



Analysis of Different MPPT Techniques

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ABSTRACT: MPPT techniques which automatically finds the voltage or current at which maximum power point of a PV module. Under partial shading conditions it is possible to have multiple local maximum at the same points so maximum power point shifts according to it. Most MPPT techniques would automatically respond to changes in both radiation and temperature. Among these some techniques are more useful. So we have to find which MPPT technique is most suitable for the present conditions and comparing the results with that of other. This paper analyze through results which MPPT technique is most suitable for the grid connections under normal and variation in the atmospheric conditions. Now a day's grid connected systems which are most common and it is used for industrial and home applications due to that for getting maximum power output from a PV module. The commonly used MPPT techniques are Perturb and Observe (P&O) method, Incremental Conductance (INC) method.

KEYWORDS: Maximum power point tracking (MPPT), Perturb & Observe (P&O), Incremental Conductance (INC)

I.INTRODUCTION

Solar energy is one of the most important distributed generation option. For the production of electricity, solar energy is widely used. Therefore, a developments in Renewable and alternative energy systems are expected to increase for this purpose. It is important to develop more and better means of alternative energy sources such as solar, wind and biomass. Solar energy is renewable, inexhaustible and non-polluting, and it is more intensively used as various applications. Solar energy is a unique perspective solution for energy crisis. All these advantages of solar energy, they do not have desirable efficiency. A solar cell which is used converts 30-40% of solar energy into electrical energy. Cells which are connected in series that satisfies higher voltage requirements and which are parallel that gives higher current requirements. The maximum amount of power that can be extracted from the solar panel. The maximum power depends on the solar radiations, temperature, and load. So the input to the solar cell is basically sunlight and temperature of that particular area. The efficiency of solar cells depends on temperature, radiation and spectral characteristics of sunlight, dust, shading, which result in poor performance. Due to the poor efficiency of PV systems, "maximum power point tracking" (MPPT) techniques were proposed. The photovoltaic has an optimum operating point to extract the maximum power of the PV module. This point is called the maximum power point (MPP), which depends on cell temperature, solar radiation level and the nature of load. Tracker is deviate from the maximum power point due to the variation in solar radiations and temperature, thus the tracker needs to response within a short time. Maximum power point tracking technique is chosen based on several factors such as simplicity, cost, quick tracking under varies atmospheric conditions, small power output locations etc. The MPPT techniques finds the voltage or current at which maximum power point in a PV module should operate. Under partial shading conditions it is possible to have multiple local maximum at the same points so maximum power point shifts according to it.

II.PHOTOVOLTAIC CELL

Photovoltaic cell is a semiconductor device which converts light energy in to electrical energy by photovoltaic effect. If the photon energy of light is greater than the band gap then the electron is emitted. Flow of electrons creates current. Photovoltaic cell or photoelectric cell is different from the photodiode. In a photodiode light falls on n-channel of the semiconductor and gets converted into current or voltage signal but a photovoltaic cell is always forward biased.

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III.PV MODULE

For the energy requirements ,usually a number of PV modules are arranged in series and parallel . PV modules of different sizes are available .Generally the power from 60W to 170W. For example, a typical small scale desalination plant requires a few thousand watts of power. PV cell is the basic building block of a power system.

IV. PV MODELLING

A PV array consists of several photovoltaic cells which are connected in series and parallel. Series connections are used to increasing the voltage of the module whereas the parallel connections for increasing the current in the array. Typically a solar cell can be modelled by a current source and an inverted diode which are connected in parallel . It has its own series and parallel resistance. The current source represents the current generated by photons and parallel resistance is due to the leakage current.

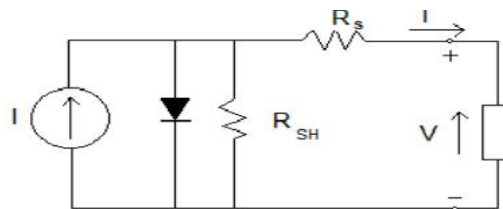


Fig.1Equivalent circuit

In this model we consider a current source (I) along with a diode and series resistance (Rs). The shunt resistance (Rsh) has a negligible effect so it can be neglected.

The output current from the photovoltaic array is ,

$$I = I_{sc} - I_d$$

$$I_d = I_0(e^{qV_d/KT} - 1)$$

where I_0 is the reverse saturation current of the diode, q is the electron charge, voltage across the diode is V_d , k is a constant called Boltzmann constant and T is the junction temperature in Kelvin (K) .

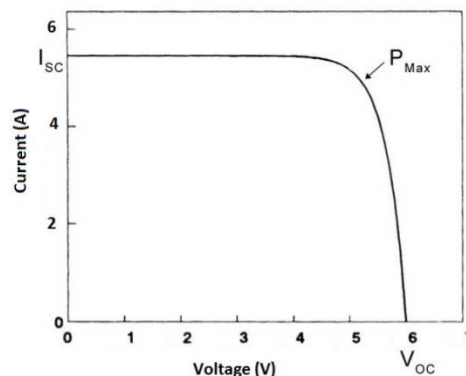


Fig.2 I-V characteristics of a solar panel

When the voltage and the current characteristics are multiplied we get the P-V characteristics as . The point indicated as MPP is the point at which the panel power output is maximum.

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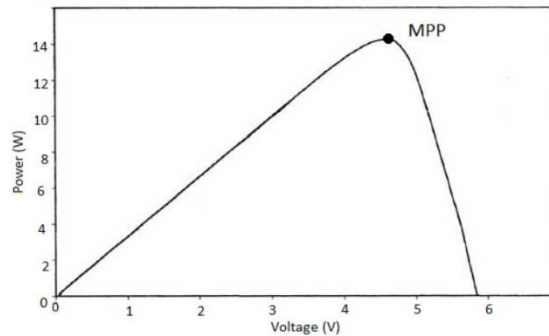


Fig.3 P-V characteristics curve of photovoltaic cell

V. MPPT ALGORITHMS

A typical solar panel converts only 30 to 40 percent of the incident solar radiation into electrical energy. MPPT technique is used to improve the solar panel efficiency. According to Maximum Power Transfer theorem, the power output of a circuit is maximum when the source impedance of the circuit matches with the load impedance. The maximum power point reduces to an impedance matching problem. Boost converter is connected in the source side of the solar panel in order to enhance the output voltage so that it can be used for different applications like motor load. By changing the duty cycle of the boost converter we can match the source impedance with that of the load impedance.

VI. DIFFERENT MPPT TECHNIQUES

There are different techniques used to track the maximum power point from a PV module. The techniques are,

- 1) Perturbation and Observation (P&O) method
- 2) Incremental Conductance (INC) method
- 3) Fractional short circuit current method
- 4) Fractional open circuit voltage method

The choice of the algorithm depends on the time complexity, implementation cost and the ease of implementation. The algorithm takes to track the maximum power point.

VII. PERTURB & OBSERVE METHOD

Perturb & Observe (P&O) method is the simplest method. It has only one sensor, that is the voltage sensor, used to sense the PV array voltage. The cost of implementation of voltage sensor is less and hence easy to implement. The time complexity of this algorithm is very less but on reaching very close to the maximum power it doesn't stop at the MPP and keeps on perturbing on both the directions. Due to this reason we can set an appropriate error limit or can use a wait function which ends up increasing the time complexity of the algorithm. However the method does not take an account of the rapid change of radiation level (due to which MPPT changes) and considers it as a change in MPP due to perturbation and ends up calculating the wrong MPP. To avoid this problem we can use incremental conductance.

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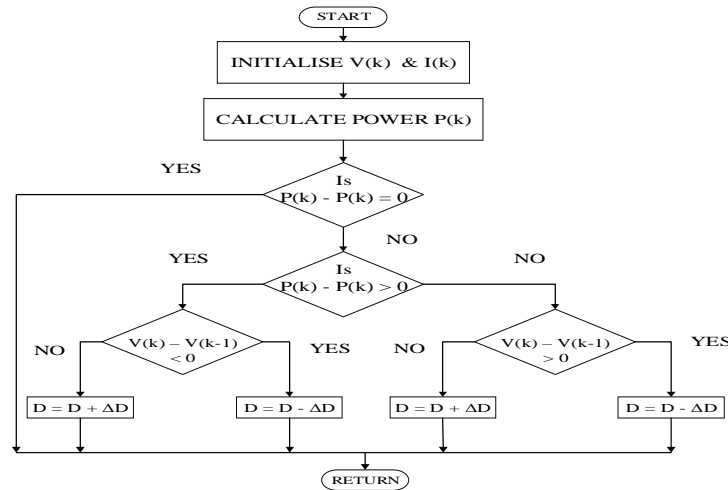


Fig.4 flow chart of perturb & observe method

VIII. INCREMENTAL CONDUCTANCE

Incremental conductance method uses two voltage and current sensors .It is used to sense the output voltage and current of the PV array. At maximum power point the slope of the PV curve is 0.

$$\begin{aligned} (dP/dV)_{mpp} &= d(VI)/dV \\ 0 &= I + VdI/dV_{mpp} \\ dI/dV_{mpp} &= -I/V \end{aligned}$$

The left hand side of the equation is instantaneous conductance of the solar panel. When this instantaneous conductance equals the conductance of the solar panel, then the MPP is reached. Here we are sensing both the voltage and current simultaneously. Hence the error due to change in radiation is eliminated. However the complexity and the cost of implementation increases. As we go down the list of algorithms, the complexity and the cost of implementation goes on increasing which may be suitable for a highly complicated system. This is the reason that Perturb and Observe and Incremental Conductance method are the most widely used algorithms.

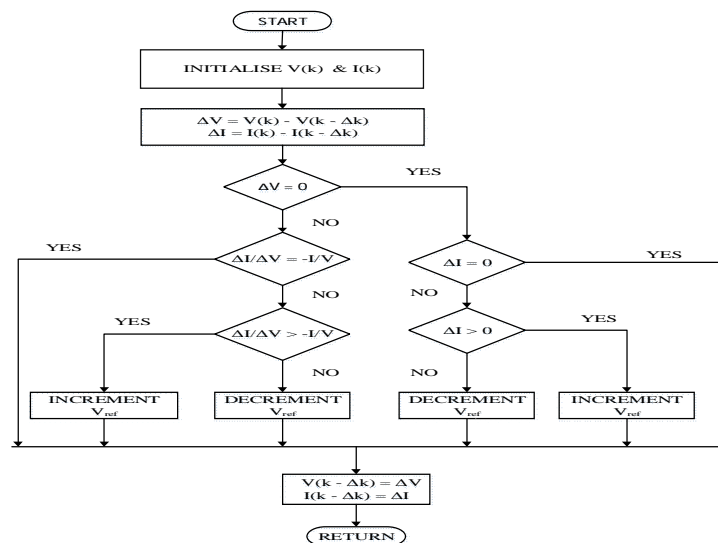


Fig.5 flow chart of INC algorithm



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IX.FRACTIONAL OPEN CIRCUIT VOLTAGE

The near linear relationship between V_{mpp} and V_{oc} of the PV array, under varying radiation and temperature levels, has given rise to the fractional V_{oc} method.

$$V_{mpp} = K_1 V_{oc}$$

X.GRID CONNECTED SYSTEM

Recently grid connected photovoltaic system have been used in residential areas and in industrial areas. So we have to find a suitable MPPT technique that gives a better power output from a PV module. 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. Grid interface inverters which transfers the energy from the photovoltaic module to the grid by just keeping the dc link voltage which is to be maintained constant. The utility network mainly demands for better power quality and power output for a grid connected system. In the case of voltage fluctuations control of grid parameters is very difficult. So for a PV system that is connected to a grid first stage is the boosting stage and the second stage is DC-AC converter. An output filter is usually employed which reduces the ripple components due to switching problems.

XI.CONCLUSION

In this paper a detailed analysis of various maximum power point tracking algorithms were carried out. Incremental Conductance algorithm which holds good performance than any other methods under normal and varying atmospheric conditions. Power output obtained from incremental conductance method is high us compared to other methods under varying atmospheric conditions. Maximum Power Point Tracking algorithm which place a major role for a grid connected Photo voltaic system. A most suitable MPPT technique is chosen based on the implementation cost, number of sensors required, complexity. So for residential and industrial purposes INCREMENTAL CONDUCTANCE ALGORITHM performs better results.

XII.FUTURE SCOPE

Now a days in residential and industrial applications solar PV system which is gaining much more importance. So we have to find a better and efficient system for that we are using MPPT technique. For battery charging applications also MPPT techniques which provides better results. The main difficulties of these system is that when connected to grid synchronization will be very difficult. In future grid connected system will become very common and solar PV system which gains much more important than other systems. The main disadvantage of these type of systems are the implementation cost is very high.

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