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SOME INVESTIGATION OF MPPT CONTROL IN GRID CONNECTED PV SYSTEM

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Abstract:

Photovoltaic (PV) arrays are used in many terrestrial applications. It has a nonlinear IV characteristic in which the production of electrical energy depends on prevailing conditions such as solar radiation and temperature. For optimal utilization, the maximum power point tracking (MPPT) algorithm technique should be properly implemented to operate the PV array at the maximum power point (MPP). As mentioned above, it is important to note that the MPP changes under different conditions in relation to the PV array properties. A detailed simulation model of the PV array was developed in MATLAB using the most popular MPPT incremental conductivity algorithm. This model allows PV generators to be characterized with different temperatures and insulation as variable parameters. Parameter variation under Nagpur conditions is also taken into account. The results of the model are the I-V and PV characteristics, voltage, current and power at MPP of the PV array simulated by MATLAB. Simulation results are displayed and analyzed. This paper, explored some MPPT operating procedures. For general investigation we started simulation of PV system connected to load and understand merits and demerits of it. After understanding the drawback we perform further simulation with MPPT and Inverter control to obtain maximum power transfer and stable voltage for non critical load. Broadly, simulation circuit consist of PV module, MPPT, Boost converter, Inverter, LCL filter, RL load and Single phase grid. Study of different methods and algorithm of MPPT enhance our understanding about how PV system reacts on them and change in stability of whole circuit in the motive to get better efficiency and also fulfill basic and overall requirement of PV system.We had done details analysis on incremental conductance method which is widely use and has more inclination in PV system.

1. Introduction

Installation of PV system has two important requirements, one is maximum power transfer and another is stable output voltage. To achieve this requirements many modification are proposed in the system and many works are still to be done. Study of various control methods of MPPT can help us to achieve our aim. So by studying different methods and algorithm we compare their result and output, basically we find out their merits and demerits. Initially we perform simulation without any control for maximum power transfer and continue our investigation of MPPT control up-to Incremental Conductance method. Installation of PV system has very low efficiency which can be improve by using mono-crystalline solar panels, using extra batteries, providing maximum irradiance and temperature by adjusting solar panel direction and area, balancing supply and demand, improving maximum power transfer etc. After so many modifications still many problems are faced by PV plant such as voltage fluctuation and regulation, short circuit contribution, unintentional is landing, frequency variation and regulation, harmonics & flickers, reactive power requirement. Maximum power transfer and voltage regulation this two major issues can be solve by using Controlled MPPT technique. Hence many methods and algorithm are came into existence according to needs and requirement. So there is a need study of various methods and algorithm and comparing all of them give us a wide knowledge about all

2. Maximum Power Point Tracking (MPPT)

MPPT is electronic tracking that looks at the panel's output and compares it to a reference voltage. Then determine the best performance the panel can output. It converts this to the optimum voltage to allow the battery to deliver maximum performance. Most modern MPPT's have conversion efficiencies of around 93-97%. Performance is typically 20-45% better in winter and 10-15% better in summer. Actual generation will vary greatly depending on the weather, temperature, battery level, and other factors. The efficiency of these MPPT conversions is around 94% to 97%. MPPT provides current and voltage combinations in such a way that maximum power transfer is achieved. MPPT gives the input to the booster. This allows the system to regulate voltage to deliver maximum power and improve efficiency.As shown in Figure 1, for a PV array under irradiance, there is a distinct point on the current-voltage (I-V) curve where the array operates at maximum efficiency and produces maximum output power.A MPPT is a device, employing a microprocessor, to constantly track the power output of the PV array and to maintain the optimal operating point, at which the PV array will produce maximum power [3]. Changes in illumination and cell temperature change the optimal

operating point of the solar array. Therefore, a new optimal operating point for PV generators needs to be identified either by model calculations or by search algorithms.

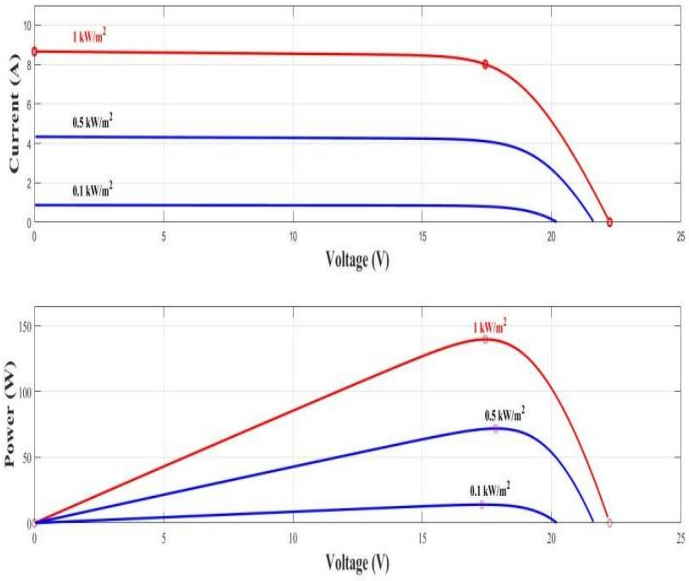

Figure No. 1 IV & PV Curve

2.1 Perturb and observe (P&O)

P&O method is typically used to track MPP's. This technique introduces a small amount of perturbations to cause power fluctuations in the PV modules. PV output power is measured periodically and compared with the previous power. The same process continues as the output power increases. Otherwise the disturbance is reversed. In the algorithm a perturbations is applied to the PV module or array voltage. Increase or decrease the voltage of the solar module to see if the power increases or decreases. If an increase in voltage leads to an increase in power, the PV module's operating point is to the left of the MPP. Therefore, another perturbation to the right is required to reach the MPP. Conversely, if an increase in voltage leads to a decrease in power, this means that the operating point of the PV module is to the right of the MPP, so more left perturbations are required to reach the MPP. The micro-controller then calculates the existing power P_{new} at the output by measuring the voltage and current and compares this calculated power with the previously measured power P_{old}. When P_{new} is greater than P_{old}, the PWM duty cycle is increased to extract maximum power from the PV panel. If P_{new} is less than Plot, the duty cycle is reduced to ensure the system returns to its previous maximum performance. This MPPT algorithm is simple, easy to implement, inexpensive and highly accurate.

2.2 Incremental conductance method

Incremental conductance method exploits the assumption of the ratio of change in output conductance is equal to the negative output Conductance Instantaneous conductance. We know

$$,P = V\ I$$

When we apply the chain rule for the derivative of products yields to

$$\partial P/\partial V = [\partial(VI)]/\ \partial V$$

At MPP, as $\partial P/\partial V=0$

This equation can be written as of array voltage V and array current I as

$$\partial I/\partial V = -\ I/V$$

The MPPT regulates the PWM control signal of the dc – to – dc boost converter until the condition:

$$(\partial I/\partial V) + (I/V) = 0$$

is satisfied. In this InC the peak power of the solar module lies at above 98% of its incremental conductance.

3. Model Development (MatLab Simulation)

The system includes Solar PV Array, DC-DC converter and Inverter connected to grid. This system is simulated with MatLab simulation(R2022a) software. We have used TP140 for the simulation 12 modules in series and 2 Strings of 12 moules in parallel are taken.In developing the MPPT algorithm, traditional P&O MPP search methods were developed in a Simulink model and their performance was verified.

Parameters	Values
Maximum Power (V_m)	139.6944W
Open circuit voltage (V_{oc})	22.25V
Short-circuit current (I_{sc})	8.66A
Voltage at MPP (V_{mp})	17.44V
Current at MPP(I_{mp})	8.01A
Temperature coefficient ofV_{oc}	-0.33%/deg.C
Temperature coefficient of I_{sc}	0.063799%/deg.C

Table no. Solar parameters

For incremental conductance, the variable step size technique (modified incremental conductance). Both tracking techniques were implemented by a direct control strategy and the duty cycle of the de-de boost converter was calculated directly by the algorithmFor simulation purpose we have designed a variable weather with variable irradiation and temperature. This includes different Irradiation as they change in day time same for temperature. Irradiation starts from 100-1000 Kw/m^2 and for temperature 20-28 ^{o}C. For simulation purpose we have designed a variable weather with variable irradiation and temperature. This includes different Irradiation as they change in day time same for temperature. Irradiation starts from 100-1000 Kw/m^2 and for temperature 20-28 ^{o}C.

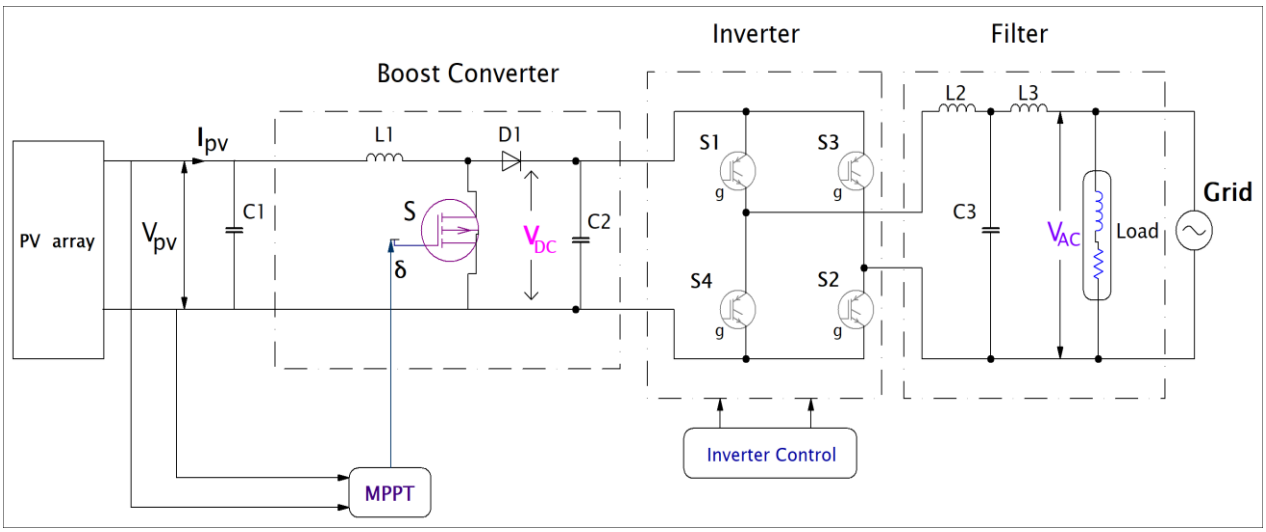

Figure No. 2 Block diagram

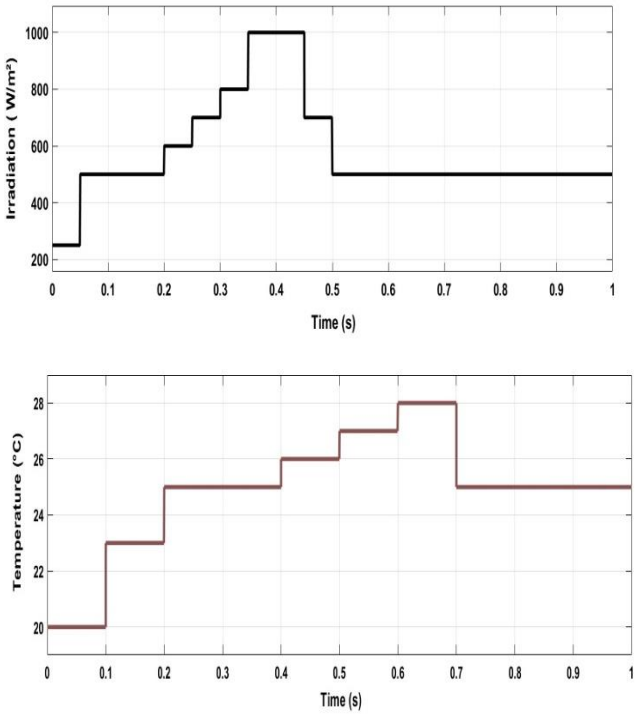

Figure No 3. Variable temperature and irradiations

4. Results and Discussion

Simulations of the two MPPT methods were performed in Matlab Simulink using a DC-DC boost converter. The performance of the two algorithms was evaluated under different irradiance change conditions. In this section, we discussed algorithm performance.

4.1 System with MPPT VS Without MPPT

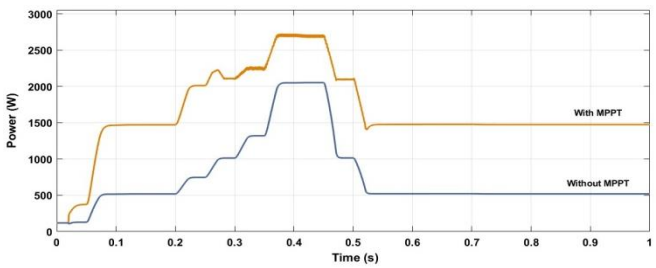

Figure 4. Power MPPT VS Without MPPT

This can clearly be seen that when we use MPPT system instead of using the traditional alone system the outputs are as shown in figure no 4. At different radiations from the sun the maximum power is to be delivered to the load. This make the efficient use of the awilabe resources.

4.2 P&O VS Incremental Conductance MPPT

Model of a photovoltaic panel has been developed using MATLAB Simulink. This model is used for the maximum power point tracking algorithms. The P&O and Incremental conductance MPPT algorithms are discussed and their simulation results are presented. It is proved that Incremental conductance method has better performance than P&O algorithm. These algorithms improve the dynamics and steady state performance of the photovoltaic system as well as it improves the efficiency of the DC-DC converter system.Because output voltage and current with incremental conductance method is more than P&O, so the overall power transfer through the system with incremental conductance method is more i.e with the use of incremental conductance algorithm we got improved maximum power point than of P&O algorithm. Hence the overall accuracy in incremental conductance method is more than of P&O so the overall efficiency is being improved. When atmospheric conditions are constant or change slowly, the P&O MPPT oscillates close to MPP but Incremental conductance finds the MPP accurately at changing atmospheric conditions also.The only drawback is time response of operation; in the case of incremental conductance the response time is more than the P&O.

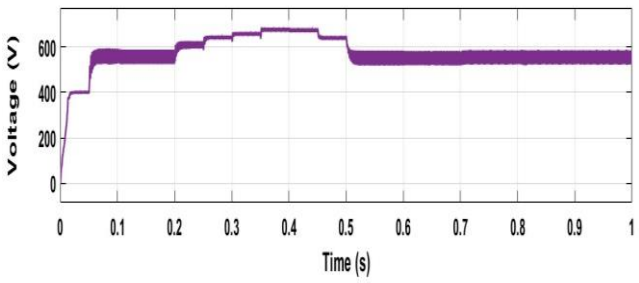

Figure No 5. P&O MPPT system Voltage

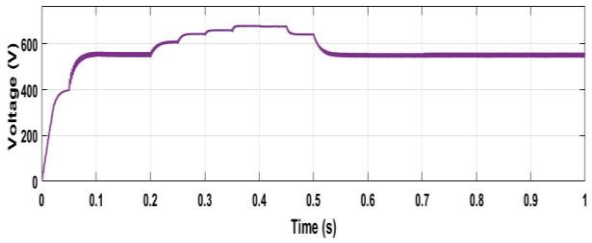

Figure No 6. Incremental Conductance MPPT Voltage

5. PCC Observations

Point of common coupling means the point where the generating facility's local electric power system connects to the electric system, such as the electric power revenue meter or at the location of the equipment designated to interrupt, separate or disconnect the connection between the generating facility and electrical company. We have Connected Solar to grid which makes a comment point.

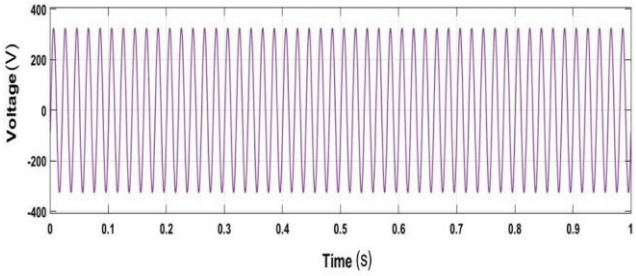

Figure No 7. PCC Voltage

6. Conclusion

Electrical energy can drawn from renewable and nonrenewable energy resources but now a day renewable energy resources are more widely used all over the global because it is very convenient to use and it reduce pollution and also cut the cost of generation. There are many renewable energy resources for example wind energy, hydro energy, and the most widely use solar energy. Conversion of solar energy into electrical energy has some drawback, the main drawback is efficiency, this conversion has only 30% to 40% conversion efficiency. To maximize this efficiency we have to improve the power transfer rate and adjust panels in such a way that it can absorb maximum heat and sun radiation. The first method that is transfer of maximum power through this system is going to study in this mini project. There are various method for tracking the maximum power which is known as maximum power point tracking system. Maximum power point tracking is done by various method and algorithms and also various digital equipment. Detail analysis of various maximum power point tracking algorithm where carried out. Incremental conductance algorithm which hold good performance than any other method. Under varying atmospheric condition maximum power point tracking algorithm which place a major role for a grid connected PV system based on the implementation cause, number of sensor required, complexity, so far residential and industry purpose, incremental conductors algorithm performs better results.

From this study, we find that both MPP tracking methods can efficiently track MPPs under various changing irradiance conditions. The working voltage deviation during the tracking process is much smaller for modified INC compared to P&O. This makes the operating conditions of the system more stable, especially when the irradiance changes rapidly. Stronger voltage fluctuations during the tracking process not only make the tracking process more difficult, but also cause more power loss. Modified INC has a faster tracking speed, but its higher complexity requires more computational power than P&O to implement. However, it is important that both algorithms are PV independent and able to track the true MPP of the PV module under various irradiance changing conditions.

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