

Design of Two-channel Oscilloscope in LabView

Rosen Miletiev¹, Plamen Balzhiev²

Abstract - The paper represents the design and experimental results of two – channel oscilloscope in LabView environment. The designed oscilloscope is a part of the virtual laboratory measurements tools, which may be used locally or remotely to display the analog or digital waveforms with a high accuracy in the real – time situations.

Keywords – oscilloscope, LabView

I. INTRODUCTION

National Instruments LabVIEW graphical development is wide used programming environment and has revolutionized the development of scalable test, measurement, and control applications [1-4]. The LabView environment allows designing rapidly and cost-effectively interfaces with measurement and control hardware, analyze data, share results, and distribute systems. Also laboratory based on LabVIEW makes researchers more productive and improves the way students learn. The main aim of the current paper is to develop a useful measurement tool which presents the analog or digital waveforms in time domain. It is designed as a helpful instrument predominantly for laboratory measurements and provides the needed knowledge concerning the measurement process or as a remotely based measurement tool. The computer-based approach combined with clearly presented graphics and animations of the measured electrical signals makes the measurement process more interesting, comprehensive and easier to understand.

For designing such an instrument the National Instruments' programming environment LabView is used. It is preferred to the other simulation software because of its simplicity flexibility and also availability. LabView is based on graphical programming language and has powerful mathematical functions for analysis and simulations. It is also specialized in the measurement and control and it supports a wide variety of hardware [5-6].

¹ Rossen Miletiev is with Technical University of Sofia, Bulgaria, Faculty of Telecommunications, 8 Kliment Ohridski Str., Sofia 1000, e-mail: miletiev@tu-sofia.bg

²Plamen Balzhiev is with Technical University of Sofia, Bulgaria, Faculty of Telecommunications, 8 Kliment Ohridski Str., Sofia 1000, e-mail: balzhiev@abv.bg

II. TWO-CHANNEL OSCILLOSCOPE DESIGN

The two-channel digital oscilloscope designed in LabView environment is a data acquisition system (DAQ) which uses hardware measurement devices connected to a personal computer. To communicate with the acquisition module the NI-DAQmx drivers are used. They provide increased productivity and performance in measurement and simplicity for implementation in the virtual instrument. This drivers support the whole family of DAQ devices provided by National Instruments. [7]

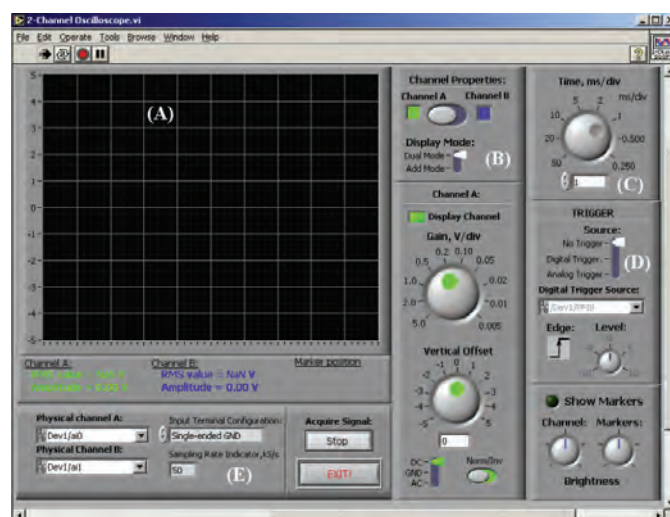


Fig.1. Oscilloscope front panel

The user part of this tool is the front panel (Fig.1). It is employed as a measurement instrument in laboratory classes. Therefore it should be easy to operate with and should have the basic functions of a conventional oscilloscope. First of all it consists of graphic screen (A) to observe and measure the input signals. Then, there are physical channels settings (E) to configure the channels for acquiring the signals and the type of input. The gain settings and vertical offset are placed in section (B). The time adjusting for the horizontal scale and triggering parameters are presented in (C) and (D) respectively.

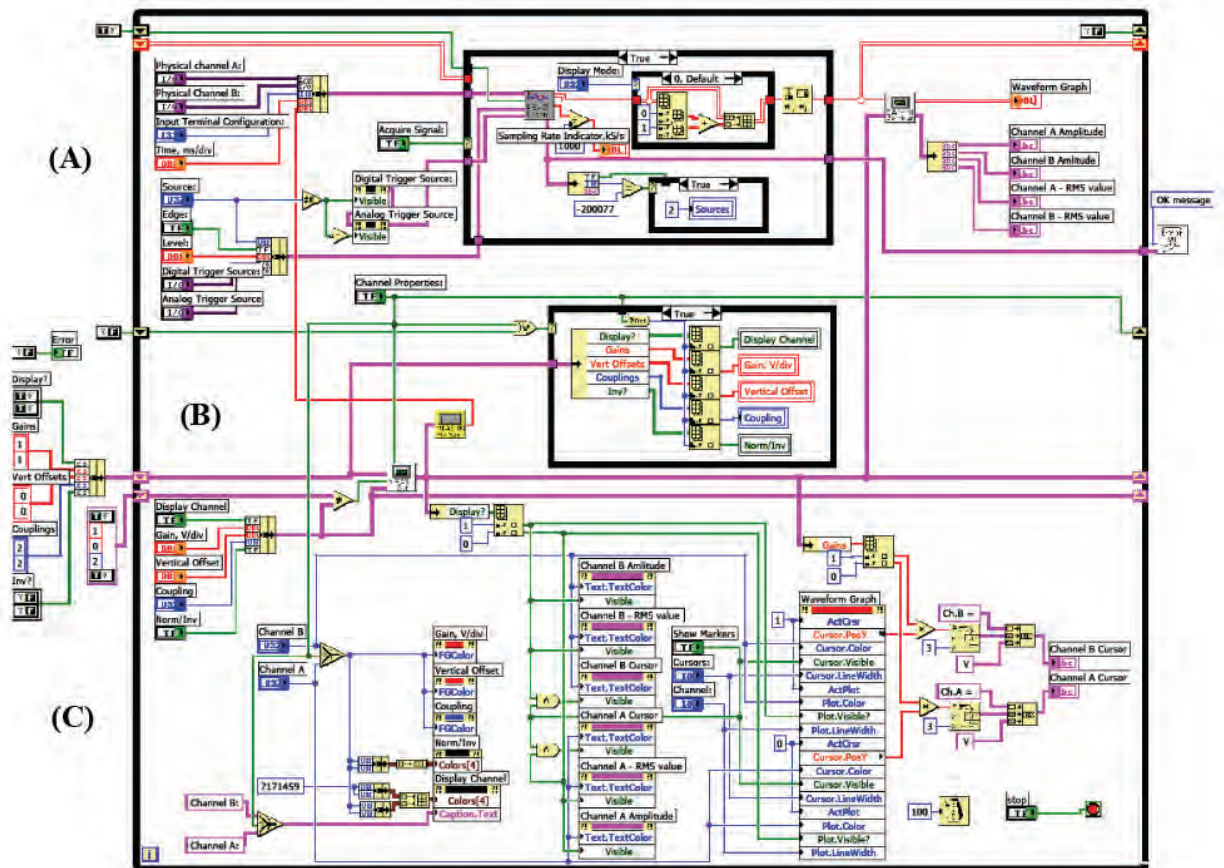


Fig.2 The block diagram of the two-channel oscilloscope



Fig.3. Control panel sections

Signal measurements, data analysis and visualization of the chart are realized in the block diagram (Fig.2). Part (A) from the diagram performs the data acquisition and sets the gain values and vertical offset. It handles the physical channels, sampling rate and triggering settings (Fig.3). After the data is acquired the gain settings are applied to the channels. Finally, it is visualized on the front panel graphic chart. Part (B) handles the settings from the front panel. If any change from the initial state is detected the new parameters are memorized and applied to the measurement process. Part (C) handles the graphic settings – signals and cursors visualization and front panel controls – colors, visibility and values [1].

The block that performs the measurement of the signals is shown on Fig.4. The input parameters of the block are the physical channels address, input type, sampling rate, the triggering settings and time scale parameters.

Data acquisition process consists of the following steps: (A) Reset the measurement device – to clear all the channels and hardware parameters; (B) Set the desired physical channels as inputs and choose the type of the channel – differential or single ended (referenced to the ground); (C) Give the sampling rate of the measurement process; (D) Put the triggering type and parameters – triggering channel, levels and position; (E) Start acquiring the signals from the two channels; (F) Stop the acquisition and release the physical channels.

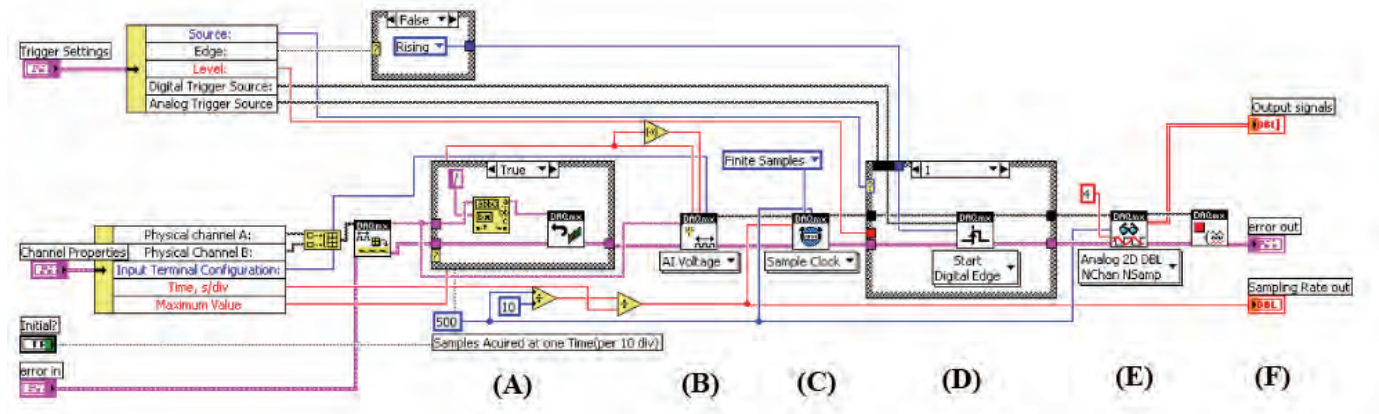


Fig.4. The signal acquisition block diagram

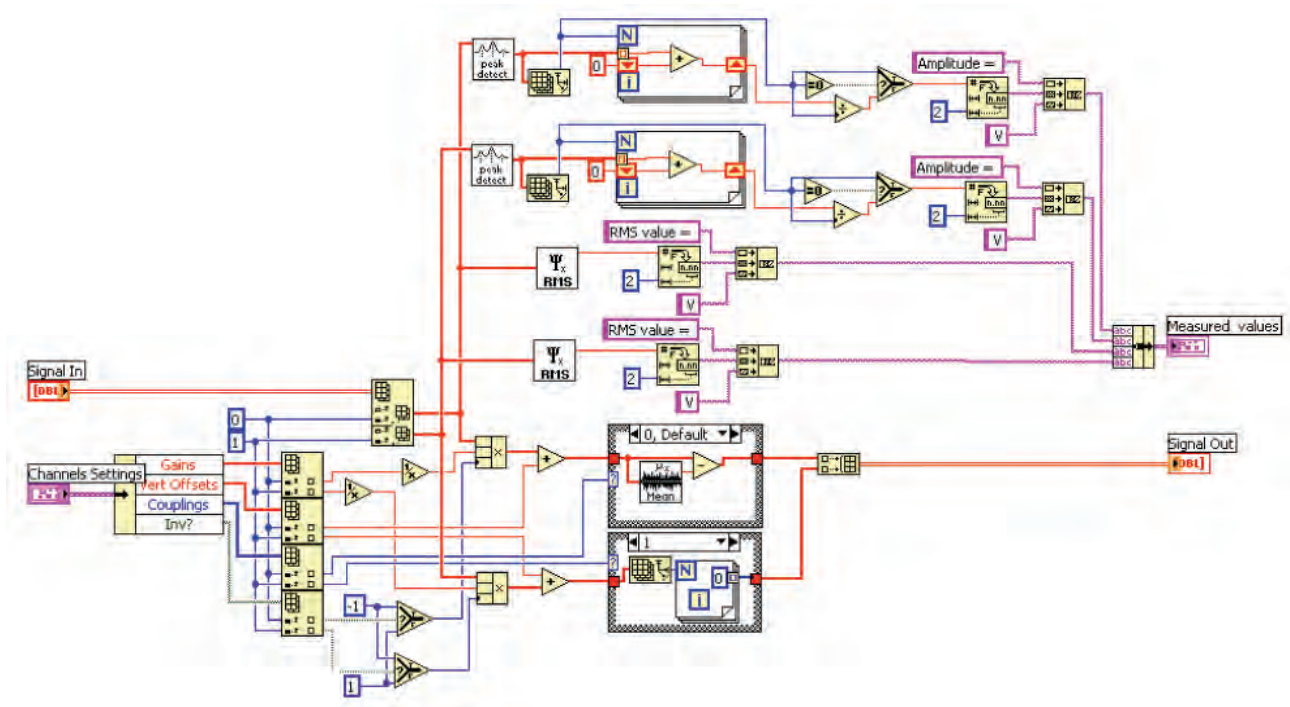


Fig.5. Signal processing block

The acquisition process is realized with *for* loop and different case structures. The other blocks of this diagram are build-in functions for communication with the hardware device. The *case* structure which includes steps from (A) to (D) is executed only in the beginning of the measurement procedure. Thus the data acquisition device is reset for the new measurement. With other *case* structure in step (F) is executed when the measurements are finished and the oscilloscope is closed or the acquisition is stopped from the front panel. The result of this block diagram is an array of 500 samples which are furthermore processed before they are visualized on the front panel screen. If an error occurs it is handled with the appropriate error structure.

The measurement process contains in the following steps:

1. Restart (RESET) of the DAQ module to initialize the virtual instrument. This process clears the previous instrument settings
2. Selection of the physical channel and its measurement parameters – X, Y and time resolution, trigger settings, etc.
3. Time parameter and strobe frequency selection. Since the front panel display size is set to 500 points, the strobe frequency is calculated according to the following equation:

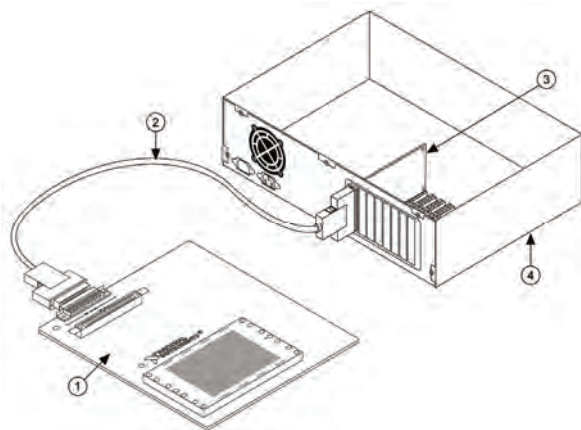
$$f_s = \frac{n, [S / div]}{Ts, [s / div]}, [S / s]$$

where n – discrete number per one division
 Ts – time resolution
4. Start of the measurement process

The received measurement data is fed to the next processing block (Fig.5), which set the selected settings to the front panel. The block output is recognized as vector data, which are sent to the display.

III. OSCILLOSCOPE MEASUREMENT RESULTS

The designed two – channel oscilloscope is tested using the following hardware and software basis (Fig.6):



1. Terminal board –SC-2075 type;
2. Data cable - SH68-68-EP;
3. DAQ module –PCI-6024E type;
4. PC based computer with installed LABVIEW software

Fig.6. Oscilloscope design

The implemented measurement of a sinusoidal and square waveform from the hardware acquisition device is shown at Fig.7. The proper gain, time and triggering settings are adjusted. The values of amplitude, period and phase offset can be read out with the help of vertical and horizontal scales. For the sake of convenience amplitude and RMS values are calculated and presented at the bottom of the graphic for both channels. The operator could use the vertical cursor lines to measure other parts of the displayed characteristic.

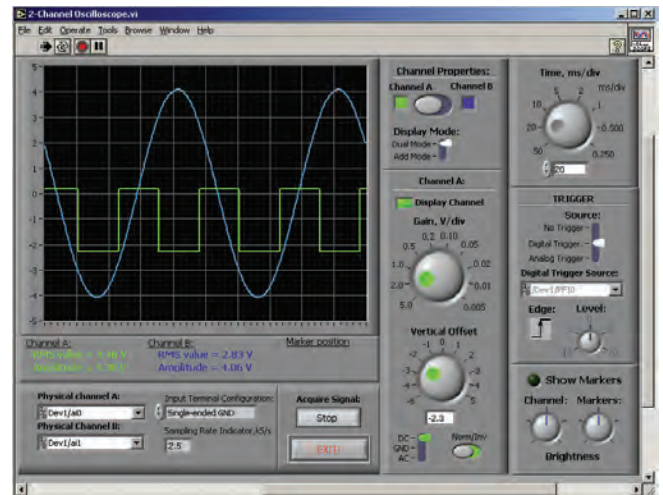


Fig.7. Two-channel signal measurement

IV. CONCLUSION

The two-channel oscilloscope designed in LabView is easy to use and flexible for future developments. The oscilloscope is the basic tool for circuit analysis and metrology too. The virtual instruments designed with LabView are very flexible and provide good opportunities for future developments and optimization. One instrument already realized could easily be modified or other useful functions and attributes could be added. In this project the instrument can be further developed in several aspects – introduction of additional data analysis or adding other functions. Calculations of RMS, peak-to-peak or average values, period or frequency are some of the opportunities for instrument improvements. Also spectrum analysis could easily be applied.

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