ABSTRACT

In the habilitation thesis my main professional and research results achieved during the period 2002 – 2013 are presented. The above period follows the public presentation of my doctoral thesis which was in 2001.

In the aforementioned period my main research fields were: *Signal Processing*, *Analog-to-Digital Converter* (ADC) *Testing*, and *Synchrophasor Measurements*.

In *Signal Processing* my work was focused on the parameter estimation of a sine-wave by both frequency-domain and time-domain methods. The frequency-domain methods used are the Interpolated Discrete Fourier Transform (IpDFT) method and the Energy-Based (EB) method. Conversely, the time-domain methods used are the sine-fitting algorithms. In *ADC Testing* I worked on the analysis of the estimation accuracy of some of the most important dynamic parameters of an ADC, which are the Effective Number Of Bits (*ENOB*) and SIgnal-to-Noise And Distortion ratio (*SINAD*), achieved by means of the frequency-domain and time-domain sine-fitting algorithms when the sine-wave test signal is non-coherent sampled. In *Synchrophasor Measurements* my work is recent (beginning in 2011) and it is performed in order to find the best frequency-domain and time-domain algorithms which should be adopted for fast and accurate synchrophasor estimation. The used frequency-domain methods are based on the DFT and the used time-domain algorithms are based on Least Squares (LS) algorithm.

The habilitation thesis contains three Sections. In the first Section an overview of my teaching and research activities is performed. Also, the achievements related to both these activities are revealed. In the next Section my main contributions to each aforementioned research field are presented in a separate subsection.

In the first subsection the IpDFT and EB methods are separately presented. In the EB method both direct and indirect procedures are considered. For each method the expressions for the variances of parameter estimators are given. Besides, for the IpDFT method the expressions of the combined standard uncertainty and the PDF of the frequency estimator are given. Also, the criterion proposed for selection of the optimal window to be used in the IpDFT method is presented. Furthermore, two multipoint IpDFT methods for frequency estimation are described and their performances are compared. Besides, the expression of the combined standard uncertainty of the frequency estimator achieved by the most suited to be used in practice multipoint IpDFT is given. Then, the performance of the average-based IpDFT method is presented. Also, the effectiveness of a multipoint IpDFT method for amplitude estimation as compared with the IpDFT method is revealed. It should be noted that the multipoint IpDFT methods reduces the detrimental effect of the spectral interference due to the fundamental image component to the parameter estimation achieved by the IpDFT method. Conversely, the results of the comparison between the theoretical means of the sum-squared fitting and residual errors achieved by the three-parameter sine-fitting (3PSF)

algorithm with frequency *a priori* estimated by the IpDFT method (3PSF-IpDFT algorithm) and the four-parameter sine-fitting (4PSF) algorithm are presented. In the second subsection the procedure used to estimate the *SINAD* and *ENOB* parameters by a sine-fitting algorithm is given. Then, the expressions for the mean and variance of the *ENOB* estimates provided by a sine-fitting algorithm are presented. In the third subsection the synchrophasor estimation results achieved by some DFT-based estimators in the case of an electrical signal with decaying dc offset component are presented. Then, the performance of the IpDFT synchrophasor estimator is presented. In all subsections computer simulations and experimental results are shown. The last Section of the habilitation thesis presents the perspectives of future works. There are specified new possible research directions in the aforementioned fields and a new research field.

It is worth noticing that the main results achieved in *Signal Processing* field were published in 12 papers (all as first author) in the following prestigious measurements ISI journal: *IEEE Transactions on Instrumentation and Measurement*, *Measurement*, *IET Science Measurement and Technology*, *Computer Standards & Interfaces*, and *Measurement Techniques*. Also, the main results achieved in *ADC Testing* were published in 5 papers (all as first author) in *IEEE Transactions on Instrumentation and Measurement* and *Measurement* journals. Moreover, I am coauthor of the Chapter entitled "*Dynamic testing of analog-to-digital converters by means of the sine-fitting algorithms*," of the book *Design, Modeling, and Testing of Data Converters*, which is now in press at Springer-Verlag Publisher, Germany. The main results achieved in *Synchrophasor Measurements* were published in 2 papers (one as first authors) in the *IEEE Transactions on Instrumentation and Measurement* journal.