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New multitask prototype architecture for virtual laboratory

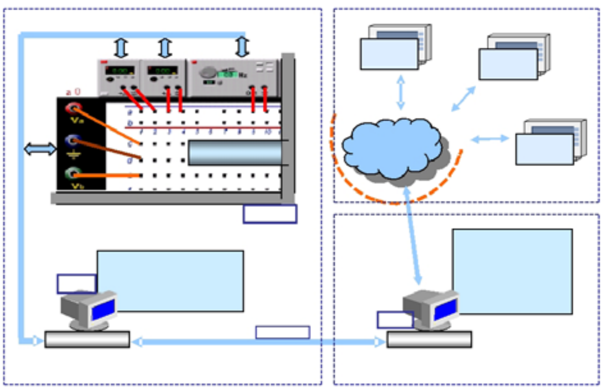
C.Donciu[1], M.Temneanu[2], C. Dosoftei[3]

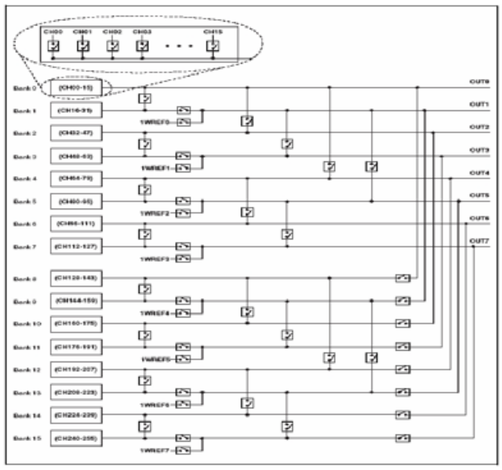
[1] "Gh. Asachi" Technical University, Iasi, Faculty of Electrical Engineering, Bd. D. Mangeron, 53, 700050, Iasi, Romania, phone +40232278680, Fax +40232237627,cdonciu@ee.tuiasi.ro, mtemnean@ee.tuiasi.ro, cristiandosoftei@ee.tuiasi.ro

Abstract- The project proposes accomplishing of a new informatics system architecture, under the form of a high-speed virtual laboratory, with a multitask type access on laboratory work, to remove users' waiting lists and allow reconfiguration of electric assembling in real time. The accomplished project was preceded by a thoroughly analysis of didactic requests according to economic problems, so that, the following aspects would be solved: Students will access from the distance real instruments and will accomplish online test workbench, in the idea of understanding all the aspects of a real experiment (including possible flaws). Detected errors in prescribing the commands towards the machine will not be corrected automatically, but the student will be warned. The results of the tests will be supplied by the user in the same way the real instrument does.

I. Introduction

The system architecture is composed of multitask server with the role of realizing the interactive communication between users and workstation, having the multitask administration interface as a resident software procedure, workstation with a role in controlled and assisted accomplishment of laboratory work and the reconfigurable platform that represents the physical area of work development and whose equipment chaining structure is commanded by prescription from the users of the assembling scheme accomplishment nodes.





System's architecture (figure 1) is structured on three main levels: reconfigurable workstation level, multitask server level and user server. Initiating the execution of a laboratory work comes from the user level, by accessing the server's web interface through a commercial browser.

In this project we use NI SCXI-1130 (figure 2) matrix to realize a programmable platform witch allows the configuration by soft of an independent work papers laboratory. This matrix has 256 switches (8 lines by 32 columns). Every switch is commanded through a code sent by matrix and each time must be connected one active source on line or column. The analog to numeric interface connected on the PC bus has several tasks to realize the virtual laboratory: - Its sends numeric codes to the programmable matrix to command the switches; - Its sends numeric codes to command the digital to numeric converter from the work platform; - Its reads the voltages from the measure points of the laboratory papers, it saves them in the pc memory and sends them to the final user;

II. Study of papers laboratory

II. A Analog to digital converter

Analogue to digital converter (figure 3) ensure interface between the measured analogical signal and systems used for processing and display of the results, systems that work only whit numerical signals.

By the type of conversion there are two types of analogue to numerical converter: integrated and non-integrated. We will use an analogue to digital converter with reaction which uses a comparator that compares the voltage to be measured and voltage generated by a digital to analogue converter.

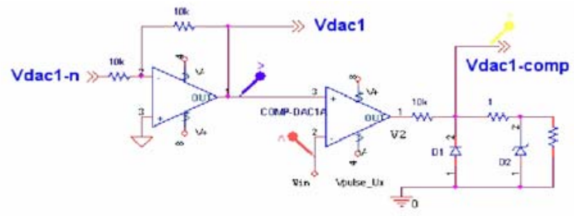


Figure 3. Comparator for analog to digital converter

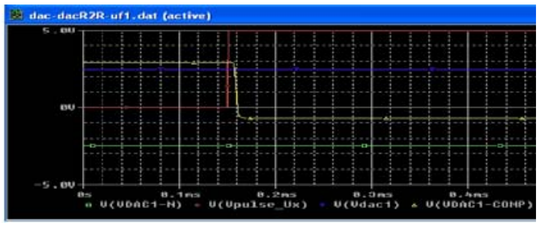


Figure 4.The output of the comparator

A/D converter whit reaction uses one comparator and at his outputs is applied voltage to be measured and voltage generated by a digital to analogical converter. The final code, witch realizes the best approximation of the input voltage represents the outcome of the conversion process. There are three types of reaction converter. We use a second amplifier (COMP-DAC1A) in the comparator circuit to realize a numeric to analogical converter. The unknown voltage Vin is connected to the input IN- of the amplifier and voltage Vdac1 at the IN+ input.

The output voltage at V2 amplifier is: V2=A2*(Vin-Vdac1) =25000*(Vin-Vdac1)

Were A2 is the amplifier in open lock of the operational amplifier. For differences more than 0.5V between Vin voltage and Vdac1 voltage, V2 voltage will be equal to input voltage. So the amplifier without reaction will work as a comparator whit a resolution better than 0.5mV. Diodes D1 and D2 will limit V2 signal to a range of [-0.7V; 4.7V] to be compatible whit digital input of the acquisition board witch takes the signal from the comparator.

In the figure 4 we see the output of the numerical to analogical converter, Vdac1,Vin and the output of the comparator (Vdac1-comp) which represents the numeric result of the comparison between numerical to analogical converter voltage and unknown voltage Vin. Vdac1 voltage will be read through a digital output of the acquisition board.

II B. The study of operational amplifier

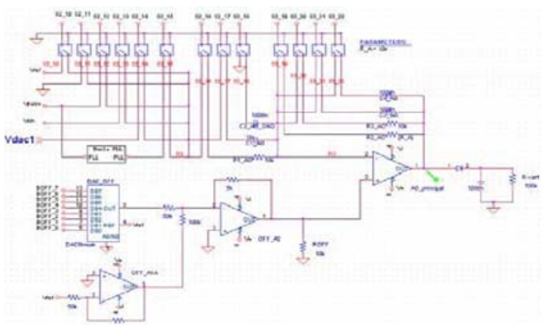


Figure 5. Circuit used to study the operational amplifier

In this paper we will study the behavior of the operational amplifier: as a repeater, voltage inverter, current adder and integrator. Every circuit will be obtained connecting the input and reaction of the amplifier through the switch matrix. There are 2 lines connected to the switching matrix:

- R2 through C10, C11….C15 columns connects a signal source at the input of the amplifier. C16, C17, C18 determine the input impedance: resistance, capacitor.
- R3 through C19, C20, C21, C22, we set the impedance in the amplifier reaction;

II B.1 Study of the operational amplifier as a inverter

We use a sinusoidal signal whit a 5 KHz frequency and 4V amplitude.

$$Vout = A(V3 - V2) \quad , \quad V2 = V\sin\frac{R2}{R1+R2} + Vout\frac{R1}{R2+R1}$$

$$V2 = \frac{V\sin\frac{R2}{R1+R2} + V3\frac{AR1}{R1+R2}}{1+\frac{AR1}{R1+R2}} \; , A \to \infty \; , \; \Rightarrow V2 = \frac{V3\frac{AR1}{R1+R2}}{\frac{AR1}{R1+R2}} \; \Rightarrow V2 = V3$$

The connection is made through R1_AO (10 k), and the reaction is made by the R2_AO. In figure 6 is presented voltages which characterize the operational amplifier as an inverter and in figure 7 is presented the wave form of the voltages. We can see that the first 2 sine waves are deformed because of the high load currents of the capacitor used to pick detection.

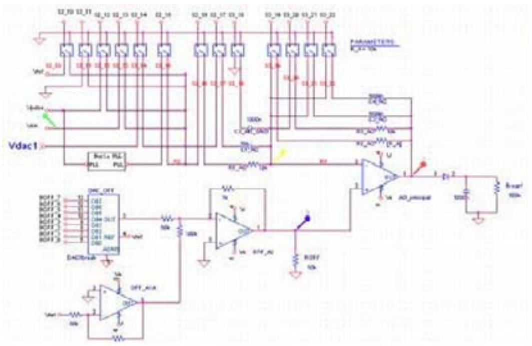


Figure 6. Voltage to be measured in the circuit.

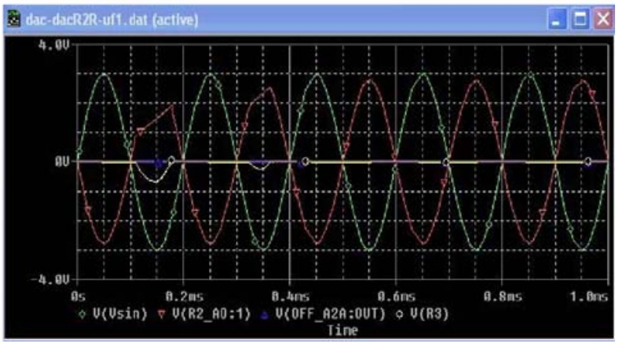


Figure 7. Waveform characteristics

II B.2 Study of the operational amplifier as an integrator

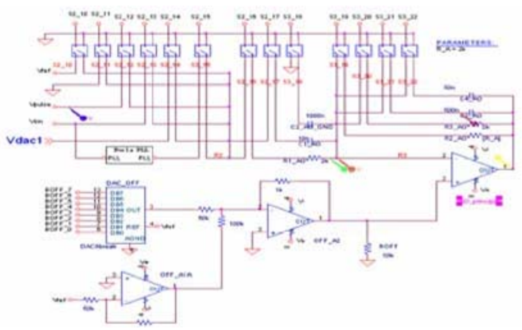


Figure 8. Voltage and currents as an integrator

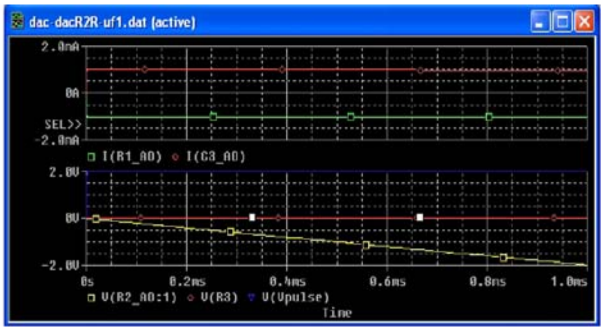


Figure 9. Integrator voltages. Load currents of capacitor.

As long as Vout is not saturated, Cr1 ≠0 → V3 = V2, V3 = 0V, and if t= 1ms →Uout = -2V.

$$\left.\begin{aligned} Ir1 &= \frac{Vpulse}{Rin1} = \frac{2V}{2K} = 1mA \\ I_{AO-} &= 0mA \end{aligned}\right\} \Rightarrow I_{Cr1} = -1mA$$

To study operational amplifier as an integrator at his input is applied a Vpulse=2V, and switch configuration is S2_12 (Vpulse), S2_16 (R1_AO), respective S3_21 (C3_AO) are ON. (Figure 8)

Voltage on capacitor is rising linear after 1ms at -2 V.

II C. Voltage to frequency converter

Voltage to frequency converter (figure 10) generates a train of impulses of which frequency is proportional with voltage applied at input. These are simple circuits but whit big precision. The big advantage of this circuit is that the information is transmitted through frequency. Disadvantage of this method is the small rate of conversion.

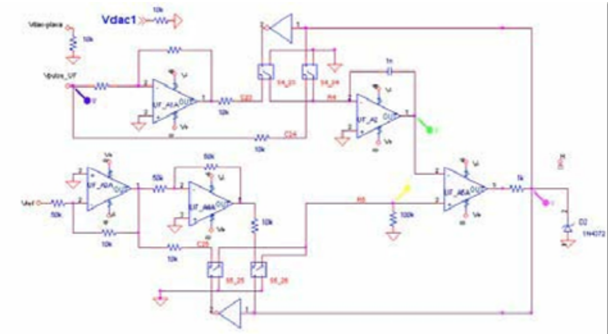


Figure 10. Voltage to frequency converter

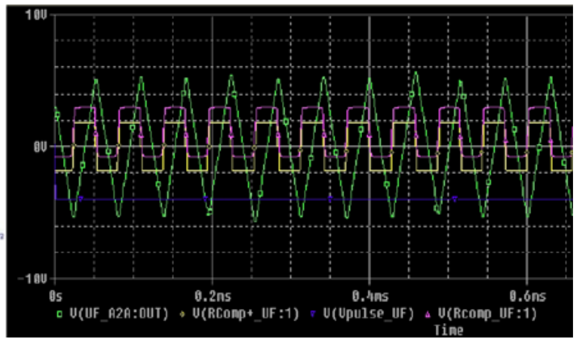


Figure.11. Waveform for voltage. Frequency converter

III. Conclusions

The paper is distinguished by two aspects of new:

First of all it is desired to realize a flexible system, where users can practice to design realization of online reconfigurable electronic montages. So, by developing the reconfigurable platform, users can realize physical circuit traces by selecting placement coordinates of the reconfigurable matrix nodes, they can introduce measurement equipment in the electric montage, by selecting the measurement points and they can choose the electronic components to test.

Secondly, by introducing multitask concept at the laboratory work realization level, through multitask management interface and multitask execution interface, the waiting lines are eliminated. So, after setting the parameters for the laboratory work, by the user, the execution is developed automatically under soft control. Optimizing execution order is insured by the E-Multitask interface. All this circuits and analysis will make part from the lessons which will be implemented in the final e-learning system. The student will cover all the theoretical problems and he will take a test. After this he will program the switching matrix to realize the practical task of the laboratory. The results of the experiments will be text or graphic files and with these results the student has to establish several parameters of the circuit (frequency, offset, gaining error).

The student will experiment with the acquisition board as if he is working on the host PC. The major advantage of this system is that more students can work simultaneous to the same acquisition board. The time in which the student builds the program doesn't block the acquisition board and the PC. When the program made by the student is compiled with success this will be executed in a very short time then the server is free for new compilations. All this circuits and analysis will make part from the lessons which will be implemented in the final e-learning system.

Acknowledgements

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