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Nonlinear Flatness Control Applied to Supercapacitors Contribution in Hybrid Power Systems using Photovoltaic Source and Batteries

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Abstract

For a stand-alone application, and to demonstrate role of supercapacitors as a transient power source, a nonlinear control strategy based on the flatness approach is applied to manage energy flows in two systems: the first includes a photovoltaic (PV) source considered as a main source and lead-acid batteries used as storage unit; the second is obtained with the hybridization of the PV source, lead-acid batteries, and supercapacitors.
The simulation results are presented and discussed when applying different solar illuminations and consumption profiles.

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Keywords: Photovoltaic source; Battery; supercapacitor; hybridization; energy management; flatness control

1. Introduction

The Photovoltaic production is a renewable energy that can be produced when it is consumed, and is highly dependent on weather conditions. Therefore, it should be stored during the day [1]. Presently, the lead battery is the most common electrochemical storage technology. Her use has been widely demonstrated, but, costs and life-cycle characteristics are not yet satisfactory and need to be improved for stand-alone applications [2]. Developed at the end of the seventies for signal applications (example: for memory back-up), a supercapacitor presents a capacitance of some farads and specific energy of about 0.5 $Wh.kg^{-1}$. The power supercapacitor appeared during the nineties and

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