ELECTRONICS EDUCATION SYSTEM FOR NON ELECTRONIC ENGINEERS

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Abstract* ¾ *This article describes a CAL system for electronics education of non-electronic engineers. Our system uses hypermedia combined with simulation and electronic modules to achieve a complete education about the capabilities of electronics as a tool to improve the efficiency of industrial processes including mechanics, fluidics, etc.

Index Terms* ¾ *CAL, Hypermedia, Virtual Instrumentation, Simulation Tools.

INTRODUCTION

Traditionally, Electronics education of non-electronic engineers has been carried out combining theoretical education with the assembly of circuits using specific measurement instruments like power supplies, voltmeters, oscilloscopes, and signal generators [1] [2]. But this method is very costly and it is not really useful for non-electronic engineers.

The previously mentioned disadvantage can be overcome using computer assisted learning (CAL) methods. The potentiality of computer hypermedia resources, and the low cost and widespread diffusion of computers, convert CAL into an essential teaching tool. In the case of Electronics the computer can be used as support both for theoretical and practical teaching. In this sense three kinds of applications can be pointed out:

- Tutorial systems [3]
- Simulation programs [4]
- Virtual Instrumentation systems (VIS) [5].

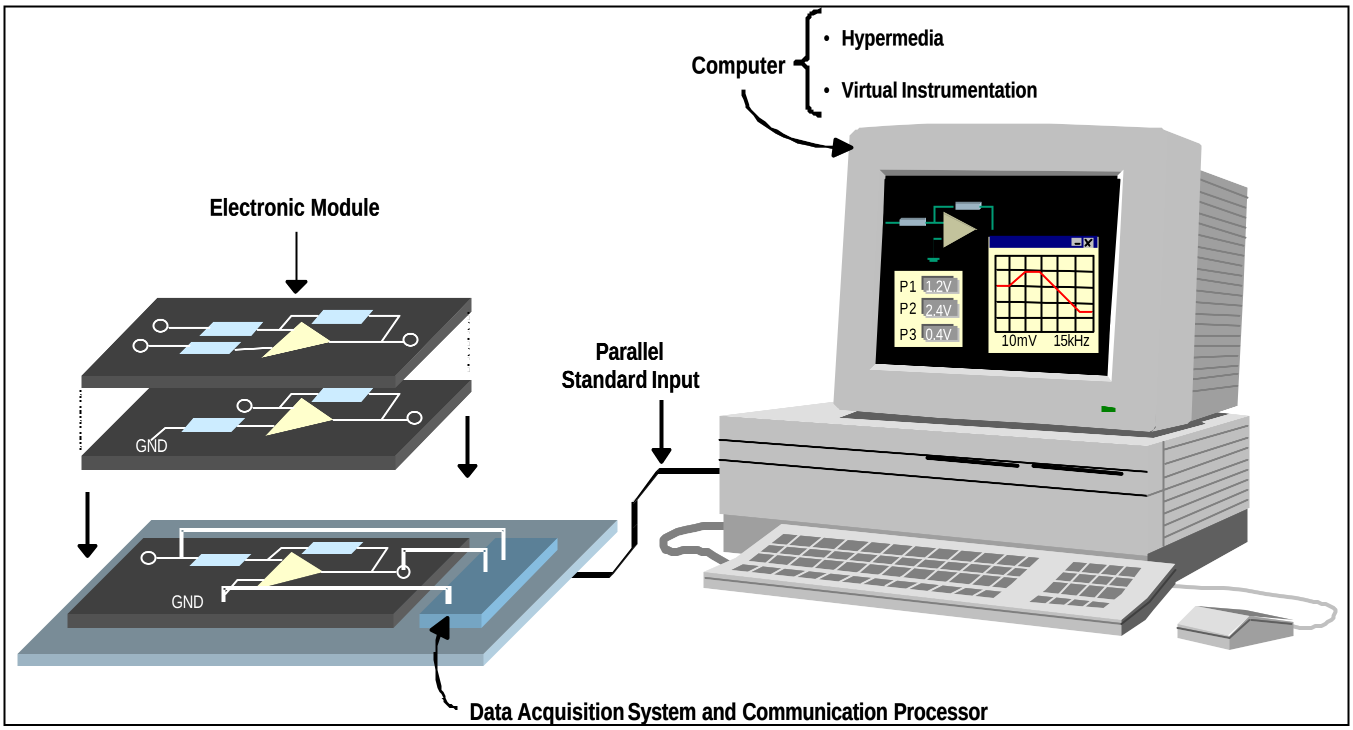

FIGURE. 1
ELECTRONIC EDUCATION SYSTEM HARDWARE

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The features of a system oriented to the education of non-electronic engineers of small and medium sized companies must take into account the following aspects:

- Consistent theoretical contents allowing progressive and individual learning.
- Availability of resources for simulation and analysis of real circuits, including faults detection and changes.
- Possibility of individual (at home) or co-operative learning.
- Low cost.
- Portability.

To meet these requirements we developed a CAL system combining theoretical lessons with simulation and experiments using adequately chosen electronic modules.

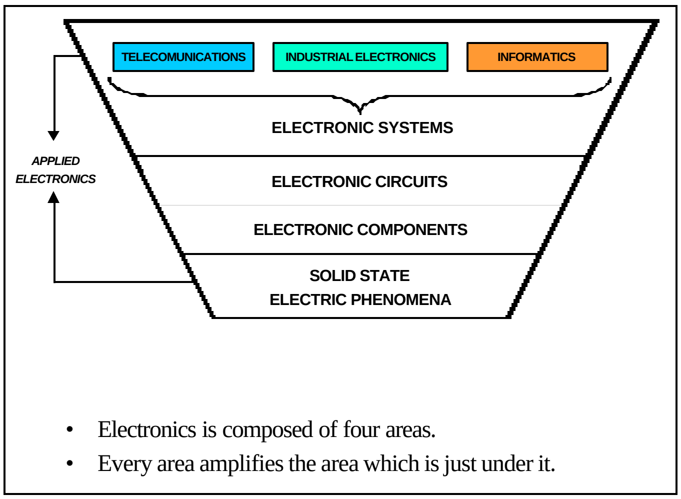

FIGURE. 2
INDEX SCREEN OF LESSON 1.

HARDWARE DESCRIPTION

The hardware system consists of three basic elements:

- A set of real modules related to each lesson. These modules are electronic circuits oriented to the introduction of the applications of the different simple electronic devices. They can also be practical electronic systems that can be interconnected to obtain more complex ones.
- A base to support the modules. It includes a data acquisition system and communication processor connected to a personal computer using the standard parallel port.
- A personal computer, sending information to the data acquisition system and communication processor for generating test signals or inducing faults. It also receives information from module selected test points.

SOFTWARE DESCRIPTION

The software system is made up of:

a) A hypermedia application oriented toward the presentation and evaluation of contents.
b) Simulation tools to facilitate the circuit analysis.
c) Virtual instrumentation (oscilloscope, logic analyzer, voltmeter and functions generator) for data acquisition from different test points.

Hypermedia Application

Hypermedia application is the core of the system. It is made up of theoretical lessons complemented with simulation exercises and experiments. Each lesson has hyperlinks permitting access to a glossary including the principal concepts of other lessons to facilitate navigation through the system.

To guarantee progressive learning, information is structured from general to more specific concepts using an original method for complex technologies education [6] [7]. Users can navigate through the application linking related information which broadens their previous knowledge.

Lesson 1 includes Electronics definition (Figure 2) with their principal areas. Clicking on every area the definition and related classification is displayed.

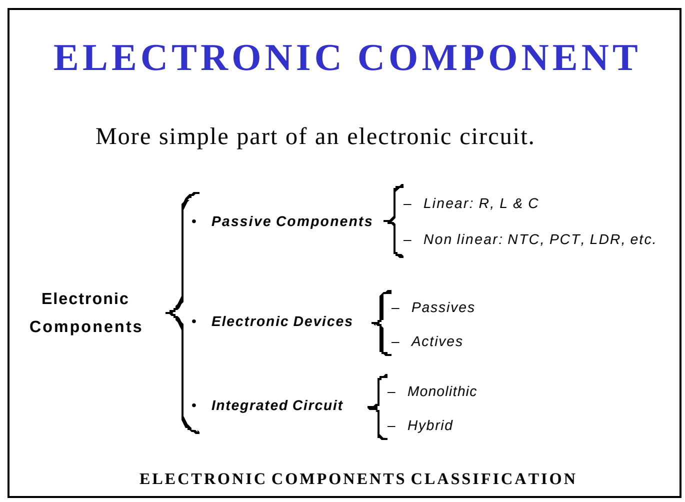

FIGURE. 3
ELECTRONIC COMPONENTS CLASSIFICATION

Figure 3 displays the screen when clicking on the Electronic component area. Clicking on "passive electronic devices" Figure 4 is displayed including different examples like the photodiode. It is then possible to display a practical circuit of an application using a photodiode (Light Irradiation Measurement on Figure 6) or the photodiode electrical characteristics (Figure 5).

The advanced lessons explain the principal kinds of electronic control systems. Figure 7 shows the microcontroller block diagram. Every block is a hot word and the student can navigate from everyone to its description. We also use multimedia as a very powerful tool to supply application information oriented to non electronic engineer. Figure 8 show the microcontroller device application

Lessons are under HTML format. Figure 9 displays the inverting amplifier explanation, which shows the most important parts of the theory. At the same time HTML files are especially useful to display animated graphics and, in that way, to compose difficult circuits step by step, very slowly including each step explanation. The system includes spoken comments, in other that the students can listen the explanation of the theoretical part (Figure 10).

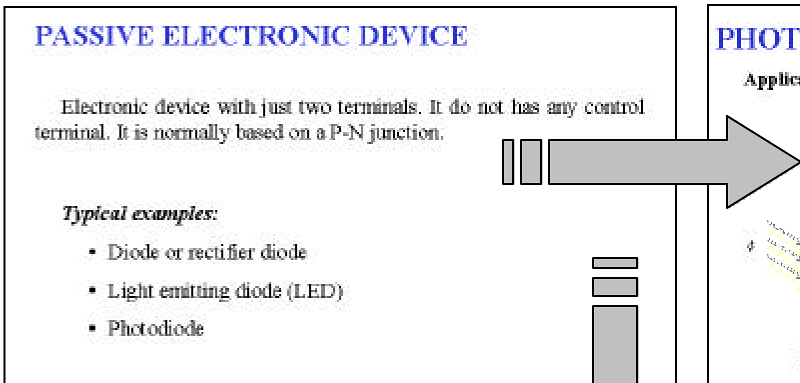

FIGURE. 4
WHAT IS A PASSIVE ELECTRONIC DEVICE?

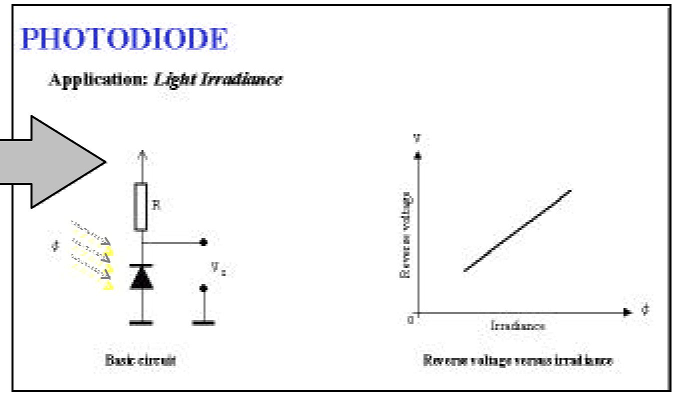

FIGURE. 5
AN EXAMPLE OF AN APPLICATION CIRCUIT OF A PHOTODIODE.

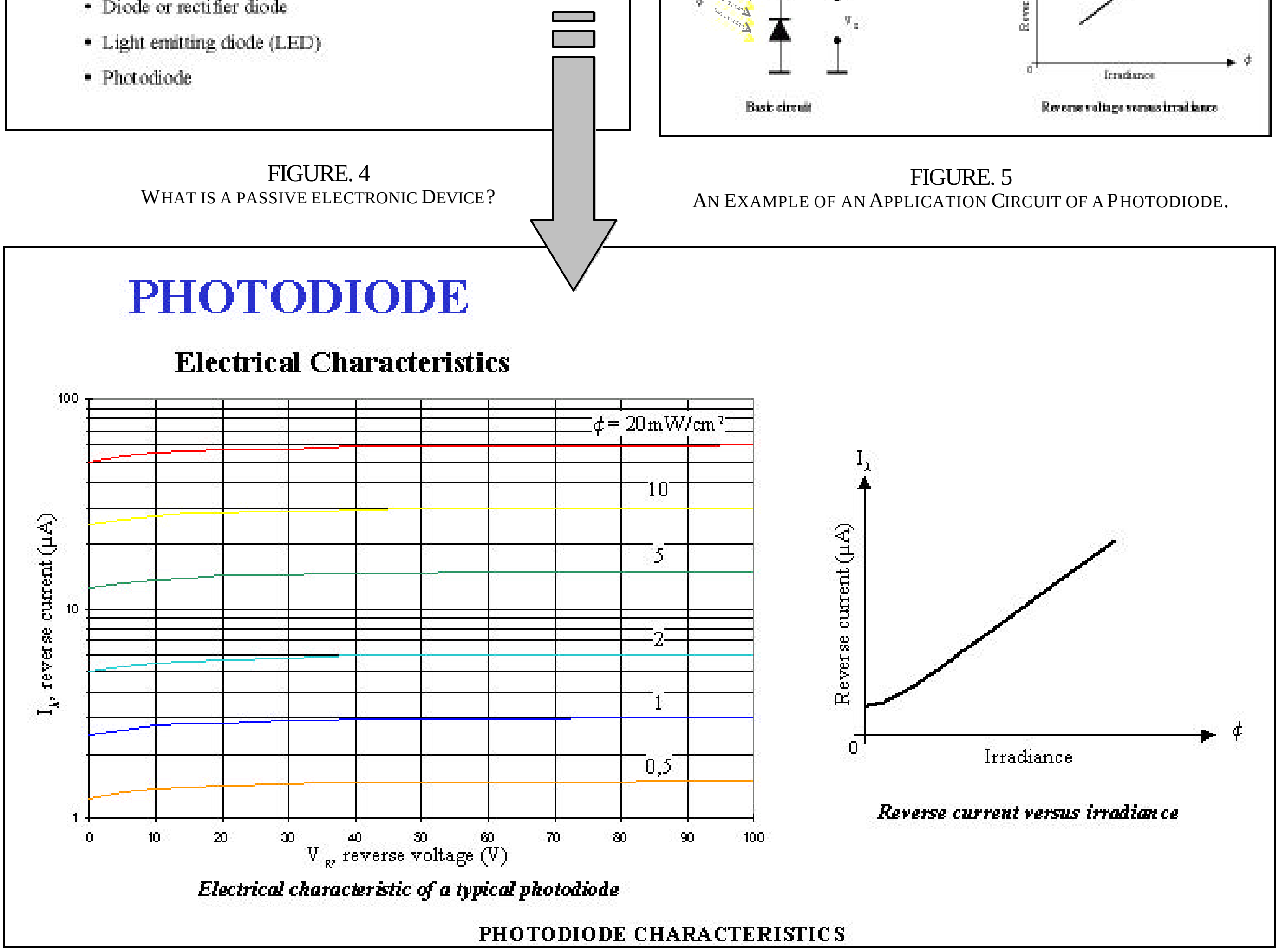

FIGURE. 6
THE ELECTRICAL CHARACTERISTICS OF A PHOTODIODE.

Simulation Tools

Simulation is a very useful activity before practical experimentation with real circuits. Our system uses MSIM evaluation version, a free version of PSPICE. Although the limitations of this free version, it is possible to simulate the most important circuits. The students learn to use the most popular electronics simulator with pre-designed circuits and, step-by-step, she/he learns to modify them.

A disadvantage of simulation systems is to allow the student to use non-existing devices, such as 10 Farads capacitors or 10 GigaOhm resistors. With our system, when the user tries to do so, a splash window appear showing the mistake.

When the student solves an exercise and gives a wrong answer, the same window is displayed but the systems allows the user to continue. The system generates the schematic file (Figure 11) with the wrong answer and simulates the wrong circuit. The idea is that the student checks her/his wrong answer and then compare it with the good one. The student can learn from her/his own mistakes.

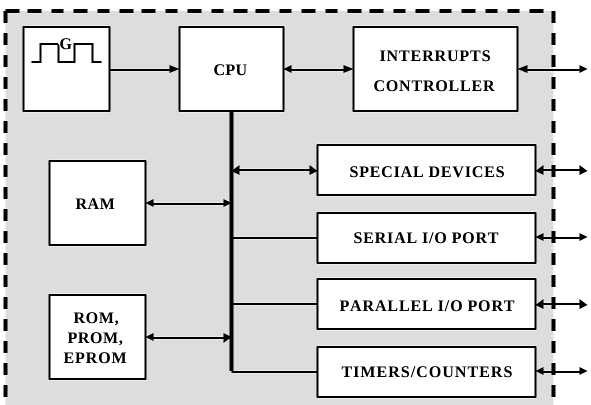

FIGURE. 7
BLOCK DIAGRAM OF A MICROCONTROLLER.

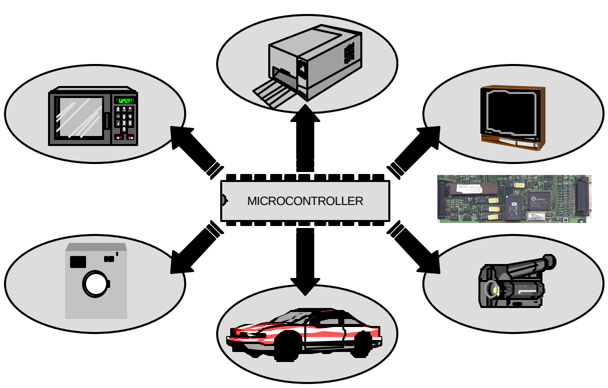

FIGURE. 8
MICROCONTROLLER BASED APPLICATIONS.

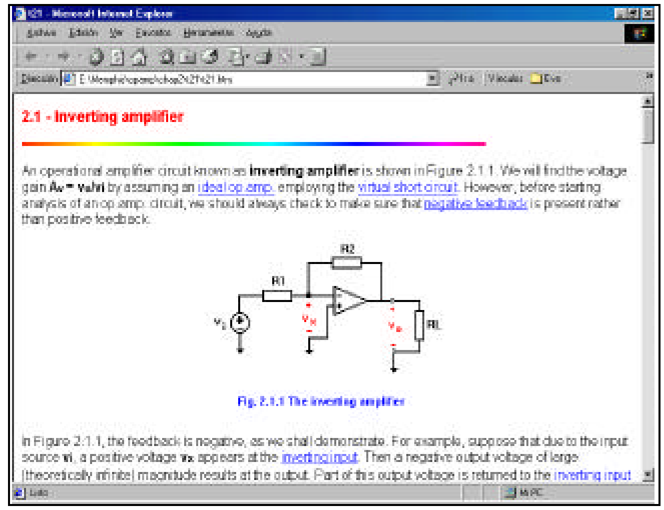

FIGURE. 9
AN SCREEN OF A THEORETICAL LESSON.

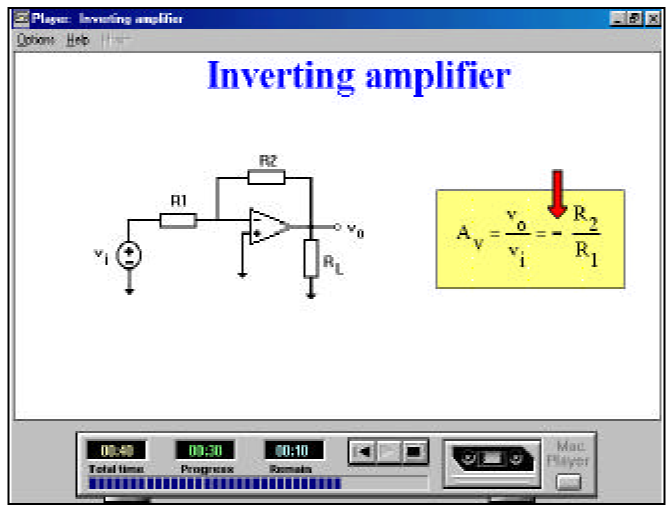

FIGURE. 10
AN SCREEN WITH SOUND RESOURCES.

Virtual Instrumentation

Using traditional measurement instruments for educational purposes presents some drawbacks. Firstly, commercial instruments provides many features not needed for educational purposes where the experimental systems normally operate far away from their maximum rate and the number of signals to be tested is low. On the other hand, commercial instruments operation becomes a difficult task because of their complex functions oriented to the professional market. Attending to the above considerations, the instruments required for educational purposes must be simple and interactive and their functionality must be adapted to the student level and to the final application. Virtual instrumentation technique provides an easy way to achieve these purposes.

The application of virtual instruments for educational purposes offers a lot of advantages:

- Low cost due to the decreasing cost of personal computers.
- Reusability of the available resources because many different instruments can be implemented using a personal computer and a simple external hardware.
- Virtual instruments take advantage of the available software and hardware resources of personal computers. For example, virtual instruments use the advanced graphical resources to represent the acquired data. At the same time, multitasking capability of the current operating systems permits that two screens of different active programs can be presented simultaneously. In this way, the data acquired by two different instruments can be represented simultaneously or compared, for example, with the simulation results. Moreover, data files can be shared between several applications and the students can analyze their results using datasheet programs, mathematical tools, etc.
- The control panel of the instrument can be adapted to different applications, according to the student requirements and their knowledge level. For example, basic interfaces can be used and many parameters can be automatically configured in the firsts courses. By this way, the students focus on the design of the system instead of wasting time studying complex manuals of different commercial instruments. The interfaces of the virtual instruments can become gradually more complex according to the students advances. This is possible because human interfaces are implemented by software. Besides, the students are familiar with the computer environment and the software of virtual instruments results in a easy to use tool.

Actually, the first version of a logic analyzer is available. Digital circuits verification is carried out using a pattern generator, avoiding any external stimulus. Figure 12 shows the user interface of the logic analyzer.

The virtual instrumentation is now in development under Windows operating system. The application programs connects with the physical system through the drivers or control programs (Figure 13).

Virtual instrumentation system has to attend to the events generated by the physic system and the user. Because of this, our system must be designed with multithread characteristics. So, we dedicate one of this threads to attend to the user events and another one to attend to the physic system.

User events are caused by the adjust of the virtual instrument, the generation of the test vectors or the acquired signals display.

Hardware events are brought about the actions of acquisition/generation.

When the virtual instrumentation application is running, every instrument is assigned to a new thread of the application. This thread connects to the driver and this one, with the hardware system.

Using this system, the student knows the behavior of the circuit he is studying and the values of its signals and their variation with the time are displayed in the PC screen.

CONCLUSIONS

Combining hypermedia with simulators and actual application modules, we can improve education on electronics of non-electronic engineers. To do so it is necessary to develop a complex system including hardware and software. This system is a result of the collaboration between electronic engineers and informatic experts.

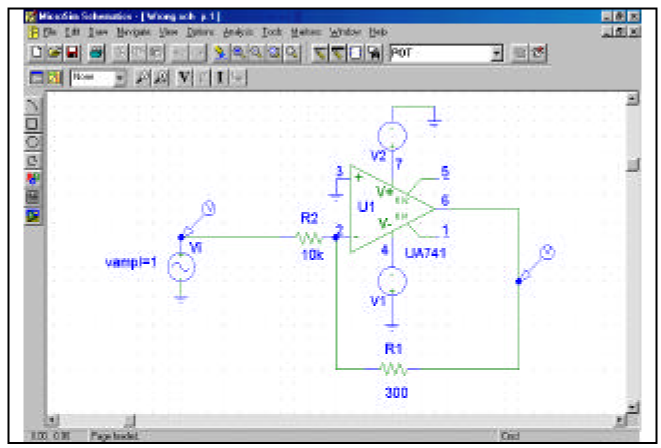

FIGURE. 11
SIMULATING A CIRCUIT.

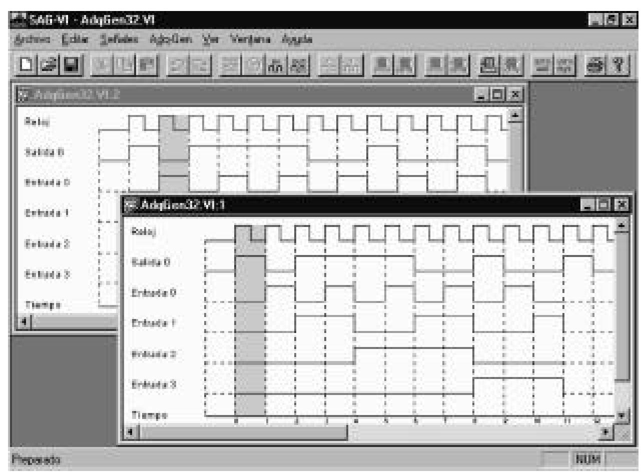

FIGURE. 12
USER INTERFACE OF THE LOGIC ANALYZER.

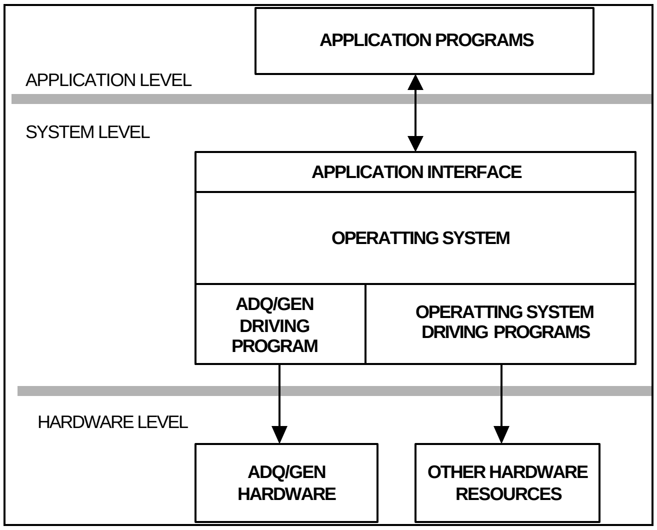

FIGURE. 13
STRUCTURE OF A VIRTUAL INSTRUMENT.

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