Comparison of Gabor-Wigner Transform and SPWVD as tools of harmonic computation.

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Abstract. The measurement algorithms applied in power quality measurement systems are based on Fast Fourier Transformation. That one-dimension frequency analysis is sufficient in many cases. However, to illustrate the character of the signal in a more comprehensive manner, it is crucial to represent the investigated signal on time-frequency plane. There are a lot of time-frequency representations (TFR) for presenting measured signal. The TFR: Short-Time Fourier Transformation (STFT), Smoothed Pseudo Wigner-Ville Distribution (SPWVD) and Gabor-Wigner Transform (GWT) are described in the paper. The ability of implementation of mentioned methods in harmonics computation according to the power quality standards were presented in the paper.

Key words

Harmonics, Short-Time Fourier Transform (STFT), Gabor-Wigner Transform (GWT), Smoothed Pseudo Wigner-Ville Distribution (SPWVD).

1. Introduction

The measurements of the power quality frequency parameters (i.e. THD factor) are currently performed with the help of FFT transformation [2][3]. In spite of high computation efficiency, the method does not give positive results during measurements of the fast spectrum changes. Therefore, current research is performed into the application of alternative methods enabling spectrum measurements and time localization.

Simultaneous localization disturbances in time- and frequency- domains may be performed with the help of time-frequency methods. Among many of time-frequency methods monitoring of power quality parameters is taken into consideration: Short-Time Fourier Transform (STFT), Smoothed Pseudo Wigner-Ville Distribution (SPWVD) and Gabor-Wigner Transform.

The SPWVD does not include characteristic distortions for Wigner-Ville Distribution (WVD) – time and frequency cross-terms. The SPWVD features loss of excellent WVD time-frequency resolution. To get better resolution than SPWVD and to avoid cross-term distortions the Gabor-Wigner Transform (GWT) has recently been proposed. Unfortunately, there are some specific circumstances, where GWT gives wrong results. The special signal's model, which includes these features in the researches was implemented.

It is interesting comparison of: standard STFT, SPWVD and GWT in measurements of power supply harmonics and interharmonics.

2. Power quality and standards

The power quality (PQ) issue should be regarded in relation to: EN 50160 [1] and EMC standards 61000 [2,3] family. Moreover, in many countries, there also exist local regulations defined by governmental order.

The standard [1] defines the main voltage parameters and their permissible deviation ranges at the customer's point of common coupling in public low voltage (LV) and medium voltage (MV) electricity distribution systems, under normal operating conditions.

Recommendations included in the standard characterize PQ with the help of parameters describing: power frequency, voltage magnitude, shape of voltage waveform, three-phase voltage unbalance and continuity of supply. It does not yet define the measurement methods required for computation of particular parameters. Detailed definitions, measurement methods and measurement equipment construction guidelines are presented i.e. in [2,3].

The harmonics and interharmonics measurement procedure is specifically defined in [2]. The main guidelines are described below:

- measurement systems should include: input circuits equipped with anti-aliasing filters, analog-to-digital converter with sample-hold circuit, synchronization and window-shaping unit, DFT-processor,
- the time window shall be synchronized with each group of 10 or 12 cycles according to the Power system frequency of 50 Hz or 60 Hz. These recommendations define the spectrum resolution of DFT: 5Hz for 50Hz systems and 6Hz for 60Hz systems;
- sampling frequency and number of samples in a time window should be matched to minimize synchronization error, with a permissible error of 0.03%;
- the definition of indices which characterize the content of harmonics in 50 Hz systems is