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Modeling of PV System under Partial Shading Conditions using Fuzzy Based MPPT

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ABSTRACT

The main aim of this paper is to propose a new concept for high step-up based DC-DC converter for PV system. This step-up converter improves the photovoltaic voltage level. And also an MPPT technique is proposed for controlling Boost converter. This paper also concentrates on the concept of grid interface. For this a PWM based inverter is proposed for PV system in order to achieve the grid synchronization. The proposed grid interfaced PV system is tested and verified using Matlab/Simulink.

Index Terms: Photovoltaic System, MPPT technique, DC-DC converter and PWM technique.

I.INTRODUCTION

Because of the expanding request on power, and constrained accessibility and high costs of non-renewable sources, the photovoltaic (PV) vitality transformation framework has turns into an option as it is openly accessible, contamination free, and has less operational and low maintainece cost. In this way, the use of PV vitality frameworks must be expanded for independent and in addition matrix associated methods of PV frameworks. Photovoltaic (PV) as a renewable vitality asset actually is not steady by area, time, season and climate and its establishment cost is nearly high. A vital thought in expanding the proficiency of PV frameworks is to work the framework close most extreme power point (MPP) so to acquire the roughly greatest force of PV exhibit. For getting greatest conceivable vitality delivered by a nearby planetary group. In this paper Figure 1 demonstrates a photovoltaic framework that is a blend of sun based exhibit, a high stride up converter, a charge-release controller, a battery set, and an inverter.

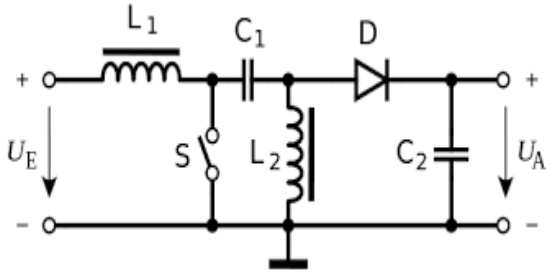

Figure 1: PV array system with High step-up converter.

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II.PHOTOVOLTAIC ARRAY MODELING

In the PV network of electrical phenomenon, cell is the necessary part. For the raise in appropriate current, high power and potential difference, the sunlight dependent cells and their region unit joined in non-current or parallel fashion called as PV exhibit are used. In practical applications, each and every cell is similar to diode with the intersection designed by the semiconductor material. When the light weight is absorbed by the electrical marvel sway at the point of intersection, it gives the streams at once. The (current-voltage) and (Power-Voltage) attributes at absolutely unpredictable star intensities of the PV exhibit are represented in figure 3, whereas the often seen existence of most electrical outlet on each yield is shown in power diagram 2.

$$I = I_{ph} – I_D - I_{sh} \quad (1)$$

$$I=Iph –I_o [exp (q V_D / nKT)] – (v_D /R_S) \quad (2)$$

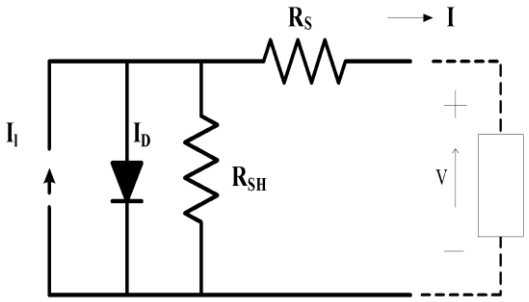

Fig 2: PV Electrical Equivalent circuit

Solar cell output power is given as the product of V and I

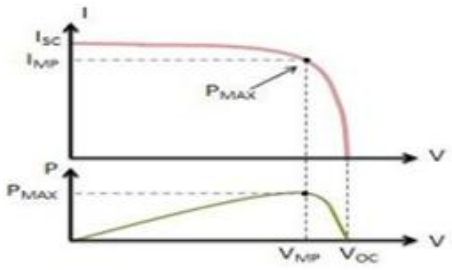

Fig 3: Response of output characteristics of PV Array

a. INC MPPT Technique:

In this technique the change of PV voltage can be obtained with respect to MPP voltage peak power. Figure 4 shows the PV power curve for incremental conductance method.

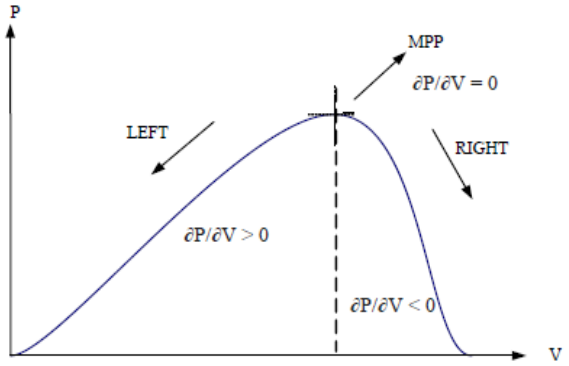

Figure 4. Characteristics of PV Power Vs Voltage under INC method

The relation for conductance in incremental and instantaneous can be expressed in three cases:

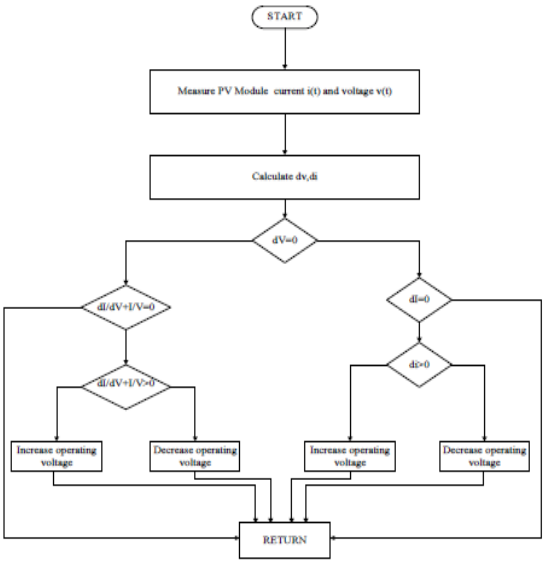

Figure 5: INC MPPT flow chart

The power expression,

$$P = V * I$$

Differentiate the power equation with PV terminal voltage,

$$\frac{\partial p}{\partial v} = \frac{\partial (VI)}{\partial v}$$

At MPP,

$$\frac{\partial p}{\partial v} = 0$$

The modified equation expressed as:

$$\frac{\partial I}{\partial V} = -\frac{I}{V}$$

This MPPT technique controls PWM signal for boost converter until (dI/dV) + (I/V) = 0 is obtained. Figure 5 shows the INC MPPT flow chart.

Fuzzy Logic Controller

In the previous section, control strategy based on PI controller is discussed. But in case of PI controller, it has high settling time and has large steady state error. In order to rectify this problem, this paper proposes the application of a fuzzy controller shown in Figure 6. Generally, the FLC [12] is one of the most important software based technique in adaptive methods.

As compared with previous controllers, the FLC has low settling time, low steady state errors. The operation of fuzzy controller can be explained in four steps.

1. Fuzzification
2. Membership function
3. Rule-base formation

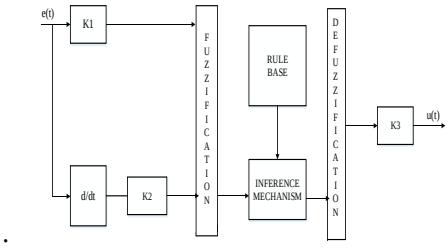

Figure 6: basic structure of fuzzy logic controller

In this paper, the membership function is considered as a type in triangular membership function and method for defuzzification is considered as centroid. The error which is obtained from the comparison of reference and actual values is given to fuzzy inference engine. The input variables such as error and error rate are expressed in terms of fuzzy set with the linguistic terms {vl,l,z,h,vh} and Pin this type of mamdani fuzzy inference system the linguistic terms are expressed using triangular membership functions. In this paper, two inputs and single output fuzzy inference system is considered. The second input is chosen as rate of change of error. The number of linguistic variables for input and output is assumed as 5.The numbers of rules are formed as 25. The fuzzy rules are obtained with if-then statements. The given fuzzy inference system is a combination of single input and single output. This input is related with the logical operator AND i.e minimum.

III.SIMULATION RESULTS:

The simulation for this type of step-up voltage multiplier based PV system is implemented in Matlab/simulink as per the figure shown in 1. For this the proposed photovoltaic system is designed for 1.2KW.

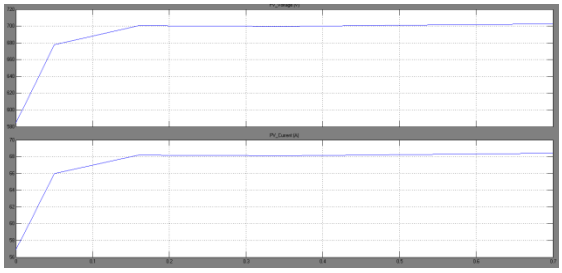

Figure 7: Simulation waveforms for PV Voltage & Current before DC-DC Converter.

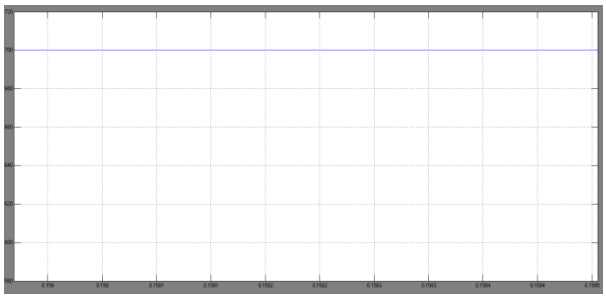

Figure 8: Simulation waveforms PV Voltage after DC-DC Converter.

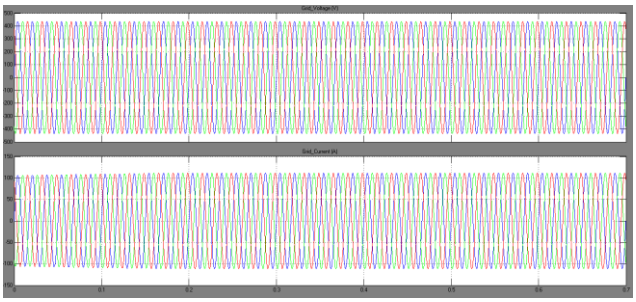

Figure 9: Simulation waveforms for Grid Voltage and Current.

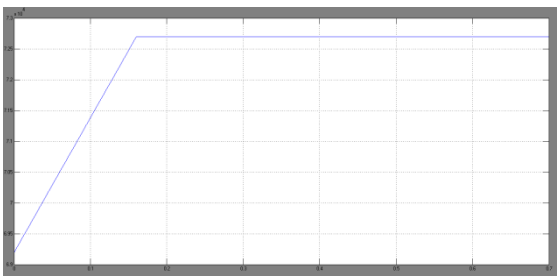

Figure 10: Simulation waveforms for Grid Active Power

IVCONCLUSION

This review article provides a classification of available MPPT techniques based on the number of control variables involved. It also gives an idea about grid-tied or standalone mode of operations and types of preferable converters for each MPPT technique. This review has included many recent hybrid MPPT techniques along with

their benefits. The review has discussed the efficiency calculation procedure of the developed MPPTs. This review is expected to be a useful tool for not only the MPPT users but also the designers and commercial manufacturers of PV systems.

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