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Design of the MPPT in PV System Based on PIC18F4550 Microcontroller

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***Abstract*—This document presents the design and the implementation of the MPPT of PV system using PIC18F4550 microcontroller. In electrical engineering the basic dominant variables are the current and the voltage. The use of the converters conditions on the operator to ensure maximum performance. The type of converter we towards one of the two variables, having a maximum current at the expense of voltage or voltage maximum at the expense of current. This problem was solved in a solar installation by MPPT (maximum power point tracking). Much work has been done to this lawsuit even by adding intelligent techniques, but the introduction of microcontrollers in this action is essential with advanced programming language. The experimental results have verified the performance and the feasibility of the proposed system.**

***Keywords*— PV system, MPPT, Microcontroller, Design, Implementation, C - language**

I. Introduction

Since the earliest MPPT method published in 1960s, we can count over than fifteen MPPT methods. They can be classified according to the research process of MPP into indirect and direct method. The indirect methods, such a short circuit and an open circuit methods, need a prior evaluation of the PV panel, or they are based on mathematical relationships or database not valid for all operating meteorological conditions. So, they cannot obtain exactly the maximum power of PV panel at any irradiance and cell temperature [1].

PV generation system should operate at its maximum power point (MPP) to increase system efficiency. Therefore, MPP tracking is very crucial for PV power generation systems to operate at the maximum power point as much as possible at any time. However, the MPP also changes with the irradiation level and temperature due to the nonlinear characteristics of PV modules [2].

Another classification can be built based on the implementation simplicity, energy efficiency, convergence speed, sensors required and cost effectiveness.

These criteria are often dependent to each other, and make the choice of a MPPT method more difficult [3]. Given the large number of studies on the MPPT algorithms in the recent years, the MPPT method analysis, based on the more used in both research and industrial applications may clarify the MPPT position method over the chosen criteria and assist to the decision [4].

Concerning the widely-adopted MPPT algorithms for PV system, some comparative studies, presented in the literature, give results from simulation tool, which provide simultaneous operating systems. In the other hand, for real PV test bench, in order to reproduce the same operating solar conditions. Comparative studies were done under solar simulator and often for only one PV panel [5].

A microcontroller is a unit of information processing which was added to the internal devices for carrying fixtures without requiring the addition of auxiliary components. A microcontroller can operate autonomously after programming. The microcontroller that we used works with the software MicroC, this software allows you to easily program the PIC18F4550. The use of the PIC microcontroller will enable us to raise the voltage and current of the solar panel, through a splitter and a filter and then calculate its power bridge. Achieving our device had five steps [6], [7]:

- The definition of the specifications is the most difficult step because it involves researching bibliographic and technical information to be used to achieve the objective.
- The choice and design of electronic components from the specifications by simulating different parts of the assembly to fix the component values, and some preliminary tests on a test plate to confirm their choice.
- The simulation of the algorithm established in real time in the microcontroller of the environment " MicroC "then programming the PIC18F4550 from HEX code obtained after compilation and simulation

program written an interface representing the wiring in ISIS.

- The realization of the full assembly on a test plate.
- Interpretation of the results and suggestions.

II. Description of a PV system with MPPT

The MPPT (Maximum Power Point Tracking) is a mechanism for tracking control is used in photovoltaic systems to maximize the power delivered by the solar panel continuously pursuing the maximum power point MPP [5]. The following figure shows a general view of a photovoltaic system with a MPPT controller.

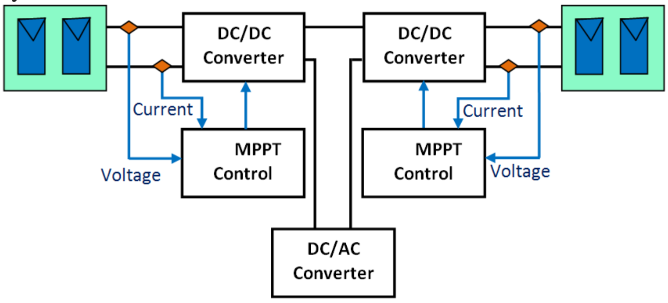


Fig.1 general view of a photovoltaic system with a MPPT controller

The mechanism tracking (MPPT) is an important component in any solar system, since 1968 several MPPT controls have been developed and implemented [6], among these methods are the methods for reacting against voltage and current. The control technique commonly used consists in acting on the duty ratio to automatically cause the generator at its optimum operating value, whatever the weather instabilities or sudden changes in loads that can occur at any time [7].

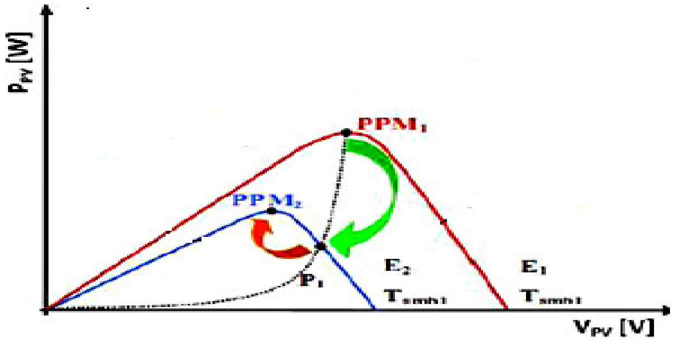
Figure (2) illustrates three cases of disturbances. Depending on the type of disturbance, the operating point swung from the maximum power point PPM1 to a new operating point P1 more or less far from the optimum. For a variation of insolation (a), simply adjust the value of the duty ratio to converge to the new maximum power point PPM2.

For a load variation (b), we can also see a change in the operating point which can find a new optimal position through the action of a command.

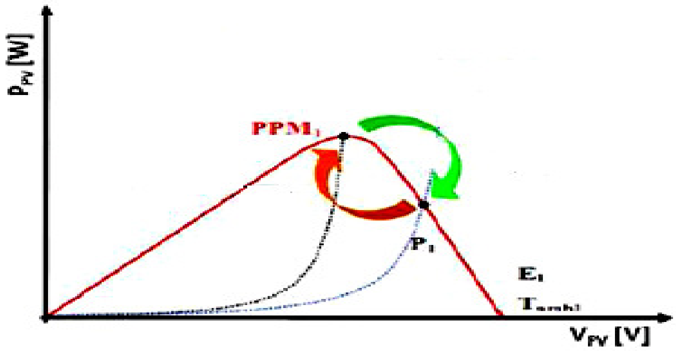
A case of variation of the operating point may occur due to variations in operating temperature of the GPV (c).

Although it must also act at the command, the latter does not have the same time constraints as the two previous cases.

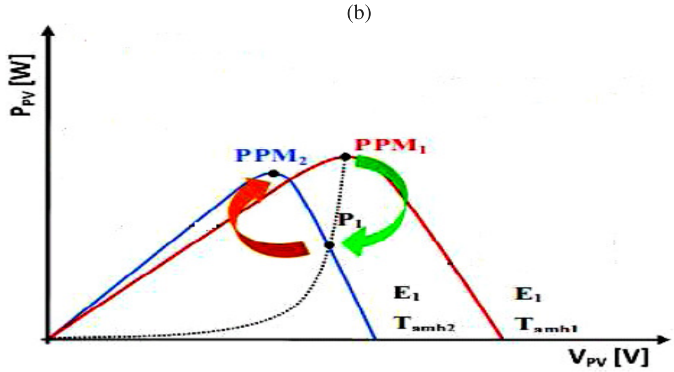
In summary, the monitoring of PPM is achieved by means of a specific command called MPPT which is primarily the duty cycle of the power converter search and reach the GPP for GPV.



(a)



(b)



(c)

Fig.2 Research of PPM

III. Simulation under Matlab/Simulink

The proposed algorithm was validated by mean of simulations performed with the Matlab/Simulink in two different situations, the former assuming the presence of the proposed control system and the latter its absence. In both cases the module output power was evaluated in order to perform a subsequent comparison. During the tests, the PV module was submitted to constant temperature and solar radiation conditions.

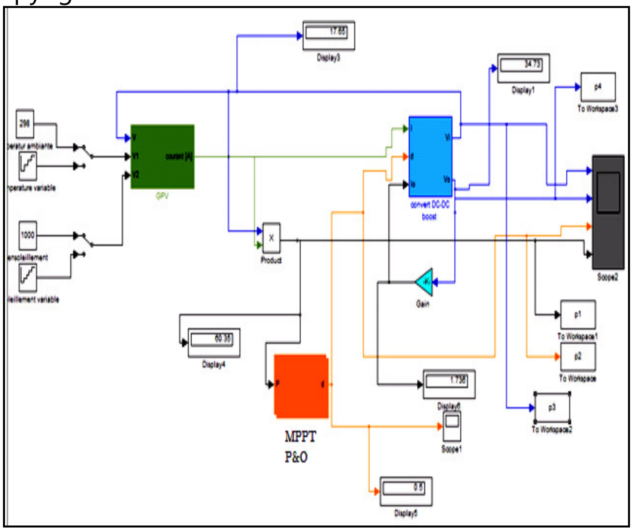


Fig. 3 Simulink model for perturbation and observation MPPT

In the former test the DC/DC converter was connected between the module and the load without controller; in this case the PV module was connected to generic impedance.

Under these conditions, the output power is always less than 800 W, as can be seen in figure (4).

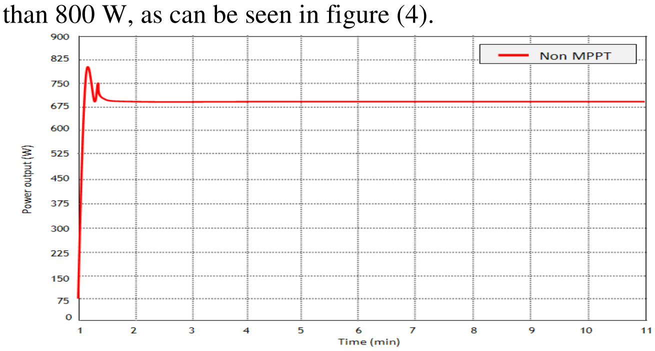


Fig.4 Output power without MPPT

In the latter test the same conditions were maintained, but the MPPT control was properly inserted. In this case the output power is always greater than 850 W, as can be seen in figure (5).

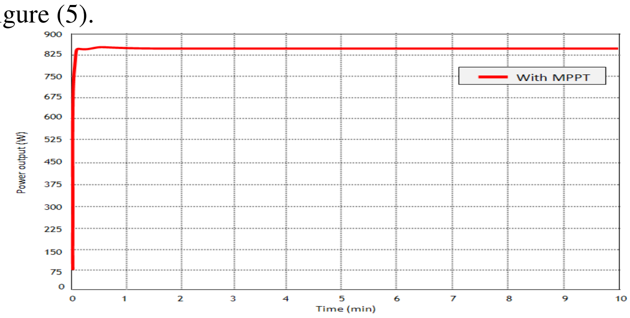


Fig.5 Output power with MPPT

IV. Implementation of MPPT

From the current and power characteristics curves, the nonlinear nature of the PV array is obvious [8]. Therefore, an MPPT algorithm must be implemented to force the system to operate at the maximum power point.

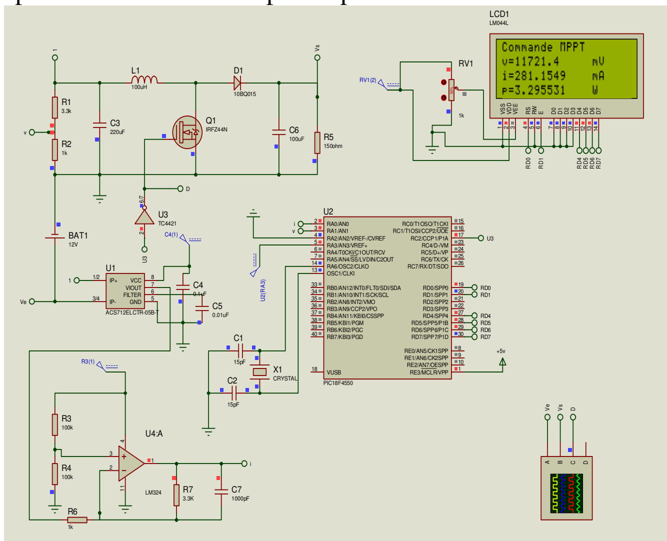


Fig.6 Electrical scheme under Proteus

V. Experimental Results

The following figure shows our device after printing on the test plate and welding.

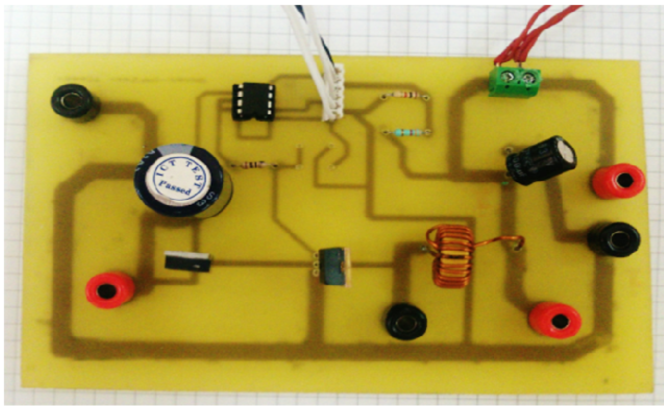


Fig.7 Practical realization of the power part

Fig.8 Practical realization of the current sensor

VI. Results Analysis

The operation of the MPPT done is managed by the HEX code injected into the "flash" of the PIC 18F4550 memory, this code is obtained after compiling the source program in the environment of MicroC, see Figure (9, 10).

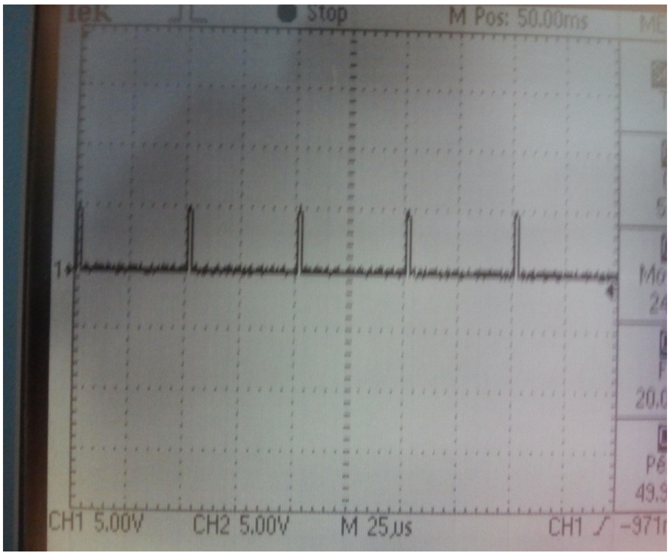


Fig.9 Output signal of the PIC 18F4550 with D= 10%, (5V/div., 25µs/div.)

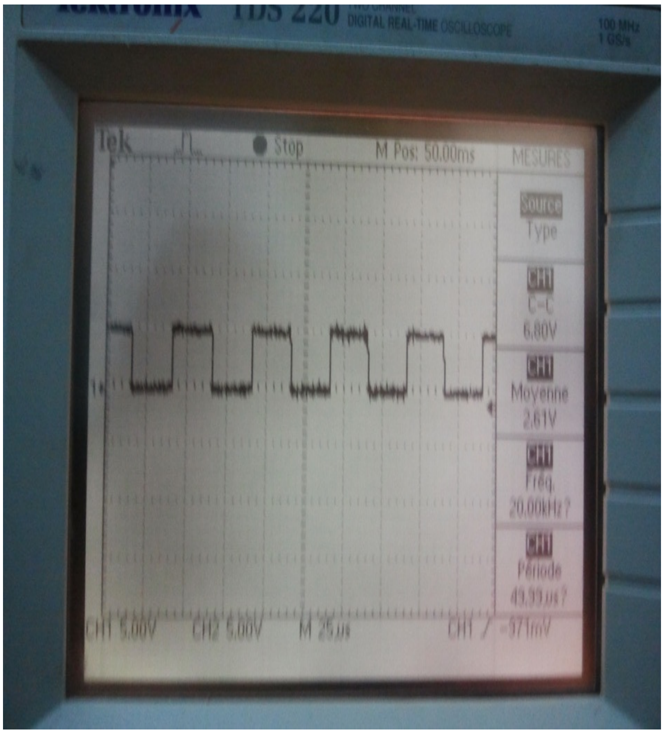


Fig.10 Output signal of the PIC 18F4550 with D= 54%, (5V/div., 25µs/div.)

A prototype MPPT system (figure 11) has been developed using the described method and has been tested in the laboratory [10].

Fig.11 Prototype of MPPT

The computation intensive parts of the model are the generation of the cells characteristics then the construction of the array's I/V curves.

However, this part is needed to run only when the environmental conditions are changing; hence it can be executed with the low sampling rate.

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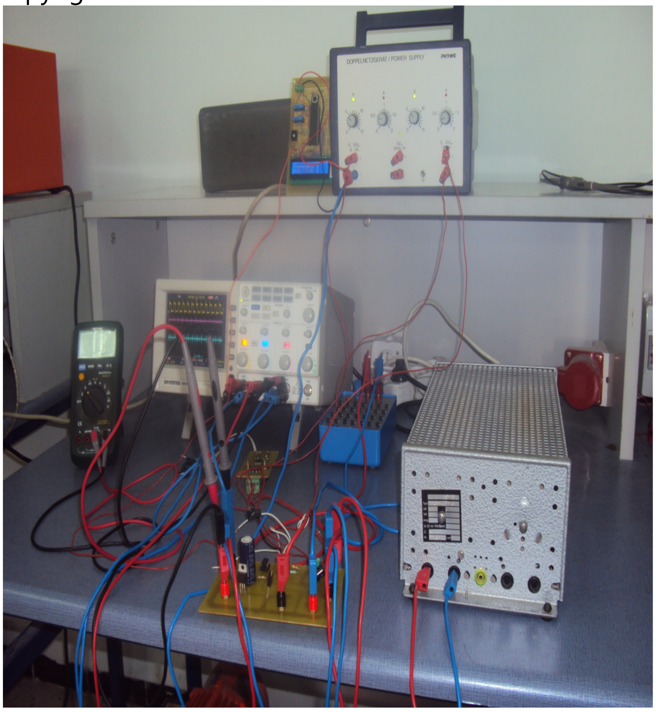
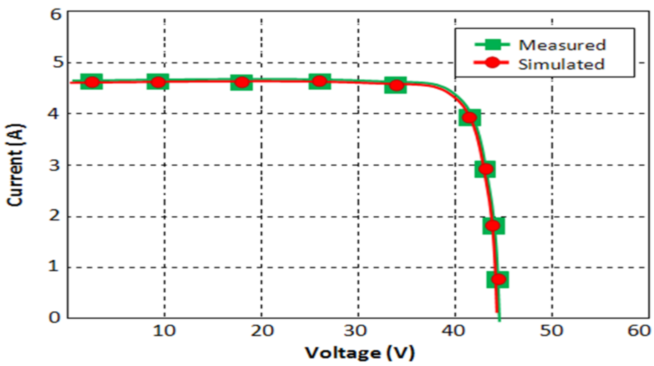
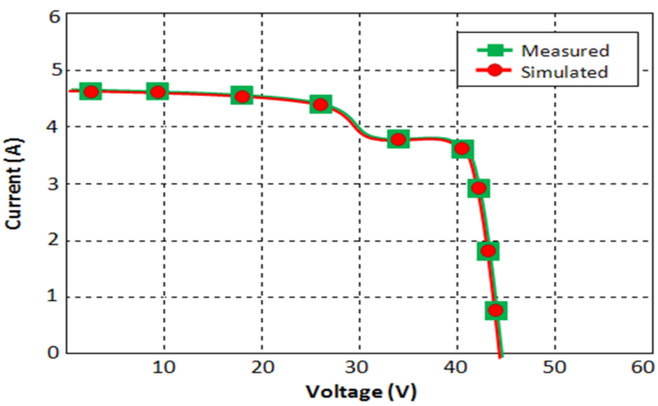


Fig.12 Benchmark test

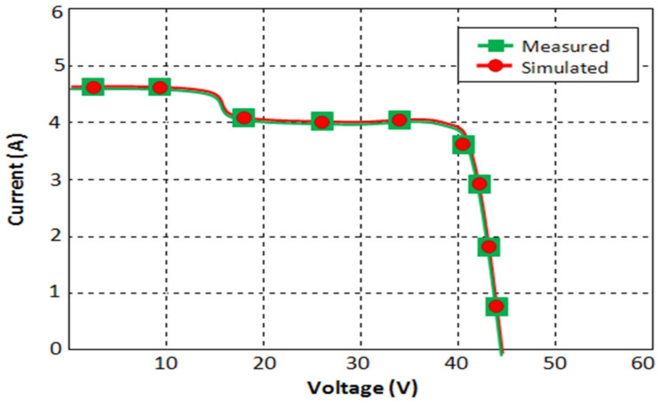
Therefore the model of the complex system is reduced to look up tables, without requiring much computational resource and is suitable for running in real-time, in order to verify the effectiveness of the model developed [11].



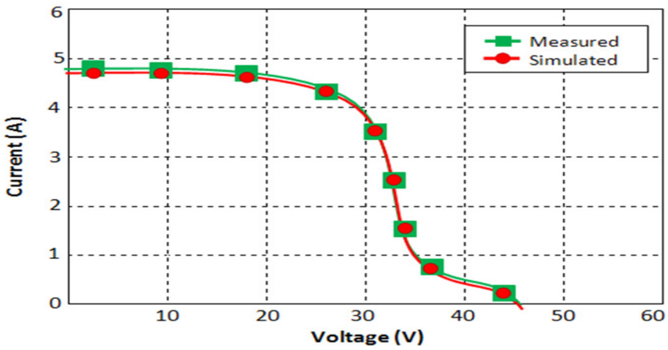
(a) Without shading



(b) With one cell partially shadowed



(c) With the same area of shadow affecting 2 cells



(d) With 2cells entirely shadowed

Fig. 13 Measured and simulated I/V characteristics of a BP3150 panel

Figure (13) shows the measured and modeled I/V characteristics of a PV module under various partial shadow conditions.

Due to the ageing of the panel used, its behavior is not identical to datasheet, therefore the environmental conditions (G and T) for the simulation have been adjusted in order to create the same short-circuit current and open-circuit voltage to the measurement.

As a result of the comparison between experimental and simulation result and in order to confirm the established MPPT control and the obtained simulations, we belonged to experimental measurements of the power according to the voltage and the PV power of MPPT method under step changing irradiance. The curves obtained are identical to the simulation ones. We can conclude that there is a similarity and concordance.

VII. Conclusions

In this paper we have realize an advanced control applied to a photovoltaic system in view to supervise the work conditions, in normal or in shadow weather conditions. All results have been achieved modeling all systems in Simulink and writing all models in Matlab code. The schemes which we focused on include the PV plant model, the estimator parameters, the reference model block and the supervision system control.

The block MPPT is necessary to track the maximum power point and to establish the reference voltage in input, it is based on the algorithm Perturb and Observe, which, step by step researches the point for the first order derivative is zero. The experimental results are quite satisfactory.

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