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# The New Method of the PV Panels Fault Detection Using Impedance Spectroscopy

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**Abstract**— The aim of our project is to develop a new method for photovoltaic (PV) panel fault detection based on analyzing impedance spectroscopy (IS) spectra. Although this technique was successful in assessing the state of degradation of fuel cells and batteries [1, 2], it has never been applied to PV cells on a wide scale. This step forward could be a turning point in PV fault identification as it provides a method that is easily implemented in the field and cheaper than the traditional techniques [3].

**Keywords**— fault detection, impedance spectroscopy, silicon PV panels

## I. INTRODUCTION

The IS measurements provides a complex impedance value ( $Z_{PV}$ ) for a range of AC signal frequencies. Using a fitting method on the measured data, it is possible to extract the parameters of the PV panel equivalent circuit [4] (see fig. 1). Analysis of the extracted parameters such as parallel capacitance  $C_p$ , parallel resistance  $R_p$ , and series resistance  $R_s$ , should allow us to rate the degradation state of PV module's individual parts [3,4].

## II. FIGURES AND TABLES

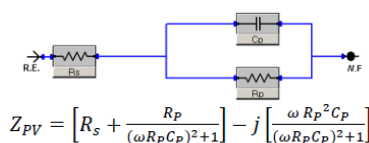


Fig. 1. The complex impedance  $Z_{PV}$  equation of a PV panel (bottom) and its equivalent circuit model (top).

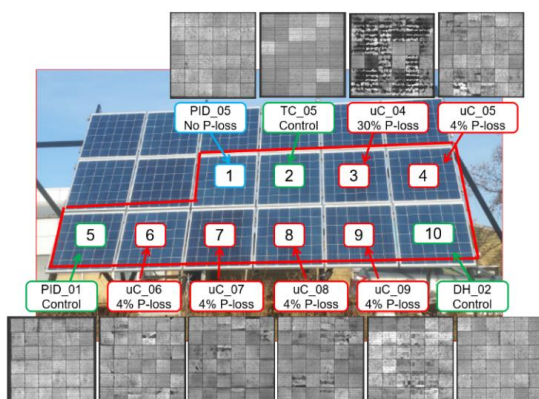


Fig. 2. The field station built at DTU Risø Campus for measuring current-voltage (IV) and IS spectra of PV panels along with weather conditions.

## III. SUMMARY

We have built a field station at which IV, IS and weather conditions measurements are performed on 10 silicon solar panels (see fig. 2). Tests run from dawn until dusk and a fitting procedure is applied after a day of data collection. Six of the modules had been subjected to stress tests and exhibit power losses ( $P_{loss}$ ) of 4% or 30% due to micro cracks. All the panels has been previously tested indoors by IS technique in dark conditions and by IV one in multi-irradiation conditions.

So far, the IS technique was only successful in the dark indoors conditions. We observe that the  $R_p$  values of control modules are 2,5x higher than the ones of modules with  $P_{loss}$ . Also, the module with 30%  $P_{loss}$  exhibits 2,5x higher  $R_s$  value than the rest of modules. These changes indicate a mechanical performance failure, which should be further investigated by IV measurements. Once  $G > 100 \text{ W/m}^2$  the shapes of collected IS curves are the same for all degradation groups and, thus, extracted  $R_p$ ,  $R_s$ , and  $C_p$  parameters do not differ either. This may be due to incorrect performance of our field test bed.

In the future we hope to be able to assess the  $P_{loss}$  value only through the field IS measurements. However, in order to achieve our goal, we first need to upgrade outdoor test bed and perform more indoor stress tests as a reference for the outdoor data.

## ACKNOWLEDGMENT

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## REFERENCES

- [1] D. Stroe et al., 'Experimental investigation on the internal resistance of Lithium iron phosphate battery cells during calendar ageing'; IECON Proc. (Industrial Electron. Conf.), pp. 6734–6739, 2013.
- [2] I. F. Grigoras, 'Performance and degradation tests on high temperature proton ex-change membrane fuel cells (HT-PEMFCs)'; Master thesis (Aalborg University), 2013.
- [3] M. Oprea, 'Fault detection in PV arrays using advanced characterization methods'; Master thesis (Aalborg University), 2013.
- [4] R. A. Kumar, M. S. Suresh, and J. Nagraju, 'Facility to measure solar cell ac parameters using an impedance spectroscopy technique'; Rev. Sci. Instrum., vol. 72, pp. 3422–3426, 2001.