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A Review on Maximum Power Point Tracking Techniques

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***Abstract*— Photovoltaic (PV) offers an environmentally friendly source of electricity, which is however still relatively costly today. The maximum power point tracking (MPPT) of the PV output for all sunshine conditions is a key to keep the output power per unit cost low for successful PV applications. This paper presents various methods and its description of MPPT techniques with their advantages and complexities.**

***Keywords*—MPPT, power control, permute and observe, constant voltage, short circuit.**

I. Introduction

Solar power is at the forefront of clean, renewable energy, and it is gaining momentum due to advances in solar panel manufacturing and efficiency as well as increasingly volatile fuel costs. Photovoltaic (PV) solar cells are the most readily available solar technology, and they operate best on bright days with little or no obstruction to incident sunlight. The power delivered by a PV system of one or more photovoltaic cells is dependent on the irradiance, temperature, and the current drawn from the cells. Maximum Power Point Tracking (MPPT) is used to obtain the maximum power from these systems. Such applications as putting power on the grid, charging batteries, or powering an electric motor benefit from MPPT. In these applications, the load can demand more power than the PV system can deliver. In this case, a power conversion system is used to maximize the power from the PV system. There are many different approaches to maximizing the power from a PV system, these range from using simple voltage relationships to more complex multiple sample based analysis. Depending on the end application and the dynamics of the irradiance, the power conversion engineer needs to evaluate the various options [1]. PV system cannot be modelled as a constant DC current source because its output power, as shown in figure 1, is varied depending on the load current, temperature and irradiation.

Generally, MPPT is adopted to track the maximum power point in the PV system. The efficiency of MPPT depends on both the MPPT control algorithm and the MPPT circuit. The MPPT control algorithm is usually applied in the DC-DC converter, which is normally used as the MPPT circuit. This paper presents a general study of MPPT techniques.

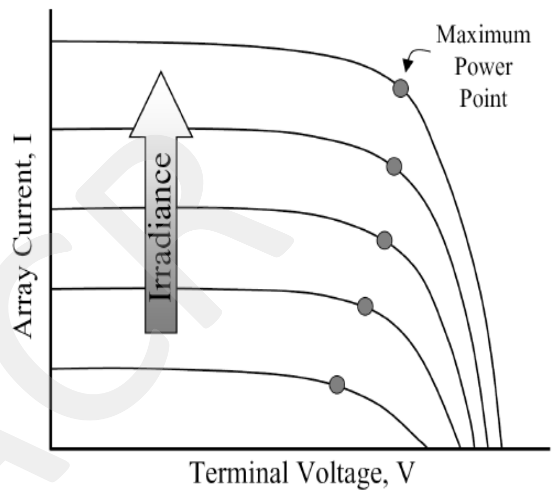

Figure-1: I-V Curve for PV System

II. MPPT Techniques

Constant Voltage Method

The constant voltage method is the simplest method. This method simply uses single voltage to represent the VMP. In some cases this value is programmed by an external resistor connected to a current source pin of the control IC. In this case, this resistor can be part of a network that includes a NTC thermistor so the value can be temperature compensated. Reference 1 gives this method an overall rating of about 80%. This means that for the various different irradiance variations, the method will collect about 80% of the available maximum power. The actual performance will be determined by the average level of irradiance. In the cases of low levels of irradiance the results can be better [2].

Open and Short Circuit Method

The open- and short-circuit current method for MPPT control is based on measured terminal voltage and current of PV arrays. By measuring the open-circuit voltage or short circuit current in real-time, the maximum power point of the PV array can be estimated with the predefined PV current-voltage curves. This method features a relatively fast

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response, and do not cause oscillations in steady state. However, this method cannot always produce the maximum power available from PV arrays due to the use of the predefined PV curves that often cannot effectively reflect the real-time situation due to PV nonlinear characteristics and weather conditions. Also, the online measurement of open-circuit voltage or short circuit current causes a reduction in output [3].

Perturb-and-observe (P&O) Method

One of the most simple and popular techniques of MPPT is the P&O technique. The main concept of this method is to push the system to operate at the direction which the output power obtained from the PV system increases. Following equation describes the change of power which defines the strategy of the P&O technique.

$$\Delta P = P_k - P_{k-1}$$

If the change of power defined above is positive, the system will keep the direction of the incremental current (increase or decrease the PV current) as the same direction, and if the change is negative, the system will change the direction of incremental current command to the opposite direction.

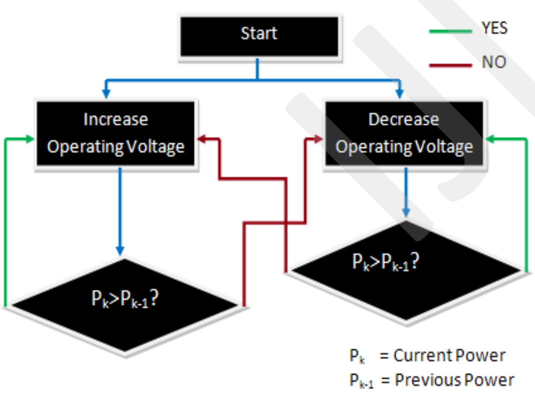

Figure-2: P & O Method for MPPT

This method works well in the steady state condition (the radiation and temperature conditions change slowly).

However, the P&O method fails to track MPP when the atmospheric condition is rapidly changed. Flow chart of the P&O method is described in Figure 2 [4].

Fuzzy Logic based Method

MPPT using Fuzzy Logic Control gains several advantages of better performance, robust and simple design. In addition, this technique does not require the knowledge of the exact model of system. The main parts of FLC, fuzzification, rule-base, inference and defuzzification, are shown in Fig. 4. In the proposed system, the input variables of the FLC are the change in PV array power (∆Ppv) and the change in PV current (∆Ipv), whereas the output of FLC is the magnitude of the change of boost converter current reference (∆Iref). The current reference is the command for controlling the current drawn from the PV. Flow chart of the proposed FLC is shown in Fig. 5. The equations for ∆Ppv and ∆Ipv are given as follows [4]:

$$P_{pv}{}^{k} = V_{pv}{}^{k} * I_{pv}{}^{k} \ldots\ldots\ldots (1)$$
$$\Delta P_{pv}{}^{k} = P_{pv}{}^{k} * P_{pv}{}^{k-1} \ldots\ldots\ldots (2)$$
$$\Delta I_{pv}{}^{k} = I_{pv}{}^{k} * I_{pv}{}^{k-1} \ldots\ldots\ldots (3)$$

Figure below showing the basic structure of fuzzy Controller:

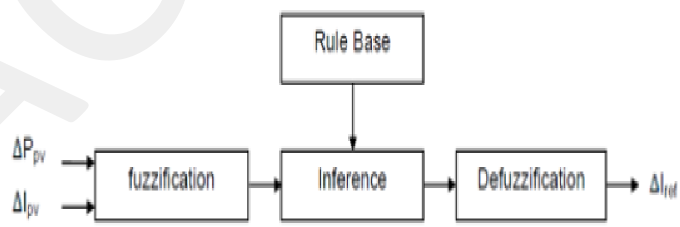

Figure-3: Fuzzy Controller for MPPT

IV. CONCLUSIONS

The There are many approaches to finding and tracking the maximum power point for PV cells and groups of cells. Many systems will combine methods, such as using VOC to find the starting point for the iterative methods like P and O or IC. In some cases, changing from one method to another is based on the level of irradiance. At low levels of irradiance, methods like Open Circuit Voltage and Short Circuit Current may be more appropriate as they can be more noise immune. When the cells are arranged in a series, the iterative methods can be a better solution. When a portion of the string is shade or does not have the same angle of incidence, then searching algorithms are needed. In general, for whatever method that is chosen, it is better to be accurate than fast. Fast methods tend to bounce around the maximum power point due to noise present in the power conversion system. Of course, an accurate and fast method

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would be preferred but the cost of implementation needs to be considered.

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