UNIVERSITAT POLITECNICA DE CATALUNIA

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Doctoral Thesis

"Analysis, Diagnosis and Fault Detection in Photovoltaic Systems"

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Abstract

The Photovoltaic market has rapidly growing last years over the world. One of the main reasons for this high growth in PV industry is the reduction of PV generation costs. On the other hand, some specific governmental policies have been promoting the introduction of grid connected PV systems in most developed countries. Some successfully examples can be Japan, Germany or Spain.

This important growth has not been accompanied by important improvements in the field of PV system Diagnosis, Supervision and Fault detection. Most PV systems, in use nowadays, are working without any supervisory mechanism, especially PV systems in output power levels below than 25 kWp. Maybe the reason has been that Monitoring systems have only been implemented in big PV generators, where it represents a very few cost increment respect to the whole system cost, but without the help of a minimum monitoring system is not possible to develop any effective supervision, diagnostic or control of the PV system.

In the present thesis, we first focused on modelling the different part of a PV grid connected system in which we put enough emphasis on modelling PV module and PV generator. The parameters involved in the modelling and simulation process has been evaluated with the help of outdoor measurements. In order to evaluate the global losses especially involved in the DC part of PV system, mainly due to the mismatch effect, a novel and simple procedure has been developed. Based on measurement in real conditions of temperature and irradiance, the procedure allows determining the deviation of the main characteristic parameters of an averaged PV array module from the parameters obtained with a single module. The effectiveness of the procedure has been verified experimentally.

To find out the amount of power losses caused by the presence of shadow on module surface, a special attention has been paid to this effect in Chapter 3. Modelling the effect of shadowing on both a single module and PV generator has been carried out and a quantification of power losses depending on the rate of shadow have been evaluated. Some cases of study are presented as application examples of this simulation methodology, showing its potential on the design of bypass diodes configuration to include in a PV module and also on the study of PV generators working in partial shading conditions.

Finally, a supervision and fault detection procedure for PV grid connected systems, based on the power losses analysis is presented. The procedure analyses the output power losses in the DC side of the PV generator. Processing certain power losses indicators such as Thermal capture losses and Miscellaneous capture losses allow the supervision procedure to generate a faulty signal as indicator of fault detection in the PV system operation. The procedure has been successfully tested experimentally