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Research paper

Comparative analysis of P&O and incremental conductance method for PV system

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Abstract

The power emergency in India can be overwhelmed by presenting the other non-customary strategies for control age. The most well-known non-ordinary technique is sunlight based power. As the primary wellspring of this strategy is sun, the power age may fluctuate with the natural conditions like irradiance, temperature varieties and sudden impedance of mists which can't be overcome or avoidable by the individuals. The Maximum Power Point Tracking (MPPT) is utilized to get the Maximum power age point despite the fact that there is a variety in temperature, irradiance or shading impacts. By utilizing this MPPT techniques we can get a handle on required measure of energy with lessened number of boards so the cost for add up to PV framework will get decreased. This paper displays a similar investigation of two MPPT strategies i.e Perturb and Observe and Incremental Conductance Method (ICM), in light of the fact that these calculations are broadly utilized because of minimal effort and simplicity of acknowledgment by utilizing MATLAB/SIMULINK. Here the fundamental amounts like voltage, Current of a board are followed to mimic the MPPT Algorithms.

Keywords: *Photovoltaic (PV); Maximum Power Point Tracking (MPPT); Perturb & Observe (P & O) and Incremental Conductance Method (ICM).*

1. Introduction

The electrical load in the India or in the World is expanding step by step past the desires, and to meet the necessity we have to utilize more measure of customary source which are constrained and prompts natural contamination, so to beat the above issue the non-traditional vitality sources or sustainable power sources are taken significant part in producing required measure of electrical power. Sun oriented power is overwhelming in this all because of no contamination, less upkeep and in debilitating in nature. What's more, the PV cell produces DC Power by straightforwardly changing over sun oriented vitality into Electrical power, so to use the created control we have to utilize the power electronic converter to change over the created DC energy to AC with indicated recurrence. The main issue in PV System is befuddle of working qualities of load and Pv cell.

The working purpose of the framework is only gathering purpose of I-V [1] bend with the heap line. Also, it shifts with variety of load, temperature and irradiance [2-3] At the point when a pv cluster is associated with the heap more often than not ideal working point i.e Maximum power point isn't accomplished, to conquer this issue Maximum Power point tracker (MPPT), here the working point will conveyed to Maximum power half quart where the heap protection is equivalent to source protection. As the heap protection is changing as per prerequisites, the source protection ought to likewise be changed as for stack resister, this can be accomplished by utilizing MPP Algorithm, and here the converter entryway can be controlled agreeing regarding source and load protections.

To extricate the most extreme power and nourished to the heap MPP Techniques are utilized alongside the DC/DC Converters [4] , in this the primary point of the MPPT is to change the obligation cycle of the converter to make the heap impedance is equivalent to stack impedance to get the greatest or pinnacle control. Here we have diverse regular and non-ordinary MPPT strategies like P&O strategy, Incremental conductance technique, Constant Voltage strategy, steady current strategy, PSO strategy and fluffy rationale strategies. What's more, among all the most prevalent and financially savvy techniques P&O and ICM are considered, executed and dissected utilizing MATLAB/SIMULINK. The paper has sorted out in the accompanying way. The fundamental working standard, Modeling and Characteristics of PV cell are examined in area 2, the P&O and Incremental Conductance strategy calculations are talked about in detail in segment 3, Section 4 relates to reproduction of pv cell alongside MPPT strategies and their outcomes and examination of two MPPT techniques, last session closes with future degree.

2. Mathematical modeling of PV cell

2.1. Operating principle of PV cell

PV Cell is basically a P-N Junction diode, and at whatever point daylight or irradiance with certain temperature hits the sun powered cell the electrons will move starting with one area then onto the next locale by making it as short out, so the present will move through the sun powered cell.

2.2. Mathematical modeling of PV cell

The basic equation of pv Cell with respect to equivalent circuit is defined as

$$Iph = Id - Ish - Ipv \quad (1)$$

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Where N_p – No of cells connected in parallel
Iph – phase current of PV System.
Id – Diode current
Ish – Shunt Current.

$$I_{ph} = [I_{sc} + K\,(T - T_{ref})G_{ref} \quad (2)$$

$$I_d = \left[exp\left(\frac{v+I_{pv}R_{se}}{k\,V_t\eta}\right) - 1\right] I_s N_p \quad (3)$$

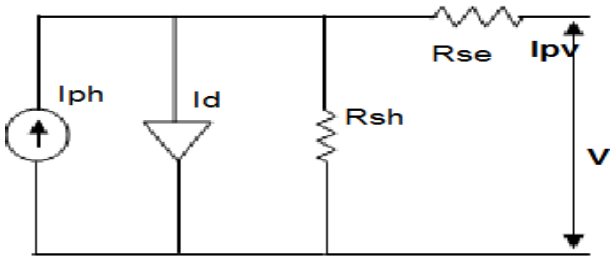


Fig. 2.1: Equivalent Circuit of PV Cell.

$$I_{sh} = \frac{v+I_{pv}R_{se}}{R_{sh}} \quad (4)$$

$$I_{rs} = \frac{I_{sc}}{ecp\left(\frac{qV}{kT\eta}\right)-1} \quad (5)$$

Specifications of solar cell are as follows

- Open circuited voltage of PV module = 37 (V)
- Short current current of PV module = 8.4(A)
- Reference temperature, Tr = 298k
- Module operating temperature = 273(k)
- Light generated current of PV module = Iph (A)
- PV module saturation current = Io (A)
- A=B is an ideality factor =1.6
- K is Boltzman constant=1.3805e-23J/K
- Q is Electron charge = 1.6e-19 C
- Series Resistance of a PV module = Rs
- Short-Circuit current Temperature co-efficient at Iscr = Ki = 0.0017A/^{o}C
- PV Module Illimination (W/m2) = λ = 1000W/m2
- Band gap for silicon = Ego = 1.1ev
- No. of panels connected in series = Ns = 8
- No of parallel strings= Np=2
- Voltage at Maximum power Vm= 32 V
- Current at Maximum Power Im= 7.9 A

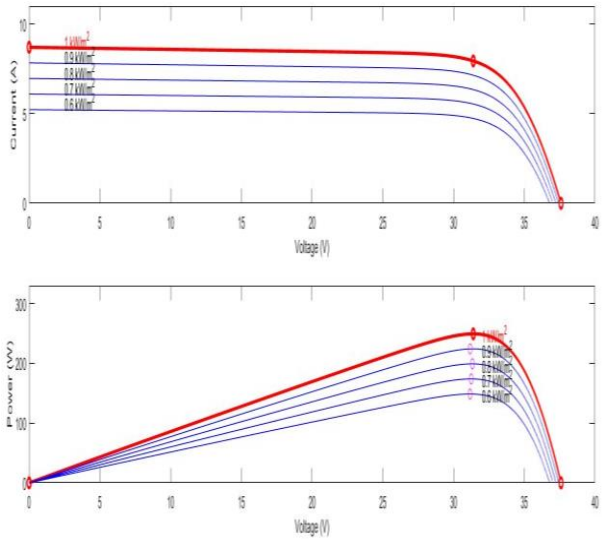


Fig. 2.2: I-V and P-V Curves of Solar Cell at Different Irradiances.

With respect to the following specifications the pv cell characteristics are as below.

3. Maximum power point tracking algorithms

MPPT [5] calculations are utilized to get a handle on the most extreme power point or working point at greatest power as the soonest when the heap or irradiance or temperature of the frame-work shifts [6]. There are numerous kinds of regular and non-customary MPPT calculations are available, here in this paper the P&O and Incremental conductance technique calculations are actualized and investigated.

3.1. Perturb & obverse method

In this strategy a little irritate is presented, this annoy is utilized to differ the power constantly, if the power is expanded as for change in obligation cycle esteem, if the power is expanded consistently then the bother increment and after some time it achieve top an incentive there after the power diminishes so bother diminishes which doesn't permit. At long last it tries to settle down close to that top esteem, i.e the annoyance vacillates ceaselessly. The irritation esteem ought to be kept little keeping in mind the end goal to keep up the changes closer to greatest esteem which prompts more opportunity to achieve relentless state esteem.
The P&O calculation [7] is all around populated and most ideal despite the fact that makes vacillation in irritation or the time taken to relentless state is high because of basic idea, and the P & O algorithm is given as

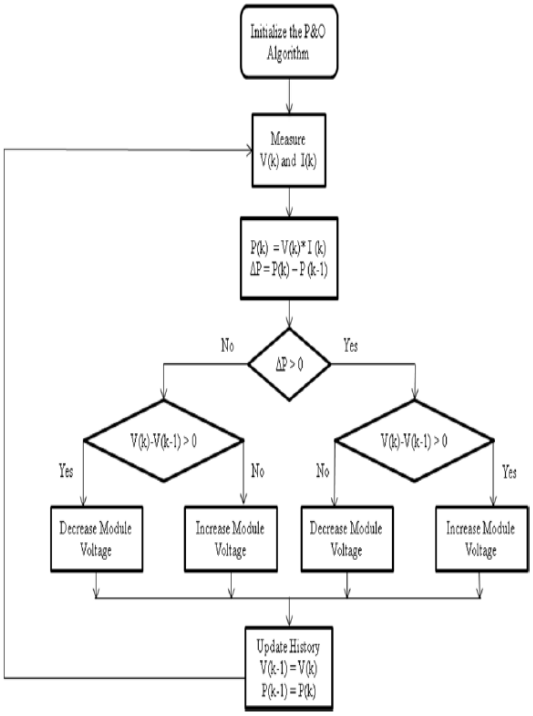


Fig. 3.1: Algorithm for Perturb and Observe Method.

In this calculation Voltage and current is gathered from PV Panel and the voltage and current is taken as the reference for getting the obligation cycle to work DC/DC Converter and making the source Impedance is equivalent to stack impedance. The obligation cycle is acquired by contrasting change in power and present power in the wake of computing [8], [9], and a little consistent obligation cycle is added to the reference esteem if the present power is more than past power, and the subtracted on the off chance that it is inverse.

3.2. Incremental conductance method

Incremental conductance strategy is acquainted [10] with beaten the issue which is looked by the irritate and watch technique i.e. the pinnacle and stable area is accomplished quick contrasted with P&O Method and the pinnacle fluctuating worth is exceptionally

close or relatively same can be gotten under quick differing barometrical conditions.
In this technique it watches whether the working point achieved its most extreme power point or not, on the off chance that it fulfills the MPP condition then it quits annoying [11], generally the adjustment in impedance will be contrasted and the present impedance by taking the voltage and present as reference, and bode well with steady and little obligation cycle included or subtracted from the reference an incentive as per correlation. In this strategy the fundamental focus and irritation is relies upon the impedance count [12].

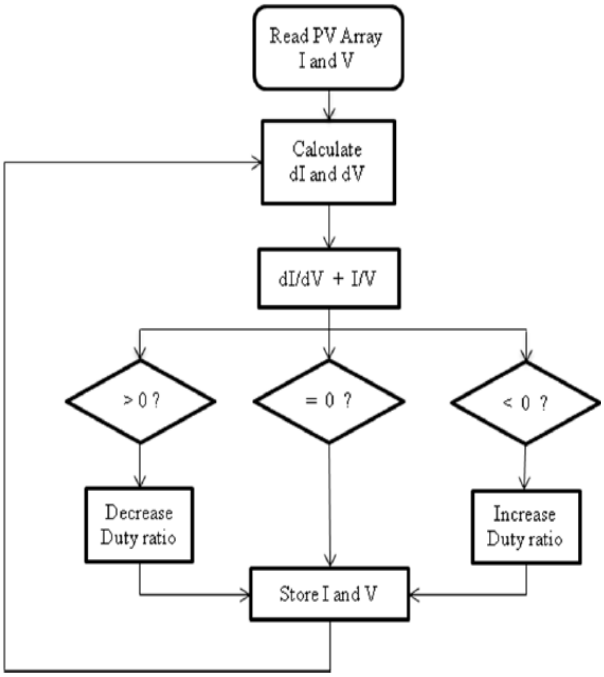


Fig. 3.2: Basic Algorithm for Incremental Conductance Method.

4. Simulation and results

4.1. The specifications of PV panel

The mathematical model of practical PV Cell is designed in MATLAB/SIMULINK by taking the practical panel specification and the series and parallel resistances Rse, Rsh are obtained by the I-V and P-V Characteristics.

$$Voc = Vm + ImRse \quad (4.1)$$

$$Isc = Im + Vm/Rsh \quad (4.2)$$

Table 1: Parameter Specification of 250W Panel

S. No	Parameter	Speciification
1	Open Circuit Voltage Voc	37 Volt
2	Short Circuit Current Isc	8.4 Amp
3	Maximum Power Output	250Wp
4	Voltage at maximum power Vm	32.4 Volts
5	Current at Maximum Power Im	7.9 Amp

The Pv Model is modeled in the simulation and the IV and PV Curves are obtained as follows when a sun light is applied with respect to constant irradiance and temperature by considering external disturbances are absent.
The mathematical Modeling of pv cell in simulation is

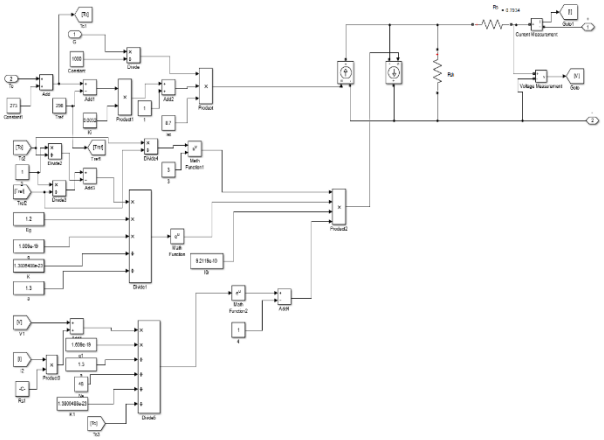


Fig. 4.1: Simulation of Single PV Cell.

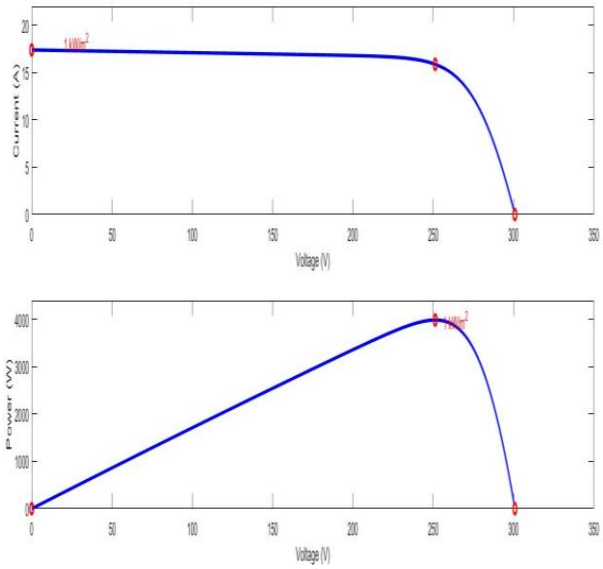


Fig. 4.2: I-V and P-V Curves of Practical Simulated PV Cell.

The total setup of PV cell with boost converter along with the MPPT controller is shown in figure 4.2 below. And in simulation of each block in designed seperatley.

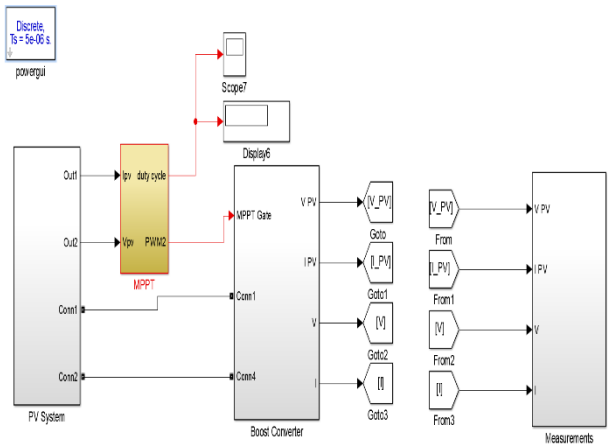


Fig. 4.2: Complete Setup of PV System with Boost Converter and MPPT Controller.

The simulation of boost converter is shown in the fig. 4.3 for the required amount of output voltage, and the input of boost converter is connected to the PV panel output terminals.

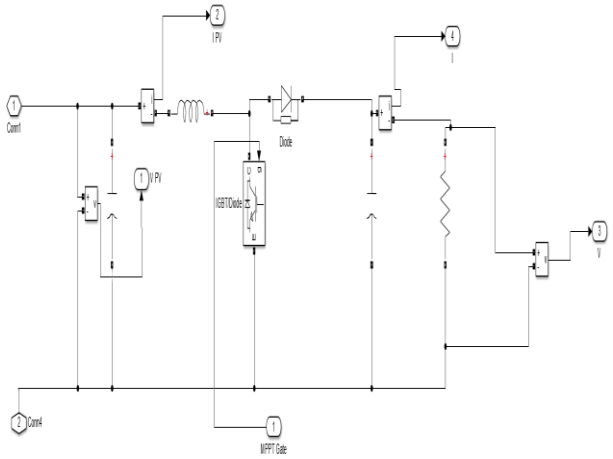


Fig. 4.3: Simulation of Boost Converter for the Output Voltage as 600 V DC.

The MPPT controller for the Dc/DC Converter is designed to get effective output or increased efficiency from the solar system. And the different MPPT controllers are P&O Method and Incremental conductance method.
The simulation of P&O Method algorithm is shown in fig4.4

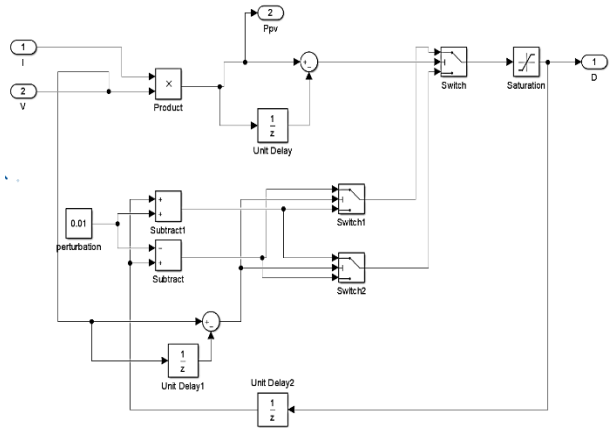


Fig. 4.4: Simulation of Perturb & Observe MPPT Method Algorithm.

The simulation of Incremental conductance method algorithm is shown in fig.4.5.

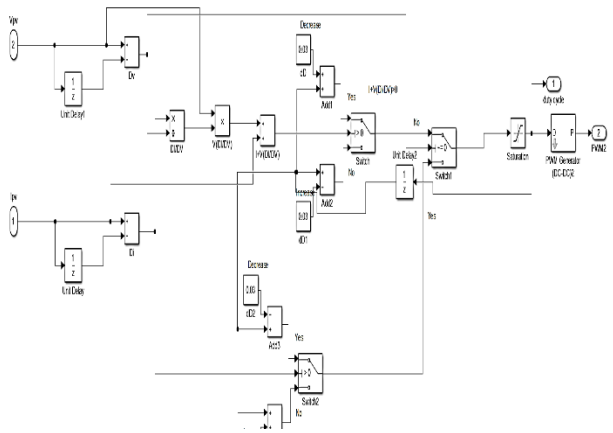


Fig. 4.5: Simulation of Incremental Conductance Method Algorithm.

The simulation of Output voltage of boost converter without MPPT controller, and with P&O, Incremental Conductance method MPPT controllers as shown in the Fig.4.6.a,b,c.
From the outcomes it is obviously demonstrated that with no controller we need to change the obligation cycle according to the varieties of the climate and load, so for this situation the yield voltage isn't kept up steady for the variety of irradiance, temperature and the heap. Where as in MPPT controller the yield voltage of lift converter is shifted by the varieties of climatic conditions however in P&O technique the required measure of yield isn't accomplished with the balanced obligation cycle and the motions are all the more contrasting with incremental conductance strategy. Coming to incremental conductance strategy the yield voltages is accomplished according to the necessities and it requires less investment to achieve most extreme power guide contrasting toward different strategies here.

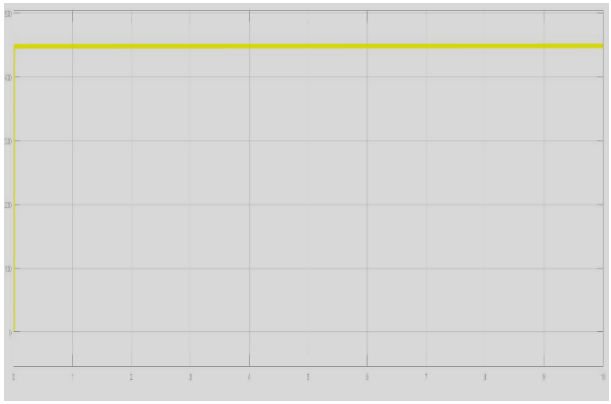


Fig.4.6: A) Voltage Profile of the Boost Converter with P&O Method.

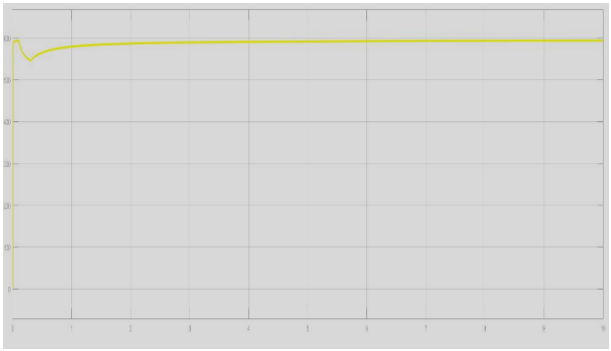


Fig. 4.6: B) Voltage Profile of the Boost Converter with Incremental Conductance Method.

Going to the power profile of the PV framework alongside the lift converter the most extreme power purpose of framework might be accomplished however the time required to achieve the greatest power point by the incremental conductance strategy is less contrasted with P and O Method and the energy of MPPT controlled technique is fairly high contrasted with without MPPT control.
The figure 4.7.a, b shows the power profile of the PV System along with the boost converter

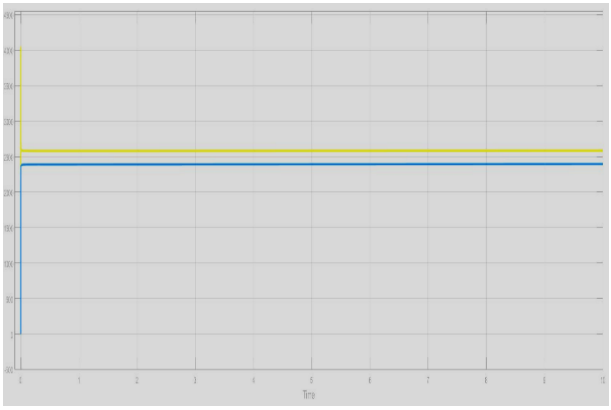


Fig.4.7: A). Input and Output Power Profile of the PV System with P & O MPPT Controller.

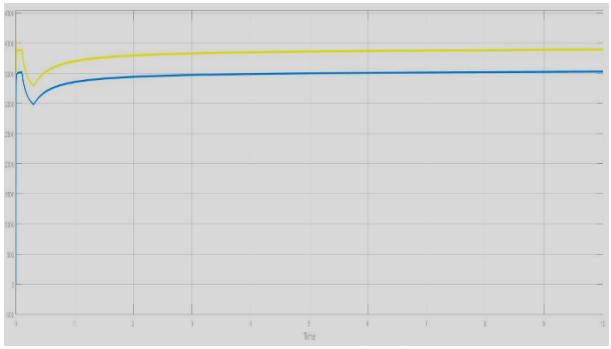


Fig. 4.7: B). Input and Output Power Profile of the PV System with Incremental Conductance Method MPPT Controller.

4.2. Comparison between P&O and incremental conductance method

Table 2: Performance Comparison between P&O and Incremental Conductance Method

MPPT Method	Output Current	Output Voltage	Output Power	Time Response	Accuracy
P&O Method	5.6 Amp	460 Volts	2576 W	0.001 Sec	Less
Incremental Conductance Method	6.1 Amp	598 Volts	3647 W	0.057 Sec	More

5. Conclusion

In this paper 250W power sunlight based board is considered as for its evaluations and has been created utilizing MATLAB/SIMULINK show, a similar model is utilized to track the greatest power point, here P&O technique and Incremental Conductance strategies are actualized and introduced. In the wake of looking at the two strategies it is demonstrated that the incremental conductance strategy can achieve the proverb control point in less time and the motions at enduring working point in incremental conductance technique is less.as the yield control by incremental conductance technique is high the effectiveness of PV System and lift converter is expanded .

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