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Implementation of Algorithm on MPPT

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Abstract: ***Solar energy is a potential energy source in India. A photovoltaic is a efficient way to cure the energy in a huge amount and keep to gather that kind of energy for future, and the PV must have good efficiency. The maximum power point tracking (MPPT) is a process that tracks one maximum power point from array input, in which the ratio varies between the voltage and current delivered to get the most power it can. Several algorithms have been developed for extracting maximum power. To increase its efficiency many MPPT techniques are used. Incremental conductance is one of the important techniques in this system and because of its higher steady-state accuracy and environmental adaptability it is a widely implemented tracked control strategy. This research was aimed to explore the performance of a maximum power point tracking system that implements the Incremental Conductance (IC) method. The IC algorithm was designed to control the duty cycle of the Buck-Boost converter and to ensure the MPPT work at its maximum efficiency. From the simulation, the IC method shows better performance and also has a lower oscillation.***

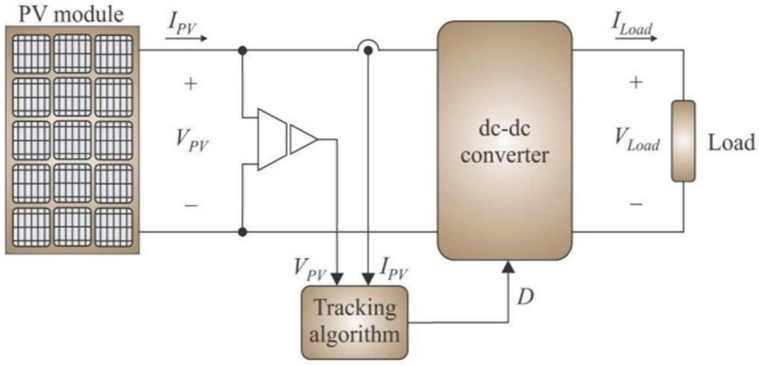
Keywords: PV Module, MPPT, Incremental Conductance (IC) Algorithm, Simulink.

I. INTRODUCTION

Solar Energy is the ultimate source of energy, which is naturally replenished in a short period, for this reason, it is called "Renewable Energy". Due to the limited supply of natural resources and the severity of the global energy crisis and environmental pollution, the photovoltaic (PV) system has become one kind of the important renewable energy source. Solar energy has the advantages of the maximum reserve, inexhaustibleness, and is free from geographical restrictions. The solar array system efficiency changes due to the nonlinear characteristics of current and power against voltage of the PV system, solar radiation, atmospheric temperature, and the nature of the connected load. [1]

In this context, photovoltaic (PV) power generation has an important role to play because it is a green source. The efficiency of a PV plant is affected mainly by three factors: the efficiency of the PV panel, the efficiency of the inverter, and the efficiency of the maximum power point tracking (MPPT) algorithm. Improving the efficiency of the PV panel and the inverter is not easy as it depends on the technology available, it may require better components, which can increase the cost of the installation. Instead, improving the tracking of the maximum power point (MPP) with new control algorithms is easier which would lead to an immediate increase in PV power generation and consequently a reduction in its price.[1]

Maximum Power Point Tracking (MPPT), is a digital way to operate the Photovoltaic (PV) modules in a way that allows the modules to produce the maximum power according to its characterstic. Additional power harvested from the modules is then made available as increased battery charge current.[2]This research was dealing with the implementation of IC on Buck-Boost converter by adjusting its PWM duty cycle. Buck-Boost converter generates bigger or lower voltage output depends on the duty cycle. The system was simulated on Simulink by injecting some irradiant and temperature changes during simulation periods.[3] The IC has observed its capability to retain the system to works at the maximum power point. The overall block diagram of the PV panel with Dc-Dc converter and MPPT is shown in this figure.[2]



Fig(1). Circuit diagram of PV Module with Incremental. Algorithm

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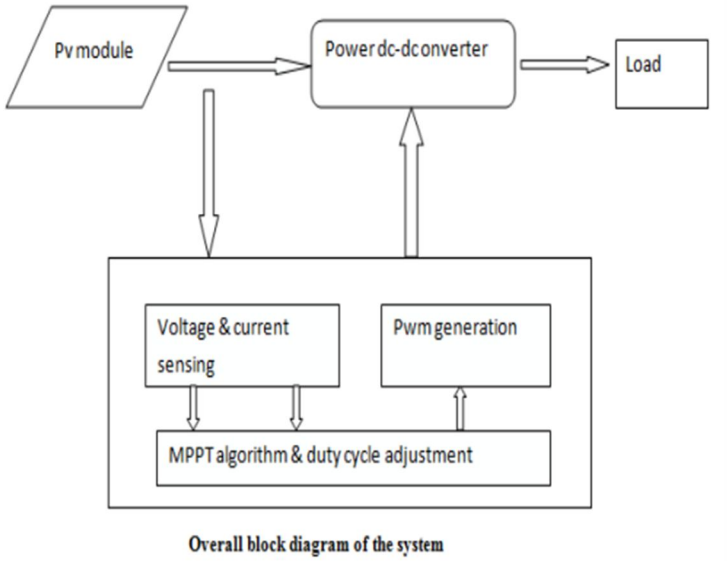

Fig(2). Block diagram of MPPT

The MPPT algorithm used in this paper is Incremental Conductance (IC) Method for tracking maximum power . But the absolute performance of the PV modules mainly depends on the power converter that is used in the solar PV circuits. The simulation model of the PV-based system with the MPPT algorithm will be implemented in the Matlab / Simulink.

In this paper, we will be focused on the comparison of the efficiency of four main techniques, being the perturb and observe (P&O), Incremental conductance (InCond), the fractional open circuit voltage (FCO), and the fractional short circuit current (FCC). Two MPPT algorithms, P&O and Incremental Conductance determine the optimum operating point (MPP) from the current and voltage supplied by the PV panel whereas the two others, FCO and FCC, use the relationship between the measured variables (Vco, Icc) to calculate the MPP. The criterion for the comparison of the algorithm's performance is the total energy produced by the solar panel during a duty cycle with these four MPPT algorithms under the same experimental conditions. For this study, Matlab-Simulink was used for the simulation of these algorithms, and therefore a discussion was done to analyze and interpret the performance and limitations of each algorithm. Therefore, we can summarize the main objectives of this work by the comparison, based on simulation results, of the behavior of four current MPPT algorithms with consideration of irradiation and temperature changes to compare their corresponding efficiencies.[8]

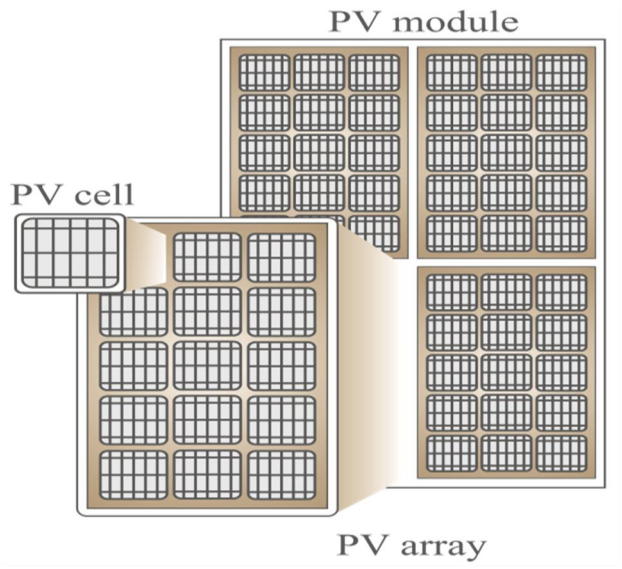

Fig (3). PV cell

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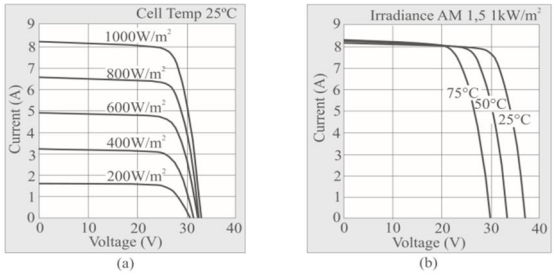
II. STC (STANDARD TEST CONDITION)

The Standard Test Conditions (STC) refers to the conditions under which PV modules are tested in the laboratory. STC defines the values of irradiance, temperature, and air mass index, in which the manufacturers feature the PV devices, permitting them to compare their performance and efficiency conversion.[6]

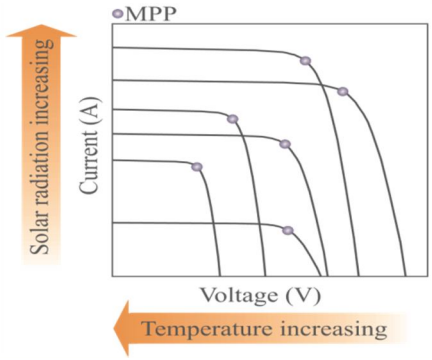
A. Irradiance

The Sun's energy reaches the Earth through electromagnetic waves, resulting in an irradiance (or solar radiation) of about 1366 W/m2 on its outer atmosphere. However, due to atmospheric effects – scattering, absorption, and reflection -, the incoming irradiance is modified before reaching the Earth's surface.[6]



Fig(4) (a) under constant temperature
(b) under constant irradinace

Thus, to dynamically set the MPP as an operation point for a wide range of solar radiation and temperature, specific circuits, known in the literature by Maximum Power Point Trackers (MPPT), are employed..



Fig(5). Current V/S Voltage with MPP

B. DC/DC Boost Converter

A DC-DC boost converter is a electronic device which is used to increase the voltage from one level to another increment level so these types of converter is used for the increment of voltage that is transmitted to the load .

For the efficient use of dc-dc boost converter we use different types of switches is used like FET, BJT, SCR, IGBT etc. here we use IGBT for the switching purpose for converter and the voltage of this converter is controlled by the help of firing angle of the IGBT , which is controlled manually or by the help of programming.[9]

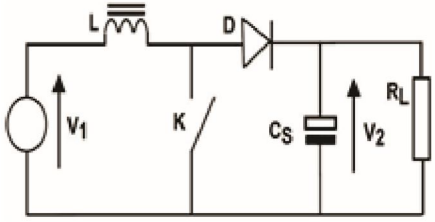


Fig (`6). DC-DC boost converter

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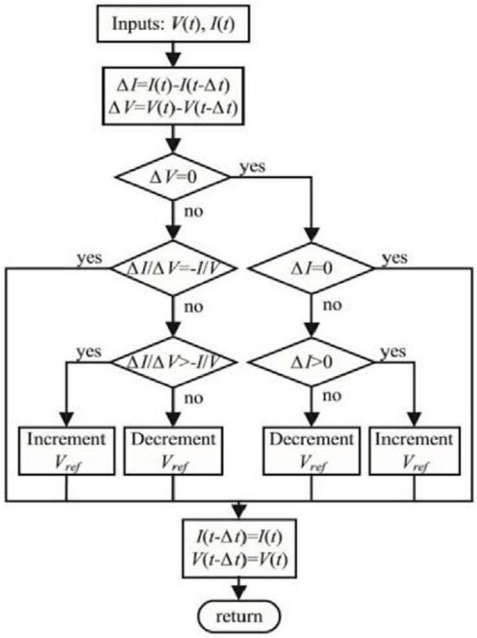
III. ANALYSIS OF ALGORITHM

Here we will implement the incremental conductance algorithm rather than perturb and observe method for the designing of MPPT models because of its efficiency to track the module of maximum power point . This method use the instantenous rate of change of power with respect to voltage (dp/dv) to calculate maximum power at a particular point.[10]

These are the following conditions that follows :

1) if dp/dv > -I/V (left of MPP), the duty cycle help it to increase the PV module voltage;
2) if dp/dv < -I/V(right of MPP), the duty cycle help it to decreasing the output voltage;
3) if dp/dv = -I/V (at MPP), the duty cycle is not changed .



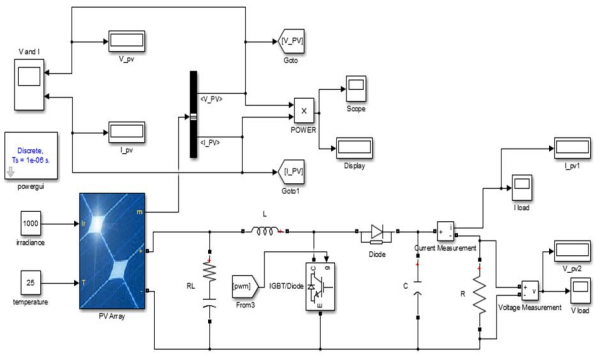
Fig(7). Block diagram of MPPT Algorithm

This method is used for showing the high tracking speed and accuracy having variable speed and no oscillations ,that's why it is more complicated then Perturb and observe method, In this firstly derivative must be calculated in real time and also require a voltage and a current sensor and an additionally a algorithm block is also required to increase the speed and accuracy for the extraction of maximum power through PV Module by the rest of the circuit by the help of algorithm used in the formation of this circuit.[11]

From the measurements of voltage (V_{PV}) and current (I_{PV}), the algorithm calculate the output power (P_{PV}) and then calculate its derivative of Power with respect to voltage dP_{PV}/dV_{PV}, by the help of above point we define that the duty cycle must be increased or decreased , by these we explain how the operating point ensure the Maximum power point (MPP). Normally, this Algorithm is implemented digitally and its derivative is taken out it from a microcontroller..[12]

IV. PROJECT ANALYSIS AND RESULT

In this paper, the main objective of our project was to design a Maximum Power Point Tracker (MPPT) that are able to constantly calculate and maintain the maximum amount of power from a solar panel to load . By using a DC/DC converter, our team was successfully able to create a system to reach this maximum power. The complete network from solar panel to load in which solar panel was excited by the solar irradiance and temperature and produce a output according to its electrical ratings, which then was connected to the DC/DC converter. A boost DC/DC converter was used to step the voltage up. This was required to have the voltage be in the acceptable input range. A code was created for the Pulse Width Modulation (PWM), which determines the frequency of the PV source. The Incremental conductance method was used to calculate the maximum power the 'PV' source outputs, and the necessary duty cycle for the PWM. That information would then be relayed back to the PV source and adjust it accordingly, to maintain the PV source at the peak power.[7] To test our design, the DC source was adjusted to various voltage inputs, and the maximum power was successfully calculated each time. This project was created using Matlab simulink software.[5]



Fig(8) Project Model Diagram

Here we design a model of Incremental conductance algorithm by the help of simulation in the Matlab. In this model we used some basic blocks like Matlab function , Integrator , PID controller , Sum block etc. in which we used a normal programming in the Matlab function in which a Vpv and Ipv is the input to the function which is set according to the given conditions by the help of programming . Then the function output is given to the PID controller which is used for stability and accuracy purpose and also damp out the transients from the output and then it compare with the reference signal to take the accurate output for our controlling device (IGBT).

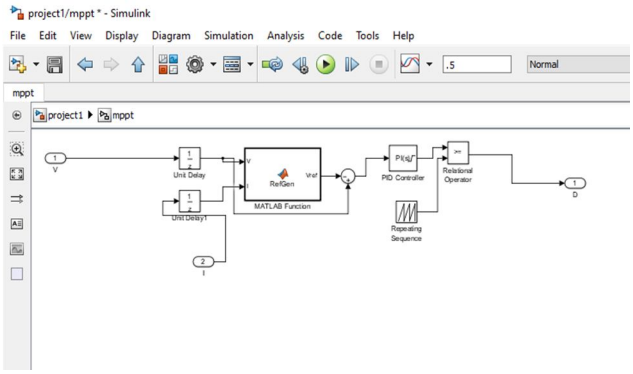
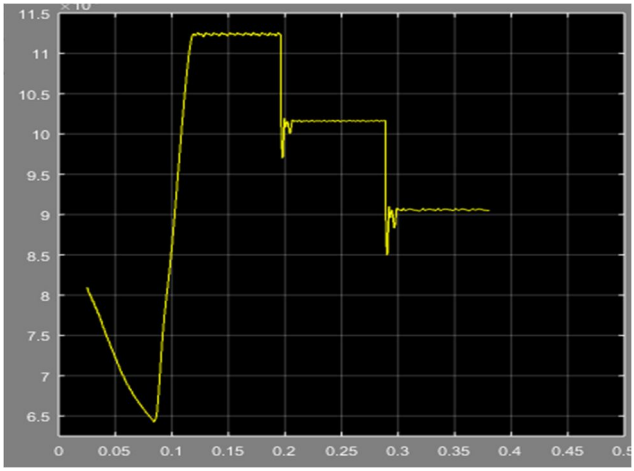


Fig (9) Algorithm Model

As seen on the graph, the output power increased until it reached the maximum power and once it reached the maximum power, it stayed constant which proves that our Incremental conductance algorithm was successfully implemented. By comparing the final results with the results from the simulation, it is shown that our design worked accurately.



Fig(10) Graph output

V. CONCLUSION

Maximum power point tracking (MPPT) is an special type of controller that play an important part in solar photovoltaic (PV) system, that is mainly used to increase the efficiency of a solar panel by tracking the maximum power point. There are so many MPPT control algorithms are present but here we used Incremental conductance. In this paper, we are discussed about Incremental conductance in MATLAB/Simulink a solar PV system with MPPT controlled boost dc-dc converter is modeled. Then by the help of solar PV parameter we were calculate the variation in power with respect to voltage and then calculate the maximum power according to temperature or irradiance. Finally,we successfully analysis the algorithms that is presented in this paper.

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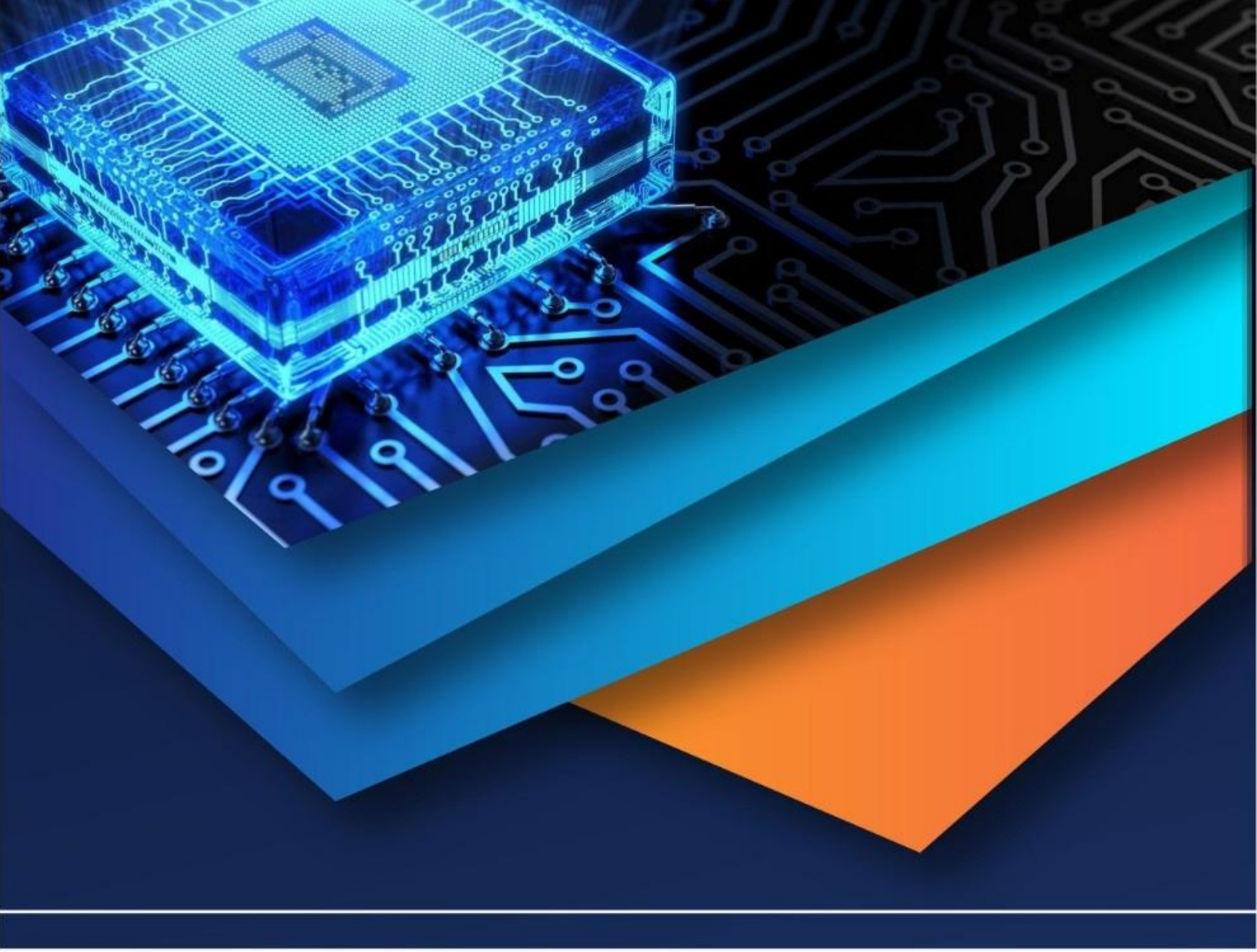

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