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# Transient Power and Quality Events Analysed Using Hilbert Transforms

Mario Ortiz[1], Sergio Valero[1] and Antonio Gabaldón[2]

*1. Department of Mechanical and Energy Engineering, Universidad Miguel Hernández, Alicante 03202, Spain*

*2. Department of Electrical Engineering, Universidad Politécnica de Cartagena, Murcia 30202, Spain*

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**Abstract:** This work presents an advanced mathematical tool applicable to the recognition and classification of power system transients and disturbances. Disturbances without a periodic pattern or with a non-linear pattern require a more suitable tool than the Fourier series (Fast Fourier or Windowed Fourier Transforms). To overcome these drawbacks, other tools have been broadly used, such as the wavelet transform. However, the wavelet transform also has some drawbacks such as the lack of adaptivity or interpretation of nonlinear phenomena that the Hilbert and Hilbert Huang Transform techniques could mitigate. The Hilbert techniques transform a time domain function into a space representation both in time and frequency. In the paper, the technique is applied to analyse several short-term and steady events, like a short circuit, a capacitor-switching transient, or a line energisation, showing the abilities of the Hilbert-based transforms.

**Key words:** Power system transients, wavelet transform, power quality, Hilbert transform, Hilbert Huang transform, empirical mode decomposition.

## 1. Introduction

Power quality has been a problem of increasing interest to researchers, utilities and customers. Problems with power quality include those caused by harmonics, voltage levels or power interruptions. Their effects can devalue the energy supply for both utilities and their customers, and so it is necessary to characterise, detect and correct these problems and their effects. In this paper, we introduce Hilbert transform methods to the identification of transients and the quality of power signals improving the extraction mode algorithm with the analysis of instantaneous frequency. We present advantages of the Hilbert transform compared with other well-known methods such as the wavelet or fast Fourier transforms. Hilbert transform methods also have the capability to appropriately compress the information recorded through monitoring instruments. It is important to note the high sampling frequency requirements of these instruments and the high volume of data to be stored, which leads to higher costs for transmission and data storage devices. Therefore, the compression characteristics of the Hilbert transform are a distinct advantage because of the ability to reconstruct the original waveform with a minimum loss of information, although this property is also common to the wavelet transform [1]. Signal denoising is another interesting and well-known property of both transforms. Consequently, the properties of the Hilbert transform and wavelet transform methods are at least comparable, but the Hilbert transform methods exhibit some additional advantages.

The Hilbert transforms are used to localise a signal in time and frequency, through a concept called the instantaneous frequency, in order to identify and

**Corresponding author:** Mario Ortiz, professor, research fields: wavelet and Hilbert applications to electricity, distribution system analysis, electricity markets, distributed and renewable energy resources, and neural network applications in power systems. E-mail: mortiz@umh.es.