Virtual Instrument Applied to Energy Meters Gauging

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Abstract - **Virtual instrument developed for metrological assurance of gauging procedure in electronic energy meters production as a product of the project sponsored by the Ministry of science and technology in Serbia is described in this paper. Multi-channel microcomputer acquisition card generates voltage and current three phase waveforms. Amplifiers provide required voltage and current levels for energy meters calibration. Output information from the current shunt, as well as those from AC dividers, across the ADC converter are returned to the PC computer, where the kWh parameter correction is done. Virtual instrument software is developed in graphical programming language LabVIEW. He is a part of feedback which in real time regulates a voltages, currents and phases in order to eliminate instability of applied amplifiers.**

Keywords - **virtual instrument, automated calibration, energy meters, LabVIEW**

I. INTRODUCTION

The rapid development of intelligent data acquisition and high-performance computing systems permits the successful application of more effective, sensitive and accurate methods in many different fields, from manufacturing and environmental monitoring, to medical systems and instrumentation. However, it has also introduced some urgent problems in the area of metrological assurance of these systems [1]. These problems concern in particular: choosing the right method for characterization of metrological properties of the system, automatic evaluation of the final results' uncertainties, and testing of both software and hardware means for metrological automatic support.

Various systems of this kind are employed worldwide, with a final goal of complete automation. Automated process, based on application of PC computer and virtual instrumentation software would significantly save time needed for calibration and presentation of results obtained during that process. There are already few completely automated systems employed in the world, and in our country, with similar characteristics [2, 3]. For example, the System Century Controls Company from India now offers a fully automatic energy meter calibration [4].

National Instruments LabVIEW [6] is a graphical development environment for designing test, measurement, and control systems, which gives the flexibility of a programming language without the complexity of traditional development tools.

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The basic building block of a LabVIEW application is a virtual instrument (VI), which consists of a front panel, where you design a user interface, and a block diagram, where you create graphical code. LabVIEW is the graphical development environment designed specifically for engineers and scientists who need to create flexible and scalable test, measurement, and control applications rapidly and at minimal cost. LabVIEW is a fully functional graphical programming language with the flexibility of a traditional, text-based language, [6].

In the framework of our project an automated system for gauging of new type of kWh meters, which are produced in the Ei - "Professional Electronics" factory in Niš, is being developed. The principal goal of our project is to develop a new traceability/calibration procedure for metrological assurance of the automated gauging system in the production of a new type of electronic kWh meters, [5].

II. TECHNICAL CHARACTERISTICS AND FUNDAMENTALS METHODS OF THE GAUGER

The gauger is designed for automated and semiautomatic simultaneous calibration and gauging up to twenty kWh meters of following types:

- Direct mono-phase kWh meters for reactive and active electrical energy measurement;
- Direct three-phase kWh meters for reactive and active electrical energy measurement;
- Indirect kWh meters for reactive and active electrical energy measurement;

There is a possibility of simultaneous calibration of kWh meters with same characteristics and of different type, e.g.:

- Mechanical kWh meters which obtain the information about the measured energy using optical reading head;
- Electronic kWh meters which obtain the information about the measured energy at the test output;
- Digital kWh meters, which obtain the information about the measured energy at the optical port, [7].

Use of PC computer and virtual instrumentation software significantly saves time needed for calibration and presentation of results obtained during that process, as well as it provides secure level of quality, reliability, and accuracy appointed by the corresponding standards for measuring of electrical energy, [5, 7].

The goal of developed virtual instrument is to generate voltages and currents for three-phase kWh meters calibration. The voltage and current waveforms are obtained from DAQ acquisition card NI PCI 6713, [8]. Then, signals of

appropriate amplitude for energy meters testing are generated by appropriate voltage and current amplifiers. Measuring transducers provide information about momentary values of voltage and current. Results are fit to input of ADQ acquisition card ED428, [9], i.e. in range at ±10V. According to measured voltage and current values, a regulation is done in loop, i.e. computation of new values that are generated by DAQ card, with purpose to get wanted values of amplitude and phase generated voltages and currents.

III. PROGRAM SUPPORT DEVELOPED BY LABVIEW

A program support is organized within of the "**Bazdarnica_glavni_ampfaz.vi**" programme. This "virtual instrument" is developed by LabVIEW version 6i. Control panel, i.e. working panel of this programme is shown on figure 1. It is alowed to the user to set effective values of voltages and currents,and also a frequency of generated signals. He can choose if to perform PID regulation of amplitudes and phases or to generate precalculated value, i.e. without regulation. Waveforms of generated and measured signals, and generated and measured values of signal amplitudes and phases are shown in front panel. Deviations of effective values in time are presented at small graphic (in the upper part of display).

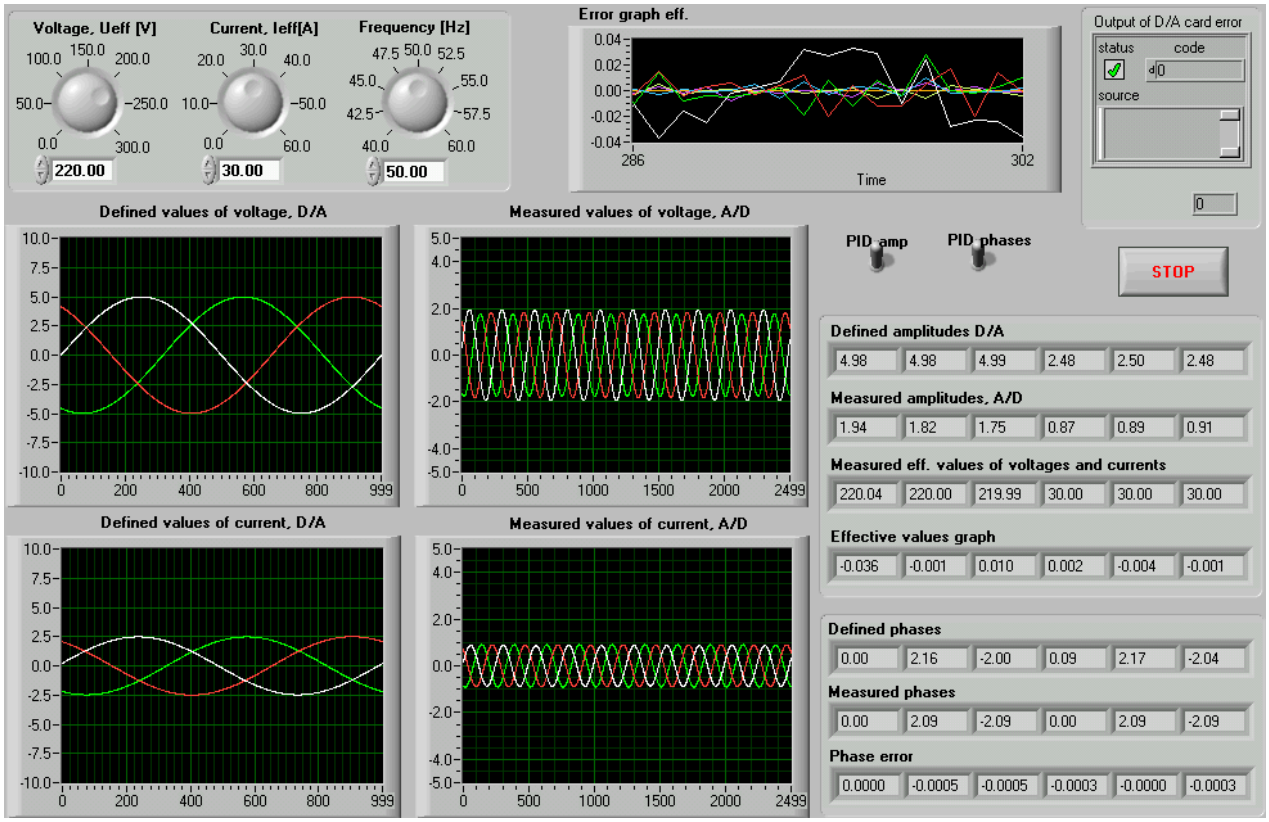

Figure 1. Virtual instrument displey

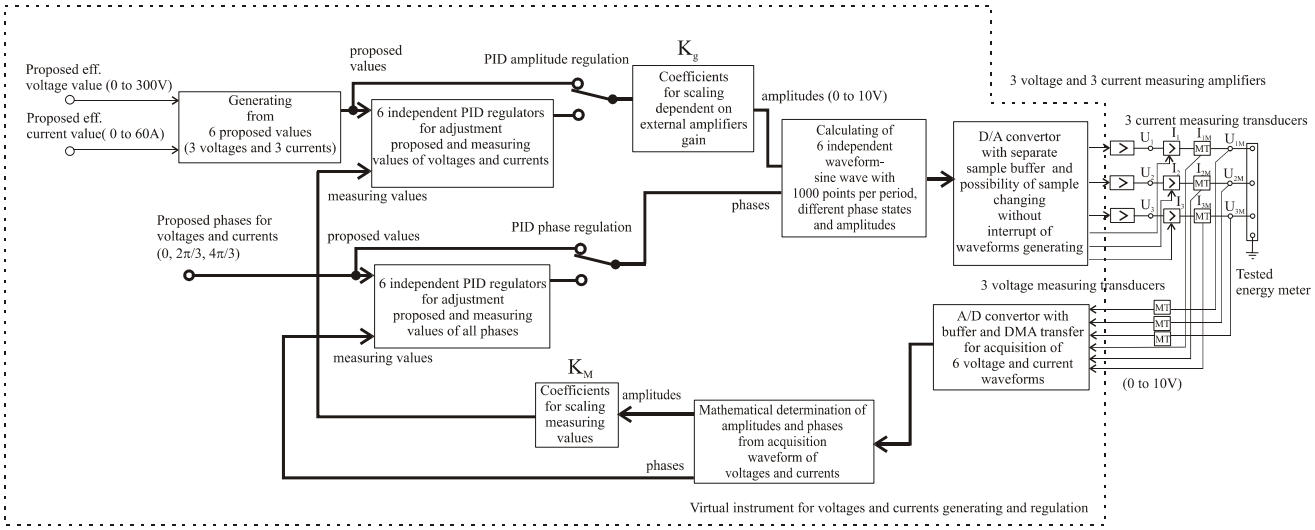

Figure 2. The system blok sheme

The block sheme of realized programme and whole system is shown on figure 2., and developed realization of LabVIEW programme is shown on figure 3. On those pictures thicker lines represent a flow with 6 data simultanously, i.e. transfer of data row. Regulation of signal amplitudes and phases is performing within the PID regulator block. Thus, 12 PID regulation loops run simultaneously, apart for all 6 amplitudes and 6 phases. PID regulators try to equal defined and measured values of amlitudes and phases, there in using *P, I* and *D* coefficients are set in programme (*P*=0,2 *I*=2 i *D*=0,01). PID regulator coefficients are choosen experimentally (they are the same for all 12 PID regulators) and it should be defined depend on the speed of the programme main loop running.

Then, the new amplitude and phase values are multiplied with coefficients K_g, so that required maximal values for generating are in range to 10V. Coefficients K_g is calculated so that signal after DA convertor, and applied external signal amplifiers, have effective value as those which are defined by programme.

SubVI **"Data_Generator_with_phases.vi"** calculates a array of samples in order to get for all 6 waveforms exactly one sinusoidal periode with proposed amplitude and phase, with already determined number of samples per period (now it is 1000 samples). D/A card circularly generates voltage for all channels based on already defined values of samples, which holds in internal baffer. SubVI **"AO Continuous_Gen_(scaled array).vi"** is using for bafer charging and D/A card initalization, which is obtained attained with card i.e. at driver installation for that card. Very important feature of this procedure, and chosen D/A card, is that new bafer charging doesn't interrupt generating, but it is executed syncronically with current generated period i.e. it is possible to continually changed values of samples, and this will not produce discontinuitet in generated sinusoids.

Accuracy of generated signals in forward loop depends on measurement accuracy of instant voltage and current values. Those informatons we get by external measurement transducers of voltages and currents. Waveforms of generated signals are gotten by acqusition in subVI- **"DMA_one_measurement.vi"**. This subVI is provided by accomodation of appropriate test programmes delirevied within Masterlink library, with A/D card. Based on calculated waveforms in range ±10V, subVI **"Amplitudes_and_phases_of_all_channels.vi"** estimates values of amplitudes and phases for all channels. True measuring values of voltages and currents are gotten after multiplying with coefficients K_m, so that measuring results are consistent to proposed effective values about 220V and to 60A. On this way, PID regulators use obtained values in next iteration, i.e. at next loop executing of main programme, to define a deviation from rezuired values of voltages and currents.

Phases of signals don't need multiplying with some coefficients, but all are calculated in relation to first channel, i.e. its phase is subtracted from the others. This is necessary to perform, because by A/D card acquisition we get reliable information only about interrelated phase of all channels, while absolute phase of measured sinusoids continually change value depends from momentary delay between generating signal start and acquisition start of same. This delay is not allways constant, and it is not syncronical with proposed frequency, i.e. signal period.

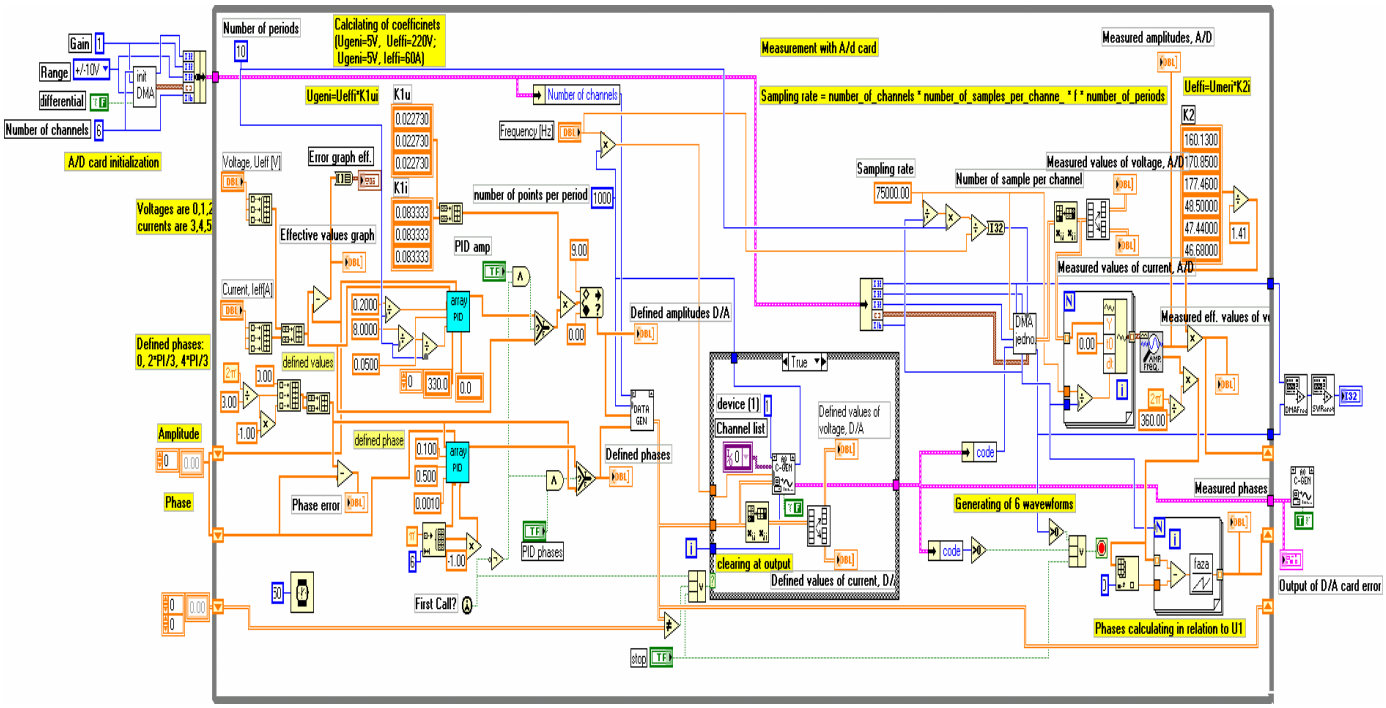

Figure 3. Blok diagram "Bazdarnica_glavni_ampfaz.vi"

IV. Conclusion

Virtual instrument developed for metrological assurance of gauging procedure in electronic energy meters production as a product of the project sponsored by the Ministry of science and technology in Serbia is described in this paper. Virtual instrument is used to generate three phase waveforms. It is also a part of feedback which in real time regulates a voltages, currents and phases in order to eliminate instability of applied amplifiers. Multi-channel microcomputer DAQ acquisition card NI PCI 6713 generates voltage and current three phase waveforms. Measuring transducers provide information about momentary values of voltage and current, which are fit to input of ADQ acquisition card ED428. According to measured voltage and current values, a regulation is done in loop, computation of new values that are generated by DAQ card, with purpose to get required values of amplitude and phase generated voltages and currents. Virtual instrument software is developed in graphical programming language LabVIEW.

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