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Identification of MPPT using Duty Ratio Method

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***Abstract*— For the past few decades, it has been observed that power generation through solar panels is regulated by the Government as well as non-government sectors. Few researchers insist on using the hybrid system for power generation through solar and wind or solar and fuel cell, solar and ultra-capacitor, etc. Here we would like to focus on the identification of max. Power-point tracking (MPPT) of solar panels using boost converter and the Duty ratio method. In the duty ratio method to implement MPPT in a boost converter, use to MPPT algorithm i.e. P&O and the incremental conductance algorithm. The output voltage & power solar arrays or panels are ascertained. Analyze the output power & voltage of both MPPT algorithms and determine which algorithms are most appropriate for MPPT of the solar system. Simulation of MPPT is done in MATLAB MATLAB/M-File environment.**

***Index Terms*— MPPT, MATLAB, duty ratio.**

I. INTRODUCTION

For maximum power production from solar panels, maximum power point tracking (MPPT) is an important method in solar photovoltaic (PV) systems. Variations in solar radiation, cell temperature, and environmental factors all contribute to the varied output power that solar panels provide. The objective of MPP is to locate the point on the panel's I-V curve where the power output is highest, or the ideal operating point. The Role of Duty Ratio

- Converters (DC-DC): A converter (DC-DC) controls the voltage and current between the solar array and the connected load (such as the battery or grid) in a typical solar PV system. The duty ratio, which is usually denoted by the letter "D," is the ratio of the entire switching duration to the amount of time the DC-DC converter's switch is ON. We can efficiently modify the impedance that the solar cell perceives by adjusting the duty ratio.
- How to MPPT works: The Current (I) and voltage (V) of the panel are continuously calculated by MPPT algorithms. The algorithm modifies the duty ratio in order to determine the ideal location on the I-V curve based on these readings.
- Hybrid Techniques: A variety of MPPT approaches, such as conventional, intelligent, optimization, and hybrid approaches, have been studied by researchers. Hybrid methods integrate several strategies for increased effectiveness. Although hybrid approaches are frequently more expensive than conventional approaches, they have more intricate designs and are more inefficient overall. In this paper, the duty ratio approach is proposed to identify MPPT.

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The suggested system's topology is covered in Section II. The MATLAB m-file is used to perform the mathematical equations. Sections III and IV of the simulation result concern the output Voltage & power with varying PV Solar irradiation. V section presents the paper's conclusion. [12-14]

II. PROPOSED SYSTEM TOPOLOGY

Fig.1 shows the duty ratio method for MPP using a Boost converter. The following methods are used [9-11]

- Reference voltage
- Duty ratio

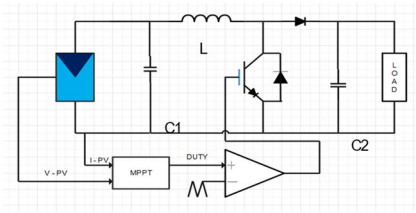

Figure 1. Proposed Duty Ratio(D) Method

A. Reference Voltage Method

The Reference Voltage Method is a technique used in MPP for optimizing the energy extraction from photovoltaic (PV) systems. This method involves adjusting the operating point of the solar panel to maximize its power output by continuously monitoring the voltage and current. The key concept point of the Reference voltage method are

- Maximum Power Point (MPP): The MPP is the point at which a PV system produces its maximum power output, which varies with solar irradiance and temperature.
- Reference Voltage (Vref): A predetermined voltage level is set based on the characteristics of the PV module. This voltage is adjusted based on real-time measurements of voltage and current from the PV panel.
- Voltage Adjustment: The reference voltage is updated dynamically. When the power output increases, the reference voltage is raised; when it decreases, the voltage is lowered. This helps in homing in on the MPP.[13]

B. Duty Ratio Method

The Duty Ratio Method is an MPPT technique employed to maximize the energy extraction from photovoltaic (PV) systems. The method controls the duty cycle of the converter (e.g., a DC-DC converter) to obtain maximum power from the solar panel. The Key Concepts of the Duty ratio method are

- Maximum Power Point (MPP): The MPP is the point at which a PV system can produce its maximum power, which varies with changes in solar irradiance and temperature.
- Duty Cycle: The duty cycle refers to the fraction of time a converter is turned on versus the total time it operates. In DC-DC converters, this ratio significantly influences the output voltage and current.
- Control Strategy: By modifying the duty cycle(D), the converter can adjust the (v) voltage and (I) current delivered from the solar panel to the load or battery.[13]

C. Simulation parameter

Table 1 shows the simulation parameters and Table 2 shows design parameter of MPPT using a boost converter [6]

TABLE I. SPECIFICATION

Sr.no	Simulation Specification		
	Variable	Value	Unit
1	Series PV array	47	No.
2	Parallel PV array	10	No.
3	Irradiance(w/m^2)	500 700 1000	w/m2
4	Temperature	25	Degree Celsius
5	Resistance	0.0001	ohm
6	C1 (Capacitor)	1000	microfarad
7	C2 (Capacitor)	3227	microfarad
8	Resistive load	1.5	ohm

The MPPT simulation employing the P&O method and incremental conductance method makes use of the given specification

D. Design Parameter

TABLE II. SPECIFICATION

Variable	Value
Current Input	400 Volt
Ripple current	20 A
Ripple Voltage	6 V
Current Output	166 V
Inductance (L)	1.45 milihendre
Capacitor (C)	3227 microfarad

III. SIMULATION RESULT

Using the Perturb & Observed algorithm for duty ratio method, the result of implementing the use of MPPT in a DC-DC boost converter for different solar irradiances was obtained

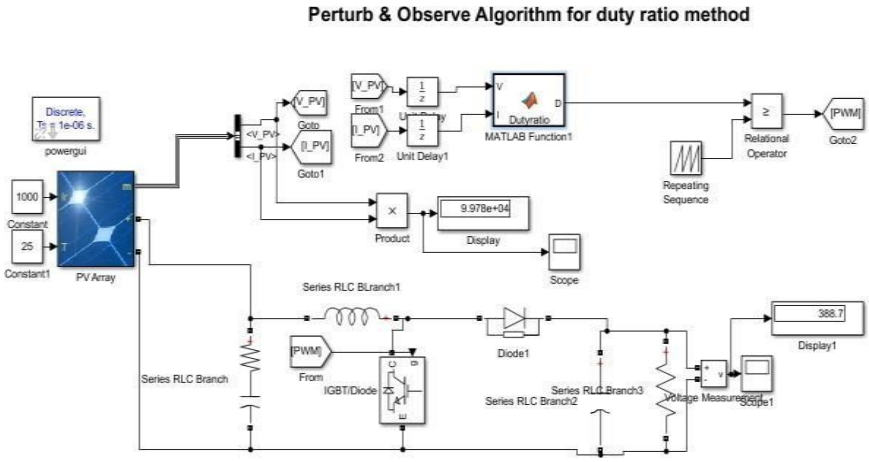

Figure 2. Duty ratio Method for Simulation Diagram P&O algorithm

A. Result of Output Voltage and Power at 1000,700 and 500 w/m2 using P&O method

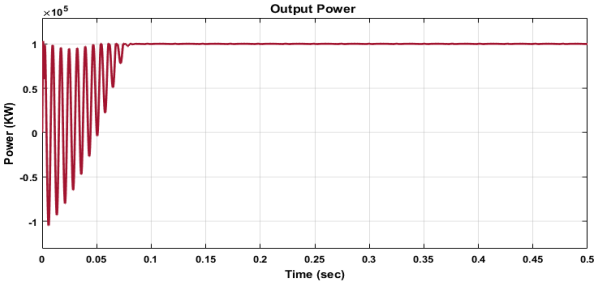

Figure 3. Power Output at Irradiance 1000 w/m²

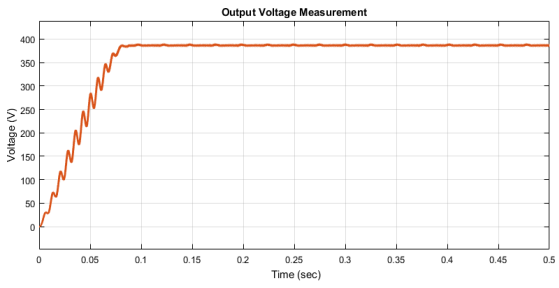

Figure 4. Voltage Output at Irradiance 1000 w/m²

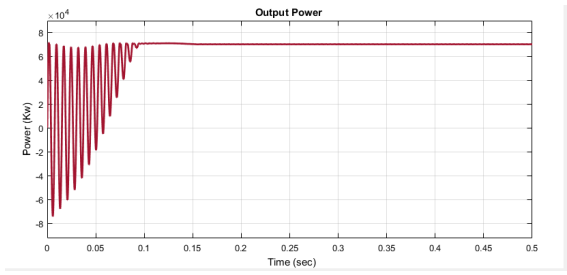

Figure 5. Power Output at Irradiance 700 w/m²

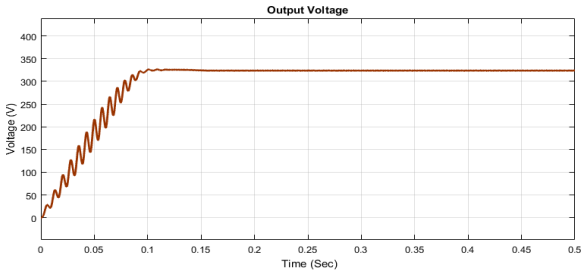

Figure 6. Voltage Output at Irradiance700 w/m²

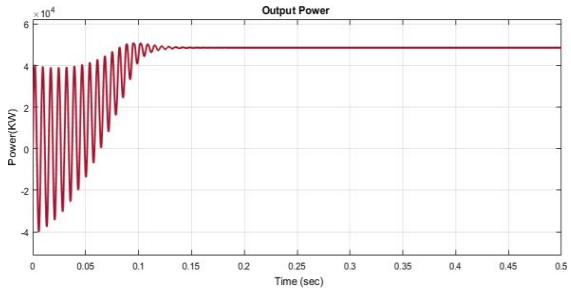

Figure 7. Power Output at Irradiance 500 w/m2

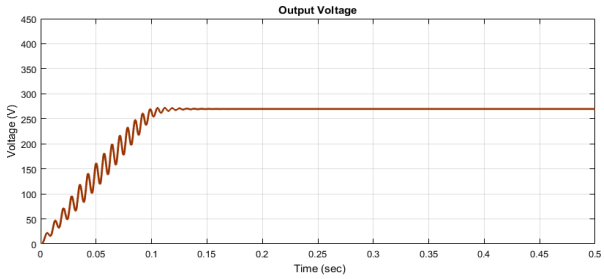

Figure 8. Voltage Output at Irradiance500 w/m2

B. Incremental conductance (IC)algorithm for the duty ratio method

The simulation results illustrate that the duty ratio method for different solar irradiances could be employed to implement MPPT in a boost converter with the IC algorithm.

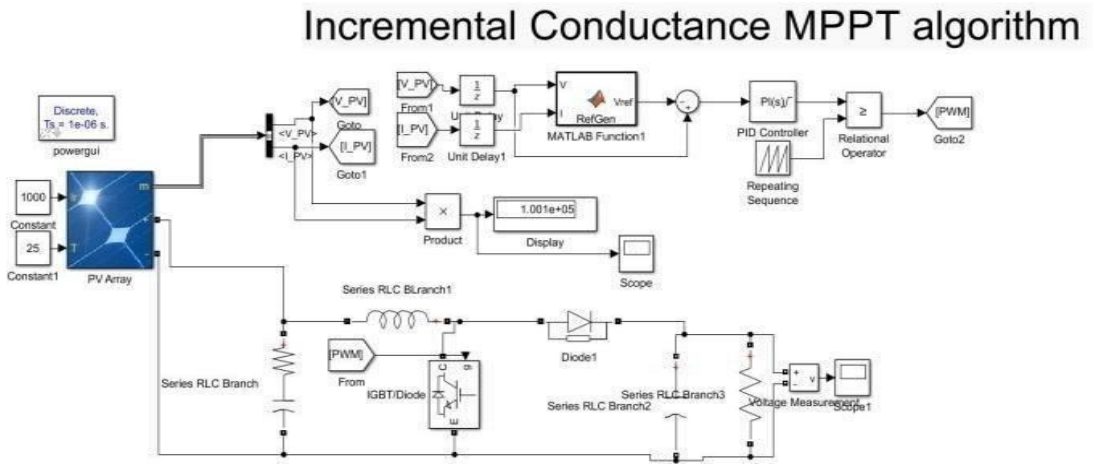

Figure 9. Duty ratio Method for simulation Diagram IC algorithm

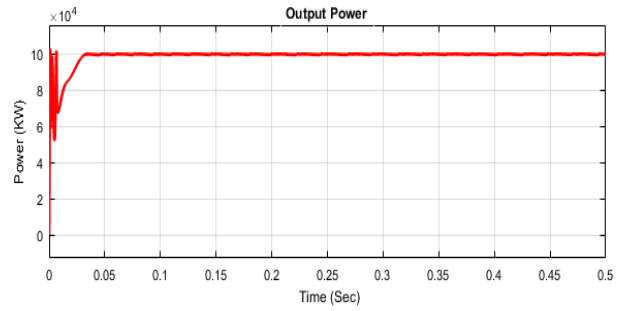

Figure 10. Power Output at Irradiance 1000 w/m^2

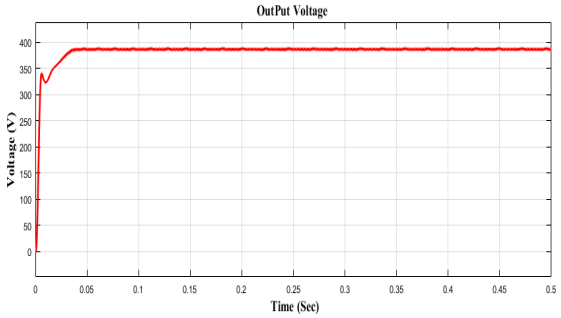

Figure 11. Voltage Output at Irradiance1000 w/m^2

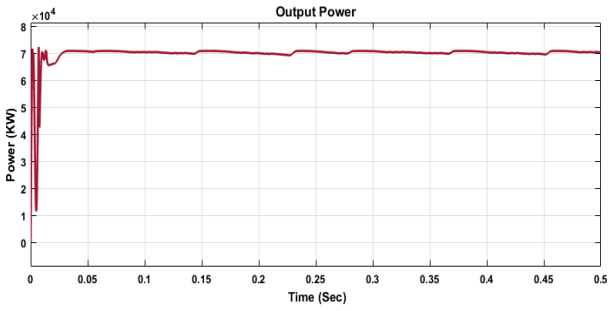

Figure 12. Power Output at Irradiance 700 w/m^2

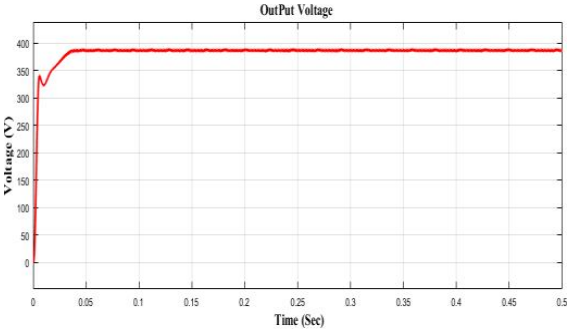

Figure 13. Voltage Output at Irradiance700 w/m^2

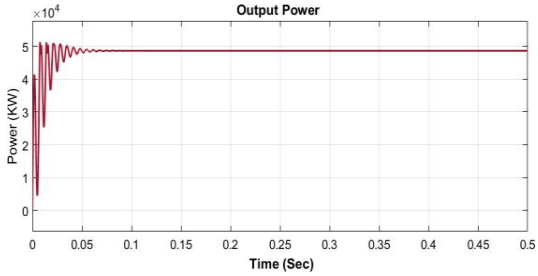

Figure 14. Power Output at Irradiance 500 w/m^2

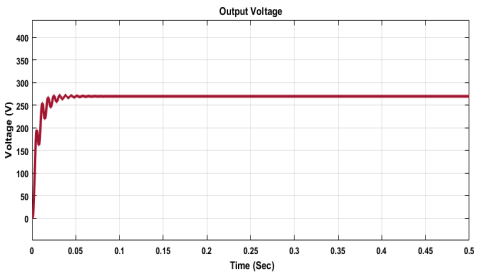

Figure 15. Voltage Output at Irradiance 500 w/m^2

C. Summary of Simulation Result

TABLE III. IC ALGORITHM

Summary of IC		
Solar irradiance	Power Output (KW)	Voltage(v)
1000 (w/m2)	100	388.7
500 (w/m2)	49.1	270
700 (w/m2)	70.45	326

TABLE IV. P & O ALGORITHM

Summary of P&O		
Solar irradiance	Power Output (KW)	Voltage(v)
1000 (w/m2)	99.78	388.6
500 (w/m2)	48.5	299.7
700 (w/m2)	70.2	324.9

The diagram encompasses the simulation for Perturb &Observed and IC algorithm, corresponding to the reference voltage technique is displayed in Figures 2 and 9. The summary sheet of simulation results for the P&O and IC algorithms is shown in Tables 4 and 5. Simulated results are included in figure 3-8, which presents the power and voltage output at different solar irradiances of (1000 w/m2, 500 w/m2, and 700 w/m2) as outputted by the Perturb and observed algorithm within the boost converter. The output voltage and power at different (1000 w/m2,500 w/m2and 700 w/m2) solar irradiances obtained from the simulation utilizing the IC algorithm in the boost converter are displayed in Figure No. 10-15. Because the IC approach provides good output power, the aforementioned result demonstrates that incremental conductance (IC) algorithms are best suited for MPPT of a boost converter utilizing the duty ratio method at varying solar irradiation.

IV. CONCLUSION

As seen above, the most appropriate way to implement MPPT for a solar PV system is to use an incremental conductance (IC) approach with a boost converter for the duty ratio method.

TABLE V. SUMMARY BOTH ALGORITHEM

Comparison		
Solar Irradiance	Power (Kw)	Voltage(v)
	P&O	IC
1000 w/m2	9.998	1.001
500 w/m2	4.86	4.91
700 w/m2	7.023	7.045

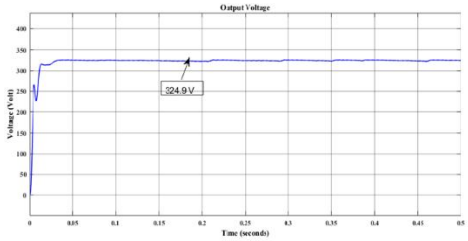

Figure 16

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