



**HAL**  
open science

## Voltage Singularity-Based Diagnostic for PEM Fuel Cell Stack designed for Operation in $\mu$ CHP Units

Djedjiga Benouioua, Denis Candusso, Fabien Harel, Pierre Picard

► **To cite this version:**

Djedjiga Benouioua, Denis Candusso, Fabien Harel, Pierre Picard. Voltage Singularity-Based Diagnostic for PEM Fuel Cell Stack designed for Operation in  $\mu$ CHP Units. FDFC 2017, 7th International Conference on Fundamentals & Development of Fuel Cells,, Jan 2017, STUTTGART, Germany. 1 p. hal-01830711

**HAL Id: hal-01830711**

**<https://hal.science/hal-01830711>**

Submitted on 5 Jul 2018

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## Voltage Singularity-Based Diagnostic for PEM Fuel Cell Stack designed for Operation in $\mu$ CHP Units

D. Benouioua<sup>1,2,4</sup>, D. Candusso<sup>1,2,4</sup>, F. Harel<sup>3,4</sup>, and P. Picard<sup>1,5</sup>

<sup>1</sup> ITE EFFICACITY, 14-20 boulevard Newton, Champs-sur-Marne, F-77447 Marne la Vallée, France.

<sup>2</sup> IFSTTAR / COSYS / SATIE, UMR CNRS 8029, 25 allée des marronniers, F-78000 Versailles Satory, France.

<sup>3</sup> Université de Lyon, IFSTTAR / AME / LTE, 25 avenue François Mitterrand, Case24, F-69675 Bron Cedex, France.

<sup>4</sup> FCLAB, FR CNRS 3539, Rue Ernest Thierry Mieg, F-90010 Belfort Cedex, France.

<sup>5</sup> ENGIE, La Plaine Saint-Denis, France.

A non-intrusive and without disturbance diagnostic strategy for a low temperature Proton Exchange Membrane Fuel Cell (PEMFC) designed to operate in  $\mu$ CHP units is proposed. The developed diagnosis strategy consists of two phases:

- ➔ In the first phase, an experimental campaign is conducted on a 12 cell PEMFC stack dedicated to stationary application. It is designed and marketed by Riesaer Brennstoffzellentechnik GmbH and Inhouse Engineering GmbH, Germany. Thereby, a database is built; it includes many physical signals measured from the stack and the testbench ancillaries such as: gas pressures, flows, temperatures... and the voltage stack signal recorded with a sampling frequency of 3kHz for nominal and faulty operating conditions.
- ➔ In the second phase, the research of relevant indicators for the PEMFC State-of-Health (SoH) is made by analyzing the stamped singularities in the stack voltage signal according to the various operating conditions.

The approved approach implements two data analysis steps:

- A data pre-processing step based on the filtering of a voltage signal (acquired during 1 hour) to achieve the separating of its low and high frequencies components. Then, a Useful Voltage (UV) signal was obtained by computing the Root Mean Square 'RMS' on the windowed filtered voltage signal (with a window size of 0.066 s).
- A data processing step that consists of computing a punctual singularity strength in the UV signals and summarizing all the founded singularities strength in the form of a singularity spectrum (SS). The signal processing method adopted in this study, namely the Wavelet Leaders-Based Multifractal Analysis (WLMA), has been published in previous works [1, 2] and showed high-performance results on a PEMFC designed for transport application.

The results of the SS features classification enable the identification of a wide range of operating failures for the studied PEMFC stack dedicated to  $\mu$ CHP application.

References:

[1] D. Benouioua, D. Candusso, F. Harel and L. Okhellou, Fuel Cells Vol. (?), 1-8 (2016).

[2] D. Benouioua, D. Candusso, F. Harel and L. Okhellou, International Journal of Hydrogen Energy Vol. (39), 21631-21637 (2014).