Remote Measurements in Educational Laboratories Using LabVIEW and DAQ Cards

Ion Bogdan Cioc, Stefan Oprea, Daniel Alexandru Visan, Ioan Lita[1)], and Adrian Ioan Lita[2)]

[1)] Electronics, Computers and Electrical Engineering Department, University of Pitesti, Romania
[2)] Faculty of Electronics, Telecommunication and Information Technology, Politehnica University of Bucharest, Romania
ioan.lita@upit.ro

***Abstract**: This paper presents an application used in educational laboratory for multiple waveform measurement and display, for analysing of the operation of electronically circuits. It was implemented as virtual instrument in LabVIEW and uses a data acquisition card for electrical signals acquisition. The application can be used in educational laboratory for multiple signals measurement, record and time correlated displaying to help students to better understand the operation of the complex electronic circuits. Using the facilities offered by LabVIEW, this application was implemented to be accessed remotely for online measurement.*

1. INTRODUCTION

For complex electronic circuits with mixed analogue and digital signals, signal correlation and visualization is essential for understanding of the circuit operation. If in case of digital domain there are multiple logical analysers with many digital channels, in case of analogical signals or mixed analogical and digital signals there are not many measurement apparatus for visualization of multiple signals (over 8 or 16). The most used apparatus for analogue signal measurement and visualization in laboratories are oscilloscopes, which has usually 2 or 4 analogue channels.

Oscilloscopes with more than four channels are usually very expensive. A simple solution for these particular situations is to acquire and measure simultaneously all the signals of interest, analogue or digital, using multichannel data acquisition cards, and then they can be graphically represented and correlated in time [1], [2]. Using data acquisition with multiple analogue inputs is suitable for laboratory measurements of electrical and electronic circuits with signals having a not very high variation speed or frequency. For high speed circuits, high speed data acquisition modules can be used.

This approach for implementation of laboratory measurements has the advantage of low cost solution and flexibility, and the possibility for remote access and control over a local network or internet.

2. MULTIPLE SIGNAL MEASUREMENT USING DATA ACQUISITION SYSTEMS

For laboratory measurements, in case of many subjects, to demonstrate the working principle of an electronic circuits, system, or electronic devices and sensors characterization, many measurements need to be performed in order to understand and analyze the circuit operation. For these measurements, different electronic apparatus can be used, like voltmeters, ampere-meters, frequency meters, oscilloscopes, spectrum analyzers, etc.

Measuring and correlating multiple signals using standard oscilloscopes with two input channels is relatively difficult to perform, so in this case, another measurement technique can be more suitable, like multiple channels data acquisition systems.

A typical data acquisition system consists in a data acquisition and conversion hardware, computer and application software. Data acquisition hardware can be implemented as data acquisition cards/modules interconnected with computer using standard internal or external interfaces for data transfer. These data acquisition modules are implemented as multifunctional data acquisition modules/cards (DAQ)

with many types of electrical inputs and outputs (voltage/current analogue inputs and outputs, digital inputs and outputs, counter/timer inputs) or as specialized acquisition modules that can accept signal types specific to different applications (audio/video acquisition modules, specific sensor types inputs, high speed analogue signal digitizers, high speed digital signal analyzers, etc.) [3], [4].

A typical multifunctional DAQ module has the internal block diagram as in figure 1 [5].

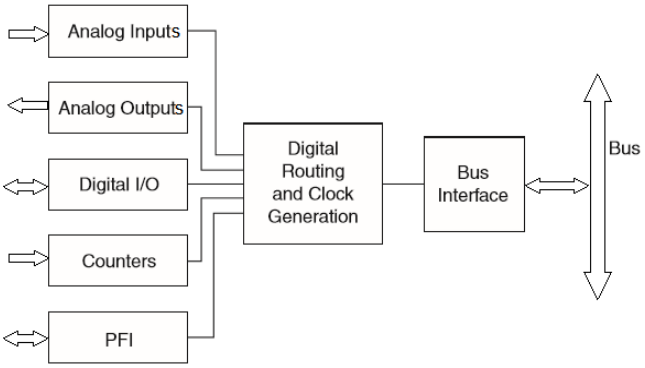

Fig. 1. Typical multifunctional DAQ module.

The measurement and testing system implemented with data acquisition systems take the advantages of using computers, like data storage, complex graphically representation, printing facilities, communication facilities on network or internet, remote measurement and control possibility.

The performance of the measuring system depends on the DAQ module performances, like sampling frequency, resolution, number of analogue inputs and outputs, and number of digital inputs/outputs. The precision of voltage measurement is usually better than analogue or digital oscilloscopes, and that is due to the 12 to 16 bits resolution of the ADC within DAQ, while high speed digital oscilloscopes use an 8 to 10 bit resolution.

3. Implementation of the Remote Measurement System for Educational Laboratories

3.1. Hardware implementation

For hardware implementation, the USB-6212 data acquisition module (DAQ) from National Instruments was used. The DAQ module connects to PC using USB 2.0 interface and it has 16 analogue channelsinputs, two analogue channels outputs and 32 digital I/O lines. The measurement setup and the operation mode is presented in fig. 2. It can be controlled locally, from the computer that runs the measurement virtual instrument or remotely using web browsers on another computer.

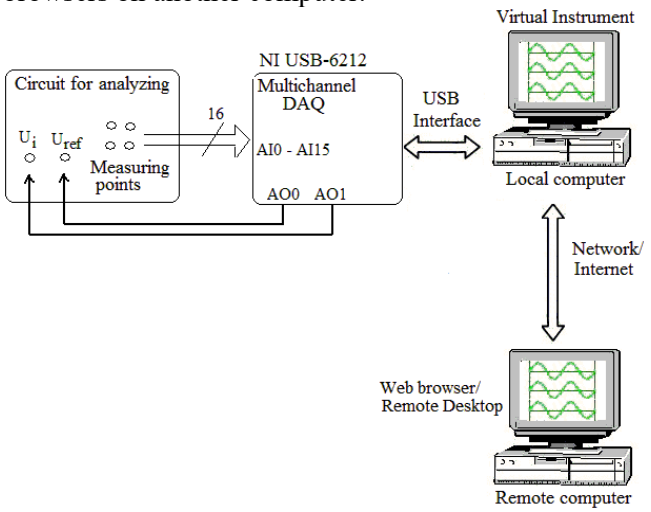

Fig. 2. Laboratory measurement using local access and remote measurement.

The application was developed for waveform measurement in case of a Staircase Digital Voltmeter circuit. This staircase digital voltmeter uses a feedback analog-to-digital conversion principle, which is presented in figure 3. The specific waveform at the main blocks output are measured and their variation in time are graphically represented, for different input voltages values. To remotely measure the waveforms for different voltages applied at the input of the voltmeter, an analogue output channel from DAQ card was used.

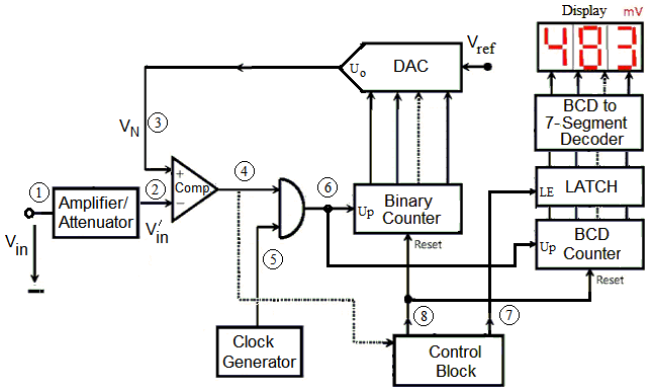

Fig. 3. Staircase digital voltmeter block diagram.

3.2. Software implementation

The application for remote measurement of multiple signals within an electronic circuit was

implemented in LabVIEW, and can measures and record up to 16 analogue signals and represents them on time correlated axes. The code in LabVIEW is presented in figure 4.

Using as data acquisition hardware the USB-6212 module, with 16bits resolution and 400Ksamples/s ADC maximum conversion rate, results a measurement accuracy of about 320uV over -10V to +10V input range, and a 25Ksample/s per channel if 16 analogue channels are used [5].

If faster signals must be acquired, this can be done by reducing the scanned analogue inputs (for example 8 inputs will results in doubling the sampling rate on each channel, at 50Ksamples/s), or replacing the acquisition module with a faster one. For example, if USB-6251 will be used (1Msamples/s, 16bits resolution), then the sampling rate on each of the 16 analogue channels will be increased at 62.5Ksamples/s, at the same accuracy.

The application can be controlled locally, from the computer that runs the measurement virtual instrument or remotely using web browsers on another computer.

The remote operation uses the built in web server and Remote desktop connection facility available in LabVIEW. Figure 5 presents the measurement and control on local computer, while the remote measurement and control mode is showed in figure 6.

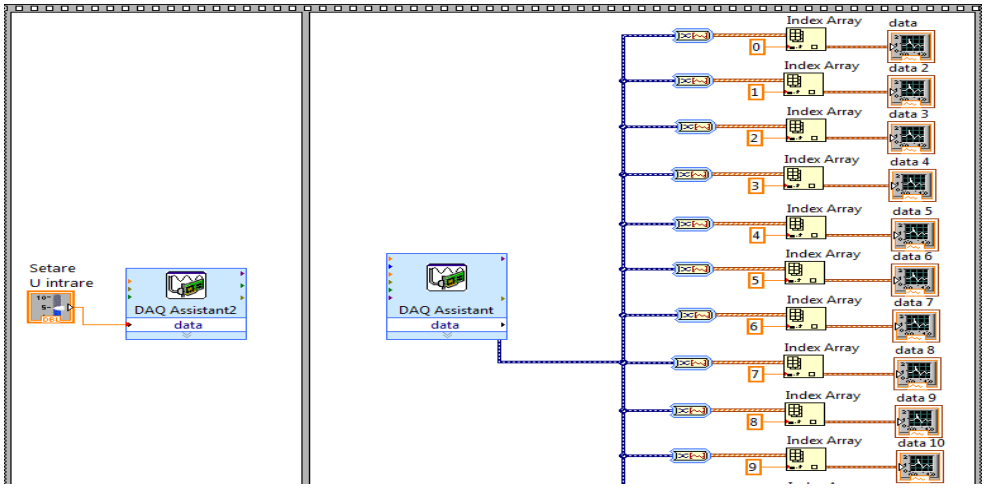

Fig. 4. LabVIEW code for waveform measuring of staircase digital voltmeter using NI-USB6212

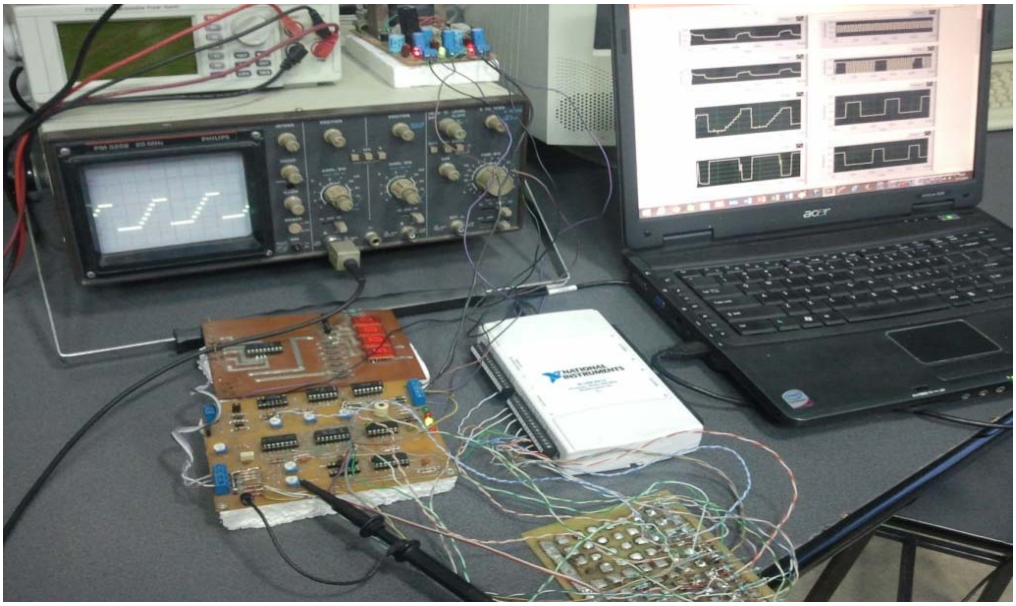

Fig. 5. Measuring waveforms in case of staircase digital voltmeter circuit and LabVIEW application.

Fig. 6. Remote control of the application in web browser using Remote Desktop Connection in LabVIEW

Another possibility for utilisation of remote measurements can be done by using remote connection technique to the computer running the measuring application. This can be done through a remote connection that gives the completely control of the locally computer, and then of the application.

The remotely control of a computer is achieved by setting up a secured Remote Desktop Connection in Windows or using different software for remotely access and control of the locally computer. Using this type of access, the remote users can totally control the computer and the application. They can even remotely modify the measuring application, like changing the acquisition parameters, or adding new functionalities to the applications.

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