System for Testing of the Current Measuring Transformer Basic Parameters supported by LabVIEW Software

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***Abstract* – Procedure for verification of the current measuring transformer basic parameters, which is functionally supported by virtual instrumentation software LabVIEW, is presented in this paper. Hardware configuration of developed measurement and acquisition system includes regulation source of AC voltages, power transformer 150A/0.4V, standard computer configuration with data acquisition card NI 6008 and virtual instrumentation software support. Virtual instruments developed in LabVIEW software environment perform signal presentation, measurement and software processing of measurement results, regarding to the basic parameters of input and output transformer waveforms. Statistical processing of measurement results includes recordings of transformer transfer characteristics, graphical presentation of diagrams for measured signal parameter values and calculations of measurement errors and standard uncertainty components.**

***Keywords* – Current transformers, Virtual instrumentation software, Standard measurement uncertainty.**

I. INTRODUCTION

Development and further improvement of the measurement methods, instruments and additional equipment applicable for metrological verification of the voltage and current measuring transformer basic parameters, are very important and complex activities, which are significantly determined by development of the transformers itself. Special attention to these problems must be dedicated in the process of measurement and analysis of the relevant power quality parameters. Primary purpose of these measurement procedures is to provide preconditions for increasing of total efficiency level concerning electrical power production, distribution and consumption process. Important metrological parameters of the voltage and current measuring transformers applied in the mentioned processes significantly affect to the total accuracy level of complete measurement procedure. From previously mentioned facts can be concluded that metrological verification procedure applied to the current measuring transformer basic characteristics, is very significant activity and therefore must be performed on regular basis [1]. Measurement instruments and additional equipment applied to these specific purposes must be designed to provide nominal measurement accuracy level significantly better than specified nominal accuracy value of the current measuring transformer under test. Besides initial testing of the measuring transformer nominal characteristics immediately after production process inside factory testing facility, there is necessity for performing of periodic checking of the measuring transformer parameters, at precisely determined time intervals. Such testing procedure can be performed inside specialized metrological laboratories or alternatively directly on the remote locations of individual measurement stations. Measurement and control instruments must be adjustable for work at various operational conditions, that can be significantly different from laboratory conditions. Among the rest this involves instrument capability to hold on various possible transportation problems, including resistance to tremors and noise. These measurement equipment primarily includes reference instrumentation for generation of reference input signals having the nominal values of basic parameters according to the relevant standards and documents. A second necessary component of this system is control instrumentation which performs measurement of basic parameters regarding to signals obtained from measuring transformer outputs [2,3].

Solution of the laboratory measurement system described in this paper, developed for metrological verification of current measuring transformer basic parameters, is functionally based on the data acquisition USB card NI 6008 [4], supported by software application in LabVIEW progrramming package [5]. As reference system component which provides generation of the reference input current signals for measuring transformer inputs, here is used power transformer with specified nominal output current of 150A maximum value. Power transformer is supplied by means of the AC voltage regulation source having maximum RMS voltage values of 245V and signal frequency of 50Hz Programming application of virtual instrumentation software in PC environment controls execution of the testing procedure algorithm. This involves continuous measurement, graphical presentation, recording and statistical processing of measurement results concerning basic parameters of input and output signals for current measuring transformer under test.

II. DESCRIPTION OF THE MEASUREMENT SYSTEM HARDWARE CONFIGURATION

Simplified hardware block configuration of the laboratory measurement system, which is developed for the purpose of current measuring transformer basic parameter verification, is illustrated on the Fig 1. Presented solution of the measurement laboratory system, developed on Department of Measurement

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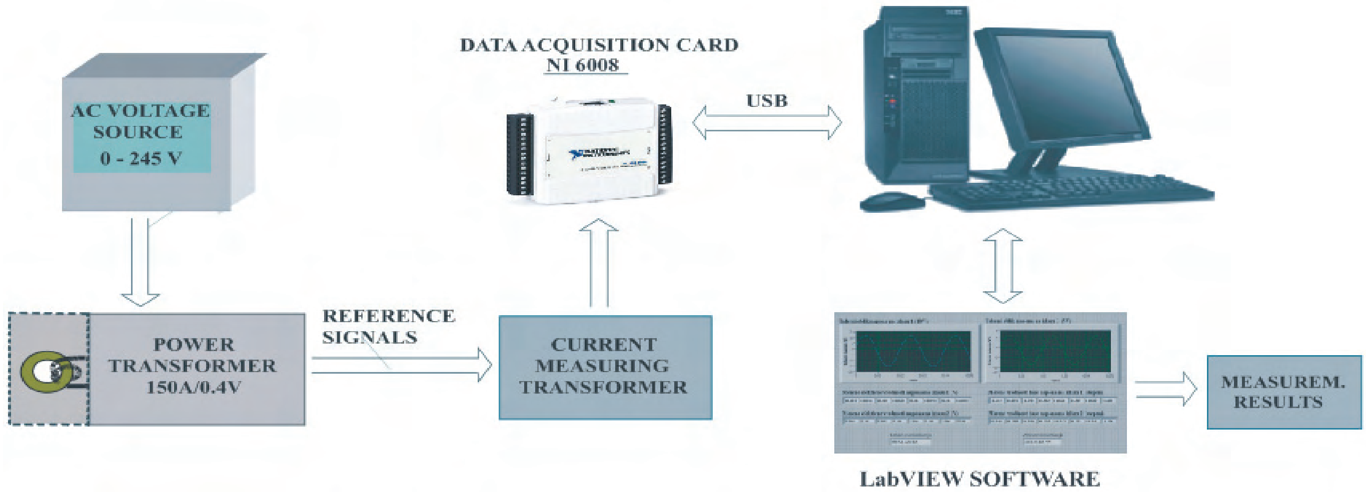

Fig. 1. Hardware configuration of the laboratory measurement system for current measuring transformer testing procedure

at the Faculty of Electronic Engineering in Niš, is consisting of the AC voltage regulation source, 150A power transformer used as generator of the reference current input signals, USB data acquisition card NI 6008 and standard PC configuration supported with virtual instrumentation programming package LabVIEW. Depending on the actual requirements, AC voltage regulation source provides continuous adjustment of the basic parameters for reference waveforms on the current measuring transformer inputs. Using this specific regulation AC voltage source and power transformer, reference input waveforms can be generated with maximum RMS current value of 150A, but upper limit value of the reference current signals used for this laboratory application was significantly smaller from nominal maximum value. Recording and graphical presentation of the measuring transformer current and voltage characteristics is provided by measurement and recording of the basic current and voltage signal parameters on the measuring transformer outputs, in dependence on the continuous variations of input reference current values. In order to perform signal acquisition waveforms generated from the current measuring transformer outputs must be sent directly to the inputs of analog to digital converter within data acquisition card, developed with 12-bit resolution [4]. Data acquisition 12-channel USB card NI 6008 developed with possibility for analog to digital and digital to analog data conversion, from manufacturer company National Instruments Corporaton, for this specific application purpose uses a several analog input channels, which receive measuring acquisition signals from tested current transformer outputs.

Direct two-way signal communication and data interchange between data acquisition card and PC computer is provided by means of standard USB communication interface. Defining of the basic parameters used for acquisition of the measurement signals is performed according to the specific user demands by means of the specialized control software application DAQ Assistant. Front panel of this control application for defining of the signal acquisition parameters is presented on the Fig 2.

Previously presented and described procedure applied to the metrological verification of the current measuring transformer basic parameters and characteristics, including measurement and statistical processing of the obtained measurement results, is software controlled by programming application developed in LabVIEW software environment. Some solutions of virtual measurement instruments, developed as metrological support of presented measurement and data acquisition system, will be illustrated and analyzed in the following segment of the paper.

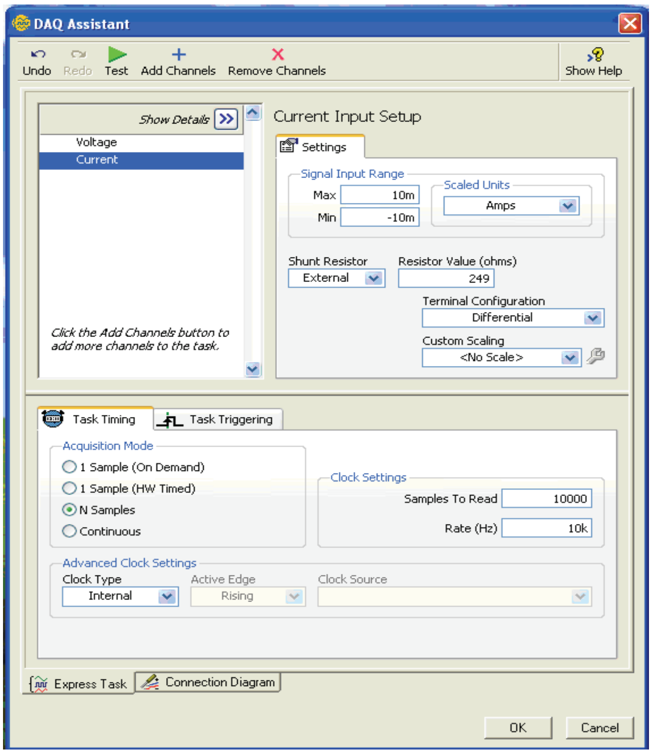

Fig. 2. Front panel of the software application for defining of the basic parameters for measurement signal acquisition

III. Programming Support of the Procedure

Virtual instrumentation presents software oriented method for realization of the measurement instruments with traditional functions, which is based on using of the standard computer configurations, hardware components for measurement signal acquisition and graphical programming packages capable for measurements, software processing, recordings and graphical

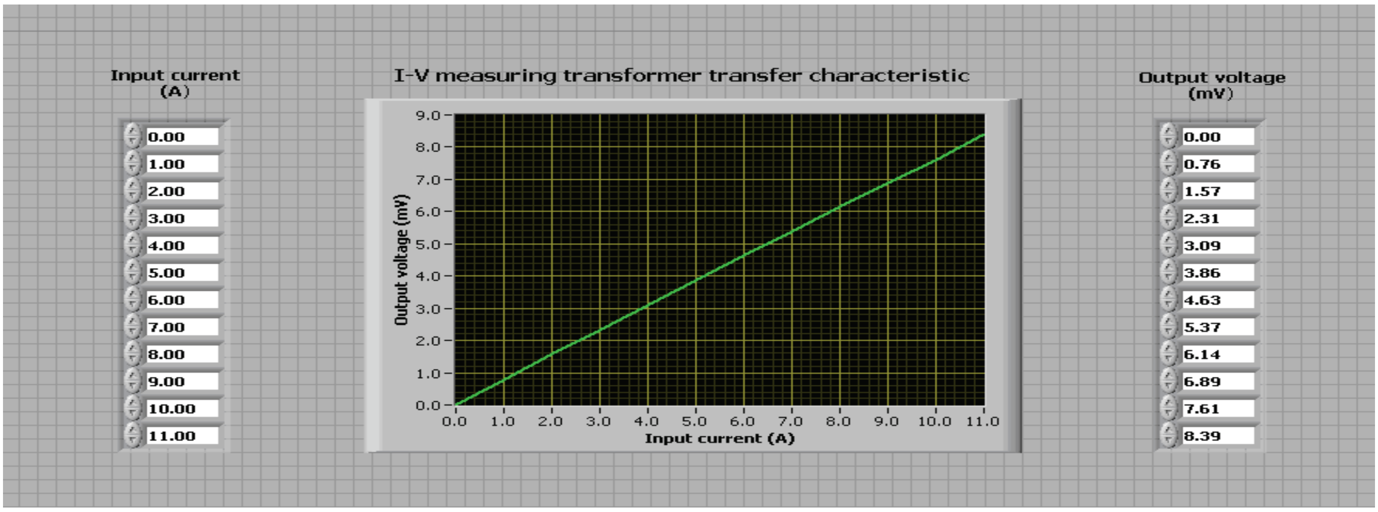

Fig. 3. Input and output transfer characteristic of the current measuring transformer recorded in LabVIEW environment

presentation of obtained measurement results. Functionality of developed virtual instruments can be easily changed by simple corections of the software algoritm sequence which controls execution of entire measurement and acquisition process [6].

Software application designed using virtual instrumentation programming package LabVIEW, which performs automated recording and graphical presentation of measuring transformer transfer characteristic, is presented by virtual instrument front panel on the Fig 3. Illustrated transfer characteristic function indicates dependence of the RMS voltage values measured on transformer outputs from variations of the RMS input current values. Besides function diagram of the recorded current and voltage transfer characteristic, on presented virtual instrument front panel are indicated measurement results regarding to the RMS values of the measuring transformer input current and output voltage. These illustrated measured current and voltage parameters are obtained from twelve successively performed measurement cycles, which are corresponding to variations of transformer input current values within a range from 0 to 11A.

Front panel of the LabVIEW based virtual measurement instrument, which simultaneously performs presentation of the recorded waveforms and measurement of the basic parameters for input and output measuring transformer signal waveforms, is illustrated on the Fig 4. Besides graphical presentation of voltage signal waveforms recorded at measuring transformer inputs, on presented virtual instrument front panel are shown measurement results regarding to the RMS values and phases of the voltage waveform from measuring transformer outputs. In this specific case from totally one hundred measured values for each of the transformer signal parameters, obtained during measurement procedure, in order to provide better visibility options on the presented virtual instrument are indicated only sixteen repeatedly measured values of the signal parameters.

Besides indicated measured values of output voltage basic parameters, virtual instrument previously shown on the Fig 4. indicates some additional information regarding to the precise date and time for recording of signal waveforms and measured RMS and phase values of the output voltage waveforms. Also,

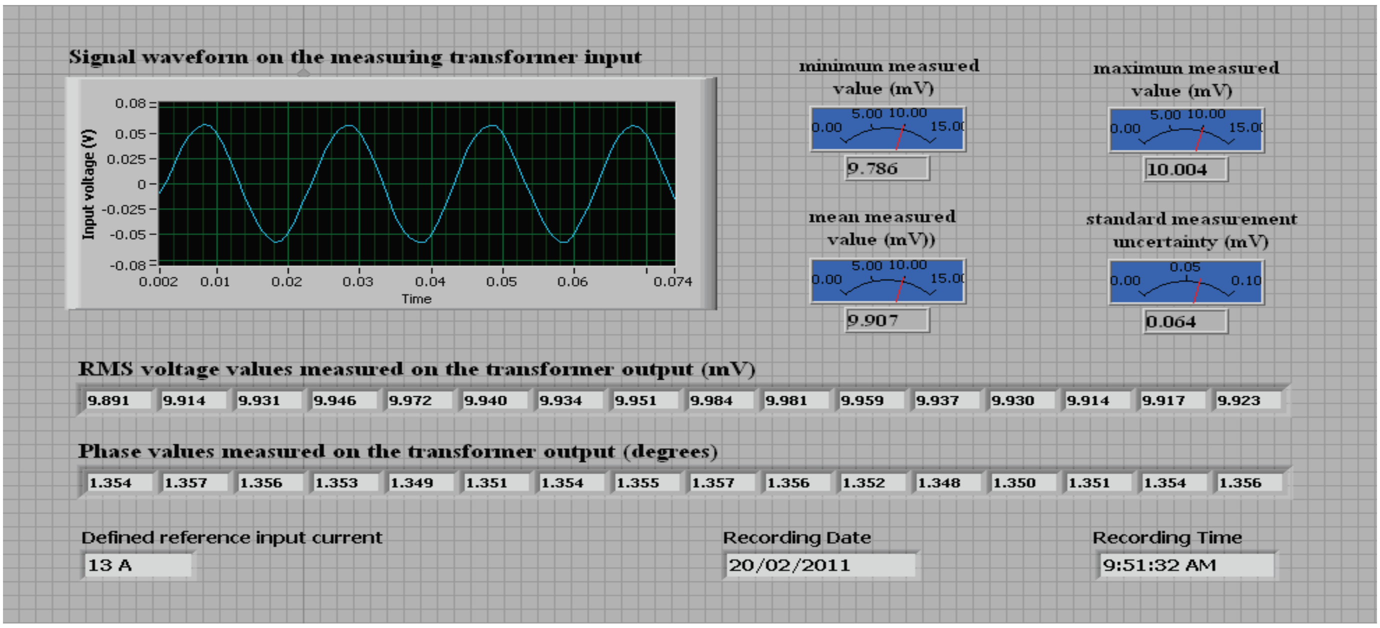

Fig. 4. LabVIEW virtual instrument developed for measurement and software processing of the measured signal parameters

here need to be mentioned that presented signal waveform and measurement results of basic voltage parameters are recorded for the case of previously defined RMS value of the reference measuring transformer input current of 13A. This predefined specific value of reference input current can be easily changed according to actual user requirements and demands, by means of the previously described reference system consisting of the regulation AC voltage source and power current transformer.

Control application of the virtual instrumentation software performs measurement, presentation, recording and statistical processing of the obtained measurement values. Some results concerning statistical processing of the measured RMS output transformer voltage values are presented by virtual instrument from Fig 4. Statistical processing of the measurement results generally gives possibilities for recordings and presentation of time diagrams and corresponding histograms of the measured signal parameter values. A large number of the measurement results from successively performed measurement procedures demands additional information about mean measured values and standard measurement uncertainties, that can be estimated by statistical procedures applied to the obtained measurement results. According to these mentioned demands, front panel of the virtual instrument given on the Fig 4. performs calculation and indication of the minimum and maximum measured RMS transformer output voltage values, obtained during previously described measurement procedure. Besides that, this software analysis of the measurement results involves calculations and indication of mean measured output voltage values, including calculations of the standard measurement uncertainty values.

Calculation of the standard measurement uncertainty values is performed according to recommendations of the document: Guide to the Expression of Uncertainty in Measurement [7], prescribed by International Standard Organization, ISO. Mean value of the measured output voltage parameters is calculated as arithmetic mean value of the obtained measurement results. Standard measurement uncertainty value is estimated from the statistical based procedures applied to the measurement results software analysis. Specifically measurement uncertainty value corresponds to the standard deviation of the measured values.

Finally, need to be mentioned that laboratory measurement results presented in this paper are only part of the beginning segment in development of the measurement and acquisition system for described purposes. Next segment of this process will be focused on upgrade and improvement of the described measurement procedure. Special attention will be oriented on measurement and software processing of measurement results regarding to the phase and high-order harmonic components.

IV. Conclusion

Solution of the measurement system developed for testing of the current measuring transformer basic characteristics and parameters, based on virtual instrumentation software package LabVIEW, is described in this paper. Hardware configuration of the presented experimental measurement and acquisition system includes regulation source of the AC voltage signals, power transformer in this specific case applied as generator of reference current input signals, data acquisition card NI USB 6008 and computer configuration with application software. Control programming application developed using LabVIEW software package monitors measurement procedure execution and performs recording, graphical presentation and statistical processing of the measurement results regarding to measuring transformer basic signal parameters. This statistical processing of the measured values includes recording and presentation of input and output transformer transfer characteristics, detection and indication of the minimum and maximum values obtained from measurement process, calculation of the mean measured parameter values and correspondent measurement uncertainty values, according to the valid documents for calculations and presentation of the uncertainty in measurements. By means of presented solution based on computer and cost-effective data acquisition hardware components, can be provided significant level of the software supported automation in the procedures for verification of current measuring transformer parameters.

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