DIGITAL MEASURING SYSTEM FOR RECORDING DEFORMED FUNCTIONS

Paweł Ptak [1)], Marek Kurkowski [1)], Zygmunt Biernacki [1)], Tadeusz Zloto [2)]

[1)] Institute of Electronics and Control Systems, Czestochowa Technical University,
Al. Armii Krajowej 17, 42-200 Czestochowa, Poland,
e-mail: biernac@el.pcz.czest.pl , marekekb@poczta.onet.pl , ptak@el.pcz.czest.pl
[2)] Institute of Machine Technology and Production Automation,
Czestochowa Technical University,
Al. Armii Krajowej 21, 42-200 Czestochowa, Poland, e-mail: zloto@itm.pcz.czest.pl

Abstract: The paper deals with the application of DasyLab software package for measuring voltage and current in circuits with non-sinusoidal waveforms. The presented procedure may be used for constructing complex measuring systems and control systems.

1 INTRODUCTION

Instead of the regular sinusoidal waveform, deformed waveforms may occur in the grid, causing difficulties in measurements. In order to prevent deformations, it is possible to find their causes by the analysis of higher harmonics. Machines functioning on the principle of electromagnetic induction deform the sinusoid especially by inducing the third harmonic. Also power electronic devices deform the sinusoid. The most important aspect of current and voltage measurements is the root-mean-square (RMS) value. It can be measured directly or indirectly. Indirect measurements (the mean value) of RMS can be accompanied by significant errors. Direct measurements by the thermal method give accurate results, some difficulties, however, may be encountered due to the complicated construction, low input resistance and long response time of the measuring device. Direct measurements of RMS by the analog method also has some limitations since the 0,1% accuracy of the measurement decreases when the peak coefficient of the measured waveform increases or when the frequency increases. Direct measurement of the RMS and higher harmonics by means of the digital method, on the other hand, provides measurements not only of RMS of the signal but also of higher harmonics, peak coefficient and deformation coefficient of the measured waveform. The measurements can be obtained with the frequency up to 10kHz.

The recent development of microprocessor systems has facilitated constructing a new generation of measuring devices based on virtual instruments. Apart from LabView - one of the most popular programs for broadening the measuring abilities of traditional measuring systems, also DasyLab by Dasytec is widely used. This software is intended for the automation of measurements, analysis of results and their graphic representation. The program is compatible with most PCL cards made by company Advantech. Friendly graphic user interface and large abilities make it a useful tool both for commercial users and for research purposes. DasyLab version 5.0 operates under Windows environment and its hardware requirements include a Pentium, 32 MB of RAM and 20 MB free disc space. The program has a library of objects which can be used for the visualization of waveforms and for the controlling of various processes. Depending on the kind of used PCL card, the program can communicate with a 16-bit input port, 16-bit output port, 8 or 16 analog input ports, and one analog output port with the 12-bit resolution converter. The sampling frequency of waveforms at the analog input port depends mainly on the number of channels and type of the card.

2 MEASURING SYSTEM

The measurements were obtained during the start-up of a three-phase asynchronous motor type SZBJd of power 0,4 kW, voltage 500 V and rated velocity 493 rpm. The power is supplied from the grid by means of SOFTSTART with parameters U = 500V, 50 Hz, I = 8A. For the measurements of voltage anf phase current of the motor a PC computer was used, equipped with measuring card PCL-818L and application software DASYLab 5.0 for recording and processing of signals. The sampling frequency of the measuring card was 100 kHz with the maximal amplitude of input signals ± 10V.

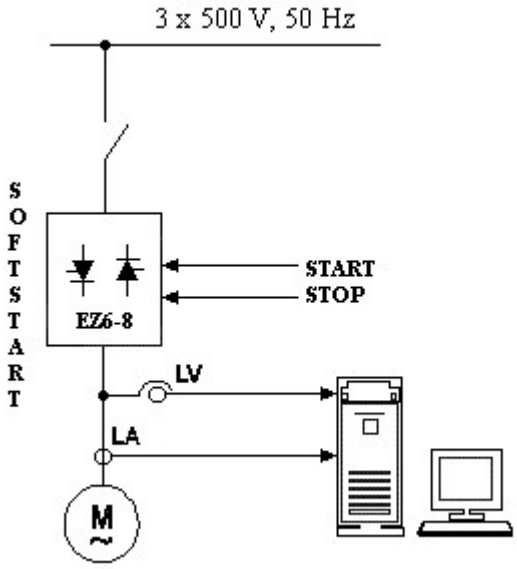

Fig. 1. Diagram of measurement

The necessary galvanic separation of the computer system from the power grid 500V was obtained by means of measuring converters LEM type LV and LA (Fig.1).

The main parameters of LEM converters include:

- transmitted frequency band $f = 0 \div 150$ kHz for LA,
- transmitted frequency band $f = 0 \div 25$ kHz dla LV,
- linearity of processing ± 0,2%,
- accuracy of measurement ± 0,8%.

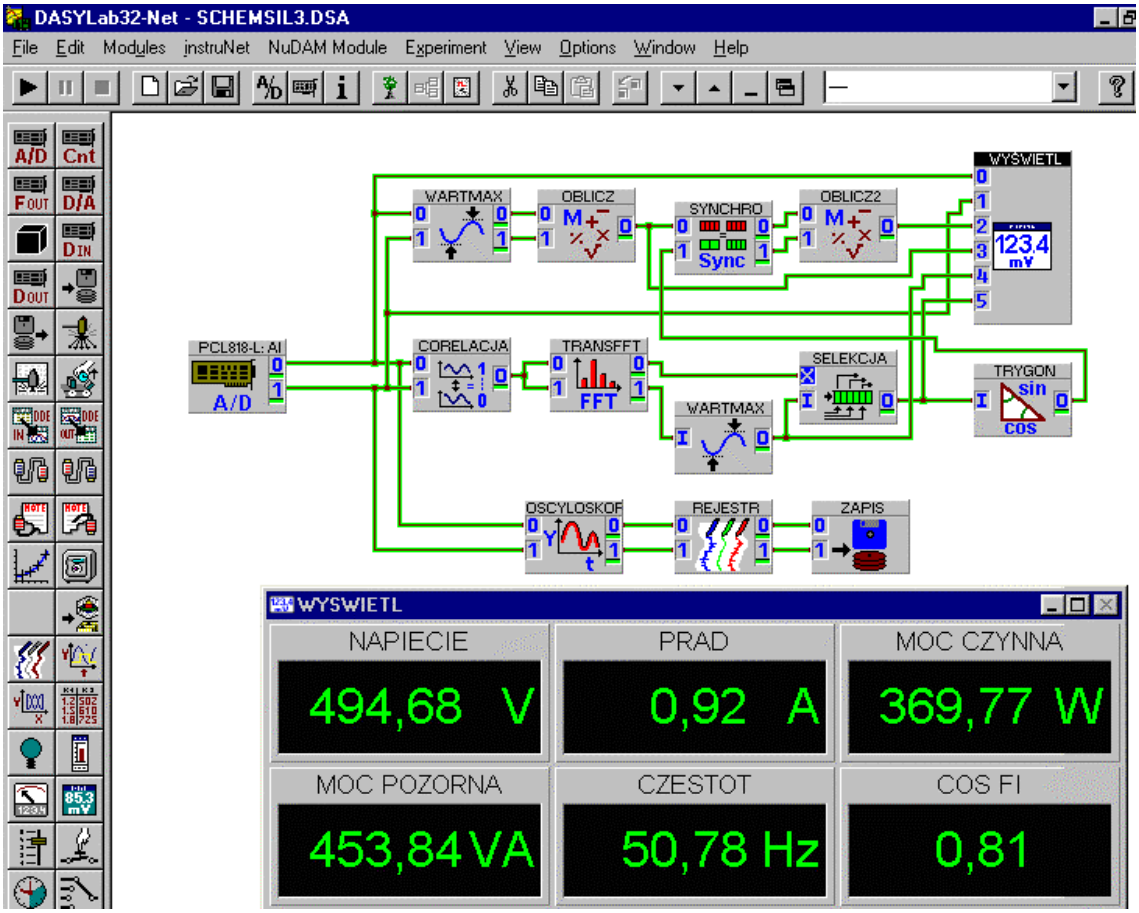

Fig. 2. System for the recording and analysis of signals

The functions of system presented in Fig. 2 are the following:

- *Acquisition of the values of electric signals "voltage" and "current" from the measuring card (module PCL818L AI);*
- *Calculation of the value of active power and apparent power (modules WARTMAX, OBLICZ, SYNCHRO, OBLICZ2);*
- *Determining the value of the similarity function for the recorded signals as well as calculating frequency and phase displacement (modules KORELACJA, TRANSFFT, WARTMAX, SELEKCJA TRYGON);*
- *Visual representation of the obtained results (module WYŚWIETLACZ);*
- *Visual representation and saving the data (modules OSCYLOSKOP, REJESTR, ZAPIS).*

3 EXPERIMENTAL STUDY

The measurements included voltage and current waveforms during the start-up of the engine:

- voltage and current of the engine for the complete start-up cycle (Fig.3);
- voltage and current of the engine fot the initial phase of the start-up (Fig.4);
- voltage and current of the engine for the final phase of the start-up (Fig.5).

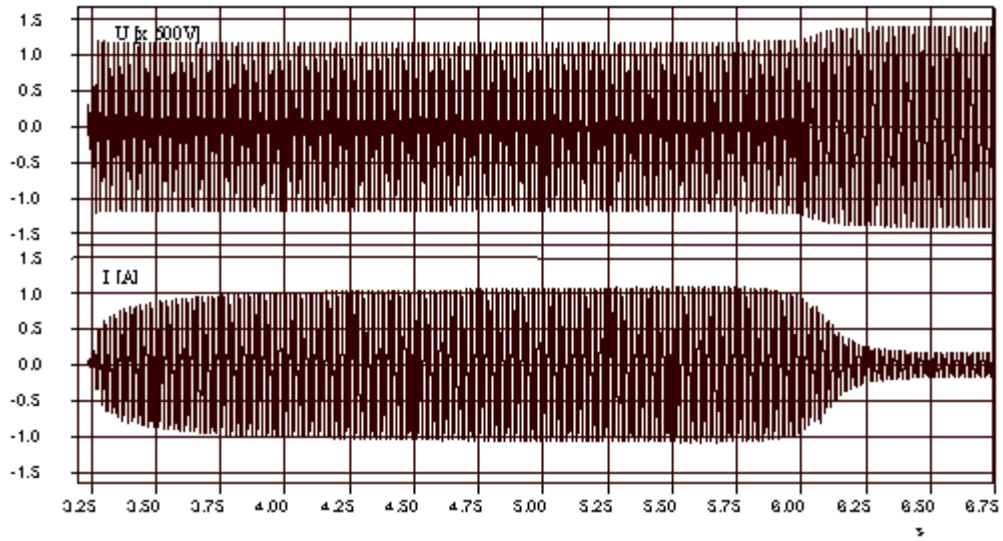

Fig.3. Start-up of the engine

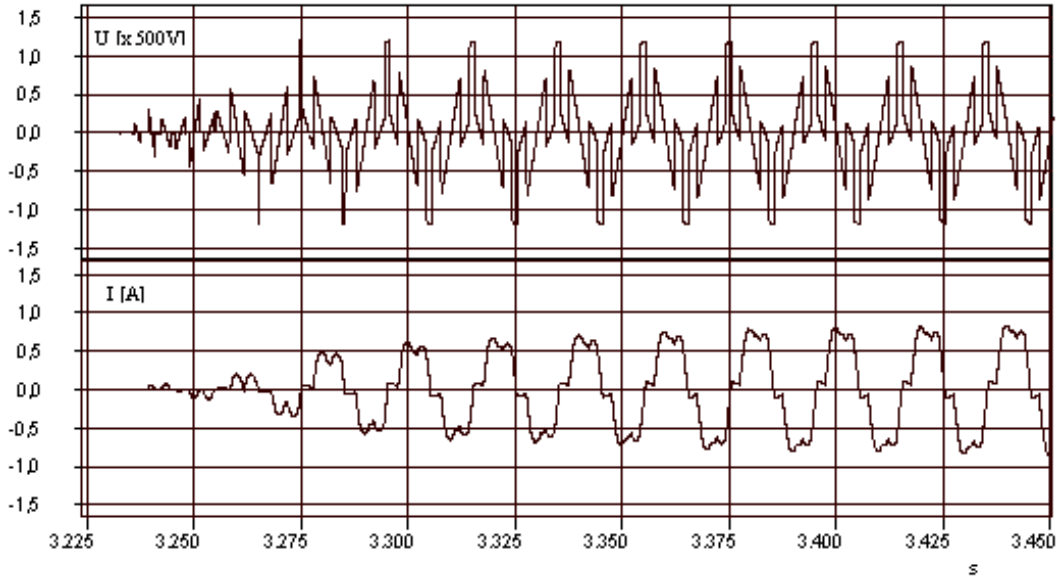

Fig. 4. Initial phase of the start-up

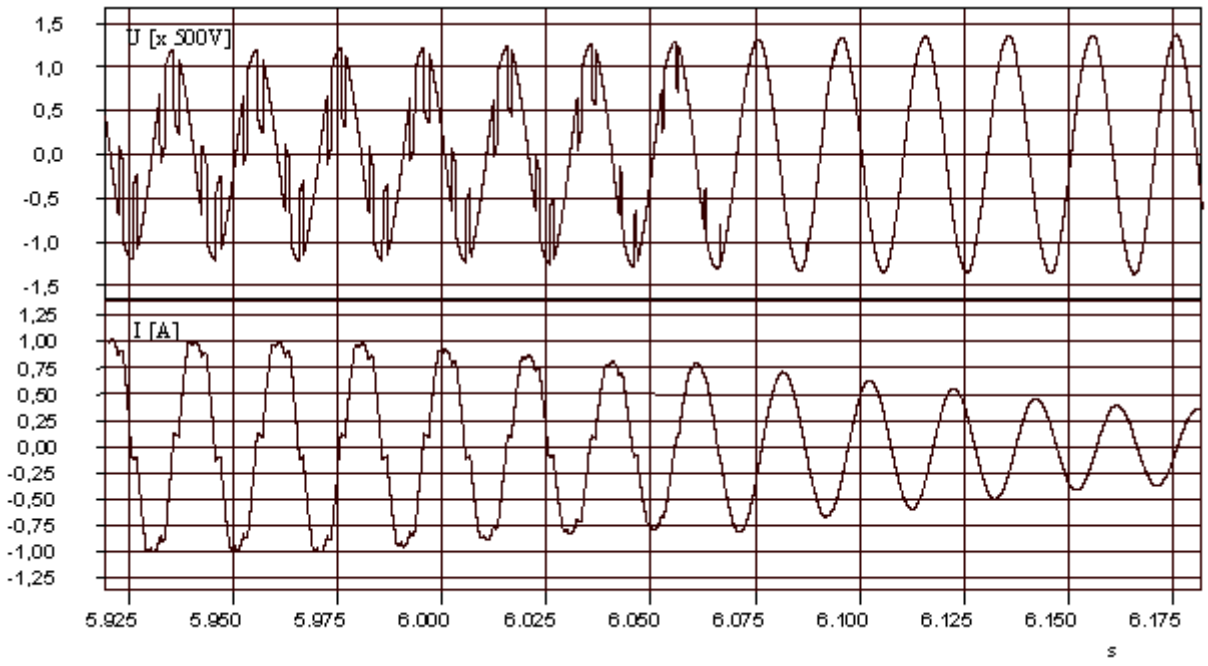

Fig. 5. Final phase of the start-up

4 CONCLUDING REMARKS

The study confirms the usefulness of DasyLab software for the application in circuits with non-sinusoidal waveforms. The considerations concerning the possibilities of constructing devices can be applied for developing complex measuring systems based on virtual instruments.

One of the most important advantages of computer recording of signals is the possibility of digital analysis of waveforms with the use of statistical methods or fast Fourier transform (FFT).

REFERENCES

[1] Advantech 3.2 – User's Guide.
[2] Pc-LabCard Lab & Engineering Add-on's for PC/XT/AT – PCL 818 L, User's manual.
[3] Z. Kuśmierek: Zastosowanie komputerowych technik pomiarowych do badania jakości energii elektrycznej (Applying computer measuring technology for testing the quality of electric energy), JUEE, t. I, z. 1, 47 53, 1995.
[4] B. Jakubiec, R. Bąbka, K. Olesiak: Zastosowanie programu DasyLab do cyfrowego pomiaru mocy przemiennika PWM (Application of DasyLab software for the digital measurements of the power of PWM converter). PES-2, s. 103-110, Zakopane-Kościelisko, 1999.
[5] User Guide „DasyLab – Data acquisition System Laboratory ver. 5.0".
[6] W. Bobrowski: Pomiary wyższych harmonicznych w sieci (Measurements of higher harmonics in the grid). Wiadomości Elektrotechniczne 4/99.
[7] M. Kurkowski: Analiza sygnałów przy użyciu pakietu DasyLab (Signal analysis by means of DasyLab package). XXXII Międzyuczelniana Konferencja Metrologów MKM'2000, Rzeszów-Jawor, 11-15.09. 2000. Materiały T.2 s. 389-394.