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DISTANCE LEARNING IN LABORATORY SESSIONS

Bruno Andò, Nicola Pitrone

Engineering Faculty, D.I.E.E.S., University of Catania, Catania, ITALY

Abstract – The incoming technologies allowing for a massive use of remote driven instruments could improve the quality of the experiments in laboratory sessions, especially for what concerns the very specific high level classes. Moreover, taking into account the large number of students, the availability of the lab can be greatly extended. In order to give flexibility and high performances to the educational tool a user friendly virtual instrument has been realised allowing distance learning. Some basic experiments can be performed by the user, namely the analysis of both the RC and the RLC circuits, frequency measurements and also measurements on audio-frequency amplifiers. Indeed, the user can make the choice of the experiment which he is interested in and can choose the particular procedure among the implemented ones. By using the adopted procedure the user can carry out a proper training without loosing the contact with real instruments. In order to emphasize the features of the implemented system some examples are presented. A "presence effect" will be added in the next future, by using a web camera in the lab.

Keywords: Laboratory session, distance learning, remote driven instruments.

1. INTRODUCTION

In the last few years the approach to the practical training of the undergraduate students has received great attention because the use of advanced technologies will dramatically change the way of teaching electronic measurements; indeed, didactic sessions during Conferences emphasize the continuous developments carried out by the researchers. Undergraduate students can start the experimental training by using driven measurement systems as well as by running simulation software. This approach can be very useful for beginners: as a matter of fact they can test their theoretical knowledge, can perform an useful self-training and can acquire a limited hands-on experience with some problems correlated with the real-world experiment. These considerations are very important, taking into account the large number of students and the short time available for a correct training in the three years courses, recently introduced in Italy.

Indeed, real experiments with real electronic components and circuits, using advanced instrumentation, are very important for an accurate training on measurement procedures and measurement system design [1, 2].

In previous works the authors proposed several educational tools aimed to enhance the effectiveness of the experimental activity in the laboratory. A first step was accomplished in order to reduce the boring waste of time for writing accurate technical reports [3]; this initial idea has been followed by a deep study on the possibility of controlling remotely connected instruments [4].

On account of the already obtained results, a step by step work has been carried out and a new implemented hardware/software tool has been recently presented [5]: it has been designed in order to support some tutorial assistance to the students; moreover, it reduces the loss of time due to rough inconveniences and represents a key point in the topic of realising remote laboratory sessions.

In particular, it has been presented a totally PC controlled board, which includes circuits that are suitable for a basic experimental training that can be carried out by the undergraduates. In this way the students can improve the knowledge acquired in the short time that they can spend in the laboratory, in a distance learning activity.

The previously realised tool has been carefully revised, in order to enhance the reliability of the hardware in the lab. Additional attention has been paid and will paid in the next future to improve the features of the implemented software, in order to make it more user friendly.

Moreover, the values of the components of the circuits that can be analysed have been carefully chosen, for a more meaningful experimental activity.

Additionally, enhancing the presence feeling seems to be very important for far users, therefore a web camera located in the lab will give an overview of the system adopted for carrying out the experiment. In this way, the distance-learning user will have the plain feeling to be in the lab, carrying out the chosen experiment by using the real instruments. An attempt has been made to introduce such additional device, but a better coordination with the implemented software is needed for the optimisation of the transmission.

In the next sections the implemented system is outlined and some examples of its features are presented.

2. AN OUTLINE OF THE DEVELOPED SYSTEM

The already developed system consists of a mother board connected to two function generators and a digital oscilloscope: these instruments are controlled and driven by a dedicated software running on a personal computer. The sketch of the system is shown in Fig. 1.

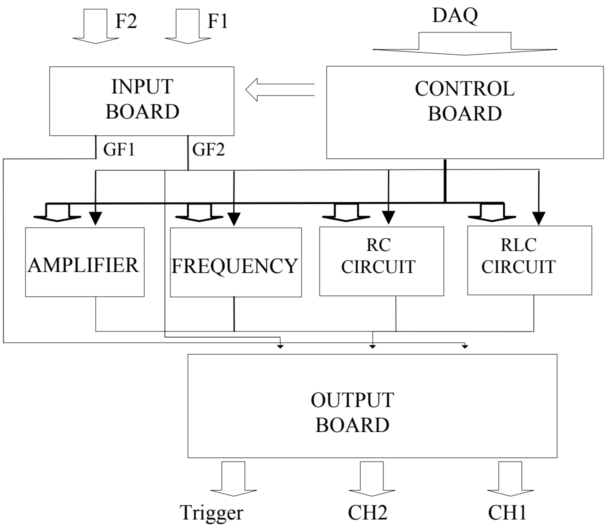

Fig 1. The already developed system.

The mother board, which includes some suitable measuring circuits, is aimed to perform suitable connections between these circuits and the instruments (two function generators and the oscilloscope).

The implemented circuits allow for carrying out some usual measurement sessions, in particular on first-order and second-order systems, as well as frequency measurements and characterisation of an audio-frequency amplifier.

First of all, the user can choose the mode that will characterise the laboratory session, according to the level of the assistance that will be supplied by the expert system: indeed, an automatic mode is available, in which case the experiment will be completely driven by the system; furthermore a system driven mode can be chosen, in which the user can make some choices; finally, a mode completely driven by the user can be carried out.

Subsequently, the user will select the experiment to be performed, the values of the circuit parameters, the function generator that will be used to force the investigated circuit and the signals that should be sent to the channels of the oscilloscope.

The software that has been realised for this work consists of a virtual instrument, implemented in the LabVIEW™ environment, that enables the student performing the management of the realised hardware.

The control of the instruments is performed via the IEE488.2 standard interface, while the board is controlled by the digital port of a DAQ board installed in the PC and software managed.

The configuration panel of the software tool is reported in Fig. 2. As it can be observed, the user can act on the dialog box in order to choose the experiment to be carried out (upper part of the left-hand side), the execution mode for the measurement session (driven by the user, guided by an expert system, automatically performed by the software), the circuit configuration (the user can select the values of the passive components of the circuit) and signal paths.

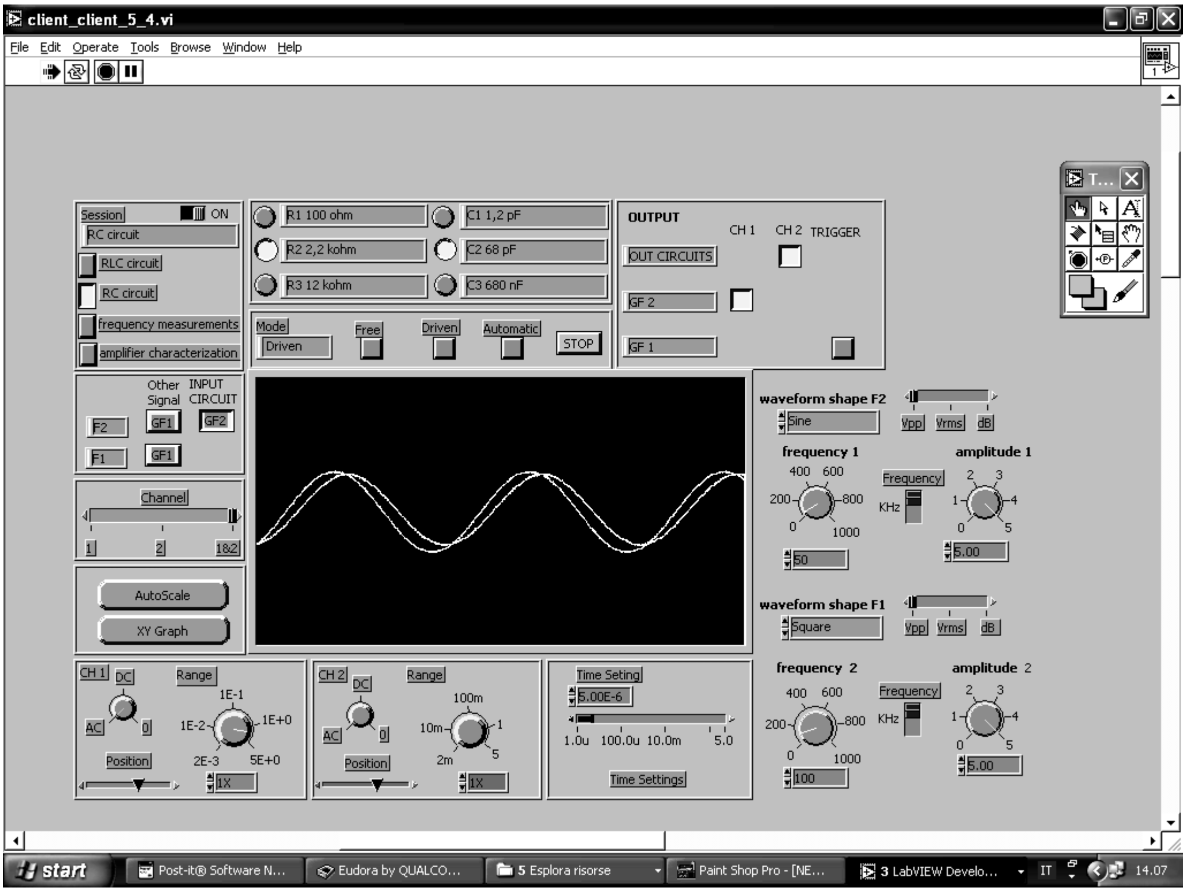

Fig. 2. Configuration panel of the software for the remote control of the developed board.

Moreover the user can totally control the parameters of the function generators and the configuration of the scope channels (right side and bottom part of the panel). The signals sent to the scope can be easily accessed by means of the waveform graph in the centre of the panel allowing for monitoring the rightness of the performed choices.

3. SOME EXAMPLES

Some basic experiments can be performed be the user. The RC and RLC circuits have been implemented on the board in such a way that the user can suitably select the values of the parameters, in order to analyse the loading effects of the probe of the oscilloscope, the effect of the internal resistance of the function generator and the effect of different values of R in a second order system.

As far as the user has made the preliminary choices (for instance, the experiment will be driven by the user, as it is shown in Fig. 2), he can proceed to the choice of the experiment to be performed (analysis of the RC circuit, see Fig. 2), the resistor and the capacitor values, among the installed ones (R=2.2 kΩ and C=68 pF, in the given example). Moreover, the user can choose the configuration of the signal paths from the function generator to the scope trough the circuit. At last, he can configure the forcing signal on the basis of the measurement target (in the example, the function generator number two supplies the RC circuit with a sine wave, and the input and output signals are applied at the input channels of the oscilloscope).

After the user had finished taking his decision, he can start carrying out the experiment by using the measurement panel. It enables the user to perform several kinds of measurement in both the time and the frequency domains, aimed to a deep characterisation of the investigated device.

In the frequency domain the Bode diagrams can be obtained.

By applying a square-wave at the input of the circuit, in the time domain analysis the values of the characteristic parameters can be measured.

In the next sub-sections some examples are presented in order to show the features of the realised system.

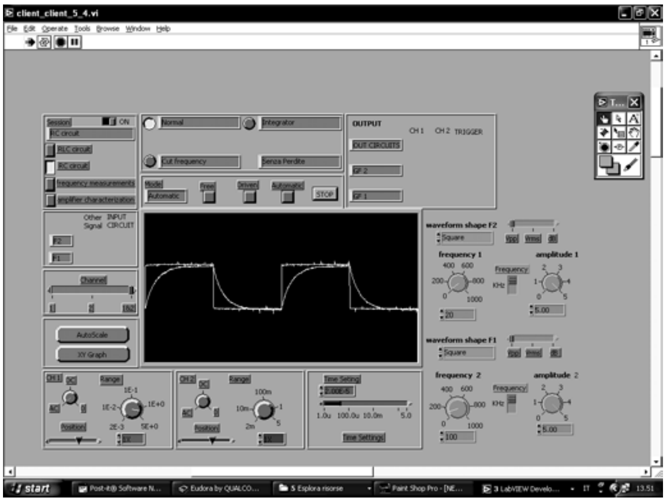

Fig. 4. Time domain analysis of the RC circuit

Moreover, it seems to be very important for the user to have the feeling to be in the lab, while performing the experiment. Therefore, a web camera has been adopted, the software has been modified, in order to show to the far user the instrumentation he is using in the lab.

3.1 The RC circuit

As an example, Fig. 2 and Fig. 3 show the configuration panel in the case of a measurement session on the RC circuit in the frequency domain. The user has chosen the driven mode, the values of the system parameters, the values of the frequency and of the voltage level supplied by the function generator, and the working conditions of the oscilloscope. The user interfaces show the adopted settlements and the representations.

The time domain analysis can be carried out by applying a square wave of suitable frequency at the input terminals, as it is shown in Fig. 4. Increasing the frequency the student can verify the integrating behaviour of the circuit (Fig. 5).

3.2 The RLC circuit

The analysis of the RLC circuit in both the frequency and

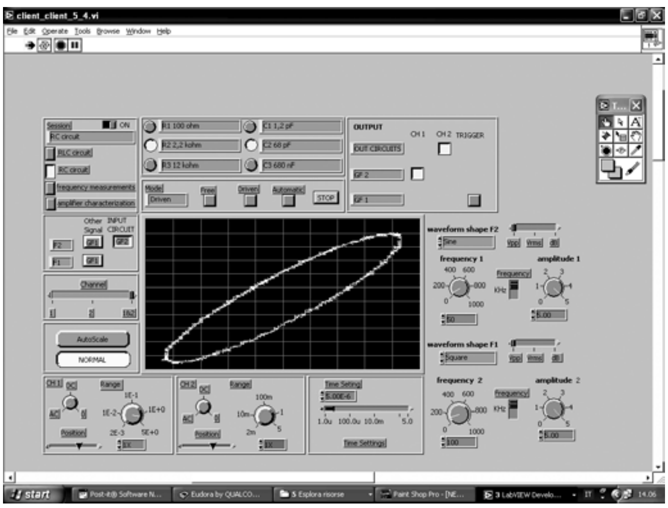

Fig. 3. X-Y representation for phase measurement

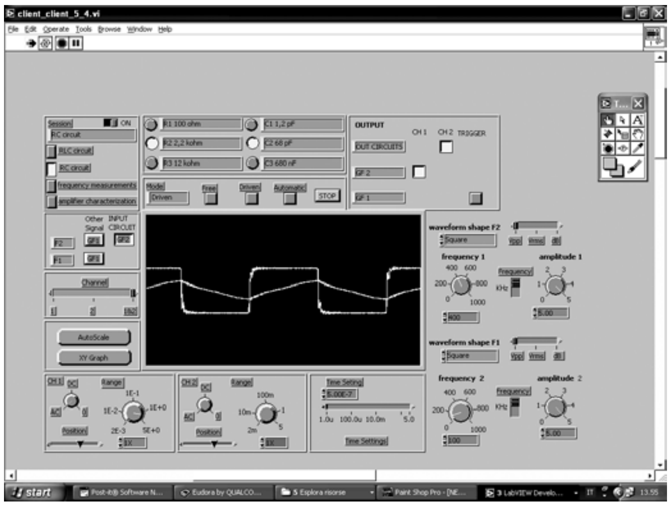

Fig. 5. The RC circuit as integrator

the time domains is meaningful for the user. Fig. 6 and Fig. 7 show the results of a time domain analysis.

4. CONCLUSIONS

In a step-by-step developing work, a realised mother-board has already been presented; it includes some circuits that will be used for carrying out classical experiments. To drive the various pieces of the used hardware a suitable software has been implemented. The main features of the system have been analysed in some details and partially tested. The hardware as well as the software can be easily modified and upgraded.

Some interesting features of the system has been shown.

An attempt has been made to the use of a web camera. In this way the far user can have a look at the instrumentation that he is using in the lab, and can verify the effects of the performed choices. It will be included in a next release.

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Authors: dr. eng. Bruno Andò, prof. eng. Nicola Pitrone, D.I.E.E.S., Engineering Faculty, Viale A. Doria, 6, 95125 Catania, Italy, phone: +390957382309 , fax: +39095330793, e-mail: npitrone@dees.unict.it.

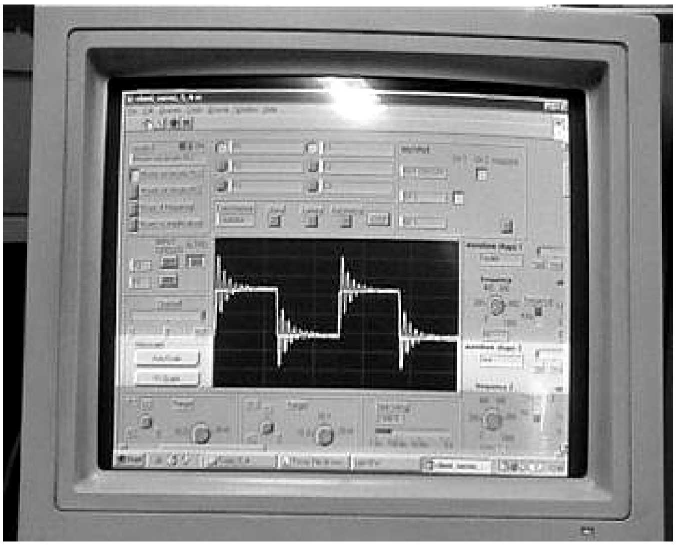

Fig. 6. Time domain analysis of the RLC circuit

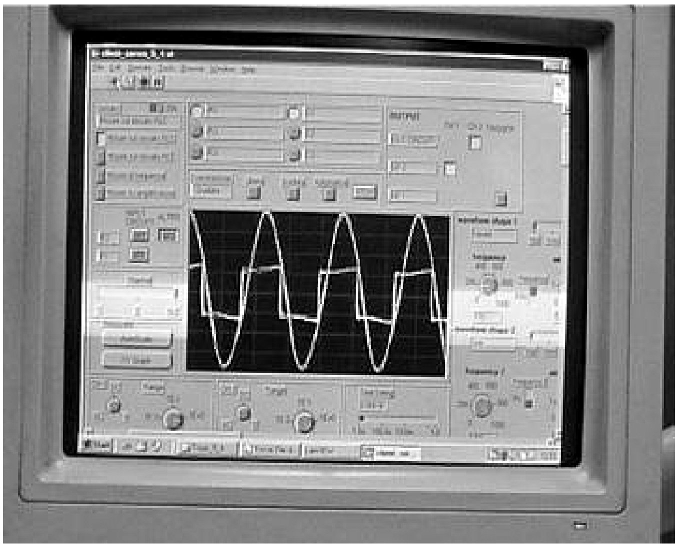

Fig. 7. Filtering behaviour of the RLC circuit