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A Tool for Performance Evaluation of MPPT Algorithms for Photovoltaic Systems

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***Abstract*-- The use of photovoltaic (PV) systems as electrical power generator is increasing rapidly and this growth is expected to be continuous. As well known in PV systems the tracking of the maximum power point (MPP) is fundamental. For this reason, many testing systems and maximum power point tracking (MPPT) algorithms have been developed. Testing systems are used for the development as well as for assessing the quality of PV products. The typical problem related to the evaluation of PV system performances and MPPT algorithm comparison is the guarantee of the repeatability of the testing conditions (e.g. temperature and radiation).**

In this paper, a testing system for PV applications has been developed and characterized. Flexibility, ease of use, low cost, capability to evaluate the characteristic curves of more than one PV panel simultaneously (same environmental conditions), the capability of algorithms simulation, and capability of tracking MPP on the base of different MPPT algorithms are some of the main characteristics. Experimental tests have been carried out to show the capability of the developed architecture. Different MPPT algorithms have been compared in the same environmental conditions both in the steady and dynamic state.

***Index Terms*- Maximum power point trackers, Photovoltaic systems, Solar panels, PV testing systems.**

I. Introduction

Among all renewable technologies, Photovoltaic (PV) energy is considered as the future of sustainable energy generation in many countries. More efficient and saving PV components and devices have been introduced making this technology more and more valuable. As well known the problem of finding and tracking the maximum power point (MPP) is vital for this kind of system. To fulfil this task, many maximum power point tracking (MPPT) algorithms have been developed. The testing of the devices and algorithms is a very important activity not only for PV system development but also for the quality verification of the products on the market. The main issue for the experimental testing is the need of guarantee environmental condition repeatability since, as well known, the PV cell performance strongly depends on solar radiation and temperature. The definition of current-voltage (*I–V*) curves in different environmental conditions, completely characterize a solar cell, module or array. Unfortunately, the knowledge of these curves is not sufficient to estimate the actual generated power of the panels in working condition. In fact, as well known, the production also depends on the employed MPPT.

The typical experimental characterization is based on the use of artificial sun emulators that are extremely expensive and suffer of issues related to dimension limits of the testable system [1]. In literature, different studies comparing MPPT algorithms and PV modules have been developed [2]-[10]. However, just a few works compare different algorithms or different PV panels at the same environmental conditions and are mainly based on simulations analysis without experimental evaluation [11] [12].

For this reason, a testing system for PV applications has been developed. The system has been designed according to the following constraints: flexibility, ease of use, low cost, capability to evaluate the characteristic curves of more than one PV panel simultaneously. Moreover, it is able to implement every desired algorithm, simply changing the tracking software.

The system is based on a board for control and measurement management, controllable from the Simulink environment by MathWorks© and hosted on a PC. The system gives the capability to measure the characteristics curve of four different panels in the same environmental condition, as well as the radiation and their temperature. Moreover, it is possible to simulate and directly implement different MPPT algorithms so as to compare their performance in real-time. The computation capability of the developed system allows the implementation of even complex MPPTs algorithms.

The paper is organized as follows. Section II the state of the art in PV testing systems is presented. Section III describes the hardware platform used in this paper for the MPPT algorithms and PV panel comparison. The MPPT algorithms utilized in the paper are presented in section IV. Section V is dedicated to the performance evaluation and comparison of employed MPPT algorithms and finally, Section VI presents the main conclusions.

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