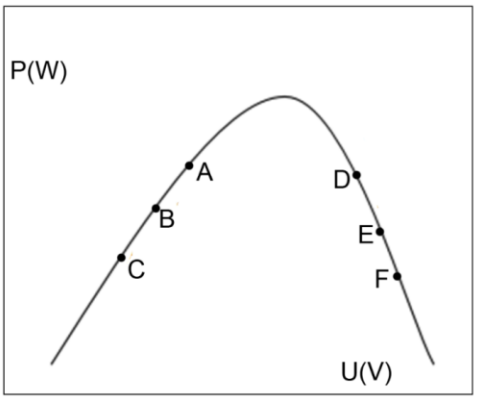

Fig. 2 Schematic Diagram of Perturbation Observation

the next disturbance voltage direction should be changed opposite direction.

When the reference voltage is reduced (U1=U-∆ U) and P1<P, the current operating point is on the left side of the maximum power point and the next disturbance voltage direction changes.

When the reference voltage (U1=U-∆ U) is reduced and P1>P, the current operating point is on the right side of the maximum power point and the next disturbance voltage direction remains unchanged.

In the actual test, the impact of the maximum power factor of the light plate is still a lot, illumination, ambient temperature, etc. According to general experience, that the work of the maximum power of the light board operating voltage of 0.78 times the open circuit voltage; MPPT start, will introduce a small process , As shown in Figure 3,

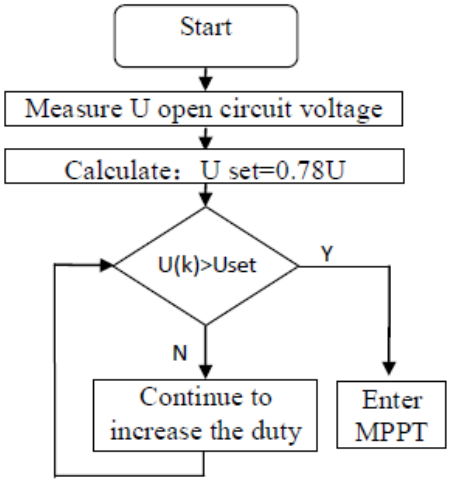

Fig. 3 Open Circuit Voltage Method

So that MPPT will be more smoothly into the vicinity of the maximum power point.

On the Perturbation Observation System Process

In the actual control process, a reasonable introduction of disturbance observation method, the program design block diagram shown in Figure 4.

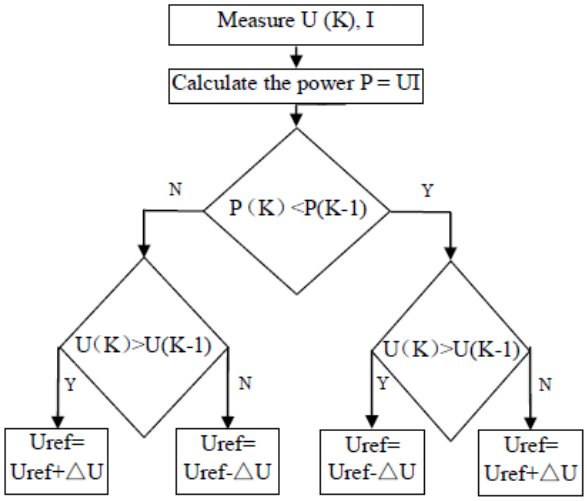

Fig. 4 Disturbance Observation Method

In the actual disturbance control, since the target value of the system is always being sought, in order to reduce the oscillation and output ripple, the variable step size control ΔU is introduced, and in the actual calculation and control, ΔU (step size) is changed , And less than the set value ΔU_{max}=10, where the actual correspondence for the duty cycle, while the corresponding ratio K=3; control method is as follows:

U d=(P(K)-P(K-1))/(I(K)-I(K-1));

△ U=k*Ud;

Table 1 3KW PV controller test

△ U	P(W)	K	Refer to the MPPT device P(W)	Efficiency(P/P1)
7	700	3	1000	70%
8	750	3	1000	75%
10	1080	3	1000	108%
12	980	3	1000	98%

The control results at the same time are shown in Table 1.

Table 1 for the actual product through the company, the MPPT the actual engineering test, in the actual operation control, the use of timer to quickly enter the interrupt method, every 312.5μS into an AD conversion, while collecting 40 cycles of data for the average Calculation, such sampling accuracy will reach 0.1% or less. At the same time in the MPPT task when about 20mS transferred into the MPPT task, dealing with variable step perturbation control.

Simulation Experiment Analysis

PSIM software is used to simulate the above algorithm. According to the actual PV module is 25 degrees Celsius, the light intensity of 1000W / m2, a model of photovoltaic performance parameters are as follows: open circuit voltage 22.1V, short circuit current ISC = 7.8A, the maximum power point voltage Um = 17.6V, IM = The simulation time is 8S, the initial search point is set to 0V, and

changes in 3S and 6S, the change is 800W / M2 and 1200W / M2.

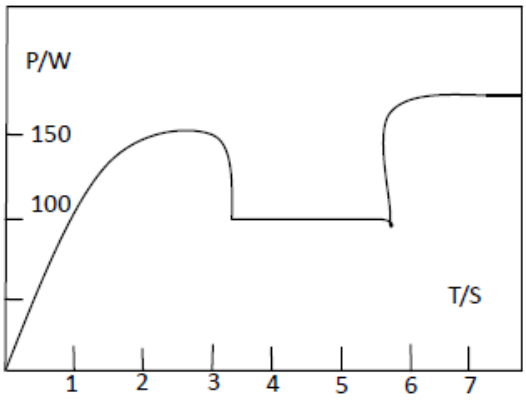

Fig. 5 Algorithm of Changing the Step Size

Algorithm with variable step size As shown above, this method can quickly achieve maximum power (T = 1.5S), and near PM = 141W, with the actual maximum P = 140, the error is only 0.7%; at the same time after T = 6S quickly into the new stability point.

Conclusion

In this paper, the MPPT algorithm is applied to the actual product testing of the 3KW controller. Through the actual engineering verification of MPPT, the variable step is adopted in the process of product development, which improves the oscillation and improves the efficiency. But also the application of three-phase staggered parallel technology, making the output ripple smaller.

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