Comparitive Analysis of a MPPT Control Techniques

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Abstract- Solar energy, it is a clean energy source in the universe. It is essential to define and monitor the maximum power point in PV arrays. Every technique in this technique has its own set of benefits and drawbacks. PV energy is one of the most significant energy sources because it is both pure and infinite. To optimize the output energy of PV arrays, PV energy conversion systems must be operated at their full power point (MPP). To get the most power out of the PV arrays, MPPT control is needed. Many methods for monitoring the maximum power point have been suggested in recent years. This paper compares various MPPT approaches and recommends one that uses a power estimator, as well as evaluating their suitability for systems that operate under a variety of conditions. The incremental conductance (IncCond), perturbation and observation (P&O), and ripple correlation (RC) algorithms, which have been extensively studied, are suitable and realistic. The simulation results of a single-phase NPC grid-connected PV system using the methods are presented to demonstrate the scheme's and algorithms' effectiveness. The results of simulations show that the various MPPTs and the proposed algorithm work correctly.

Index Terms- MPP, MPPT, NPC

I. INTRODUCTION

The Renewable energy will be increasing day by day because usage of energy is also increasing day by day Due to its consumption and exhaustion of fossil fuel. The photovoltaic (PV) power system is also increasing because the most available source of renewable energy is clean, less maintenance and without any noise. So, thus the usage of electricity cannot be decreased. So, the generation must increase by using renewable energy sources. Solar energy is one of the universe's renewable resources. We don't have to pay for it either. The sun is a renewable source of energy. It has a great deal of energy and generates a lot of heat. We know

that the sun's temperature is 27 million degrees Fahrenheit. In addition, the sun's power is 1360 watts per square meter. Problems in PV systems include low-radiation conversion (less than 17%), as well as a nonlinear characteristic that is dependent on radiation and a temperature of operation that is dependent on the amount of power produced.
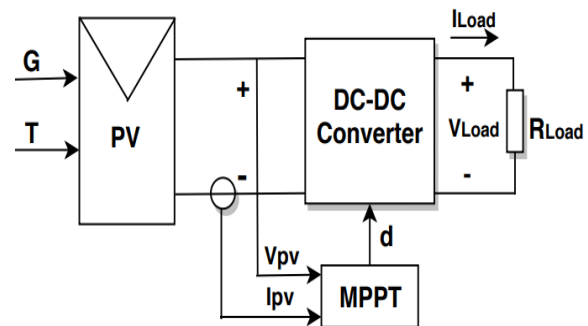

FIG 1: Control Structure of a PV panel using MPPT.

P-V and *I-V* characteristics

Since a PV array is a costly device to construct, knowing the total output power is important. Multilevel converters are becoming increasingly popular in high-power applications. Different algorithms can be used to calculate the location of the highest power point. Maximum Power Point Tracking (MPPT) techniques are used to keep the operating point of the PV array at its maximum power point (MPP) and extract the maximum power available [1], Perturbation and observation (P&O) technique [2], incremental conductance technique [3], ripple correlation technique [4], short circuit current (SCC) technique [5], and open circuit voltage technique [6] have all been listed in the literature. The cost, complexity, speed of convergence, number of sensors needed, hardware implementation, and effectiveness of these techniques vary. Different research in PV systems has provided a comparative study of MPPT techniques due to the various MPPT approaches. Indeed, some papers present a comparative analysis of just a few methods, while others present a simulation-based comparison of multiple MPPT methods from the

perspective of energy production. The MPPT techniques are tested by calculating the energy supplied by the entire PV array under various irradiation and temperature variations. PV solar systems can be configured in a variety of ways, depending on their relationship to inverter systems, external grids, battery banks, or other electrical loads. [5] Formal paraphrase Regardless of the final destination of solar power, the central issue addressed by MPPT is that the efficiency of power transfer from the solar cell is dependent on the amount of sunlight falling on the solar panels, the temperature of the solar panel, and the electrical characteristics of the load. As these conditions change, so does the load characteristic that provides the best power transfer efficiency.
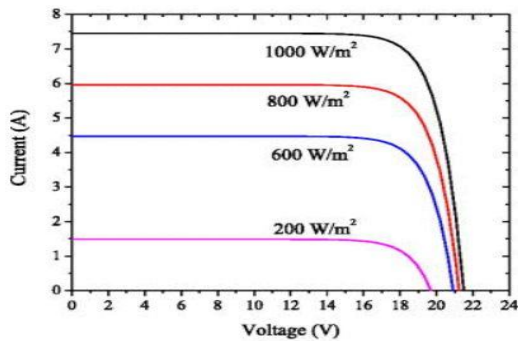

FIG 2.1: I-V Characteristics of the module at different Insolation level
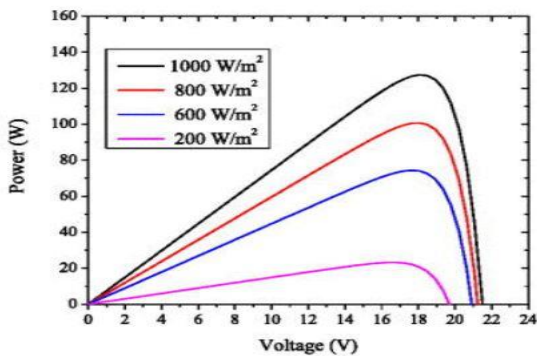

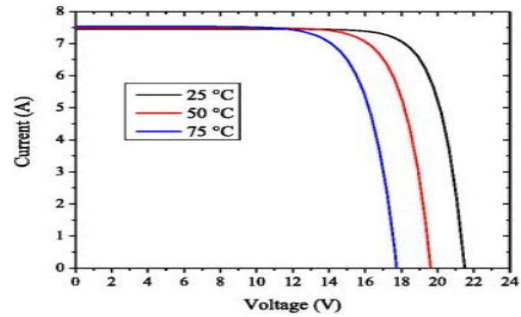FIG 2.2: P-V Characteristics of the module at different Insolation Level

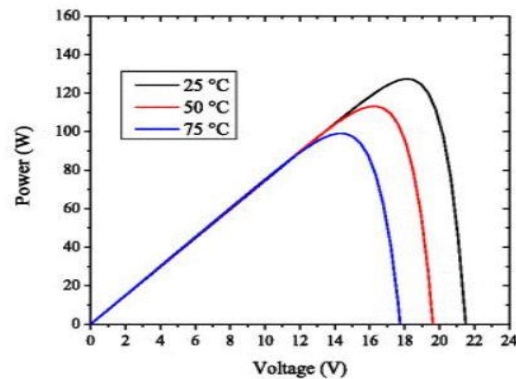FIG 2.3: I-V Characteristics of the module at different Isolation Level

FIG 2.4: P-V Characteristics of the module at different temperature values

II. OPERATING PRINCIPLE

The output current is controlled such that it follows a sinusoidal reference waveform that is aligned and phased with the grid voltage. We can extract a unitary signal in phase with the grid voltage using a phase-locked loop (PLL) algorithm. The number of the DC-link voltage regulator and the MPPT output generates the amplitude of the reference current Iref. The MPPT algorithm adjusts MPPT in response to environmental conditions in order to maintain the PV system's operating point as close to the full power point as possible. The PWM technique can be used to power this inverter. Two superposed triangular carriers are used to enforce the PWM. Each carrier is linked to one of the two complementary groups of switches. The switching state is fixed by the positive part of the carrier.

III. MPPT ALGORITHMS

The maximum power supplied by photovoltaic panels is not always constant and set at the same operating point; it fluctuates depending on environmental conditions such as solar irradiation, shadow, and temperature. To get the most power out of your system, you'll need to use an MPPT algorithm that changes the power extraction dynamically. One of the most important characteristics of all MPPT algorithms is convergence speed. Any increase in the MPPT rise time enhances the system's stability and increases the power extraction and performance of the entire system.

3.1. Perturbation and Observation (P&O).

The observe algorithm is easy to implement with analogue and digital circuits and does not require prior knowledge of the PV generator characteristics or the calculation of solar intensity and cell temperature. Even if the solar irradiance and cell temperature are constants, it perturbs the system's operating point, causing the PV array terminal voltage to fluctuate around the MPP voltage [6]. Furthermore, due to the trade-off between accuracy and speed when choosing the phase size, it is the most used and workhorse MPPT value [8].

3.2. Incremental Conductance (Inc Cond).

The incremental conductance approach works on the assumption that at the MPP, the slope of the PV array power curve is zero.
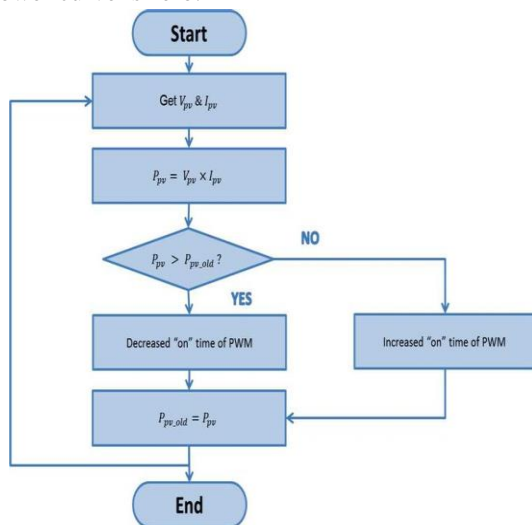

FIG 3.1: Flowchart for algorithm of MPPT techniques

IV. COMPARATIVE ANALYSIS

4.1 perturbation and observation (p&o) technique:

The Perturb and Observe (P&O) maximum power point tracking (MPPT) algorithm can be confused in the presence of rapidly changing atmospheric conditions because it is unable to differentiate between variations in photovoltaic array output power induced by duty cycle modulation and those caused by irradiance variation. The negative effects of such a drawback can be significantly reduced if the severity of duty-cycle perturbations is tailored to the dynamic behavior of the particular DC-DC converter used to realize the P&O MPPT, as shown in this paper.
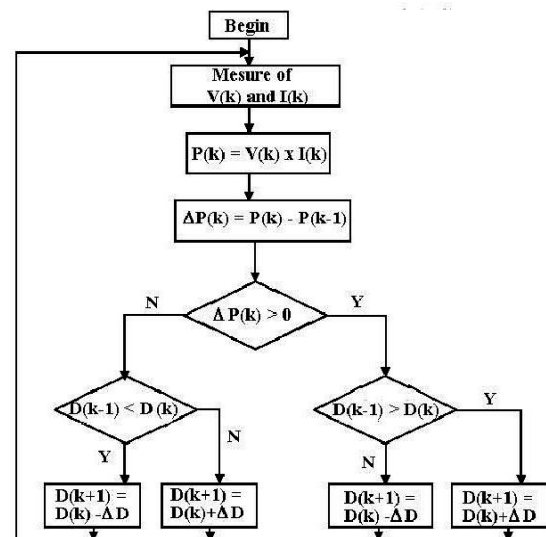

FIG 4.1: Flowchart for perturbation and observation technique

4.2 The Incremental Conductance Technique:

It calculates the MPP by comparing the PV array's instantaneous, gradual conductance. The INC approach has the same problem as P&O. The accuracy and response speed of MPPT are normally determined by a defined phase size. It has been proposed to boost the tracking accuracy and dynamic efficiency under rapidly changing conditions based on the assumption that the slope of the PV array power versus voltage curve is zero at the MPP.
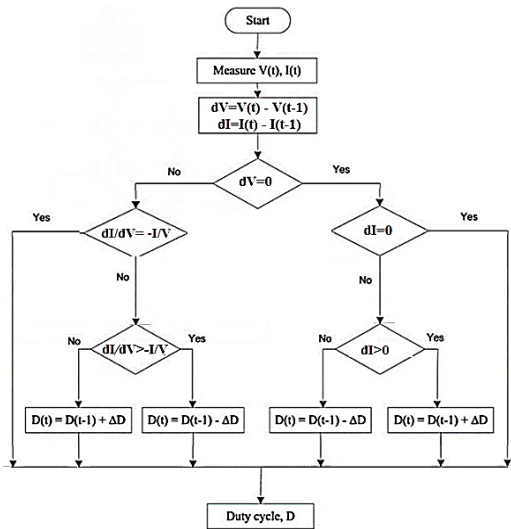
FIG 4.2: Flowchart for the incremental conductance technique

4.3 The ripple correlation technique:

To perform MPPT, Ripple Correlation Control (RCC) uses ripple in PV voltage and current. To push the power gradient to zero and meet the MPP, RCC correlates the time derivative of the time-varying PV array power with the time derivative of the time-varying PV array current or voltage.
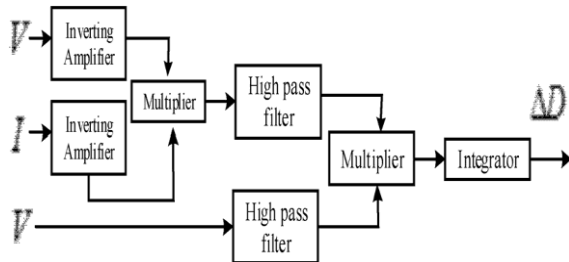

FIG 4.3: Flowchart for the ripple correlation technique

4.4 Short Circuit Current technique:

When the voltage around the solar cell is zero, the short-circuit current flows through the cell (i.e., when the solar cell is short circuited). The generation and aggregation of light-generated carriers causes the short-circuit current.
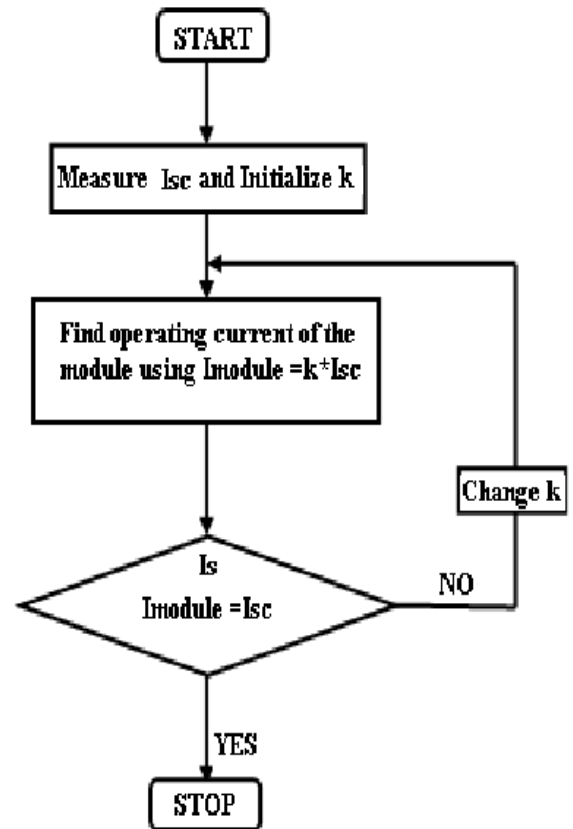

FIG 4.4: Flowchart for short circuit current technique

4.5 Open circuit voltage technique:

The fractional open circuit approach assumes that the voltage of a PV panel at the MPP is approximately linearly proportional to the open-circuit voltage. The proportional constant varies depending on the solar cell fabrication technologies, fill factor, and weather conditions.
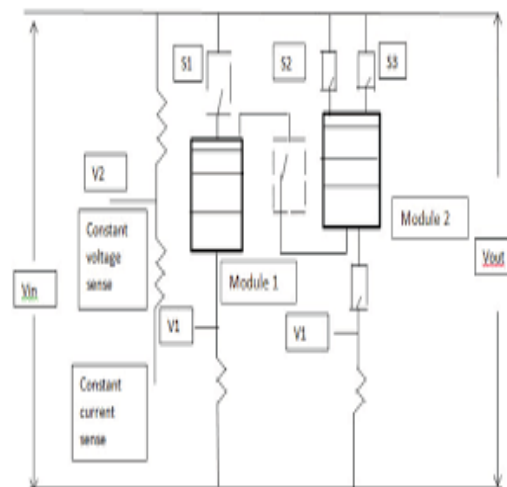

FIG 4.5: Flowchart for open circuit voltage technique

CONCLUSION

MPPT is a technique for extracting high-level power from PV systems. This paper compares MPPT methods and proposes one that is the most efficient based on MPPT performance, as well as considering their suitability for systems that operate under a variety of conditions. As a result, each MPPT approach has its own set of benefits and drawbacks. Furthermore, the MPPT should be able to reduce the ripple around the MPP. The dynamic response of the PV system, as well as the efficiency and implementation of different MPPT methods, are compared. As a result, while incremental conductance and P&O are easy to use, they have some drawbacks in terms of DC-link and output inverter current. In the absence of an external perturbation, the RC perturbs itself. Simulating a grid-connected PV device with a single-phase NPC inverter to link the PV panel to the grid was used to test these three methods. The efficiency of each tool has been examined under a variety of conditions in particular. With the proposed MPPT, the proposed device will always extract the full power available from the solar PV panels.

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