A New Power Angle based Maximum Power Point Tracking (MPPT)Technique and Analyze Performance of Solar PV System

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***Abstract*— In this thesis a new modified Maximum Power Point tracking (MPPT) scheme is professed. In this technique Maximum (peak)Power tilt (Angle) (MPA) determination method is adopted. By using matlab coding Maximum power angle is determined based on graphical and arithmetic methodology. The Maximum power (MPP) point is determined by using the predictable factors of the solar PV modules. Also the static characteristic, step change response of PV module is depicted. This MPPT technique is able to reduce the need of various voltage and current sensor requirements, also the reduced requirement of hardware components. The operation cost of this technique is estimated low and required less maintenance**

Keywords—PVmodule, MPPT, Maximum power angle ,efficiency, static characteristic, graphical.

I. Introduction

Maximum power tracking from solar PV system is important parts of exploitation of these systems. Several maximum Power Point Tracking (MPPT) methods and algorithms have been suggested by the various researchers. MPPT techniques like fuzzy logic based MPPT, Neural network based MPPT and Constant voltage based MPPT, Incremental conductance based MPPT and Perturb and observe (P&O) method based MPPT etc. have been explained.

Perturb and Observe (P&O) method is the most familiar MPPT technique. The advantage of this method easy to implement and easier to be modified to an improved version of P&O method. But it has some draw back that it generates fluctuations around the MPP which consequently causes the power wastage. Some improved versions of P&O methods have also been evolved by the workers which have improved the performance of the P&O method. But no MPPT provides an improved efficiency of solar PV system at any instant of time. Supplying power simultaneously to dc and ac loads.

Nowadays a huge number of power renovation applications is dependent on dc-dc converters with high voltage capability. This paper focuse a new hybrid cuk converter.

It gives extensive boost-up and boost-down renovation ratio. Compared to other classical converter in step-up mode this converter reveals a wide range of the voltage renovation relation with the same duty cycle. Therefore, the function of supreme power point tracking (MPPT) for PV systems is not so far developed for HBC. converter. This implementation is not a trivial problem since it requires a systematic understanding on HBC switching mechanism and the coordination of MPPT function and the vector control function.

II. Existing MPPT Techniques

A. Perturb and Observe (P&O) Based MPPT

This is the widely used MPPT algorithm which is modest and comfortable to implement the power gained from the PV array increases also the PV panel functional voltage is flustered in a exact direction. Also the direction of perturbed operating voltage is in same direction. So the operative point has shifted to the direction of MPP. Else, if the operating point takes shifted left after the MPP and then the power obtained from the PV array also decreases, and, then perturbation of the operating voltage must be in reversed the direction

A drawback of P&O MPPT technique is that, at steady state, the operating point oscillates around the MPP giving rise to the waste of some amount of available energy. Several improvements of the P&O algorithm have been recommended in order to reduce the number of oscillations around the MPP in steady state, but they reduced the speed of retort of the algorithm at various atmospheric conditions in cloudy days also reduce the efficiency of algorithm. Due to this P&O algorithm is not suitable. But the novel mppt technique overcome the above problem and track the maximum power point accurately.

The P&O MPPT technique is represented by following figure

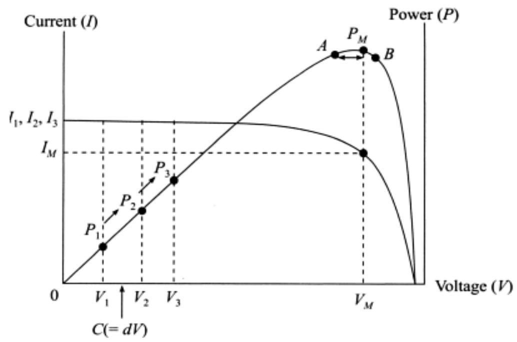


Fig. 1 Perturb and Observe (P&O) MPPT Technique

In this paper it is shown that, appropriate to constraint the negative effects associated to the above drawbacks, the P&O MPPT parameters must be customized to the active functioning of the particular converter adopted. A hypothetical study permitting the best choice of such parameters is also carried out.

B. *Incremental Conductance MPPT Algorithm*

Under fast changing atmospheric condition supreme power tracking is difficult in Perturb And Observe algorithm. Using the Incremental Conductance Method (INC) to beat the above problem. This algorithm proves that the PV array voltage vs power curve slope is like to zero at the highest power point. If The gradient is positive in the area to the left-hand side of the peak power point and negative in the area to the right hand side of the maximum power point [11]. Arithmeticly This can be precised as

$dP/dV=0$ at,MPP (1)
$dP/dV >0$,Left of peak power point (2)
$dP/dV < 0$,right of peak power point (3)

This can be simplified using the following approximation
$dP/dV= d(IV)= I + VdI/ dV$ (4)
From that, (3) can be rewritten as:
$dI/ dV= -I/V$ at, MPP (5)
$dI/ dV> -I/V$ Left of MPP (6)
$dI/dV<-I/V$ Right of MPP (7)
The operation of Incremental conductance method can be represented as in the following figure

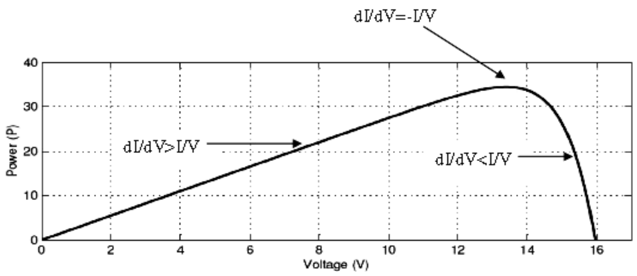


Fig .2 .Incremental conductance method

There is no communal pact in the literature on which one of the two methods is the best one, even if it is often said that the efficiency—expressed as the ratio between the actual array output power and the supreme power the array can yield in the same equal temperature and irradiance level—of the INC algorithm is better than that of the P&O algorithm. To this regard, it is worth saying that the comparisons presented in the literature are carried out without a proper optimization of P&O parameters. In is shown that the P&O method, when properly optimized, leads to an efficiency which is equal to that obtainable by the INC method. These are often merely chosen on the base of trial and error tests. Appropriately, no procedures or general rules are provided to regulate the optimum values of P&O parameters. This novel method is devoted to fill such a hole drawbacks. While grid-connected systems not essential for batteries, they are more economical and need less conservation and reinvestment than stand- alone systems. This concept together with the cost saving, technology growth, environmental consciousness, and the right inducements and regulations has unleashed the power of the sun.

Disadvantages:

1.Less operation

2.Low stability

III. PROPOSED SYSTEM

A. *Design Procedures*

In the recommended MPPT method, the supreme power point (MPP) is traced using the geometrical and arithmetic analysis of the I-V characteristic curve of the solar PV module. In this system, the angle built by using from the meeting point of short circuit current (I_{sc}) and open circuit voltage (V_{oc}) with esteem to the voltage (V) axis to the point of supreme power (MPP) is determined using the known parameters of the solar PV module. The supreme power angle determination for the following characteristic curves is evaluated as follows. The point of hypothetical power (P_{TH}) is the meeting point of V_{oc} and I_{sc}. So the hypotenuse is illustrated from the point P_{TH} to the point of origin. Next the angle built by this hypotenuse and the voltage (V) axis is 45° (as evident from the figure). It also replicates that the angle built by this hypotenuse and current (I) axis is also 45°.Currently it is desired to determine the angle built by the line (joining P_{TH} and I_{SC}) and the line (joining P_{TH} and M_{PP}). The above method is an efficient method for determination of the supreme power angle (ΘMPP). After obtaining this angle, the working point is forced to reach at MPP by using ΘMPP. By using the recommended method, the requirement of sensors is reduced. Arithmetic approach of the method gives a room of modifications easily as needed. Thereby the different versions of the method are possible to introduce for various applications.

B. Equations

The subsequent design stages are used for marking the MPP angle for the specified characteristic curves.

The corresponding value of voltage at MPP ($V_{Peak\ power}$) = 32.62 volts
The corresponding value of current at MPP ($I_{peak\ power}$) = 7.249A
The corresponding value of voltage at V_{OC} = 44.56 volts
The corresponding value of current at I_{SC} = 7.57A

$AB=I_{sc}-I_{mp}=7.57-7.249=0.321$ (8)

Where, AB = distance between MPP and (I_{SC} –P_{TH} line)
And BC = $I_{peak\ power} - I'_{peak\ power}$ distance between MPP and hypotenuse (line joining P_{TH} to origin)

Therefore AB<BC

$BP_{TH}^2=AB^2+AP_{TH}^2$ (9)
$AP_{TH}=44.56-32.62=11.94$
$BP_{TH}=11.94431417$
$Cos\theta=AP_{TH}/BP_{TH}$ (10)
$\theta_{MPP} = Cos^{-1}(11.94/11.9443) = 1.8498$
$\theta_{MPP}=1.8498^0$

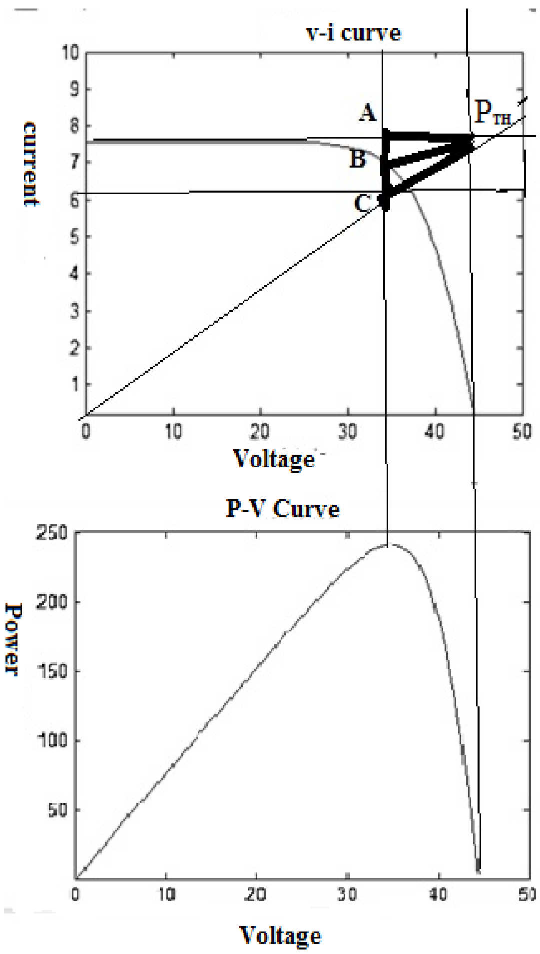


Fig 3.shows graphical implementation of MPA method.

Flow Chart of Novel MPPT

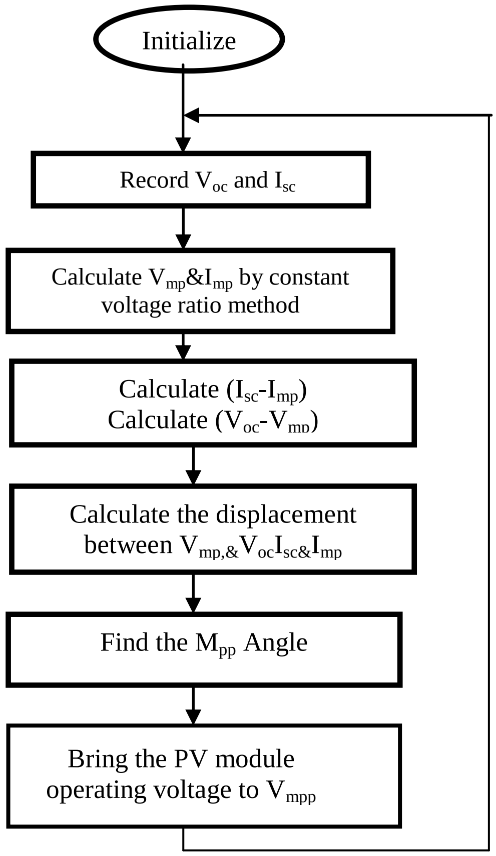


Fig.4.shows flowchart of novel MPPT

Advantages:

- ✓ High efficiency
- ✓ High Performance
- ✓ Analyze the maximum power angle

D.Flow Diagram

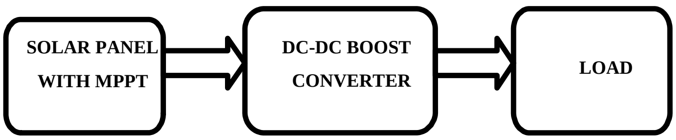


Fig .5. shows proposed system block diagram

F. Module Description

- ✓ Solar panel
- ✓ MPPT(Maximum Powerpoint Tracking
- ✓ Dc-Dc converter
- ✓ Load

The PV system will continue to produce electricity as long as there is sufficient sunlight to generate and sufficient load or battery capacity to absorb it. The power storage system acts as a intermediary connecting the PV and the load so that the user doesn't notice any fluctuation in power as a result of unstable sky conditions. The time to the energy supply will utmost complex to forecast because it is a function of the amount of sunlight available, the demand of the selected back-up loads and the state-of-charge(soc) condition at battery system the moment of isolation from the grid.

G. MPPT

Maximum power point tracking (MPPT) is an algorithm carry out in photovoltaic (PV) inverters to constantly adjust the impedance observed by the solar array to save the PV system close to the highest power point of the PV panel in changing atmospheric conditions, like changing solar insolation, temperature, and load. MPPT algorithms are normally used for to design the controller for Photovoltaic(PV) systems. The algorithms tale for factors such as flexible irradiance (sunlight) and temperature to certify that the PV system generates maximum power at all times.

H.DC-DC CONVERTER

DC/DC converter, the input to an converter can be a taut source for example battery, solar cell, or fuel cell or can be from an intermediary DC link that can be delivered from an AC source. A new hybrid Ćuk converter with wide boost up and boost-down renovation ratio and reverse output voltage polarity relative to the input voltage. Compared to the traditional Ćuk converter, in boost-up mode, the novel converter exhibits a extensive range of the voltage renovation ratio with the equal duty cycle. The DC equations are derived, the static characteristics are depicted, then stresses of devices are evaluated. The converter is simulated and experimentally tested in order to check the possibility of the proposed hybrid Ćuk converter.

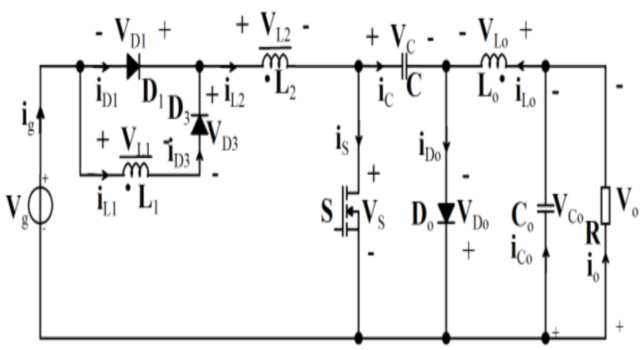


Fig .6. shows the hybrid cuk converter circuit diagram

I.Load

A load is take into consideration linear if its impedance variants by the functional voltage. The varying impedance causes that the current gotten by the non-linear load will not be sinusoidal even when it is joined to a sinusoidal voltage. These non-sinusoidal currents include harmonic currents that interrelate through the impedance of the energy distribution system to make voltage distortion that can disturb both the distribution system paraphernalia and the loads fixed to it.

IV. MATLAB RESULTS

A.Simulink model

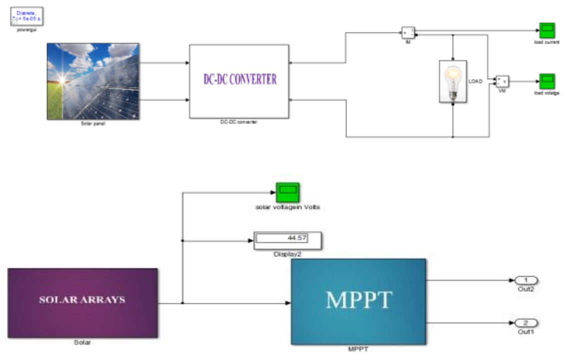
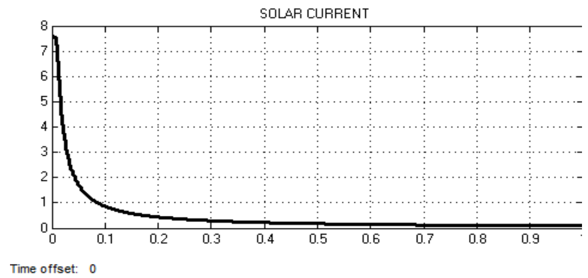


Fig.7.Shows Simulink model of recommended system

B.Solar Output Waveform at constant irradiance



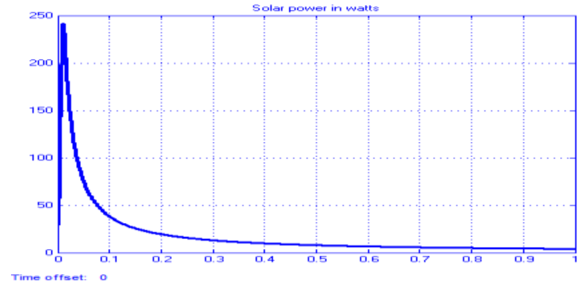


Fig.8.(b)

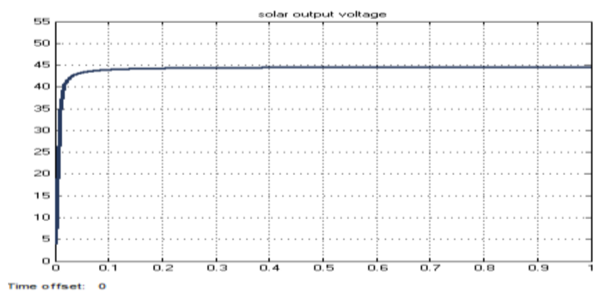
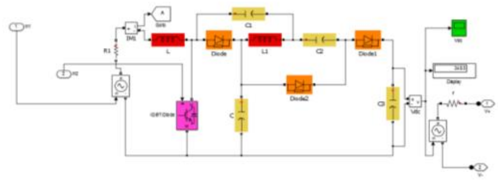


Fig.8(c)

Fig .8.(a),8(b),8(c) Shows waveforms of PV output voltage, current and power at constant temperature of 25°C and constant irradiance of 1000 W/m^2The PV voltage have 44.5 volt and current and power will be 7.5 Amps, and 240 Watts

C. Simulation and Result of Dc-Dc Converter



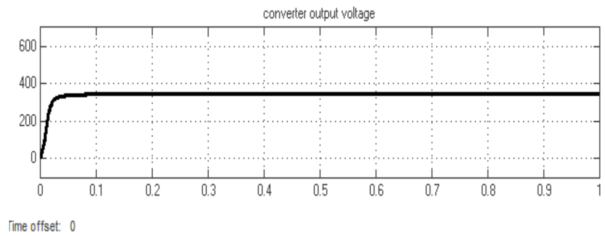


Fig .9.shows converter output voltage have 348 volts at constant irradiance level 1000 W/m^2

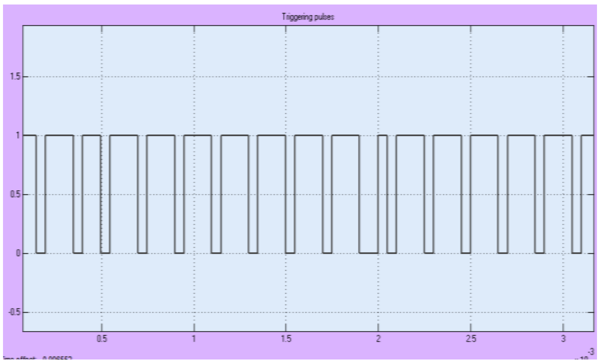


Fig.10. shows pulse generator triggering pulses

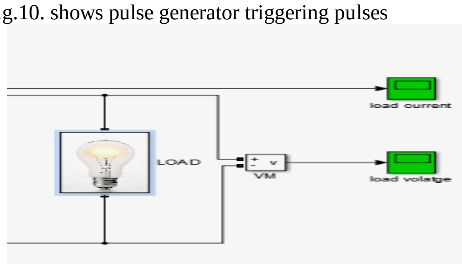


Fig.11.(a) shows load

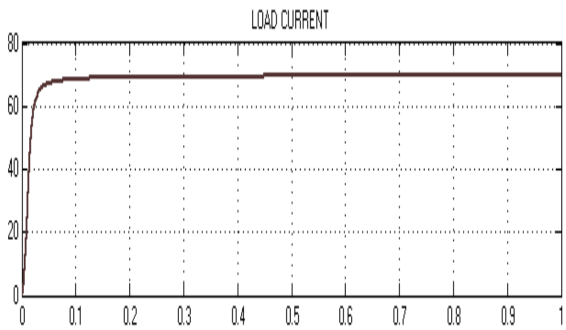


Fig.11.(b)

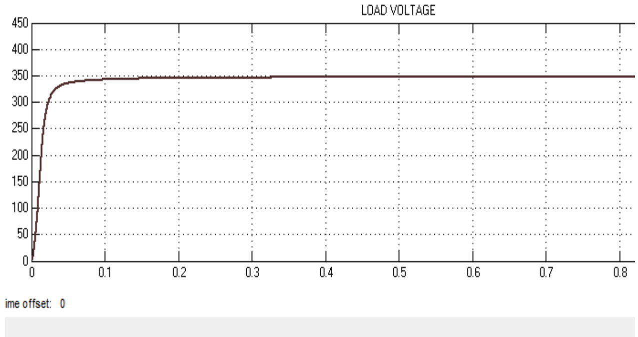


Fig.11. (b) shows load voltage and load current at 5ohm load at constant irradiance 1000 W/m^2

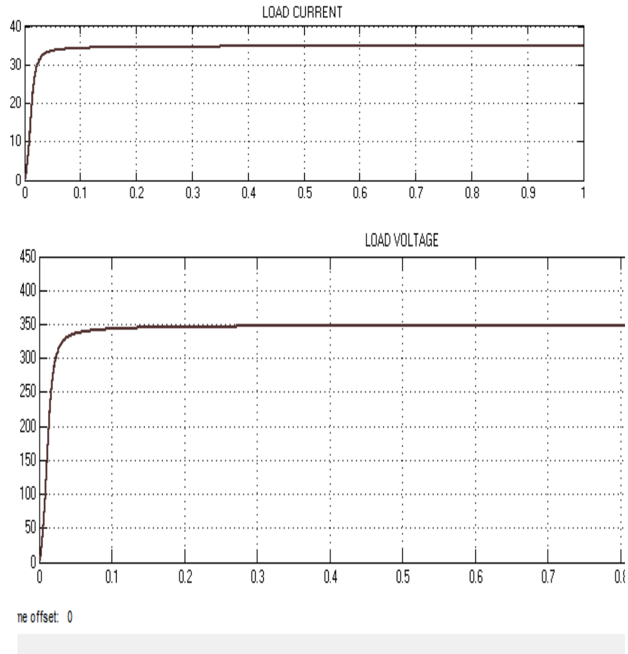


Fig.11.(c) shows load current (35amps) and load voltage at 10 ohm

Load at constant irradiance 1000W/m^2

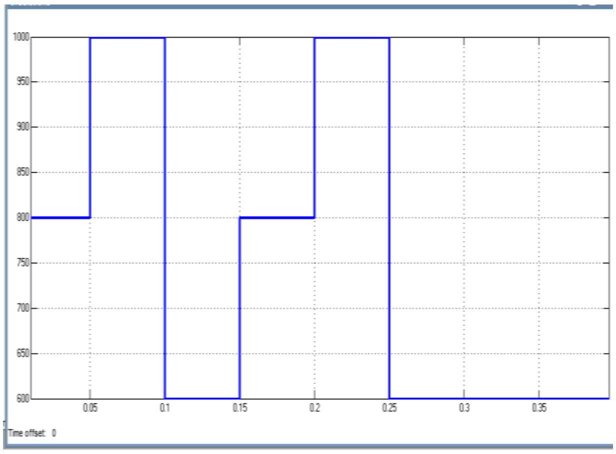


Fig .12. shows at constant temperature 25°C with step changes of irradiance(800W/m^2,1000W/m^2,600W/m^2)

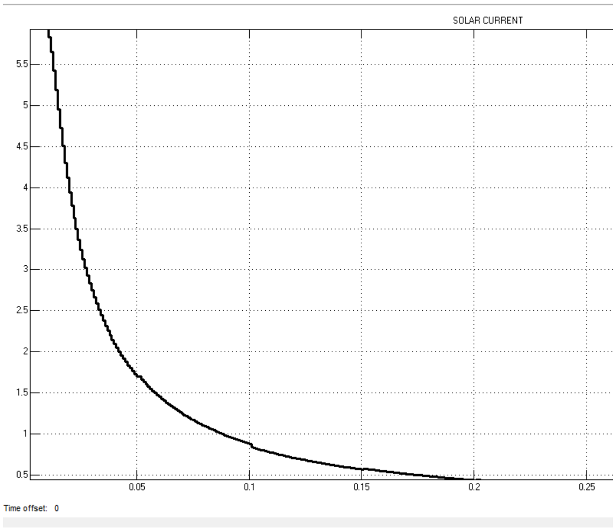


Fig. 12.(a). shows current at constant temperature of 25°C with step changes of irradiance at (800W/m^2,1000W/m^2,600W/m^2)

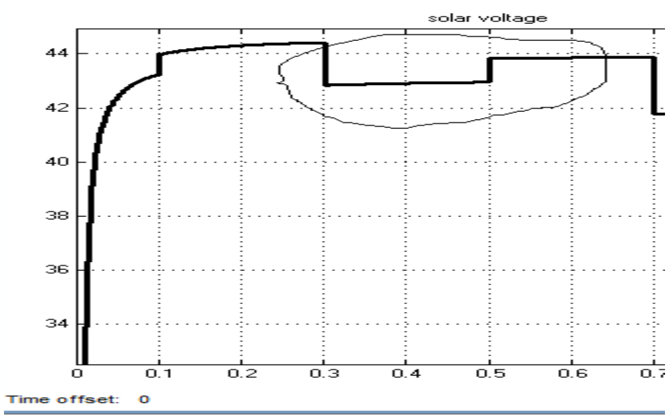


Fig.12.(b)

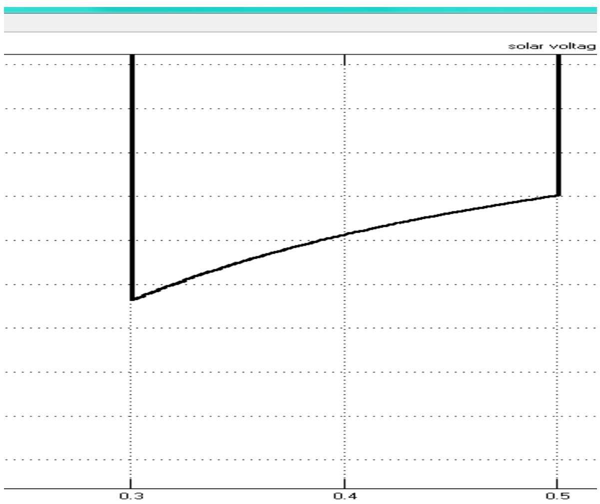


Fig.12.c. results of zoom out area in above figure 12.(b)

Fig. 12.(b). shows voltage at constant temperature of 25°C with step changes of irradiance at (800W/m^2,1000W/m^2,600W/m^2)

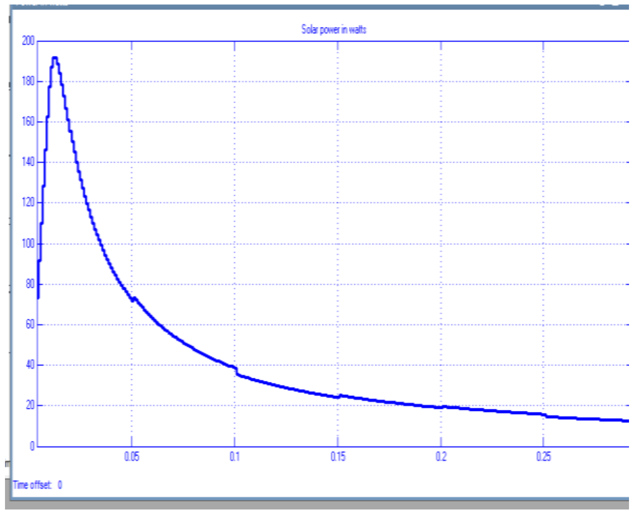


Fig.12.(d). shows solar power at constant temperature of 25°C with step changes of irradiance(800W/m^2,1000W/m^2,600W/m^2)

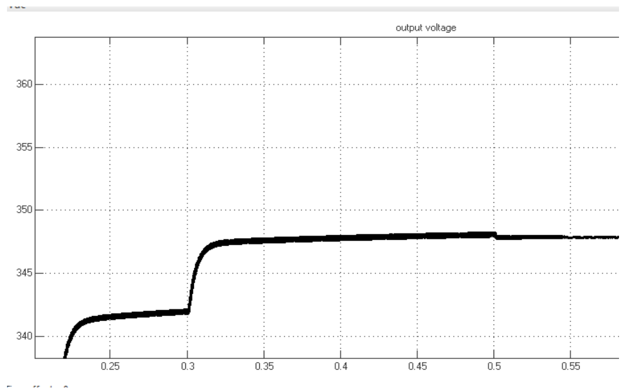


Fig.13.shows the converter output voltage at constant temperature 25°C with step changes of irradiance at (800W/m^2,1000W/m^2,600W/m^2)

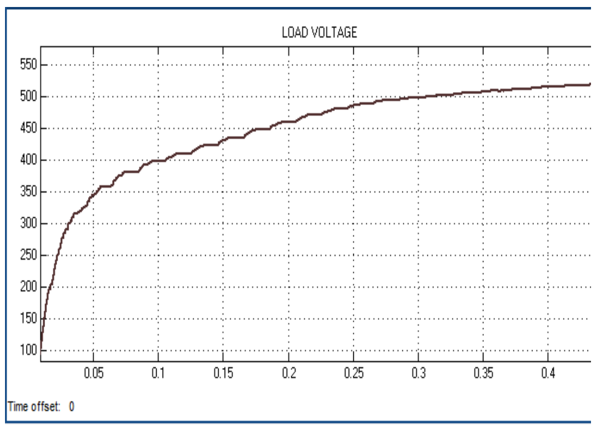


Fig.14.(a) shows load voltage and load current at 100 ohm

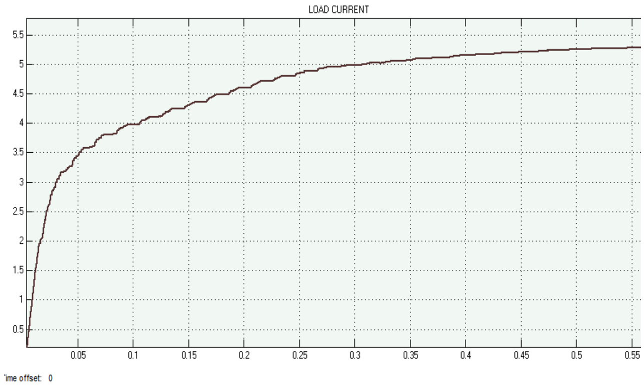


Fig.14.(b)

Fig. 14.(a),14.(b). shows load current at 100 ohm with step changes of irradiance at (800W/m^2,1000W/m^2,600W/m^2)

D. Figures and Tables

(a) PV panel and simulation circuit specifications

Table 1:

Solar panel specifications at 1Kw/m2,25°C		Converter circuit parameters	
Maximum power	200W	inductance	180mH
Opencircuit voltage	44.5	capacitance	9.6 µF,4.8 μF 1.2 µF
Shortcircuit current	7.57	Switch	IGBT
Maximum current	7.249	Diode	3nos
Maximum voltage	32.62	Switching frequency	50HZ

Table .1 shows PV panel and simulation circuit specifications

(b) Determination of Maximum power angle (MPA) with its factors like I_{mp}, V_{mp}, V_{oc}, I_{sc} & theta

Table 2:

Irradiations	Voc	Isc	Vmp	Imp	Power angle
600	42.39	3.785	35.04	3.519	1.6510
800	43.85	6.056	35.28	5.65	1.7933
1000	44.56	7.57	34.72	7.249	1.8498

Table.2. Shows Determination of maximum power angle (MPA) with its factors like I_{mp}, V_{mp}, V_{oc}, I_{sc} & theta(θ)

Find out the Theta

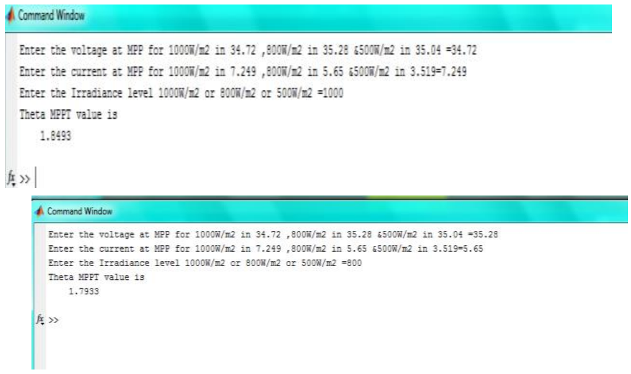
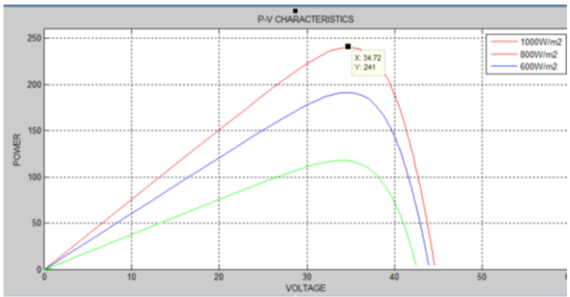


Fig.15.(a) Determination of Mamimum Power Angle (MPA) with its

factors like I_{mp}, V_{mp}, V_{oc}, I_{sc} & theta(θ).and the I_{mp}, V_{mp}, values are taken from below graph

Poof: solar panel P-V,I-V curve at(1000,800,600)irradiance level



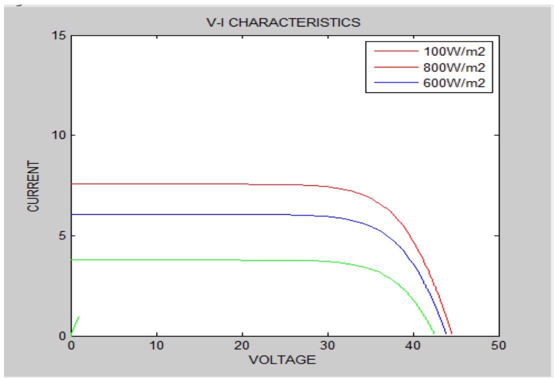


Fig.15.(b) solar panel P-V,I-V curve at (1000W/m^2, 800W/m [2] 600W/m^2) irradiance level.

Conclusions

The new maximum power angle based MPPT method for stand alone PV system is proposed and simulated. The PV system static and step change chracteristics are analyzed. A novel MPPT algorithm is simulated and applied to hybrid cuk converter to extract the maximum power from the PV array even so that of the load. The converter is designed according the load requirements. The simulation results are divided into three sections; increasing, decreasing of the insolation level, and load resistance variations. the proposed MPPT approach is that it wants the prior information about the various parameters of the solar PV module .

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Appendix-1.The contents of Maximum Angle Method main program

```
clear all;
close all;
clc;

% The corresponding value of voltage at MPP
Vmp=input('Enter the voltage at MPP for
1000W/m2 in 34.72 ,800W/m2 in 35.28
&600W/m2 in 35.04 =');

% The corresponding value of current at MPP
Imp=input('Enter the current at MPP for
1000W/m2 in 7.249 ,800W/m2 in 5.65
&600W/m2 in 3.519=');

% The corresponding value of voltage at Voc
Voc=44.56; %this value take in solar cell array

% The corresponding value of current at Isc
Isc=7.57; %this value take in solar cell array

AB=Isc-Imp;
BC=Imp-Imp';

%(i.e.,) AB<BC
% Take the Right-angled triangele AB BPTHR

% BPTH^2=AB^2+BPTH^2
APTH=Voc-Vmp;
BPTH=sqrt(AB*AB+APTH*APTH);

ir=input('Enter the Irradiance level 1000W/m2
or 800W/m2 or 600W/m2 =');

% The generalized formula for determining the
MPP angle has been derived as
theta=cos((APTH/BPTH))^-1;
disp('Theta MPPT value is');
disp(theta);
```

```
% suitable(ir,Voc,Isc,Vmp,Imp,theta);

yy=[ir Voc Isc Vmp Imp theta];
cnames = {'Irradiance(Irr)','voltage Open
circuit(Voc)','Current short circuit(Isc)','voltage
MPPT(Vmp)','current MPPT(Imp)','Maximum
Power Angle(MPA)'};

f1=figure('Name','Determination of Maximum
Power Angle(MPA)','NumberTitle','off');

u1 =
suitable('Parent',f1,'Data',yy,'ColumnName',cna
mes);


load('data.mat')
figure,
x=plot(V,P,'r');

hold on;

load('data1.mat')
y=plot(V,P,'b');
hold on

load('data2.mat')
xlim([0 60])
ylim([0 260])
xlabel('VOLTAGE')
ylabel('POWER')
title('P-V CHARACTERISTICS')
grid on
z=plot(V,P,'g');
% end
legend('1000W/m2','800W/m2','600W/m2')
```