

Pawel Ptak. Application of DasyLab in Teaching Electrical Engineering

## APPLICATION OF DASYP LAB IN TEACHING ELECTRICAL ENGINEERING

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**Abstract.** *The teaching of subjects connected with electricity, such as electrotechnics or electronics is an important part of school and technical university curricula. Due to the recent development of computer technology, laboratory exercises can be performed through simulation. Such simulations can be performed in a virtual environment measurement. The paper presents an example simulation process of a measuring system in the software environment DasyLab.*

**Keywords:** *DasyLab environment, electricity subjects, simulation, teaching.*

### Introduction

The recent years have witnessed a fast technological progress in the field of computer science. Due to the development of information technology and electronics a concept has appeared of a device not existing in reality but performing a certain function for the user, and employing both material and non-material means. All the functions of a traditional measuring device are performed by its hardware, in the case of a virtual device or system it is not so. In a computer measuring system with a graphic interface, what is performed by the hardware is the acquisition and processing of data and what is performed by the software is the functions of the graphic user interface. According to some definitions, such a device can be treated as a virtual device. This term has been created also to refer to new software devices for the computer-supported designing of measuring-information systems (Winiecki, 2001; Rak, 1999). Such devices enable the use of an instrument or a system by means of the graphic interface. The development of measuring techniques and virtual measuring devices has been stimulated by:

- fast technological progress, especially in the production of computers,
- availability of supporting software suited to the user's needs,
- wide possibilities of processing, analysis, and visualisation of measurement results,
- economical factors: virtual devices are cheaper than traditional devices of a similar class.

The choice of content to be represented and the way of representing it on the particular panels of the virtual device are up to the user. The record of measurements can be created automatically and stored on the disk or printed. The software is a crucial component of the measuring system and determines the way and extent to which the device is utilized. It enables convenient monitoring

of the measuring process, archivization of and access to data, their analysis and processing and presenting results in a required form (Winiecki, 2003; Ptak & Prauzner, 2010; Petrilli, 2001; Hull & John, 1988). In the next part of the paper presents a practical application of modeling software package DasyLab. Shows an example of a project implemented at the laboratory classes with students.

### **Development of measuring devices**

The evolution of measuring devices has taken place due to the fast development of science and technology. Changes could be observed in the methods of processing measuring signals, the principles of designing devices, the ways of utilizing measuring equipment and levels of interaction among the particular devices in a system. The first generation of measuring devices included analogue devices operated manually from the front panel. The result of the measurement was read from the position of an indicator on the scale displaying numbers and measuring units (Laughton & Warne, 2003). When a/c converters were invented, the second generation of measuring devices was introduced, which became digital, with discrete measuring signals. The metrological parameters were significantly improved in these devices by eliminating reading errors but the device was still operated manually (Wilson, 2005; Sellars, 1995). The next generation was that of the so called systemic devices (Winiecki, 2001; Rak, 1999; Swisulski, 2004), which could be either used as an independent measuring device or it could be remotely controlled by providing channels of external digital communications, i.e. digital interfaces. The current generation of measuring devices includes virtual devices, consisting of a general-use computer with software and systemic devices or measuring devices of a new generation, such as measuring cards (Prauzner & Ptak, 2014; Smetana & Stracapova, 2013; Beamish, 2000).

### **Functional modules in the DasyLab package**

Specialized programs enable not only analysis of signals from measuring sensors but also simulation of such signals in the programming environment. The programs have to be fairly easy to install and to adapt to the user's preferences. These requirements are met by integrated measuring environments based on object programming, such as DasyLab produced by National Instruments (Ptak & Prauzner, 2010).

The fact that it is easy to construct a measuring schema with the types of analyses required and that it is possible to represent them in real time is also of great value. It only takes minutes to create one's own application for data acquisition and analysis by means of DasyLab. The analysis of complex acquisition and control problems is fact and does not require additional programming. The symbols of particular modules, representing input and output

blocks, displays, and operations are simply to be placed in a Worksheet window and connected (Swisulski, 2004; Kurkowski & Ptak, 2001).

Functional modules and functions are grouped by themes in DasyLab. The basic groups are input-output modules. Here are found elements responsible for acquiring the signal from the measuring card connected directly to the inductive sensor (Figure 1). The signal, typically a voltage one, is in the analogue form.

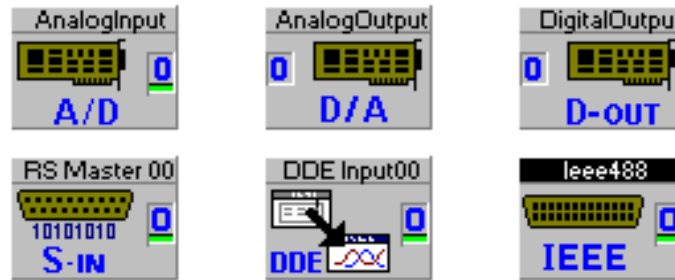


Figure 1. Functional modules – input-output

The signal has to be subsequently modified by signal processing modules so that it is suitable for analysis. It has to be amplified and filtered in order to eliminate interference and noise from the grid. The amplified and purified signal is the basis for establishing characteristic parameters of the measuring signal, such as amplitude, frequency, and phase of the fundamental harmonic, as well as for applying the functions of the FFT (Figure 2).

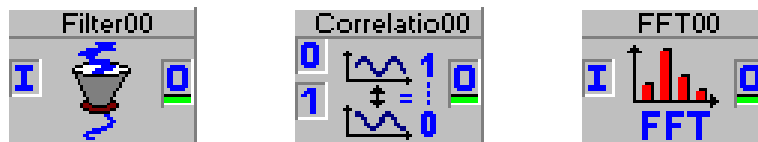


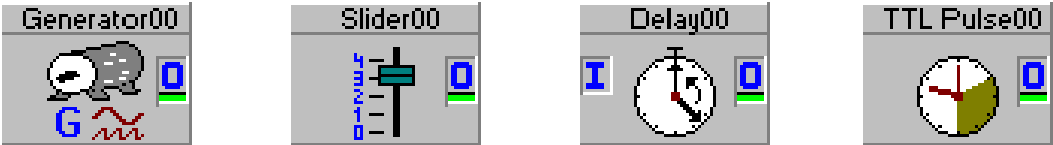
Figure 2. Functional modules – amplification and filtering

By means of the statistical modules, it is possible to obtain average, minimal, and maximal values (Figure 3). It is also possible to draw a histogram of the input signal and determine the minimal and maximal values for a specific stream of data by prescribing the number of periods of the signal to be analysed.



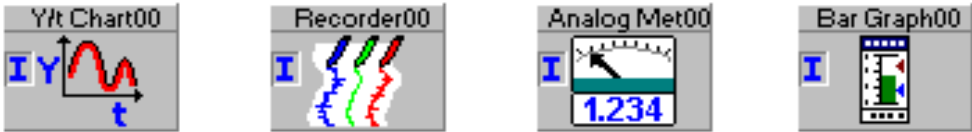
Figure 3. Functional modules – statistical analysis

The process of analysing measuring signals from inductive sensors can be controlled by means of controlling modules, which enable the starting and stopping of the analysis by additional controlling signals, or by the operator. They also control the particular parameters during the analysis by means of various kinds of controllers acquiring data from external devices or by means of variables input to the system (Figure 4).



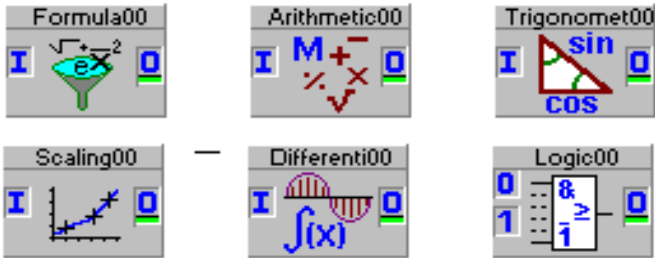
**Figure 4. Functional modules – control and regulation**

The data processed and developed on the basis of signals from inductive sensors can be represented in a graphical and numerical form as time characteristics, or as two-variable functions (Figure 5). The parameters which are relevant for the measurement can be input as analogue or digital indicators directly at any point of the analysis.



**Figure 5. Functional modules – display and recording**

The output data can be subjected to mathematical analysis to establish accuracy and eliminate measuring errors (Figure 6).



**Figure 6. Functional modules – mathematical analysis**

There is yet another group of modules, the generating modules, for simulating the measuring signal. This is useful at the stage of constructing the system for measuring signal analysis, before the analysis proper begins (Zloto et al., 2012).

### **Application of DasyLab package in teaching technical subjects**

The traditional classroom or lab for teaching electrotechnics and electronics consists of a number of terminals for conducting previously prepared experiments. The experiments are about connecting a number of measuring devices and performing measurements in the so obtained system. Students' task is to select the devices properly and to connect them in accordance with the instructions provided. After performing the measurements, students write down the results in a protocol, on the basis of which they prepare a report. The report additionally includes calculations, tables and graphs representing the results, as well as conclusions from the experiment.

Due to the fast development of computer technology it is possible to employ in the teaching various computer programmes, whose two main tasks are:

- simulating the operation of electrical or electronic systems in the computer independently of the hardware or connecting it to the traditional measuring device,
- controlling traditional measuring devices by means of a computer programme, which displays a virtual control panel for the user. Results can be recorded directly in the programme. On the basis of the results it is possible to perform any operations involving their processing or graphical representation.

The DasyLab system enables the user to tackle all problems connected with data acquisition and processing. What is innovative is the great simplicity of using the programme by constructing a scenario for the analysis by means of icons. Connecting icons represents the path of data flow and its analysis, constituting the data flow worksheet shown schematically by Kurkowski & Ptak (2001).

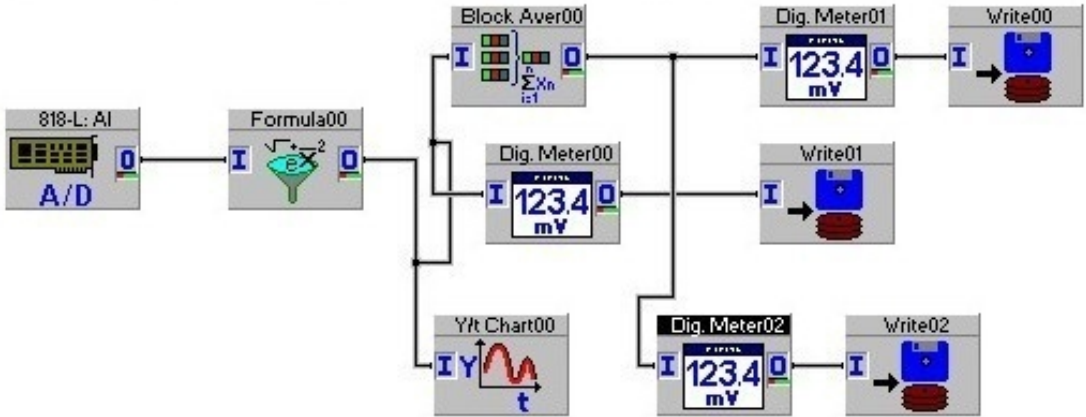
The ease of creating the measuring schema required for the analyses we need and the possibility of representing them graphically in real time are an important advantage of the software. DasyLab makes it possible to create one's own application for data acquisition and analysis within a few minutes. It also makes it possible to solve even complicated acquisition-control problems without any additional programming. The symbols of modules required are simply placed in the worksheet window and connected. The modules represent input blocks, output blocks, displays, and each of numerous operations which can be performed by the programme. The DasyLab software package constitutes a unit as a measuring system with a measuring card and a PC computer. It includes a module responsible for data acquisition and adaptation to the format suitable to be input to the computer. Measuring data processed in this way is analysed by special software operating in the Windows environment. The computer performs a central role by controlling the processes of data acquisition, its processing and analysis, and then the presentation of results in a

form chosen by the user. Results can be also archived so that access to them is possible at any time they are required for further examination.

The DasyLab environment can be used for modelling various measuring and simulation systems created within the measuring system on the basis of the programming modules available.

For example, for the measurements of the coating thickness with the inductive converter, a measuring system was modelled as presented in Fig. 7.

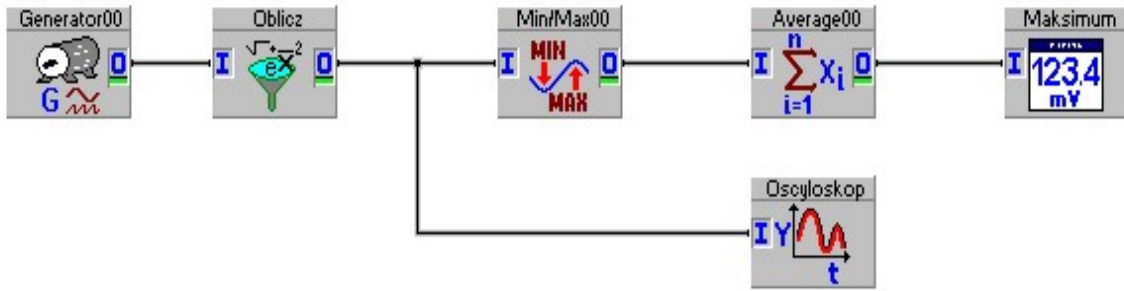
Inductive sensors are widely used as magnetic field sensors for threat detection and alarm systems (Ptak & Prauzner, 2013; Prauzner, 2014). During teaching for electrical engineering laboratory practical exercises are conducted with the measurement of the parameter inductive sensors (Prauzner, 2012). The operation of these sensors can also be simulated in specialized programs and the results compared with actual measurements.



**Figure 7. Measuring system modelled in the DasyLab programme**

Below will be presented the particular stages of modelling the system for measuring the coating thickness. Such a system can be built during the simulation class with computers with the DasyLab package. This system can be subsequently examined in the virtual environment before it is used in laboratory classes or employed for measuring real industrial objects.

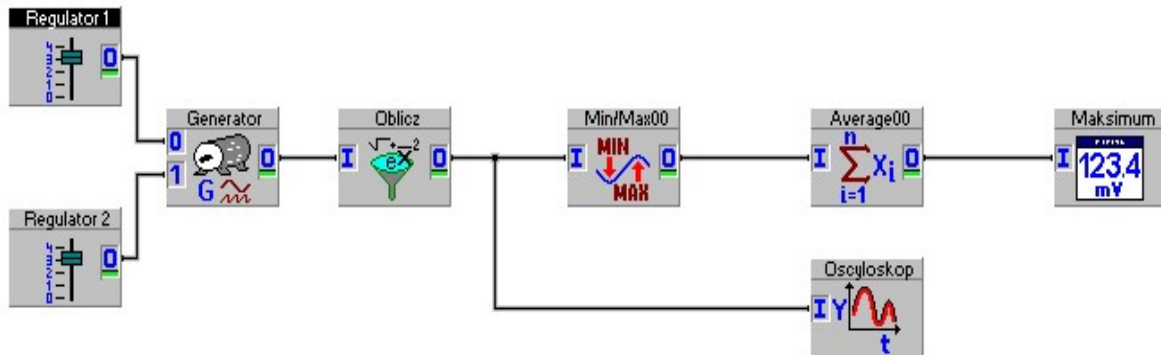
In order to adjust DasyLab to the requirements of the measurements of the coating thickness, a measuring system was especially designed. At first a system for generating a signal feeding the sensor was built together with the measuring part, representing results on the display as temporal waveforms or as values in the case of using the digital display module (Figure 8).



**Figure 8. Diagram of the programme system simulating the measuring signal and its acquisition in the DasyLab environment**

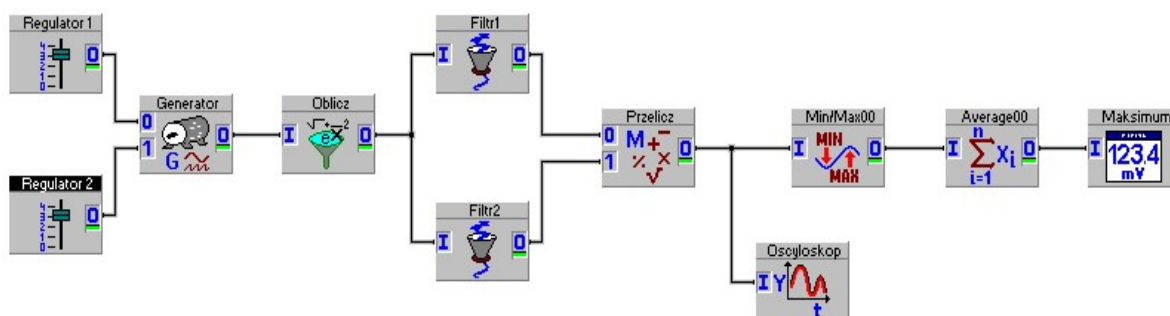
The signal simulation block consists of a sinusoidal generator of constant amplitude and signal frequency. The signal is generated and then amplified so that it fits the other parts of the system. The signal is transferred directly onto the oscilloscope output as time characteristics. Since the information on the coating thickness is encoded in the amplitude of the sinusoid signal, the amplified signal is brought to the module determining the maximal and minimal values of the waveform examined. The maximal value obtained in this way is then averaged to stabilise it and presented on the digital display.

The existing measuring system was subsequently extended to include a part enabling adjustment of the sinusoid signal frequency and amplitude. The other parts of the system were not modified (Figure 9).



**Figure 9. Diagram of the programming system with adjustable generator frequency and amplitude**

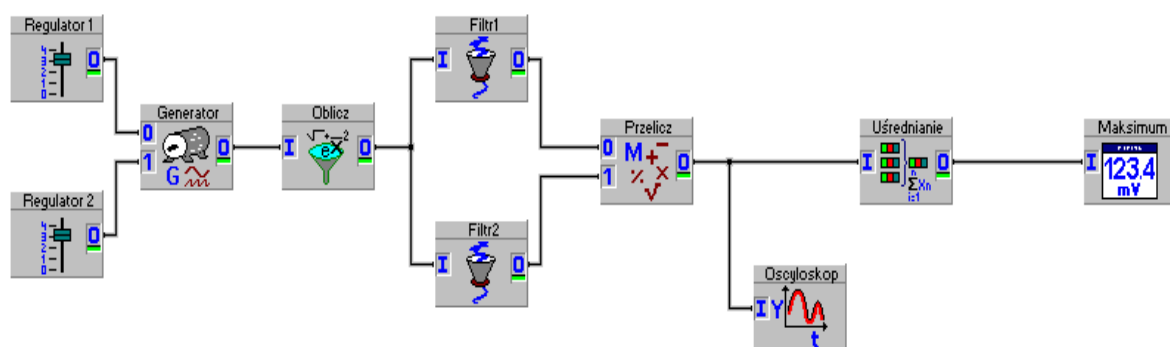
Since the measuring signal is subject to external interference of about a few tens of hertz coming from the grid and of radio frequency from the ambient environment, the system includes signal filtering modules. In this way an optimal operating spectrum is selected for the measuring system (Figure 10).



**Figure 10. Diagram of the programming system with filtering the measuring signal**

This system additionally includes a module adjusting the signal from both filters and transforming the two measuring trajectories into one common signal.

The version of system presented in Figure 11 had the acquisition path of the measuring signal amplitude modified.



**Figure 11. Diagram of the system averaging the amplitude for a prescribed number of samples**

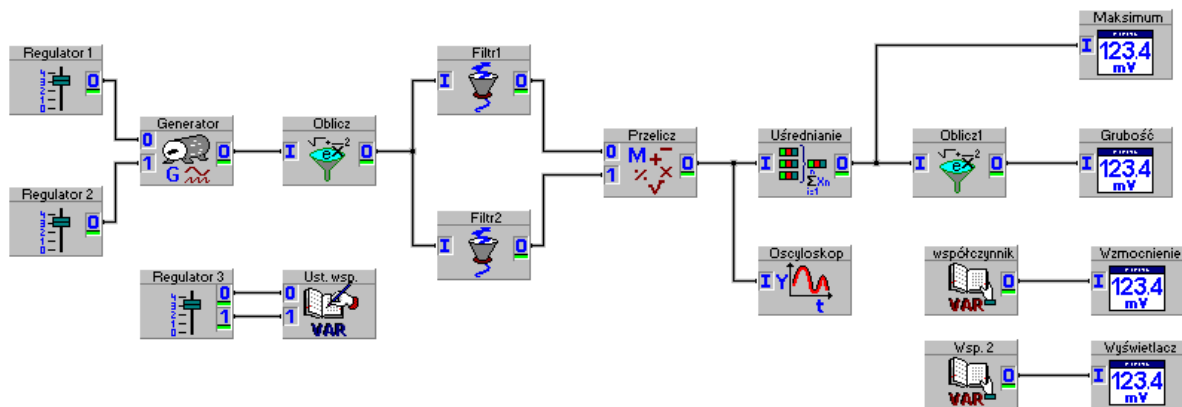
Instead of the module analyzing the maximal and minimal value of the signal and the module for averaging the two, there is a module averaging the amplitude by analyzing a sufficient number of signal samples.

With the signal averaging module it is possible to adjust the parameters during the system operation. In the previous version it was necessary to interrupt measurements, introduce corrections and only then resume operation. In the new version the so called coefficients have been introduced the value of which is input into the system through built-in regulators: knobs, or two different kinds of slides.

So far, the system for measuring the coating thickness is capable of representing a simulated signal whose amplitude corresponds to the sought value of thickness. The amplitude is presented on the display, but the coating thickness has to be derived from it outside the DasyLab environment. Naturally, then, the next step is the implementation of this operation into the measuring system. To obtain this, more coefficients were introduced and the sought value is computed in the mathematical module.



Again, the value of the coating thickness so obtained is presented in the digital form on the display. The fully extended version of the system is presented in Figure 12.



**Figure 12. Diagram of the system yielding the coating thickness as output**

The system presented above is almost a complete version of a device for measuring coating thickness. What can still be added to it is modules recording results obtained.

By using computer-aided learning results achieved not available for learning using conventional teaching methods. Many of the systems that you can build and analyze them in a computer program is not can be realized in the classical laboratory because of financial constraints or too little extensive equipment base. The most interesting element, however, remains an immediate opportunity to experiment and test his ideas in a virtual software environment. This allows to achieve very good results both in terms of objectives of teaching and skills acquired during the educational process (Ptak & Prauzner, 2010; Zloto et al., 2012).

## Conclusions

On the basis of the considerations presented above it is possible to draw the following conclusions:

- the DasyLab programming environment uses a graphical programming language therefore enabling developing a measuring system in the form of a diagram,
- by means of the programming environment DasyLab it is possible to configure the existing measuring system, to develop an algorithm for signal processing on the basis of existing procedures and to build one's own graphic interface for representing the results of measurements and results of measuring data processing,
- applying the special-purpose software package offers significant advantages over the traditional teaching methods,

- using the DasyLab software teaches independent thinking, seeking solutions to problems and drawing conclusions on the basis of experiments conducted and results obtained,
- a number of systems can be built for the sake of analyzing their operation in a simulated software environment, which reduces cost of conducting such experiments as compared to the traditional electronics laboratory,
- the system developed is an open and flexible solution, whose configuration can be extended and altered very quickly, to suit the current requirements of the user,
- the measuring systems offers an opportunity of experimenting in the virtual software environment.

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