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Currents and voltages measurements using aquisition board DAQ 6024 E

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Abstract - The program who is the subject of this paper develops many possibilities in order to facilitate reading and analysing electrical quantities (voltage, current) for analogy and digital signals. Using acquisition boards for analogical or digital data from various tranducers, signals can be analysed or conditioning and measurements instruments can be created or simulated (virtual instrumentation).

Keywords: acquisition board, rezistive inductive load, one phase rectifier

I. INTRODUCTION

In order to increase the work's productivity, data acquisition and data analyse system are used in automation's systems. One of them is LabVIEW System [1-5].

In the following lines we will present some of its possibilities and performances. We will especially describe data acquisition using DAQ 6024 E acquisition board.

LabVIEW represents a graphical alternative to the conventional programming design for instrumentation It is equipped with all necessary tools for testing the measurement systems. LabVIEW is a graphical developed environment designed in order to create flexible and scalable test, to measure and to control more rapidly the applications, at a minimal price. The fastness of this program is high, due to the introduction of an intuitive graphical interface.

LAbVIEW uses a generally graphical language for programming called „G", containing wide libraries with proper functions. The LabVIEW programs are called virtual instruments and are made from two parts, distributed in two windows:

-the front panel (containing the necessary elements for interactive operations and the display of the results)

the block diagram (actually the source code this one contains the corresponding instructions, constants, functions and pointers from front panel). Flowing data is determined in block diagram using links represented by lines between icons [3].

The hardware-software system used contains the following components and programmes:

- Toshiba Laptop
- Windows XP
- LabVIEW 6i, Measurement & Automation

DAQ Card - 6024E (National Instruments) for PCMCIA adapters.

II. THEORETICAL CONSIDERATIONS

In order to do the aquisitions we will use the next theoretical considerations. The resistive voltage divider is made with coiled resistors and it could reach a high level precision ($10^{-5}...10^{-6}$) or it is realized with metal resistors and it has a low precision ($10^{-2}...10^{-3}$), but good enough for analogical and digital instrumentation. The divider is used for D.C. or low frequency voltage measurement.

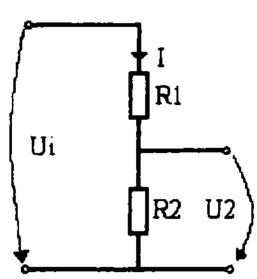

Fig 1 Voltage divider

The input, known measure is the D.C. voltage U_1 and the output measure is the D.C. voltage U_2. If the divider works no load, it will result an output voltage: -

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$$U_2 = R_2 I = U_1 \frac{R_2}{R_1 + R_2} \qquad (1)$$

and the divided factor is:

$$D = \frac{U_2}{U_1} = \frac{R_2}{R_1 + R_2} = \frac{1}{1 + \frac{R_1}{R_2}} \qquad (2)$$

The shunt is an input current-voltage convertor. It is used for currents measurements in D.C. circuits. The used D.C. shunt is made from manganină and it is included into devices in case the currents are less than 20-30A or it is external, as a separate piece, for a 1000A current.

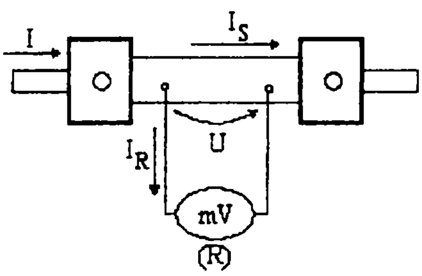

Fig. 2 The shunt

The shunt resistance R_S is defined between the voltage terminals. We can write the following equations:

$$\begin{cases} I = I_S + I_T \\ RI_S = RI_R \end{cases} \qquad (3)$$

The shunt establishes the next factor between the output measure I_R and the input one I :

$$n = \frac{I}{I_R} = \frac{R_S + R}{R_S} = 1 + \frac{R}{R_S}. \qquad (4)$$

We obtain the computed relation for the shunt resistance:

$$R_S = \frac{R}{n - 1}. \qquad (5)$$

The rectifier has a converting function for the electrical energy form A.C. into d.c. His working is depending on the load type, connected at its output. This dependence is shown in a very simple diagram, see fig.3. The diode should be an ideal one ($u_D = 0$ for working state: $i_D = 0$ for blocking state).

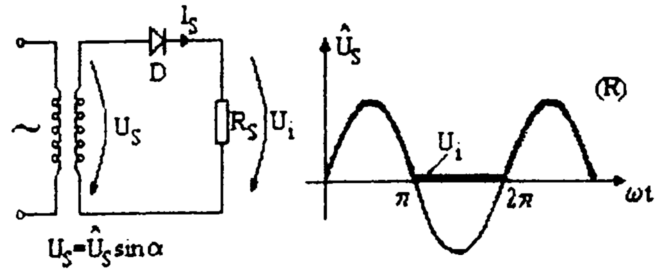

Fig 3 Electrical diagram for one phase rectifier and the output voltage for a resistive load

Sampling Theorem *(Shannon*, 1949): any signal in continuous time, with a limited spectrum, can be represented without loosing information through a sample series of the original signal, or in e w ds, th ou_h a discrete signal.

The data aquisition systems principal components are sampled circuits, the memorized ones and the analogical-numerical convertors. The numerical and analogical signals caused by processing can be used to memorize and give back the information or to command the execution (m , l), which control he physical processes.

To operate with discrete amplitude signals means a special attention. The result might be often a sum of quantification noises, with a statistical characterization factors and consequences.

IV. DAP APPLICATION

In "DAP" application (the programme is named Data_Aquisition_Programme) we will read, memorize and compute analogical and digital signals, particular currents and voltages, in order to analyse the behaviour of certain system in stationery or permanent mode.

The programme allow to operator to record data simultaneously, on maximum 16 analogical channels (ACH) and 8 digital channels (DIO). The aquisition board DAQ Card-6024E doesn't admit data reading synchronization if the aquisition is made simultaneously for analogical signals in ACH socket, respectively digital signals in DIO socket. Because of this reason we use both signals type, analogical and digital, in ACH socket. We are interesting in data reading synchronization for at least one digital channel.

We can use also the special DIO sockets when the object isn't the perfect synchronization between different channels. In this case, a late of approximatively 1 second might appear between signals.

The aquisition board DAQ 6024E can operate with a maximum analogical scan rate of 200000 scans/second, meaning a maximum scan rate for each channel of 200000/16 = 12500 scans/second. Considering that a scan rate of 1000 readings/second is equal with a millisecond data reading, we can affirm that the technological possibilities of this board are properly [4-5].

DAQ 6024E board allows signal aquisition between ±10Vd.c. limits. It's obviously that we need an intermediate electronic board to adapt the real acquired signals to the specified interval (±10Vd.c.), with suitable scan factors. The board admits the independently scanning for each channel.

The two application's windows are described in Fig. 4 and Fig. 5. In DAQ programme we use many specific functions:

- each channel has his own configuration;
- START/STOP for the acquisition, controlled by the user or from one digital channel command (this allows to display data with a seted number of seconds before/after 0/1 passing on that very channel) ;
- many possibilities for changing the parameters (scaling factors for each channel, delay factors on the OY axis for each channel, zoom on OX axis, the memory size used by the programme, the scan rate, the channels number for reading and displaying, the cursor for reading the exact acquisitioned values) ;
- the mean for diagrams (we use the arithmetical mean, with a setted number of points);
- the tangent is computed with the help of two selected point's coordinates, for the data to be analysed in every particular mode.

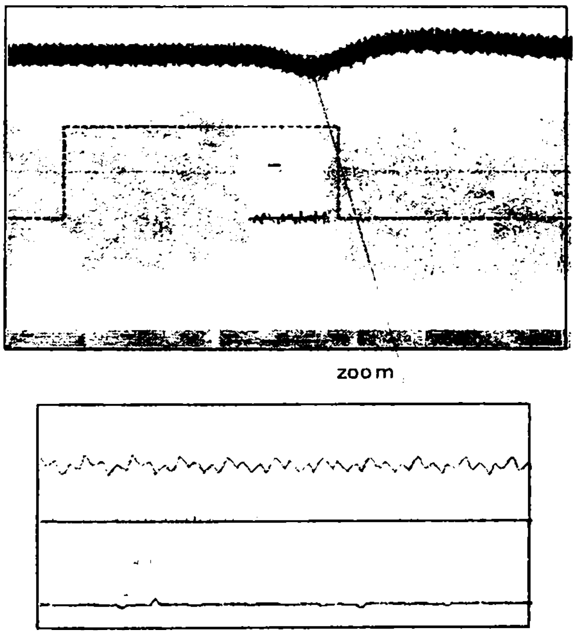

Fig 4 The Front Panel

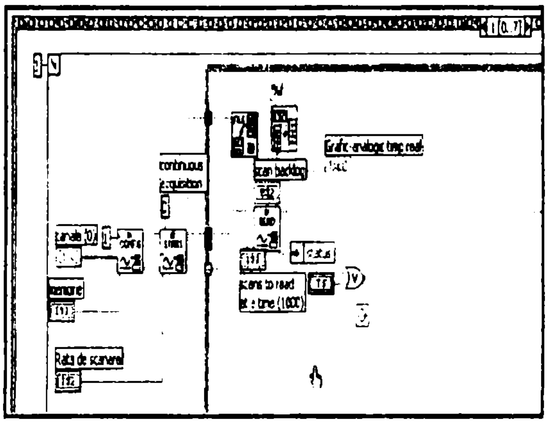

Fig 5 Bloc Diagram

Data are displayed in two different ways:

- in real time (one second constantly updated);
- historically (displaying the entire interval ordered by the user).

Data reading is made as long as the programme goes on. One digital channel can order START and/or STOP recording, having the possibility to extend and set a gap in seconds or milliseconds before START and after STOP, equal or different periods.

The advantage appear when we want to record a transitory phenomenon about whom we don't know exactly the moment it will be happen. Data reading is permanently, but data recording has a controlled start/stop, given by the operator or presetted.

This is the way to avoid a useless loading of memory or even an overcharge of hardware system.

The diagrams allow to simultaneously displaying all channels for reading or only a few of them after selection.

The utility of this programme is the possibility to use it for tracing and visualization of electrical quantities, any deviation from the normal behaviour is unliked and it must be eliminated without any delay. (Example: hydroelectric power stations, power stations – the entire national circuit of electrical and thermical energy).

The possibility of change the principal parameters, which interfere in the acquisition and in the recording, and also the filtering of the data are very important programme performances. We can print all acquired diagrams.

In Fig. 6a we choose to show an 35 seconds recording, with a 1000 readings/second scan rate, for the Excitation System supply voltage (SRAT), in case of changing it with the Backup Supply (AAR). Through a 10 data meaning we will obtain the Fig. 6b diagram.

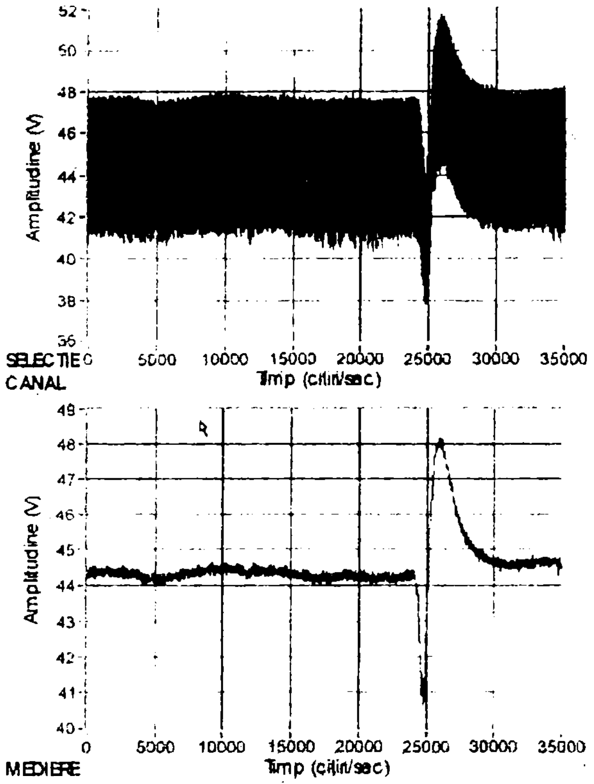

Fig. 6 a) Original Data; b) Mean Data.

Another example of aquisition is the voltage wave for the current and the voltage obtained at the output of a one phase rectifier with an inductive-resistive (RL) load.

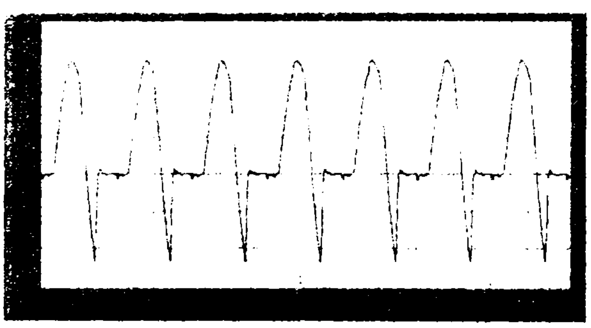

Fig 9 The dropping voltage in case of resistive-inductive load for one phase rectifier

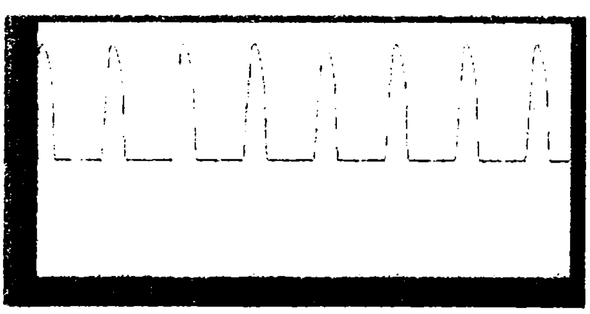

Fig 10 The dropping voltage in case of resistive load and a D C voltage supply for one phase rectifier

IV. CONCLUSIONS

The numerical computing techniques are limitated from the maximum frequency for analogical input signals and also from numerical computed speed point of view.

In an application these limitations are depending on the data acquisition system characteristics, on the work speed of the numerical computing systems and on the numerical computing algorithm's complexity.There is applications in which a real time data computing is demanded, meaning that the computing algorithms are correlated with the data access speed. Because of the time axis discretization the analogical signals become discrete. The signal becomes discrete if we also divide the OY axis. One condition for the signal to be a good approximation for the analogical one is that the sampling frequency must be big enough reported to the maximum frequency from the sampled signal spectrum (Shannon Theorem). The most insignificant bit signal level must be small enough (the scales must be small on OX and also on OY).We are interested in these requirements because the final purpose of this research paper is to simulate an industrial process, in the aim to know it better, to control and to predict it.

The useful signal, representing the physical phenomenon or system's behaviour, is mixed with perturbations, at aquisition and through the transmition channel. The discretization introduces a noise too. The perturbations and noises are continuous time phenomena, like the useful signals. Between them is a subjective difference, the specialist's point of view. Because of the high mathematical level, it is hard to analyse and to separate them.

The virtual instrumentation utilization advantages are in the decreasing expenses with new instruments (the system acquisitioning price, the expenses with the development and the maintenance) and increasing performances (flexibility, reutilization, and reconfiguration).Low prices and high performances are the desired qualities customers expect from their delivers.

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