DESIGN OF MAXIMUM POWER POINT TRACKER (MPPT) USING INCREMENTAL CONDUCTANCE METHOD

Abstract:

Due to rapid growth in the semiconductor and power electronics techniques, PV energy is of increasing interest in electrical power applications. Photovoltaic (PV) energy is the most important energy resource since it is clean,pollution free, and inexhaustible It is important to operate PV energy conversion systems near the maximum power pointto increase the output efficiency of PV arrays. The output power of PV arrays is always changing with weather conditions, i.e., solar irradiation and atmospheric temperature. Therefore, a MPPT control to extract maximum power from the PV arrays at real time becomes indispensable in PV generation system.

In recent years, a large number of techniques have been proposed for tracking the maximum power point (MPP). Maximum power point tracking (MPPT)is used in photovoltaic (PV) systems to maximize the photovoltaic array output power, irrespective of the temperature and radiation conditions and of the load electrical characteristics the PV array output power is used to directly control the dc/dc converter, thus reducing the complexity of the system. The resulting system has high-efficiency; lower-cost this paper proposes a maximum Power-point tracking (MPPT) method with a simple algorithm for photovoltaic (PV) power generation systems. The method is based on use of a Incremental conductance of the PV to determine an optimum operating current for the maximum output power. This work proposes on

Investigation of Incremental conductance Based maximum Power Point Tracking for Photovoltaic System, to have the advantages of low frequency switching.

Incremental Conductance Algorithm is highly efficient as it has Steady State accuracy and it gets easily adjustable for the changing environmental conditions thus increasing the efficiency of PV system. Additionally if the Solar radiation is also modelled using slope of the panel, latitude the temperature of the place where the solar panel is installed the panel can be installed in such a way it can produce maximum power throughout the day.

Keywords: Solar radiation, Photovoltaic Module, Maximum Power Point Tracking, Incremental Conductance Algorithm, Direct Control method, DC-DC converters.

Introduction:

Photovoltaic (PV) systems have been used for many decades. Today, with the focus on greener sources of power, PV has become an important source of power for a wide range of applications. Improvements in converting light energy into electrical energy as well as the cost reductions have helped create this growth. Even with higher efficiency and lower cost, the goal remains to maximize the power from the PV system under various lighting conditions.[2] Unfortunately, PV generation systems have two major problems: the conversion efficiency of electric power generation is very low (9÷17%), especially under low irradiation conditions, and the amount of electric power generated by solar arrays changes continuously with weather conditions. Moreover, the solar cell V-I characteristic is non linear and varies with irradiation and temperature. In general, there is a unique point on the V-I or V-P curve, called the Maximum Power

Point (MPP), at which the entire PV system (array, converter, etc…) operates with maximum efficiency and produces its maximum output power. The location of the MPP is not known, but can be located, either through calculation models or by search algorithms. Therefore Maximum Power Point Tracking (MPPT) techniques are needed to maintain the PV array"s operating point at its MPP.

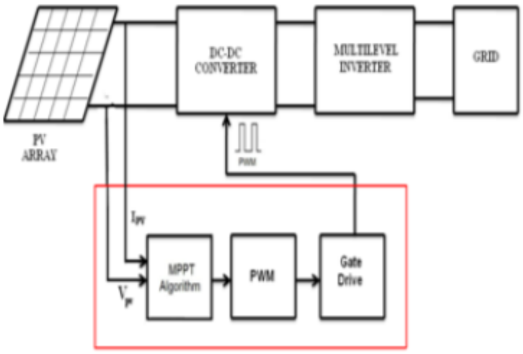
PV System:

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomen on. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Individual solar cell devices can be combined to form modules, otherwise known as solar panels. In basic terms a single junction silicon solar cell can produce a maximum open-circuit voltage of approximately 0.5 to 0.6 volts.

MPPT:

Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that "physically moves" the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power.

Additional power harvested from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different.

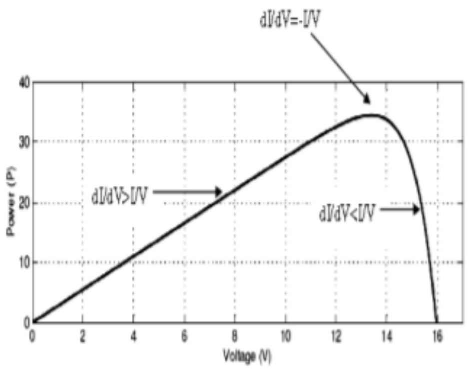


Selection of Algorithm:

MPPT is the only way of increasing the efficiency of the solar cell by extracting the maximum power from the solar panel and delivering constant voltage irrespective of variation in solar radiation. In direct coupled method i.e without MPPT solar power is delivered directly to the load the voltage will quickly collapse to zero. This can be understood from the I-V curve obtained from the solar panel. Hence a system with MPPT presents the collapse of the voltage by keeping the operating point near the Maximum Power point. A wide range of MPPT Algorithms are available. Of all the available algorithms Incremental Conductance Algorithm lends itself well to the DSP and Micro controller. A comparison between the Perturb & Observe (P & O) and the Incremental Conductance Algorithm (INC) reveals that the efficiency of P & O method is 95 % and INC Algorithm is 98.2 % The drawback of using PI controller in the Maximum Power Point Tracker due to Non linear nature of the PV cell is overcome by using Direct control method in this paper. MPPT using Fuzzy control and Neural Network is highly accurate but require sound technical knowledge in creating the rule based table. Hence among all the techniques discussed above Incremental Conductance Algorithm is found to be best technique and easily adaptable to the changing environmental conditions.

INC Method:

In incremental conductance method the array terminal voltage is always adjusted according to the MPP voltage it is based on the incremental and instantaneous conductance of the PV module.



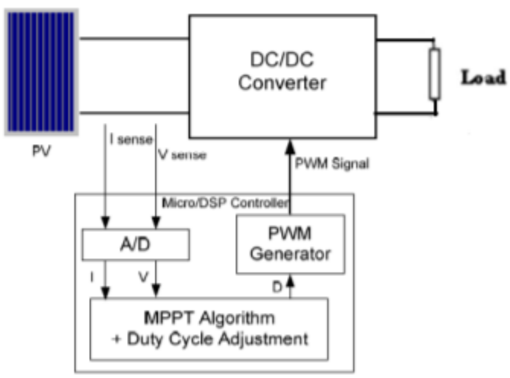
The slope of the P-V array power curve is zero at The MPP, increasing on the left of the MPP and decreasing on the Right hand side of the MPP. The basic equations of this method are as follows:

$$\frac{dI}{dV} = -\frac{I}{V} \text{ at MPP}$$

$$\frac{dI}{dV} > -\frac{I}{V} \text{ left of MPP}$$

$$\frac{dI}{dV} < -\frac{I}{V} \quad \text{right of MPP}$$

Where I and V are P-V array output current and voltage respectively. The left hand side of equations represents incremental conductance of P-V module and the right hand side represents the instantaneous conductance. When the ratio of change in output conductance is equal to the negative output conductance, the solar array will operate at the maximum power point.



INC Algorithm:

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

We have,

$$P = V\ I$$

Applying the chain rule for the derivative of products yields to

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

At MPP, as

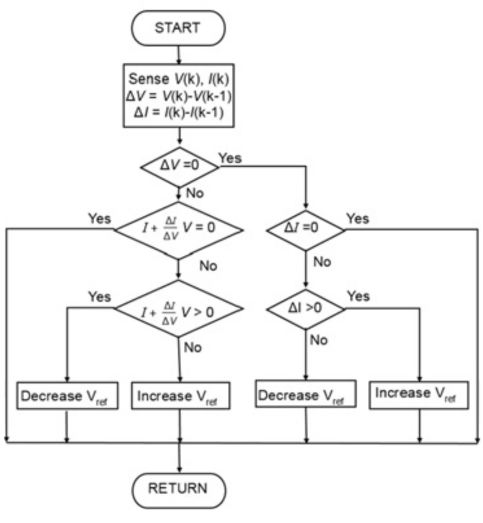
$\partial P/\partial V=0$

The above equation could be written in terms 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 method the peak power of the module lies at above 98% of its incremental conductance. The Flow chart of incremental conductance MPPT is shown below.



DC to DC Converter:

DC- DC converter is the core of the Maximum Power Point tracker. The main objective of using DC-DC converter in MPPT is (i) Regulating the input voltage at the PV MPP and (ii) for providing load matching for the maximum power transfer. DCDC converters are of many types. Basically there are two types (i) Isolated and Non Isolated topologies. Isolated topologies provide DC isolation between input and output. They find application in switch mode DC power supplies. In PV applications this type of topology is used in grid tied system for safety reasons. Isolation transformers are not present in Non-isolated type. The main topologies are (i) Buck (ii) Boost (iii) Buck – Boost (iv) Cuk converters. Buck topology is used in charging batteries and in LCB for water pumping systems. In MPPT buck converter is not suitable when the maximum power point goes below the charging voltage of the battery and also at low irradiance time. Boost converter can provide a medium tracking of the MPP because when the maximum power point is at a very low operating point Boost converter will not be suitable. But Boost converter has the capability to increase the overall efficiency by boosting the voltage. There are also other topologies (i) Cuk (ii) Buck – Boost which can either step up or step down voltage and hence can provide accurate maximum Power Point tracking. Both the converters almost give same output but the energy is stored in inductor in the case Buck – Boost whereas its Capacitance in case of Cuk converter. The advantage of Cuk over Buck- Boost is that the output current has less ripples and Cuk can be connected in parallel to measure PV modules with greater power.

Conclusion:

The paper proposes a simple MPPT method that requires only measurements of Incremental conductance. The proposed MPPT algorithm is called Incremental conductance Method. However, by using this MPPT method we have increased efficiency by 44%. This method computes the maximum power and controls directly the extracted power from the PV. The proposed method offers different advantages which are: good tracking efficiency, response is high and well control for the extracted power.