ABSTRACT

Maximum Power Point Tracking (MPPT) is very important and useful for an optimal operation of solar PV system. In this thesis, the various control strategies for improved Maximum Power Point Tracking (MPPT) for efficiency maximization of solar PV system are investigated. Firstly, the importance of utilization of solar energy is highlighted. In this reference, the active and passive solar techniques have been discussed, analyzed and recommended for energy independent buildings i.e. called “Green Buildings (GB)”. Then, the various types of MPP tracking techniques (a total of 17) have been described and compared in terms of different performance parameters. In the next chapters of this thesis, a total of five MPP Tracking control techniques have been designed and analyzed for an optimal operation of solar PV system.

(1.) Advanced Perturbation & Observation (AP&O) based MPPT
(2.) Differential power (dP) algorithm based MPPT,
(3.) Hybrid control method based MPPT,
(4.) Fill factor (FF) based MPPT and
(5.) Maximum Power Angle (MPA) based MPPT

In the advanced Perturbation & Observation (AP&O) based MPPT, the classical P&O algorithm is modified by increasing the perturbation steps. This technique is able to overtake the problem of higher oscillations of operating point around MPP. Due to higher oscillations, the power in finding the MPP is wasted. By using the AP&O method, the oscillations around the MPP and hence power wastage in tracking the MPP is minimized.

In the differential power (dP) algorithm, the difference of three consecutive levels of power are calculated and compared in order to find the MPP at different instant of time. The results show that the MPP tracking using this method is able to provide more stable and efficient operation.
Hybrid control method is designed by combining the two classical methods viz. P&O method and constant voltage (CV) method. This method works in dual mode as when the solar insolation is steady, the CV method works and when solar insolation is dynamic, it switches over to P&O method to find and track the MPP. Due to dual operation of this method the power in finding the MPP and oscillations around MPP are reduced.

Fill factor method, investigated by us, is a mathematical approach for finding MPP by using the relationship between fill factor (FF) and open circuit voltage ($V_{OC}$). For an optimal operation of solar PV system, the FF should be approaching to unity. For a unit FF, the efficiency of the system is 100% which is an ideal case therefore it should be maximum as much as possible. In this method, an empirical relationship is developed between FF and $V_{OC}$. For a maximum value of FF (i.e. equals to 1), the FF is differentiated with respect to $V_{OC}$ and is put equals to zero. Then the value of optimal value of $V_{OC}$ is found which would be equal to maximum power voltage ($V_{MP}$).

We have proposed a new graphical approach with simple mathematics to find and track the MPP, named as Maximum power angle (MPA) based MPP tracking. This method uses the information of various parameters of solar PV module on the characteristic curves. Due to its data based approach, this technique ensures the reduced requirement of sensors and other hardware components. This method provides an accurate tracking of MPP which is a cost-effective and simpler MPPT approach.