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A review of linear advanced current control techniques for grid connected PV inverters

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Abstract. The following paper presents the work being done on the comparative design, simulation and experiments concerning advanced digital linear control techniques for power inverters. Based on an existing inverter topology being developed and implemented, with a conventional DSP-programmed PI control, a research is done on more advanced linear control techniques that might improve the PI response, allowing at the same time a separate regulation of active and reactive power for electricity connection to the grid.

Key words

Inverter, isolation transformer, filter, linear control, dead beat, resonant, PI.

1. Introduction

The Energy Technological Institute (ITE) has as one of its objectives, to study how to improve energy efficiency in both industrial and domestic sectors. This implies not only loads, but also generation. In this framework, a power inverter is being built, designed to work either in isolated mode, or connected to the grid.

In this paper, a review of the main linear current control techniques for a 20 kW photovoltaic inverter, connected to the grid through an isolation transformer, is carried out. The inverter has been designed and implemented by ITE, as a modular hardware platform controlled by a digital signal processor (DSP).

The main objective of this project is to review, model, simulate and test control techniques developed to control the power flow inverter, at the level of the current control loop, with two objectives:

- Power Quality, i.e., reducing total harmonic distortion (THD) and ensuring an stable supply
- A separate regulation of active and reactive power.

The performances of classical and modern techniques are compared by simulation using the power electronics software PSIM.

Different control techniques have been applied, in a framework of cooperation to overcome the drawbacks that each one might present as a stand-alone configuration. Furthermore, different issues related with enhancing the performance of the inverter have been considered and gathered in the same design. These issues have been integrated based on the bibliography and the state of the art of grid connected inverters [1].

Since the inverter is connected through an isolation transformer, its influence has been evaluated and indeed has been included as a part of the global model to design the controllers.

The work being developed is currently at the simulation stage. However, the simulations have been carried out on the same electronic design where the previous PI controller was tuned to control the implemented inverter. The new control developments will be implemented in the inverter's digital signal processor (DSP), tested and compared.

2. Objectives

The aim of this paper is to compare the classic PI dq control performance of a 20 kW grid inverter already tuned, with other control techniques found in the literature, either alone or in a framework of cooperation among them to improve the overall performance of the inverter. The techniques being developed and simulated are the following:

- Discrete PI with decoupling.
- Dead beat control with integral action [2].
- Proportional – Resonant controller [3].

Furthermore, some aspects are wanted to be assessed, such as computational delay and uncertainty robustness in the value of the parameters of the inverter and grid.