ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization Vol. 5, Special Issue 2, March 2016

National Conference on Future Technologies in Power, Control and Communication Systems (NFTPCOS-16)

on 10, 11 and 12th March 2016

Organised by

Dept. of EEE, College of Engineering Perumon, Kollam, Kerala – 691601, India

MPPT Techniques for PV Systems with Grid Interconnection

Anu.V[*1], Sruthi Sasi [*2], Athira.B[*3]

U.G Scholar, Department of EEE, Sree Buddha College of Engineering for women, Elavumthitta, Kerala, India[*1]

U.G Scholar, Department of EEE, Sree Buddha College of Engineering for women, Elavumthitta, Kerala, India[*2]

Assistant Professor, Department of EEE, Sree Buddha College of Engineering for women, Elavumthitta, Kerala, India[*3]

ABSTRACT: In the future solar energy will be very important energy source. More than 45% of necessary energy in the world will be generated by photovoltaic array. Therefore it is necessary to concentrate our forces in order to reduce the application costs and to increment their performances. In order to reach this last aspect, it is important to note that the output characteristic of a photovoltaic array is nonlinear and changes with solar irradiation and the cell's temperature. Therefore a Maximum Power Point Tracking (MPPT) technique is needed to draw peak power from the solar array in order to maximize the produced energy.
Maximum Power Point Tracking is an algorithm that includes charge controllers used to extract maximum power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point' This project work presents a comparative study of various widely adopted MPPT algorithms and their performance is evaluated using the simulation tool Simulink in both isolated as well as grid connected mode.

KEYWORDS: Maximum Power Point Tracking (MPPT), Perturb and Observe algorithm (P&O), Incremental Conductance(IC), Photovoltaic (PV).

I.INTRODUCTION

Solar energy is the most abundant form of renewable energy available for us. Solar photovoltaic (PV) system uses photo-voltaic modules which are composed of several PV cells which convert solar energy to electrical energy. Number of solar cells is connected together in either series or parallel configuration to form a solar PV module or PV panel to increase the output voltage or current. Each PV module can be characterised by its P-V as well as I-V curve..
There is a unique point on the P-V and I-V curve called the maximum power point (MPP).The location of this MPP is not known but can be tracked by using various MPPT (Maximum Power Point Tracking) Techniques.
The data from the PV module can be collected by the controller which in turn produces the duty cycle for controlling the DC-DC converter. The output from the converter is fed to the load. The DC output from the converter can be made AC by connecting an inverter in between the converter and load depending upon the load requirements
The proposed paper deals with various Maximum Power Point tracking techniques used to extract maximum power from the PV module. [2] Also this paper analyse through results which MPPT technique is most suitable for the grid conditions under normal and varying atmospheric conditions. Now a day's grid connected systems which are most common and it is very useful for residential and industrial purposes due to that for getting maximum power output from PV module MPPT techniques are used. The main problems solved by the MPPT technique are that it automatically finds out the maximum voltage and current from the PV panel such that it operates under maximum power point.

II. MODELLING OF PHOTOVOLTAIC SYSTEM

Due to uncertainty in the in global supply of fossil fuels, a continued increase in energy consumption and growing awareness of environmental deterioration we use PV system. Solar PV is a semiconductor device consisting of an array of cells which directly converts solar radiation into electricity without any intermediate steps. Higher the intensity of the sunlight, the more the amount of electricity generated from it [1]. Amount of electricity generated (say, 1milli watt to several megawatts) which depends on the size of the PV module.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization Vol. 5, Special Issue 2, March 2016

National Conference on Future Technologies in Power, Control and Communication Systems (NFTPCOS-16)

on 10, 11 and 12th March 2016

Organised by

Dept. of EEE, College of Engineering Perumon, Kollam, Kerala – 691601, India

A. EQUIVALENT CIRCUIT OF A SOLAR CELL

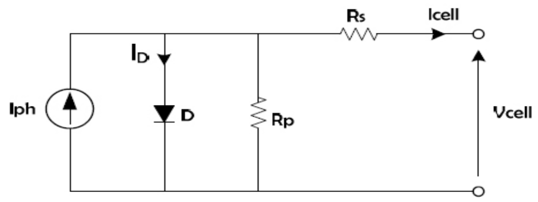


fig 1: equivalent circuit

Equivalent circuti of a solar cell that can be treated us a current source, a diode , a parallel resistor expressing in terms of leakage current and also consisting of a series resistor describing an internal resistance which helps the current to flow. Diode which represnts dark current.

$$I = I_{ph} - Ir\left[e^{\frac{q(V+IRs)}{nkT}} - 1\right] - \frac{V + IR_s}{R_p} \quad (1)$$

Where

I_{ph} is the photoelectric current

I_s is the cell saturation dark current

T_c is the cell working temperature

A is ideal factor

R_{sh} is the shunt resistance

R_s is the series resistance

The photo electric current mainly depends on solar isolation and cell's normal working temperature on a particular area which is related by $I_{ph} = [I_{sc} + k_1(T_c - T_{ref})]H$ (2)

Basically cell saturation current varies with that of temperature us

$$I_S = I_{RS}\left(\frac{T_c}{T_{ref}}\right)^3 e\left[\left(\frac{qE_g(T_c - T_{ref})}{T_{ref}\,T_c\,K\,A}\right)\right] \quad (3)$$

A PV array is a group of cells that are connected in series or parallel to get the required output such an equivalent circuit is shown in figure.

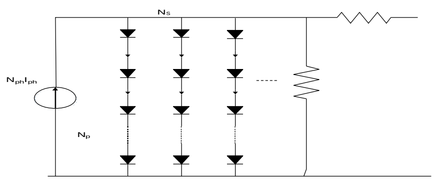


Fig 2: Equivalent Circuit of a number of solar cells in series and parallel

$$I = N_p I_{ph} - N_p I_s\left[e^{\frac{q(V/Ns + IRs/Np)}{kTcA}} - 1\right] - \frac{N_p V/N_s + IR_s}{R_{sh}} \quad (4)$$

A solar cell is modelled based on the equivalent circuit.

III. MAXIMUM POWER POINT TRACKIN TECHNIQUES

Maximum Power Point Tracking is an algorithm which uses charge controllers to extract maximum power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point'. So as to obtain the maximum power point of the PV module various MPPT techniques are used. Various MPPT techniques include:

- PERTURBATION AND OBSERVATION METHOD
- INCREMENTAL CONDUCTANCE METHOD

- FRACTIONAL OPEN VOLTAGE METHOD
- CONSTANT VOLTAGE METHOD

a. PERTURB AND OBSERVE METHOD

The P&O algorithms operate by periodically perturbing (increasing or decreasing) the array terminal voltage and comparing the PV output power with that of the previous value. If the PV array's operating voltage changes and the power increases (the control system will move the operating point in that direction; otherwise the operating point will be moved in the opposite direction. In the next perturbation cycle the algorithm will continue in the same way.
A common problem in P&O algorithms is that the array terminal voltage is perturbed every MPPT cycle; therefore when the MPP is reached, the output power will oscillate around the maximum, resulting in power loss in the PV system. This is especially true in constant, slowly-varying atmospheric conditions and also under rapidly changing atmospheric conditions. [3].

B.INCREMENTAL CONDUCTANCE METHOD

In incremental conductance method, the controller will measure the incremental changes in array current and voltage to predict the effect of a voltage change. This method requires more computation in the controller, but can track changing conditions more easily than perturbation and observe method.
This method utilizes the incremental conductance (di/dv) of the photovoltaic array to determine the sign of the change in power with respect to voltage (dP/dV). The incremental conductance method computes the maximum power point by comparison of the incremental conductance ($\Delta I/\Delta V$) to the array conductance (I/V).
When the incremental conductance is zero, the output voltage is the MPP voltage. The controller maintains this voltage until the irradiation changes and the process is repeated [3].

C.FRACTIONAL OPEN VOLTAGE METHOD

The power delivered to the load is momentarily interrupted and the open circuit voltage with zero current is measured. The controller will resume the operation with the voltage controlled at a fixed ratio such as 76%, of the open circuit voltage, which has empirically been determined as the estimated maximum power point.[3]

D.CONSTANT VOLTAGE METHOD

The Constant Voltage (CV) algorithm is the simplest MPPT control method. The operating point of the PV array is kept near the maximum power point by regulating the array voltage and matching it to a fixed reference voltage or another pre evaluated best voltage value. The CV method assumes that insulation and temperature variations on the array are not significant, and that the constant reference voltage is adequate for the true MPP approximation.

E.GRID CONNECTED SYSTEM

Recently grid connected photovoltaic system have been spreading in residential areas and in industrial areas. So we have to find a suitable MPPT technique that gives a better power output when connected is to find out. For a grid connected system there are certain factors that have been considered such that DC-AC conversion with highest output power quality with the proper design of filters System main controlling factors like MPPT. Comprehensive protection functions including Anti islanding protection and accelerated phase shift protection. The reference reactive power is typically set to be zero in order to achieve zero phase angle between voltage and current such that unity power factor can be achieved it is the main requirement. Next main factor to be considered is synchronization which is basically achieved by using a phase locked loop. In grid tied inverter synchronization and Anti Islanding protection which is to be provided to protect the inverter from over load. Synchronization which is achieved by various methods such us filtering the grid voltage using phase locked loop and by using zero crossing detector.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization *Vol. 5, Special Issue 2, March 2016*

National Conference on Future Technologies in Power, Control and Communication Systems (NFTPCOS-16)

on 10, 11 and 12th March 2016

Organised by

Dept. of EEE, College of Engineering Perumon, Kollam, Kerala – 691601, India

IV. SIMULATION RESULTS

In order to find which MPPT technique is better when connected to grid first of all PV module is modelled in mat lab/Simulink based on the equivalent circuit. Input to the PV module is solar insolation and temperature. From the solar panel voltage and current are extracted in order to find the power output.

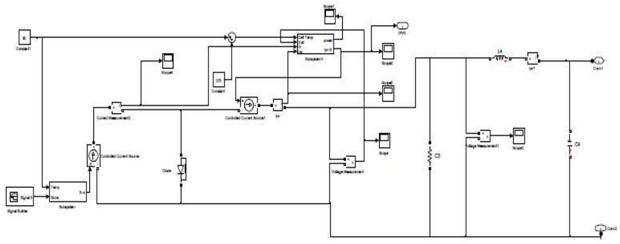
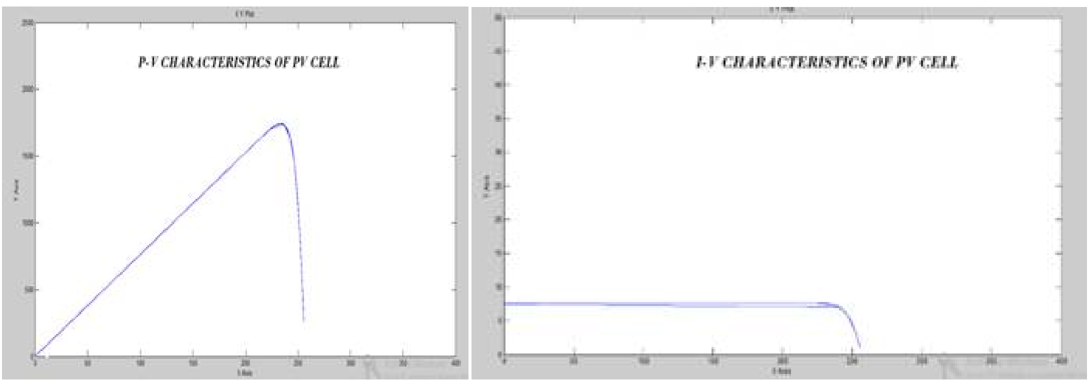


FIG 3: PV MODEL

From the equivalent circuit PV module is modelled in mat lab/Simulink platform and typical PV, IV characteristics is analysed the design specifications of the simulated PV module is shown in the table

TABLE I
DESIGN SPECIFICATIONS OF PV MODULE

Characteristics	Specifications
Power output	1860 W
Short circuit current	8 A
Open circuit voltage	261 V
Voltage at peak power	7.1 A
Current at peak power	230 V
Temperature coefficient	0.008 A/C



(a) (b)
Fig 4: Output waveforms of the PV Module
(a)PV characteristics (b) IV characteristics

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization *Vol. 5, Special Issue 2, March 2016*

National Conference on Future Technologies in Power, Control and Communication Systems (NFTPCOS-16)

on 10, 11 and 12th March 2016

Organised by

Dept. of EEE, College of Engineering Perumon, Kollam, Kerala – 691601, India

PV module is analysed and gives better results. Then each algorithm are implemented in mat lab/Simulink platform and the power output, voltage and current is compared and finds out which algorithm which gives better results when connected to grid under constant and varying atmospheric conditions.

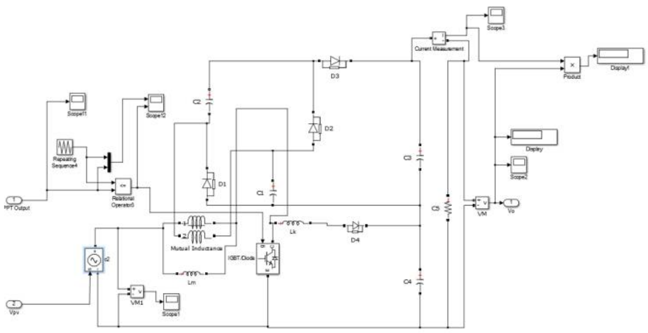


Fig 5: Boost Converter

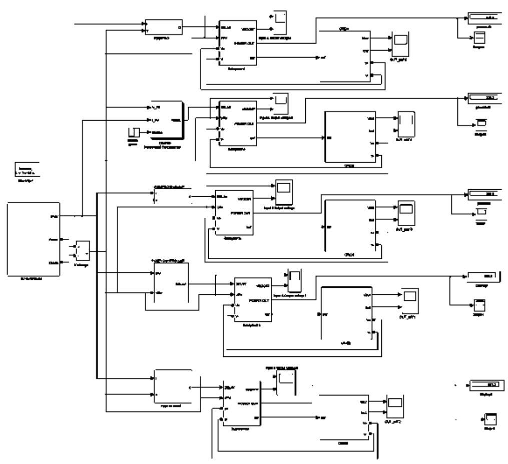
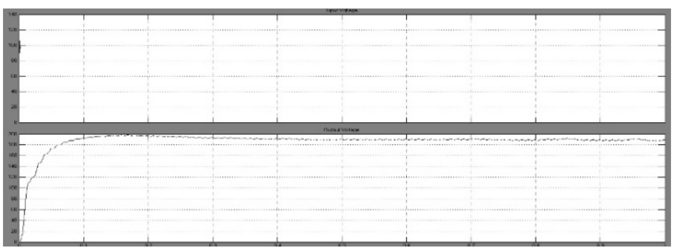


Fig 6: Grid Connected system with different MPPT Techniques



(a)

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

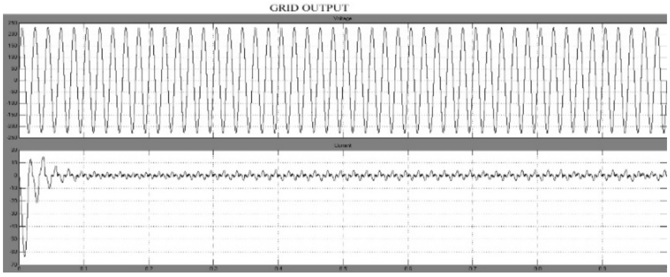
An ISO 3297: 2007 Certified Organization Vol. 5, Special Issue 2, March 2016

National Conference on Future Technologies in Power, Control and Communication Systems (NFTPCOS-16)

on 10, 11 and 12th March 2016

Organised by

Dept. of EEE, College of Engineering Perumon, Kollam, Kerala – 691601, India



(b)

Fig 7: Output waveforms of Grid Connected System Using Incremental Conductance Method
(a)Boost Converter Input And Output Voltage Waveforms (b) Grid output And Input voltage Wave Form

Figure 7(b) shows the grid output voltage and output current of an Incremental Conductance algorithm which gives a better output under normal and varying atmospheric conditions. Figure 7(a) shows the boost converter input and output voltage waveforms of Incremental Conductance algorithm when connected to grid. From the waveforms and simulation results we can conclude that Incremental Conductance algorithm which gives better output and efficiency when compared to other algorithms.

VI. CONCLUSION

Based on the simulation results we can found that Incremental Conductance algorithm holds good performance than any other methods under normal and varying atmospheric conditions. Power output obtained from incremental conductance method is high as compared to other methods under varying atmospheric conditions. For a grid connected Photo voltaic system Maximum Power Point Tracking algorithm which place a major role.. So for residential and industrial purposes INCREMENTAL CONDUCTANCE ALGORITHM this performs better results.

REFERENCES

[1] Kapil Dev Sharma1, Sumit Saroha2, Sunil Kumar3 Dronacharya Group of Institutions, Greater Noida, India1,2,3 Kdsharma.en@gmail.com1" Active Power Control of Grid Connected Hybrid Fuel Cell & Solar Power Plant ".

[2] D. S. Karanjkar, S. Chatterji and Shimi S. L. National Institute of Technical Teachers Training and Research, Chandigarh, India ,Amod Kumar Central Scientific Instruments Organization, Chandigarh, India "Real Time Simulation and Analysis of Maximum Power Point Tracking (MPPT) Techniques for Solar Photo-Voltaic System ".

[3] R. Faranda, S. Leva and V. Maugeri, "MPPT Techniques for PV Systems: Energetic and Cost Comparison," Power and Energy Society General MeetingConversion and Delivery of Electrical Energy, pp. 11-16, Mar. 2008.

[4] Michael E. Ropp, Member, IEEE, and Sigifredo Gonzalez" Development of a MATLAB/Simulink Model of a Single-Phase Grid-Connected Photovoltaic System".

[5] Huan-Liang Tsai, Ci-Siang Tu, and Yi-Jie Su, Member, IAENG"Development of Generalized Photovoltaic Model Using MATLAB/SIMULINK"