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Control with floating- and fixed-point DSPs of a low-cost Flexible Platform for a Photovoltaic Grid-Connected System working as an agent in a Distributed Generation Structure

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Abstract. In this paper, a low-cost flexible platform for photovoltaics is developed with a DSP-microcontroller arrangement for doing industrial control in an easy way, and the communication process between them is carried out with the McBSP bus. The control of the DC/DC boost converter and the d-q control approach of the 3-phase Voltage Source Inverter (VSI) have been established: the mathematical model of the plant is described and a decoupled control of the instantaneous active and reactive powers fed to the utility grid is achieved, allowing unitary power factor operation. Several measurements of the involved variables in the platform are described in order to evaluate the performance of the exerted control algorithms with the DSP-microcontroller arrangement, and the development of future complex algorithms and high computational tasks is validated.

Key words

PV Panels, DSP-microcontroller, DC/DC boost converter, 3-phase VSI.

1. Introduction

As an alternative to the traditional pollutant fuel-based Power Generation Plants, the recent liberalization of the electrical market leads to the forthcoming of may dispersed Renewable Generation Systems [1], also known as agents in a Distributed Generation Structure (DG), and capable of feeding energy to the utility grid. These are formed by the Power and Control Subsystems which jointly must guarantee not only the Power Quality [2,3], but also achieve a high efficiency.

Several studies involving the control of different industrial plants with fixed-point Digital Signal Processors (DSPs) are found in the literature [4], where it can be seen its capability of performing 3-phase industrial control algorithms such as Phase Lock Loops (PLLs), Clarke and Park Transformations, PI regulators, Space Vector Modulation (SVM) Techniques, etc., with an appropriate software programming. However, they may lack of additional resources for high-demanding and complex algorithms, such as FIR and IIR filters, Neural Networks Fuzzy Systems and non-linear control, and the use of floating-point DSPs is mandatory [5]. Nevertheless, the floating-point DSPs do not have, in general, on-chip peripherals, and the use of Programmable Logic, such as FPGAs, is needed for doing real-time industrial control [6], yielding new programming paradigms such as Hardware Description Languages (HDL), and new development tools, which increases the development cycles and the overall cost of the project.

To solve the aforementioned situation, this paper proposes a floating- and fixed-point DSP-microcontroller arrangement with the same development tool, and it is structured as follows: firstly, a brief theoretically description of the physical meaning of the variables involved in the connection of Photovoltaic Panels (PV Panels) to the utility grid is carried out, with emphasis in the Power and Control Subsystems, next the Power and the Electronic Control Units with its main modules are explained focussing mainly in the DSP-microcontroller arrangement proposed and, finally, several measurements