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Design of Maximum Power Point Tracking Method Using Modified Perturb and Observation with Cuk Converter

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ABSTRACT

Photovoltaic is a resource that cannot be depleted and is widely available as future energy. Photovoltaic modules are affected by the intensity of radiation from a changing sun. Therefore it takes a method to find the maximum power point of photovoltaic.

One of the methods used is Maximum power point tracking (MPPT). From Photovoltaic it will be connected to a current sensor and a voltage sensor so that it is read by the microcontroller and connected to the DC-DC converter circuit. The microcontroller will be embedded with the Modified Perturb & Observe (P&O) method to adjust the voltage output from the DC-DC converter by adjusting the pulse width (dutycycle) on the PWM generated from the microcontroller. After that, the results of the converter are analyzed using a load in the form of an accumulator or battery. At the output of the converter, a current sensor and a voltage sensor will be given to determine the output of the DC-DC converter with the Cuk topology. After conducting testing and analysis, using the proposed method provides an efficiency of 83%, this is proven by the power and voltage values. Using MPPT is able to optimize the panel output power of 23.92W with an accumulator load of 12 Volts.

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KEYWORDS: Power Tracking, Photovoltaic, Modified Perturb and Observe, Cuk Converter

I. INTRODUCTION

Photovoltaic has a characteristic curve V-I, where in the characteristic curve there is a special point commonly called the MPP (Maximum Power Point) point. At that point photovoltaic is at an optimal state, both from the voltage and current generated. When the voltage and current produced are maximum, it will get maximum power output. This MPP point is unknown, but it can be searched with a tracking algorithm commonly called the MPPT algorithm. The MPPT algorithm works to find the optimum point of photovoltaic and try to maintain it at the optimum state.

Increased efficiency value refers to the characteristic curve of solar cell current-voltage which depends on the value of radiation and temperature it receives. Each module has its own optimal operating point known as the Maximum Power Point (MPP). The characteristics of this Maximum Power Point will change according to sunlight and temperature. Depending on the weather, the Maximum Power Point Tracker (MPPT) is not easy to keep values at maximum conditions with reference to varying voltage and current characteristics. To solve this problem, several MPPT algorithms were proposed as reviewed by Jaiswal and Mahor. One algorithm that is often used is Hill Climbing. In their research, RaVindran and Sutaria implemented this algorithm on a 10Watt solar cell using an ARM Cortex-M3 32 bit microcontroller. This algorithm is also used by Prianda and Sulistyowati to simulate and analyze static solar panels. There have been many algorithms used as MPPT such as firefly, fuzzy control, RCC etc. For example, the P&O algorithm has the advantage of short time to converge, but there is a large ripple in the PV power produced. In addition, this algorithm also cannot cope with PV that is under partial shaded conditions [1],[2].

Not only in terms of MPPT, but PV systems can also be optimized by choosing the right DC-DC converter. Besides being used to support the work of MPPT, DC-DC converters are also used to increase or decrease the voltage from the PV voltage value to the value we want. DC-DC converters have many types, from those that only increase the voltage or lower it, to DC-DC converters that can increase or decrease the voltage. Just like an MPPT algorithm, each type of converter also has its own advantages and disadvantages. Suppose a Cuk converter that has good efficiency because it can dampen

oscillations resulting from the P&O algorithm and has a smaller current ripple than the converter in general.

II. METHOD

Photovoltaic characteristics can be modeled simply as a circuit consisting of a current source mounted parallel to a diode. Maximum Power Point Tracker is a method to determine the point where maximum power is generated by solar panels. Based on research conducted by Prianandaa and Sulistyowati, one of the advantages of using MPPT is the fulfillment of photovoltaic equilibrium conditions that are fast for conditions required by the load and that can be met by solar panels. These two components are combined to obtain a power rating of P [3],[4],[5],[6],[7]. The Modified Peturb and Observe method is the initial algorithm used for the Maximum Power Point Tracker Photovoltaic application. This algorithm has a fairly fast response in finding the power peak point of a uniform photovoltaic characteristic curve, but P&O has the disadvantage of ripple dutycycle when it reaches steady state conditions. DC to DC converter or commonly called chopper, DC to DC converter can be used to raise or lower DC voltage. The way it works is constant direct current voltage on and off switches to reduce the initial price of the voltage used on the load. Cuk Converter has output voltage characteristics greater and smaller than the input voltage. Like the buck-boost type, Cuk topology DC-DC converters can also produce a smaller or greater output voltage from a voltage source[8],[9],[10],[11].

III. RESULTS AND DISCUSSIONS

Photovoltaic Characteristics

In testing the characteristics of miniature photovoltaics is needed as a reference to design the converter topology used in this study. The data presented are characteristic data at 08 o'clock.00 WITA until 15 o'clock.00 WITA with observations of the relative radiation intensity of the sun uniformly and at orthogonal positions with respect to the photovoltaic surface plane. With a peak photovoltaic specification of 50 watts. in Table 1.

Table 1: Photovoltaic Test Data

Time	Volt (V)	Current (I)	Power (W)	Time	Volt (V)	Current (I)	Power (W)
08.00 – 09.00	0	1,75	0	12.00 - 13.00	0	1,65	0
	3	1,45	4,35		3	1,5	4,5
	5	1,35	6,75		5	1,3	6,5
	8	1,15	9,2		8	0,95	7,6
	10	0,9	9		10	0,8	8
	13	0,6	7,8		13	0,55	7,15
	16	0,35	5,6		16	0,25	4
	19	0	0		19	0	0

Each of the data in Table 1 will be plotted in the form of current to voltage and power to voltage characteristic curves presented in Figure 1 and Figure 2 as follows.

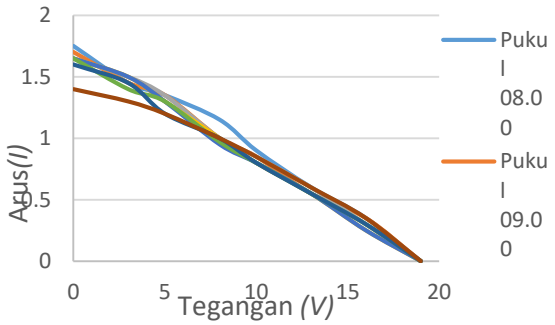


Figure 1. I-V Characteristic Curve

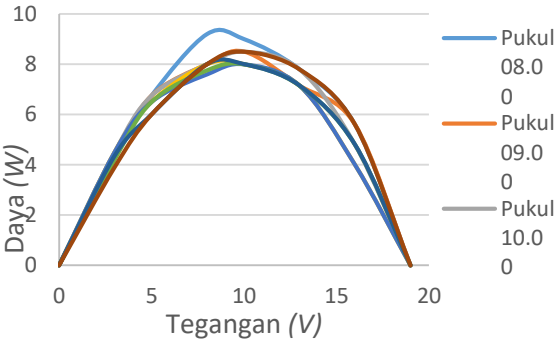


Figure 2. PV Characteristic Curve

Testing Simulated *Cuk Converter* Circuit

Testing of *Cuk converter* circuit for MPPT system. From the calculation results simulated in the PSIM software to find out the calculation results with the simulation results. Dutycycle effect on converter output [10],[12],[13]

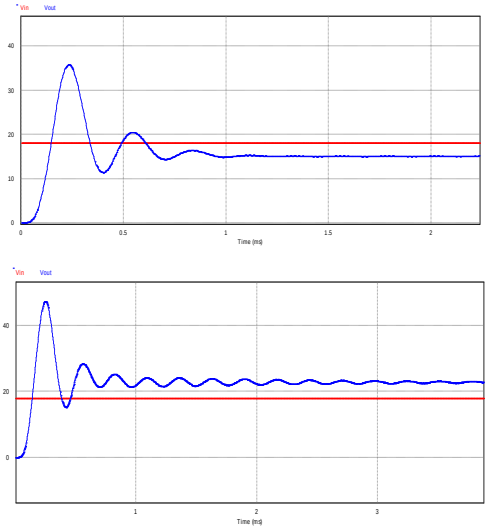


Figure 3. Simulation Results of the Output Voltage and Input Voltage of the Cuk Converter Circuit

In Figure 4 and Figure 5 the output current on inductor 1 and 2. To find out the results of the inductor current, attach the current sensor probe to the side area of the inductor in the simulation. From the simulation results, the output current of the Cuk converter shows a negative output, because the output of the Cuk converter circuit is inverted [4],[14],[15].

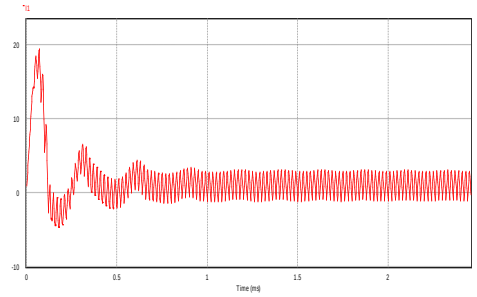


Figure 4. Current Simulation Results in Inductor 1

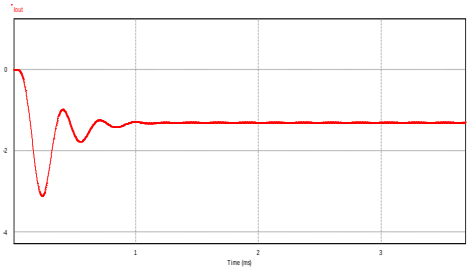
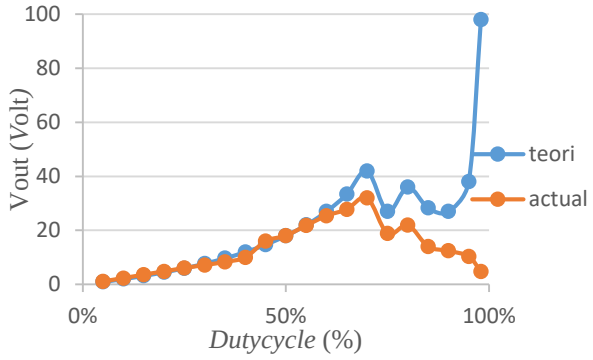
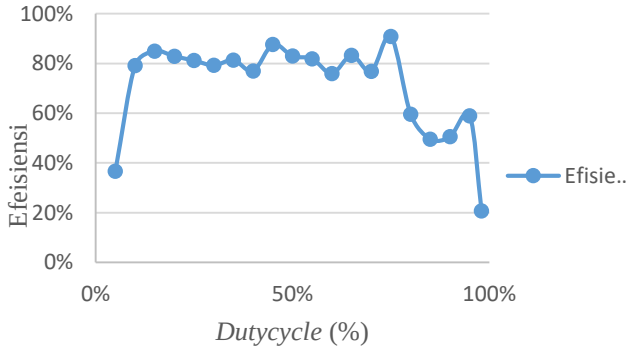


Figure 5. Current Simulation Results on Inductor 2

The results of the Cuk Converter performance test can be seen in Table 2. V-in is the voltage from the variable power supply, read using a digital clammeter placed between the power supply and the converter input [2]. The V-out which is read using a digital avometer can be seen in Figure 4 with the name of the measuring instrument. I-out is a user who uses a digital clammeter as in the alternating current input used between Iin and I-out. Because each inductor has a different datasheet. Not only that, the copper used also greatly influences the saturation effect [16]



(a) Transformation Curve



(b) Efficiency Curve Against Dutycycle.

Figure 4. Curve Cuk Converter Results

Simulation Testing with Modified PnO Algorithm

MPPT System Testing for power harvesting using the Modified PnO algorithm in this study is testing with 1 PV using a single topology. In MPPT system testing this is a system-wide test of hardware and microcontrollers using a peak power value finder algorithm, Maximum Power Point Tracker for miniature static Photovoltaics. Testing is taken using 2 methods in data collection [17],[5]. The test was carried out in the workshop room of the Department of Electrical Engineering, Universitas Pendidikan Nasional, Denpasar at 08.00 WITA to 12.30 WITA, with evenly clear weather conditions.when conducting direct testing of the MPPT system with the modified perturb and observe method. Where in this test accumulators are used as a load in the system. From tests conducted using the MPPT modified P&O algorithm method, with Cuk Converter can be seen in Table 2, the data presented are voltage, current, and power data when the system has been steady state. Table 2 is the MPPT System testing table using the Modified P&O algorithm in Single Topology. In this test, the power value at the input is greater than the value produced by the output to the load [18],[1],[19].

Table 2: Testing the MPPT System

Time	V*in* (*V*)	*Iin* (*A*)	Pin (*W*)	V*out* (*V*)	I*out* (*A*)	P*out* (*W*)	Efisiensi
08.00	14,54	0,94	13,67	13,4	0,79	10,586	67%
08.30	12,81	1,91	24,47	12,2	1,96	23,912	93%
10.00	12,81	1,91	24,47	12,2	1,96	23,912	93%
10.30	15,3	1,13	14,38	13,4	1,72	9,648	93%
11.30	12,33	2,06	25,40	12,2	1,96	23,52	93%
12.00	12,5	2,01	25,13	12,2	1,96	23,912	95%
12.30	15,32	1,08	16,55	13,8	0,84	11,592	70%

IV. CONCLUSION

From all the stages that have been carried out, starting from literature study, design and manufacture to testing, it can be concluded that using the Cuk Converter circuit can increase the voltage by 24Volt or decrease the voltage by 14Volt by adjusting the pulse width. If using the modified perturb and observe algorithm, the ripple power produced is very small compared to perturb and observe. By using the MPPT method, it is proven to be able to charge a battery of 2.01A. To further improve and perfect the performance of this tool, it is recommended that in making a series of Cuk converters use blokcore it is not recommended to use ferrite

cores. In using measuring instruments, use measuring instruments that are in accordance with the data to be taken.

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