NTERNATIONAL CONFERENCE ON ELECTROMECHANICAL AND POWER SYSTEMS
October 4-6, 2007 - Chişinău, Rep.Moldova

VIRTUAL INSTRUMENT FOR GENERATION OF DISTURBANCES WHICH AFFECT POWER QUALITY

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***Abstract* – This paper describes an implementation method of a virtual instrument, with user-friendly GUI, for generation of disturbances which affect power quality, in LabView environment, using as hardware component a sound card, an integrated codec or a data acquisition board, for the reserch of these various phenomenons, now when proliferation of nonlinear loads has driven to the increase of electromagnetic compatibility problems and consequently to the increase of the interest for ensure power quality.**

Keywords: *virtual instrument, graphical user interface, power quality, nonlinear loads, electromagnetic compatibility.*

1. INTRODUCTION

Today proliferation of nonlinear loads and the apparition of devices and equipments more sensible to electromagnetic disturbances, caused by unprecedented development of electronics and telecommunications from the last decades, have lead to the increase the electromagnetic compatibility problems and power quality problems, which affect power supply systems from many industries [1, 2]. In addition customers requirements are higher than ever before. For this reason power quality monitoring systems have became an indispensable tool in any industry [3].

Modern power quality monitoring systems provide a tremendous volume of raw data, about various phenomenons with parameters values which can varying in wide ranges, difficult to analyse [4]. For this reason are prefered automated analysis systems. The development of systems presumes an interdisciplinary research [5], it is necessary a link between power engineering, electromagnetic compatibility (power quality problems can arise from the incompatibility between power supply system and the customer equipment or the latter can produces disturbances in power supply system) and signal processing, for extraction of specific informations from raw data in a few stages: identification, classification and characterisation, using various technics in function of signal characteristics. The root mean square value (RMS) is used to measure voltage magnitude. Supplimentary informations can be obtained from time-frequency analysis, the discrete Fourier transform (DFT) grants visualization of stationary and periodic signals spectrum, in case of nonstationary signals the short time Fourier transform (STFT) is applied with the help of a few windows by changing window type and dimension. The wavelet transform (WT) has started to be used relative recent, from the beginning of 1990s. It is useful for multiresolution analysis by time-scale decomposition, mostly for tracking fast changes in high-frequency range components [6].

In LabVIEW environment can be developed power quality monitoring systems using virtual instruments, which are in fact data acquisition systems and use various signal processing methodes for extraction of desired informations about disturbances. Suplementary it can be developed a diturbances generator for their testing, this thing is the objective of the paper. The virtual instrumentation concept it was developed by National Instruments in 1986, when has appeared on market LabVIEW environment (Laboratory Virtual Instrument Engineering Workbench) base on G graphical programming language. Realization of a programme consist in assembling some components elements represented by graphical icons, choosed from a certain number of libraries with predefined functions, divided on data processing operations. The development of virtual instruments require a shorter time and can be understood by a non-programmer.

The virtual instruments are very flexible because are based on software and personal computers hardware, so are beneficiaries of new technologies performances which have an ascendent evolution and the effects are increase performances and efficiency and decrease of costs. Their functions are choosed by users and can be extended or modified after users desires, in contrast with traditional instrumentations (multimeters, oscilloscopes etc.), where the functions are vendor defined by hardware structure of the instrument and can not be changed.

Section 2 of the paper describes classification of electromagnetic diturbances which affect power quality, while section 3 provides informations about graphical user interface structure and the ouptu signals obtained for various input paarmeters and section 4 presents a few conclusions.

2.CLASSIFICATION OF ELECTROMAGNETIC DISTURBANCES

The presence of electromagnetic diturbances in power supply systems has a negative influence for operation of devices and equipments. The disturbances are classified in more categories, presented as follow: transient phenomenons (impulsive transients and oscillatory transients), short duration variation (interruptions, undervoltages and overvoltages), long duration variation (interruptions and slow voltage variations), voltage imbalances (are caused by the different values of rms phase voltages or of the phase angles from consecutive phases), waveform distorsions (DC offset, harmonics, interharmonics and noise), power frequency variations and flickers (power supply voltage fluctuations which affect illumination intesity from incandescent lightning, their severity is appreciated function of human eyes disconfort) [2].
Oscillatory transients can be classified into four subcategories: high frequency (>500 KHz), average frequency (5-500 KHz), low frequency (0.3-5 KHz) and very low frequency (<300 Hz).
Typical causes for the production of electromagnetic disturbances are: lightning, short-circuits, burning of fuses, connecting and disconnecting of some consumers, connecting of the condenser batteries, geomagnetic disturbances, switching mode power supplies, switching on/off of a synchronous machine, fluorescent lighting tubes, static frequency converters, power transmission faults, electrical motor starting, arc furnances, welding installations etc [1, 4, 7].

3.GRAPHICAL USER INTERFACE AND EXPERIMENTAL RESULTS

In the next figure are presented the elements of graphical user interface, each one has attached a suggestive label. The right part contains four elements for the visualization of output signal wave shape and its spectrum, selected sequence of signal, (fixed by start sample number and stop sample number) over which is superimosed the selected disturbance and the selected disturbance. The rest of the elements are situated in the left side and grant: selection of output signal type (sinusoidal, square, sawtooth, triangular), inserting the parameters of the selected signal (amplitude, which if it is higher than 1 the signal is normalized, frequency, number of desired periods, sampling frequency) over which on a selected sequence of signal may be overlapped a transient disturbance (impulsive transient, characterized by the constants a, b, c, for reglation of amplitude, rise time and duration, from relation (1), or a oscillatory transient, with amplitude and frequency), a short or long variation (characterized by a constant amplitude), harmonics (characterized by number and amplitude) or white noise with Gaussian distribution (characterized by amplitude). The area from left down corner allows the closing of the program.

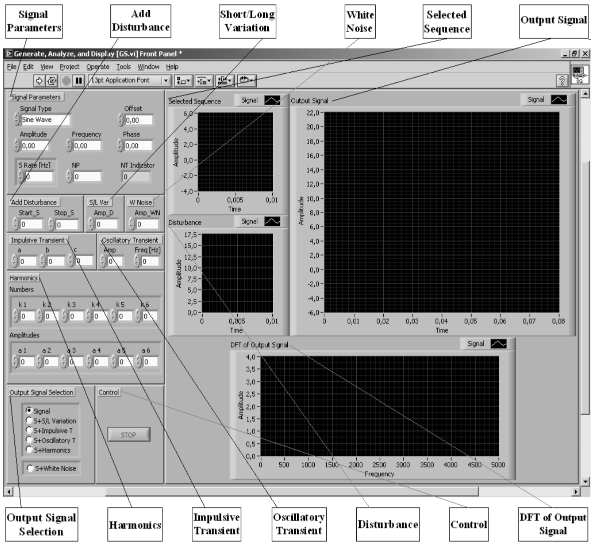
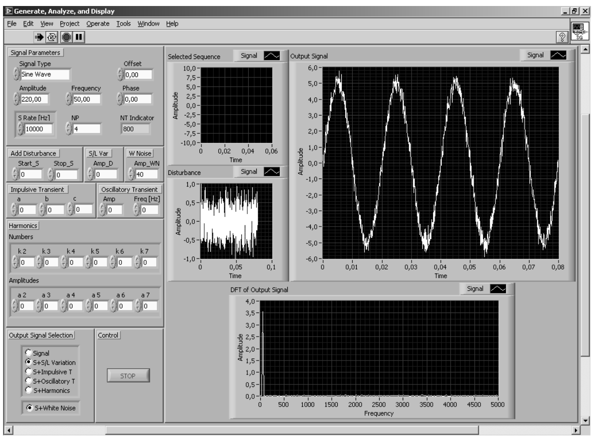


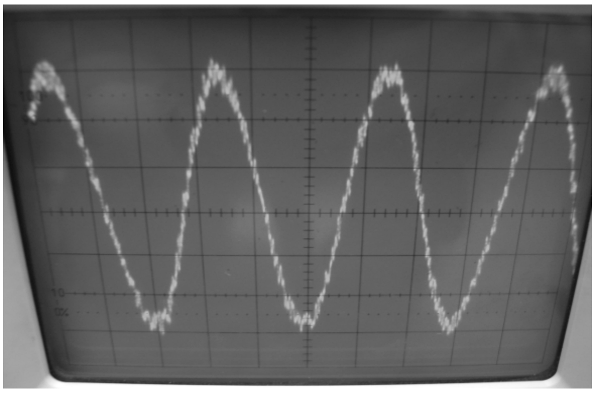
Figure 1: Elements of graphical user interface

$$s(t) = at^b e^{-ct} \qquad (1)$$

The sinusoidal signal disturbed with white noise with Gaussian distribution from next figure it is obtained, after selection of signal type, by using parameters amplitude, frequency, sampling frequency, number of periods with values 220, 50, 10000, 4, and for white noise amplitude is 40.
The spectrum of this signal contains a main peak due to the sinusoidal signal and other components with small amplitudes and various frequencies due to the presence of white noise.



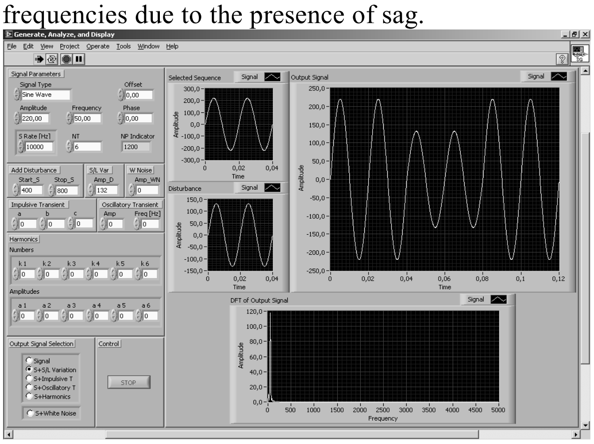
a)



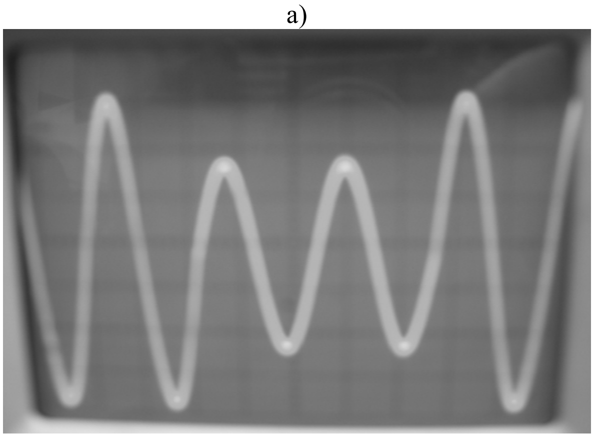
b)

Figure 2: Sinusoidal signal disturbed with white noise with Gaussian distribution

The sinusoidal signal disturbed with a sag, from figure 3, it is obtained using the same values for sinusoidal signal parameters like in the previous case. Start sample number is 400 and stop sample number is 800, amplitude of selected sequence is 132.
The spectrum of this signal contains a main peak due to the sinusoidal signal (like before) and other components with small amplitudes and close frequencies due to the presence of sag.



a)



b)

Figure 3: Sinusoidal signal disturbed with a sag

For the sinusoidal signal from figure 4 are used the same values like in previous case. The parameters a, b, c of the biexponential impulse have the values 8, 0.7, 0.1. Start sample number is 50 and stop sample number is 130.
The spectrum of this signal contains a main peak due to the sinusoidal signal, as in previous cases, and other components with decreasing amplitudes in frequence due to the presence of impulsive transient.

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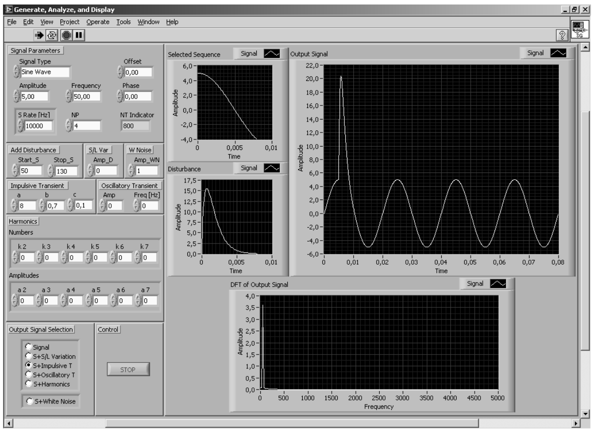

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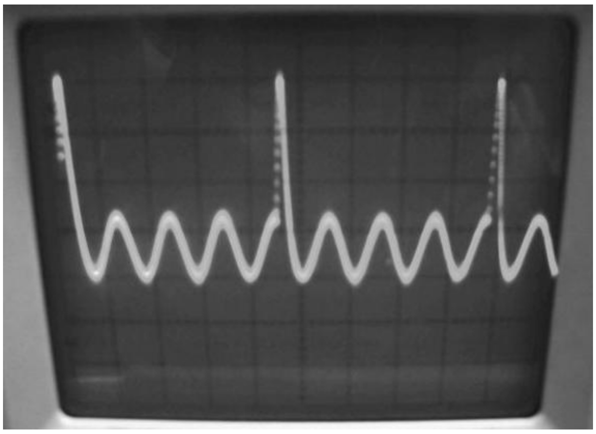

b)

Figure 4: Sinusoidal signal disturbed with an impulsive transient

4. CONCLUSIONS

The LabVIEW environment is useful to the development of virtual instruments base on personal computers resources. Using only a sound card, a integrated codec, or a data acquisition board it can be build a virtual instrument, with graphical user interface, very flexible for generation and study of electromagnetic disturbances which affect power quality. In this way these disturbances, which in power supply networks can have high amplitudes and are dangerous for electric and electronic devices and equipments, can be generated controlled and in safety with small amplitudes. The flexibility of virtual instruments is limited only by the specifications of used hardware, for example the input/output range (at integrated codecs and sound cards the range is [-1V, 1V], for usual data acquisition boards the range reaches [-10V, 10V]) and the maximum sampling frequency (for first two previous categories the value is usully 44100 Hz and for the third categorie reaches MHz or even GHz).

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