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Virtual instrument designed for data acquisition

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Current software development directions open up a world of possibilities, especially in the engineering field. Present paper is meant to highlight the advantages and in particular the ease of using virtual instrumentation facilities, with a proper and adequate design and implementation of desired instrument. In this idea we bring into discussion a design for virtual instrument which can be used for data acquisition that can be stored for further simulations according to the needs required by the process in discussion.

Keywords: *virtual, instrument, signal, acquisition*

1. Virtual instrument-architecture and functions.

The concept of Virtual Instrumentation was introduced about thirty years ago out of a desire to use the electronic computer for building a measuring instrument. Nowadays, virtual instrumentation is mainly used for complex applications, where simultaneous measurements at thousands of control points are required, or processing of a large amount of measurement information and access to remote information is imposed.

Development of digital instruments equipped with communication interfaces makes it possible to control real measuring instruments not only manually, but also by means of the computer. Various combinations of numerical, programmable, stand-alone, computer-controlled tools with different built-in tools can be used by using additional data acquisition cards and appropriate software [1, 4].

In order to communicate with the process subjected to parametric measurements, computer must be equipped with an additional hardware interface device which plays the role of converting input analog signal into output numerical signal on a certain number of bits, based on the analog-to-digital conversion [8, 12].

So, the hardware virtual instrument interface should include an analog to digital converter. In addition, the interface can contain multiplexers, amplifiers and sampling-data storage circuits [6].

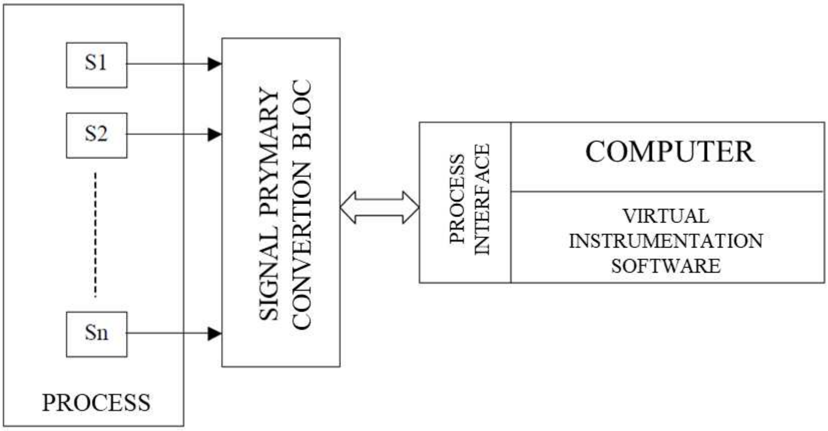


Figure 1. Basic structure of a virtual instrument

The data word transmission to the computer can be done either directly through the computer's bus, usually using DMA protocol, either through other serial and parallel communication interfaces. There is a wide range of devices on the market specialized in converting analog measurement quantities into digital signals such as: data acquisition cards, digitizers, built-in multi-meters, individual modules for distributed measurements, PXI type modules, etc. [5]. All are built with a greater or lesser autonomy in relation to computer, but all have common feature of converting analog signals from the real process, in particular those received from primary signal processing block, into digital signals, with the best possible accuracy [10].

Using digitized signals, the virtual instrumentation program controls and supervises the acquisition, processing, storage, display and remote transmission of measurement information, the software for making virtual instruments usually opting for graphical programming, easy to use. One of the basic functions that can be developed in the structure of a virtual instrument is automatic acquisition of signals obtained from sensors which carry electrical and non-electrical measuring quantities in a process, according to structure and configuration of an application [3, 7, 9].

2. Designing data acquisition virtual instrument

As earlier mentioned, a virtual instrument is the generic name used for simulating behavior of a measurement instrument or an automation, by means of a dedicated software and specific hardware interface which contains signal processing modules and data acquisition boards. For designing and testing a data acquisition virtual instrument we used a well-known simulation software, LabView. As source signal we also used LabView facilities, generating a sinusoidal waveform by means of *Simulate Signal Sine* option. Measured data are recorded and saved on computer in specific files with *.lvm extension, thus data are available for further analysis. This tool is able to display in real time information about generated signal by the indicators, and in addition, it can simultaneously record signal data.

Figure 2 shows bloc diagram of virtual instrument used for data acquisition. the Simulate Signal Sine function is used to generate the sinusoidal signal. The simulated signal is transmitted to *Write to Measurement File* tool which, when running the program, will generate and save files to hard disk containing data measurements.

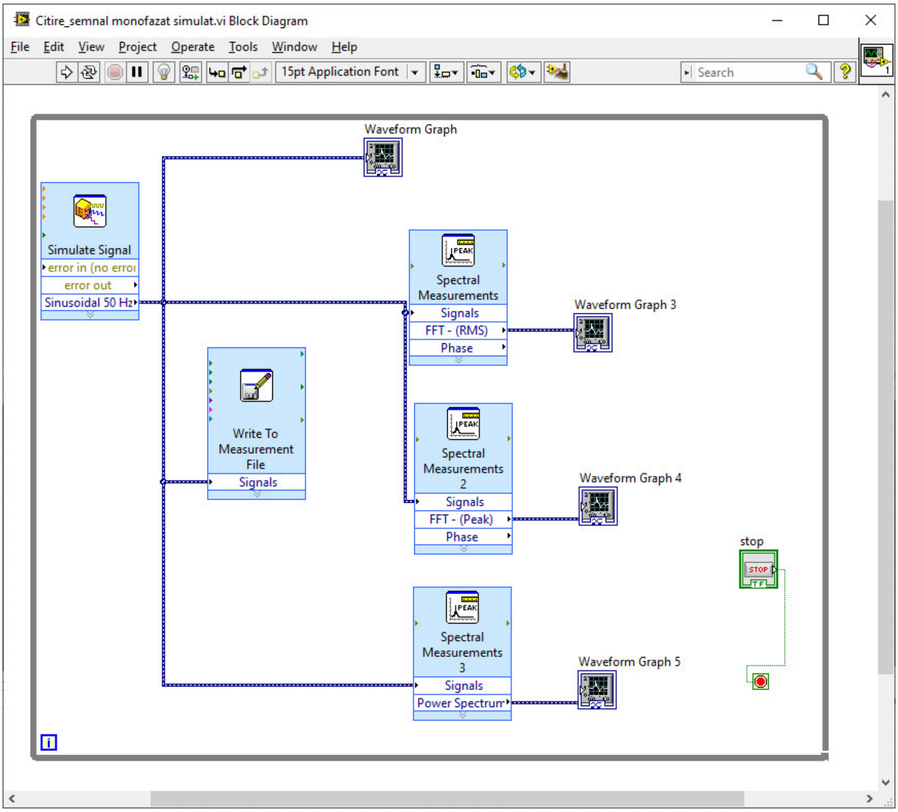


Figure 2. Bloc diagram of virtual instrument

File type, number of columns per channel, delimitation between columns, disk save path, and other characteristics of the files that will be generated and saved are defined in the *Write to Measurement File* tool window by selecting these parameters, as it can be seen in figure 3.

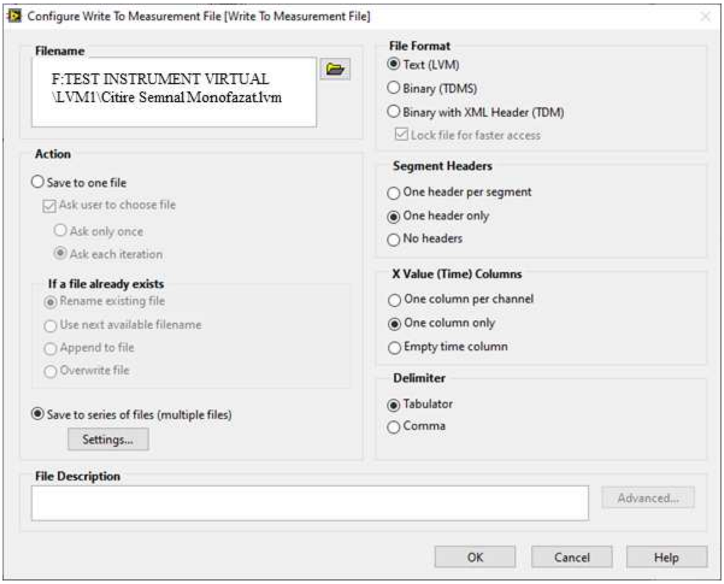


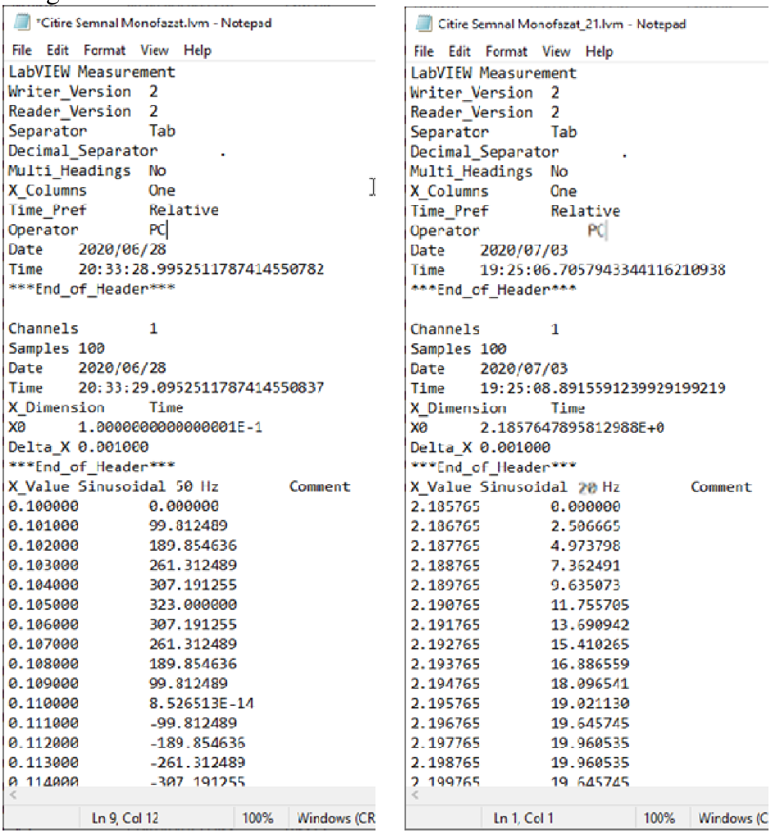
Figure 3. Parametric setup for generating data measurement files

The sinusoidal voltage signal is applied simultaneously to the Spectral Measurements instruments, which calculate and display in frequency range the average value (RMS), peak-to-peak value (Peak) and power spectrum of the simulated signal. These three values are displayed with the WaveForm Graph indicators 3, 4 and 5.

3. Simulating virtual instrument functioning and displaying results

After building up virtual instrument for data acquisition and setting up proper parametric values, front panel of the instrument will be used for simulation [11]. We have chosen two signals configured in *Simulate Signal* window: signal 1 with amplitude of 325, frequency of 50Hz and a phase Φ of 0˚ and signal 2 with amplitude of 20, frequency of 20Hz and a phase Φ of 0˚.
The program is executed by pushing START button. While the program is running, * .lvm files containing discrete values of time on the X axis and discrete values of amplitude on the Y axis will be saved on the hard disk. The values are delimited

with tab and the files have been set not to exceed 3Kb [2]. Obtained results are presented in figure 4.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LabVIEW Measurement
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Reader_Version  2
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Decimal_Separator       .
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X_Columns       One
Time_Pref       Relative
Operator        PC
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Date    2020/06/28
Time    20:33:29.0952511787414550837
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***End_of_Header***
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0.102000        189.854636
0.103000        261.312489
0.104000        307.191255
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0.106000        307.191255
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2.192765        15.410265
2.193765        16.886559
2.194765        18.096541
2.195765        19.021130
2.196765        19.645745
2.197765        19.960535
2.198765        19.960535
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Figure 4. Generated files content for defined signals

Measured data saved in files can be further processed. By using control buttons we can vary the values of frequency, amplitude and phase for each signal, thus changing the peak values, averages and power spectrum of the sinusoidal signal. Using WaveForm Graph 3, 4 and 5 we can display RMS, PEAK and Power Spectrum and the waveform of the input sinusoidal signal. Results for simulated signals are depicted in figure 5 and 6.

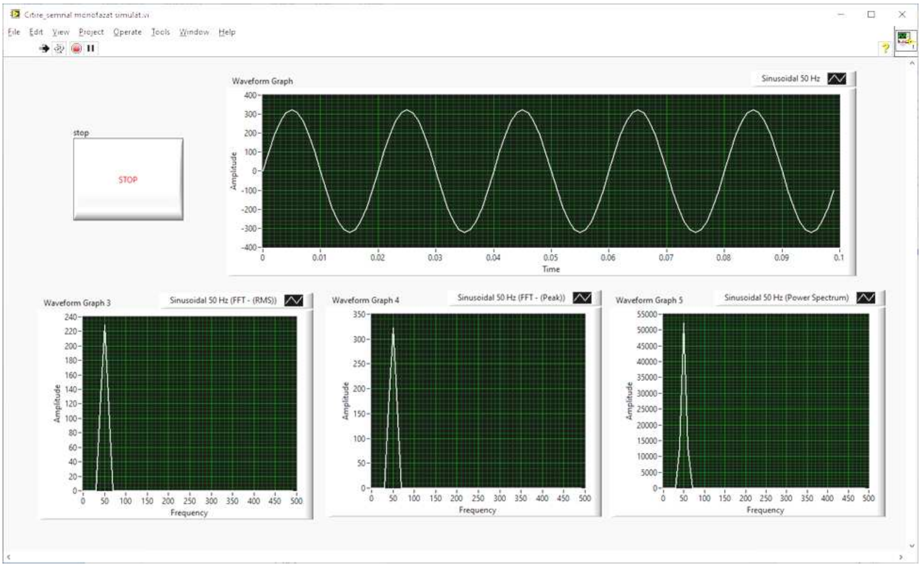

Figure 5. Simulation results for 50Hz frequency and 325 amplitude signal

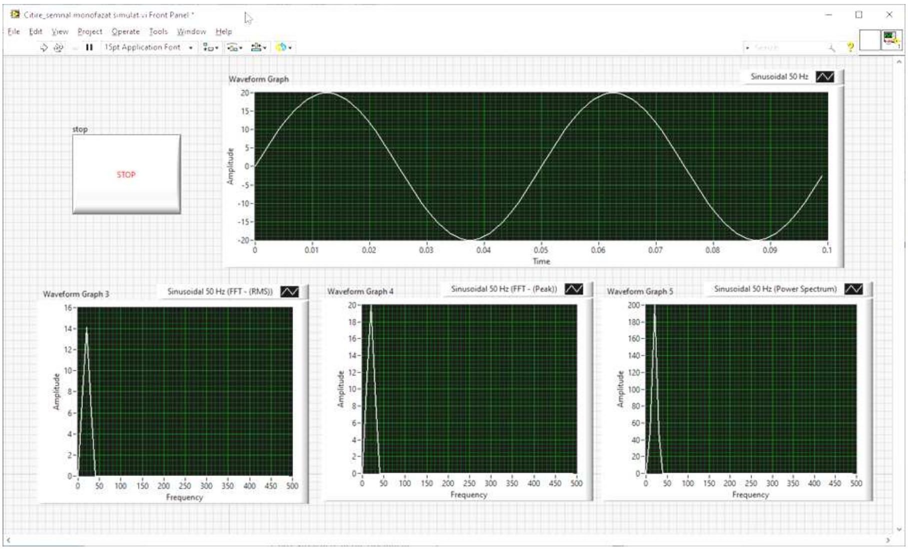

Figure 6. Simulation results for 20Hz frequency and 20 amplitude signal

4. Conclusion

Virtual instrument described in present paper is a basic tool designed for data acquisition. Due to a variety of advantages offered by virtual instrumentation, as expandability, high precision, flexibility, and the tools involved in this area we can can extend designed instrument according to different applications wich require data acquisition. For this case we generated data by means of virtual instrument but, with proper equipment, data can be saved in situ. However, latter solution has its disadvanages implying costs and frequency band limitations due to analog to digital conversion technology.

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