# MAXIMUM POWER POINT TRACKING IMPLEMENTATION USING FUZZY LOGIC CONTROLLER FOR PV SYSTEM

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***Abstract: The study presents the experimental investigation carried out to implement the maximum power point tracking using fuzzy logic controller for PV system. The basic objective of the study was to obtain maximum efficiency out of the PV module. Maximum power point tracking (MPPT) helps us in getting high values of efficiency when applied to the PV module. The results obtained by using MPPT are clear that the efficiency is increased and we get a simple and economic PV module.***

## I. INTRODUCTION

Global warming and energy policies have become a hot topic on the international agenda in the last years. Developed countries are trying to reduce their greenhouse gas emissions. For example, the EU has committed to reduce the emissions of green house gas to at least 20% below 1990 levels and to produce no less than 20% of its energy consumption from renewable sources by 2020 [1]. In this context, photovoltaic (PV)power generation has an important role to play due to the fact that it is a green source. The only emissions associated with PV power generation are those from the production of its components. After their installation they generate electricity from the solar irradiation without emitting greenhouse gases. In their lifetime, which is around 25years, PV panels produce more energy than that for their manufacturing [2]. Also they can be installed in places with no other use, such as roofs and deserts, or they can produce electricity for remote locations, where there is no electricity network. The latter type of installations is known as off-grid facilities and sometimes they are the most economical alternative to provide electricity in isolated areas. However, most of the PV power generation comes from grid-connected installations, where the power is fed in the electricity network. In fact, it is a growing business in developed countries such as Germany which in 2010 is by far the world leader in PV power generation followed by Spain, Japan, USA and Italy [3]. On the other hand, due to the equipment required, PV power generation is more expensive than other resources. Governments are promoting it with subsidies or feed-in tariffs, expecting the development of the technology so that in the near future it will become competitive [3]-[4]. Increasing the efficiency in PV plants so the power generated increases is a key aspect, as it will increase the incomes, reducing consequently the cost of the power generated so it will approach the cost of the power produced from other sources. In the past years numerous MPPT algorithms have been published . They differ in many aspects such as complexity, sensors required, cost or efficiency. However, it is pointless to use a more expensive or more complicated method if with a simpler and less expensive one similar results can be obtained. This is the reason why some of the proposed techniques are not used. Measuring the efficiency of MPPT algorithms has not been standardized until the European Standard EN 50530 was published at the end of May, 2010. It specifies how to test the efficiency of MPPT methods both statically and dynamically. In any case, there are no publications comparing the results of the different MPPT algorithms under the conditions proposed in the standard.

## II. MAXIMUM POWER POINT TRACKING ALGORITHMS

MPPT algorithms are necessary in PV applications because the MPP of a solar panel varies with the irradiation and temperature, so the use of MPPT algorithms is required in order to obtain the maximum power from a solar array.

Over the past decades many methods to find the MPP have been developed and published. These techniques differ in many aspects such as required sensors, complexity, cost, range of effectiveness, convergence speed, correct tracking when irradiation and/or temperature change, hardware needed for the implementation or popularity, among others.

Among these techniques, the P&O and the Income algorithms are the most common. These techniques have the advantage of an easy implementation but they also have drawbacks, as will be shown later. Other techniques based on different principles are fuzzy logic control, neural network, fractional open circuit voltage or short circuit current, current sweep, etc. Most of these methods yield a local maximum and some, like the fractional open circuit voltage or short circuit current, give an approximated MPP, not the exact one. In normal conditions the V-P curve has only one maximum, so it is not a problem. However, if the PV array is partially shaded, there are multiple maxima in these curves.

## III. FUZZY LOGIC CONTROL

The use of fuzzy logic control has become popular over the last decade because it can deal with imprecise inputs, does not need an accurate mathematical model and can handle nonlinearity. Microcontrollers have also helped in the popularization of fuzzy logic control. The fuzzy logic consists of three stages: fuzzification, inference system and defuzzification. Fuzzification comprises the process of transforming numerical crisp inputs into linguistic variables based on the degree of membership to certain sets. Membership functions, like the ones in Figure 15, are used to associate a grade to each linguistic term. The number of membership functions used depends on the accuracy of the controller, but it usually varies between 5 and 7. In Figure seven fuzzy levels are used: NB (Negative Big), NM

  

(Negative Medium), NS (Negative Small), ZE (Zero), PS (Positive Small), PM (Positive Medium) and PB (Positive Big).The values a, b and c are based on the range values of the numerical variable. In some cases the membership functions are chosen less symmetric or even optimized for the application for better accuracy.

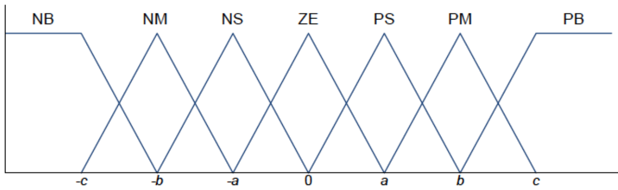


Figure 2.5 - Membership functions.

The inputs of the fuzzy controller are usually an error, E, and the change in the error, E. The error can be chosen by the designer, but usually it is chosen as □ΔP/ΔV becauseit is zero at the MPP. Then E and ΔE are defined as follows:

$$E = \frac{P(k) - P(k-1)}{V(k) - V(k-1)}$$

$$\nabla E = E(k) - E(k-1)$$

In other cases □ΔP/ΔI is used as error and other inputs are considered,where ΔU and ΔP are used.The output of the fuzzy logic converter is usually a change in the duty ratio of the power converter, ΔD, or a change in the reference voltage of the DC-link, ΔV. The rule base, also known as rule base lookup table or fuzzy rule algorithm, associates the fuzzy output to the fuzzy inputs based on the power converter used and on the knowledge of the user. Table I shows the rules for a three phase inverter, where the inputs are E and ΔE, as defined in (7) and (8), and the output is a change in the DC-link voltage, ΔV. Forexample, if the operating point is far to the right of the MPP, E is NB, and ΔE is zero, then to reach the MPP the reference voltage should decrease, so □V should be NB

## IV. SIMULINK RESULTS

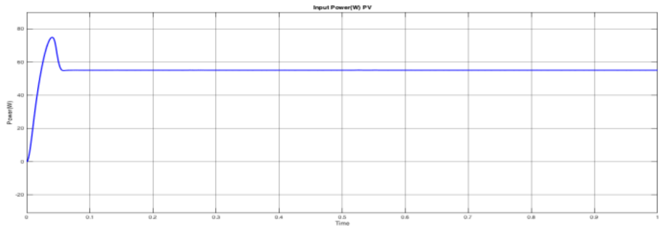

Figure 3.12 Input Power PV Module

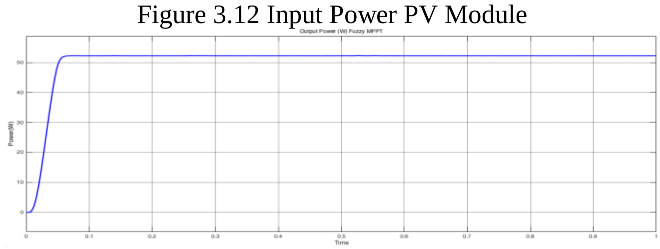

Figure 3.13 Output Power Fuzzy MPPT

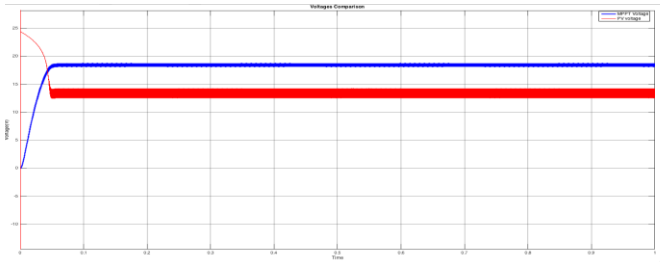

Figure 3.14 Voltage Comparison PV vs Fuzzy MPPT

## V. CONCLUSION

Photovoltaic (PV)power generation has an important role to play due to the fact that it is a green source. The only emissions associated with PV power generation are those from the production of its components. After their installation they generate electricity from the solar irradiation without emitting greenhouse gases. In their lifetime, which is around 25years, PV panels produce more energy than that for their manufacturing [2]. Also they can be installed in places with no other use, such as roofs and deserts, or they can produce electricity for remote locations, where there is no electricity network. The latter type of installations is known as off-grid facilities and sometimes they are the most economical alternative to provide electricity in isolated areas. However, most of the PV power generation comes from grid-connected installations, where the power is fed in the electricity network. In fact, it is a growing business in developed countries such as Germany which in 2010 is by far the world leader in PV power generation followed by Spain, Japan, USA and Italy [3]. On the other hand, due to the equipment required, PV power generation is more expensive than other resources. Governments are promoting it with subsidies or feed-in tariffs, expecting the development of the technology so that in the near future it will become competitive [3]-[4]. Increasing the efficiency in PV plants so the power generated increases is a key aspect, as it will increase the incomes, reducing consequently the cost of the power generated so it will approach the cost of the power produced from other sources.

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