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IVI SYSTEMS FOR AUTOMATIC DETECTION OF ELECTRONIC INSTRUMENTS

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Abstract − The aim of this work is the creation of a virtual instrument for the management of an experimental set-up in which the electronic instruments are interchangeable. This is possible using IVI drivers (National Instruments) [1], [2]. In this way the software system becomes independent of the chosen hardware [3].

Keywords: IVI Drivers, Interfaceable Instruments, Virtual Instruments.

1. INTRODUCTION

In the last years the measurements systems have become more and more complex. A helpful mean for the management of these systems is the virtual instrumentation that allows the data acquisition, processing and storage.

Using LabVIEW the time needed for the software development has decreased compared to other programming languages. Instrument drivers, a set of software routines corresponding to an instrument operation, can simplify remote control and eliminate the need to learn the programming protocol for each instrument.

However the virtual instrument may become complex if the measurement system is large and there are too many implemented functions.

It is very difficult to change the software also if little modifications are applied to the measurement system.

For example, if we need to substitute a digital oscilloscope with another one of different manufacturer, we need to modify the software in the part relating to the instrument driver, and this is not always so easy.

To overcome this kind of problems, in 1998, several companies formed the IVI (Interchangeable Virtual Instruments) Foundation. It defined formal standards for instrument driver, divided in five classes of measurement instruments:

- Oscilloscope (IviScope)
- Digital Multimeter (IviDmm)
- Switch (IviSwtch)
- Power Supply (IviPower)
- Function Generator (IviFGen)

These ones were tested in the below-described experimental set-up. Afterwards, the foundation added three new classes [4]:

- Power Meter (IviPwrMeter)
- RF Signal Generator (RFSigGen)
- Spectrum analyzer (IviSpecAn)

For each class, the IVI compliant instruments have Fundamental Capabilities and Extensions. The former are attributes and functions that should be common in that class (the goal is to cover 95% of the instruments), the latter represent more specialized features. Some of these are provided in standard drivers, called Extension Groups; the other ones need specific drivers.

If an instrument conforms to one of the above classes, it is IVI compliant (that is, must support at least Fundamental Capabilities). This allows the instruments interchangeability across manufacturers, and even across bus connection (GPIB, VXI, RS-232 or PCI based).

IVI Foundation encourages the compatibility with existing products, in order to gradually introduce IVI standards.

Also class driver must redirect operations to specific drivers, identifying through a configuration file. Although codes are embedded in DLL, in this way the system is slower than a direct calling. However virtual instruments should call class drivers rather than specific device drivers to guarantee interchangeability.

Moreover, IVI drivers give you features that do not exist in traditional instrument drivers, like simulation, state caching, range checking, status checking and coercion recording.

Using the simulation features [5], it is possible to develop code and making sure it will work in a test system even while instruments are not available, because they are being used in other systems, they need a calibration procedure, they are temporarily broken or they are not yet purchased. Simulation driver can generate instrument function calls and random values or custom data (and simulated errors too).

2. MEASUREMENT SYSTEM

In order to test the effectiveness of an IVI compliant system, we created a measurement system with the following instruments:

- Power Supply, Microset LT518
- Function Generator, Yokogawa FG320
- Oscilloscope Tektronix, TDS 220
- Multimeter, Fluke 8840A

They are connected to a PC through an IEEE 488 interface, but the software can work with different buses with no changes. In addition to these instruments, we used a simulated switch system. This possibility is offered by IVI Drivers simulation feature.

This set of instruments covers the entire five base IVI classes and the software system can manage almost all available Fundamental Capabilities.

The circuit to which these instruments are connected is shown in Fig. 1.

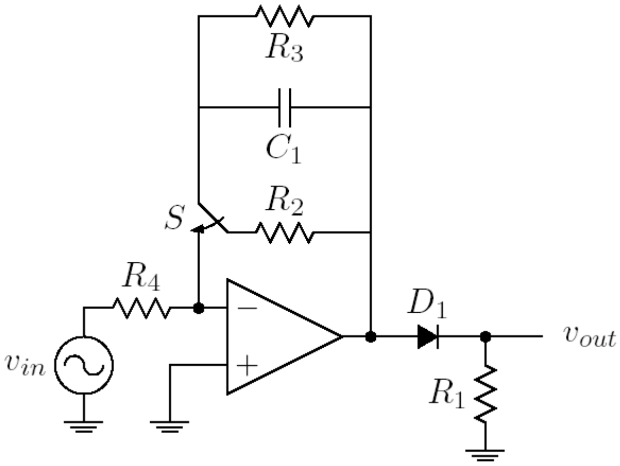

Fig. 1. Circuit with operational amplifier.

The circuit has an operational amplifier µA 741, a diode (D1n4376), four resistances and a capacitor having the following values:

- R_1 = 10 kΩ
- R_2 = 140 kΩ
- R_3 = 40 kΩ
- R_4 = 1 kΩ
- C_1 = 0,1 µF

The mechanical switch allows obtaining two different behaviors of the same circuit. It may work as an inverting amplifier or as an integrating filter, but the output can be clipped by the diode. The simulated switch card could replace it.

2.1. Measurements

The allowable measurements are:

- Input resistance
- Rising time
- Falling time
- Transfer function
- Offset voltage
- Slew-rate

Offset and slew-rate are typical operational amplifier parameters, the other ones are global circuit features that can be easily extended to almost all kind of circuits.

Each measurement needs a different virtual bench configuration.

3. SOFTWARE SYSTEM

For clarity and re-usability, the software system created for the management of the above-described measurements has two blocks: one for the user interface and the other one for the measurements themselves. So it is quite simple to add new measurements and devices.

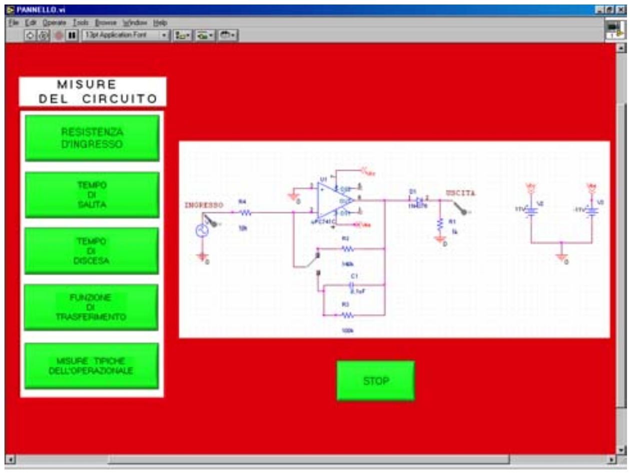

Fig. 2. Main Front Panel.

In Fig. 2 the main front panel of the virtual instrument is shown. In the left part of the display it is possible to choose the measurements to do. In the right part there is a representation of the circuit with the available probes.

Clicking a button in the list, the front panel of the corresponding measurement system appears. Only useful virtual control and indicator instruments are displayed. Therefore, the user doesn't need to know in advance which instrument class can make a particular measurement.

Furthermore, due to IVI interchangeability, user has not to worry about writing a proper code for each instrument model and driver. In fact, devices are identified only by a Logical Name, that is a symbolic and intuitive string (for instance, we selected "fluke8840" or "DMM1").

A National Instruments MAX configuration wizard allows to create Logical Name and join it to a specific driver, extensive description and physical address string that explains interface type and port (for instance, our DMM is GPIB::1::INSTR). Using the same procedure, we have also created simulated device.

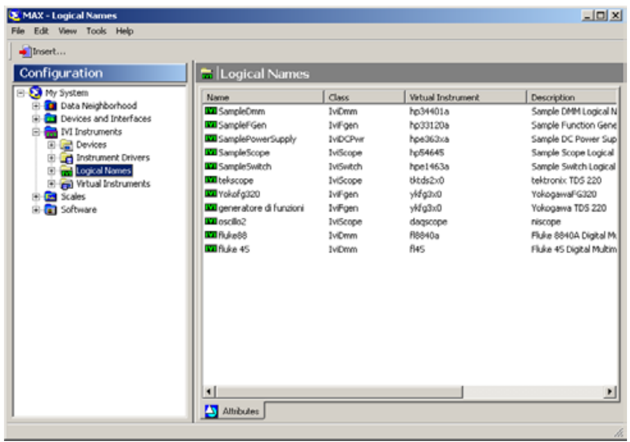

Fig. 3. Logical Name configuration wizard.

Users can ignore the above problems. They only have to change the Logical Name to select another instrument. For instance, as shown in Fig. 3, in our configuration tree we prepared three IviDmm class Logical Name: “fluke88”, “fluke45” and “sampleDMM” (simulated). They are interchangeable, simply clicking in a menu of the virtual instrument front panel.

For the IviFGen class, we developed two different virtual instrument versions. The first one is based on Fundamental Capabilities (main options are waveform type, amplitude, frequency, phase), the second one can generate non-standard waveforms (arbitrary function generator). A control allows setting the same signal on both channels: so we avoid keeping GPIB port busy twice. This is coherent with IVI philosophy whose statements include to minimize bus accesses (state caching) [6].

3.1. Measurement option details

If users choose to measure the input resistance, the measurement system can consist only in the DMM, but adding the function generator, as shown in Fig. 4, he can obtain a more refined configuration.

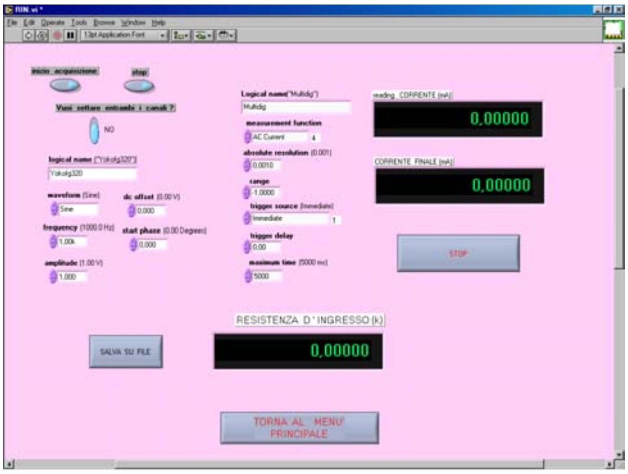

Fig. 4. Front Panel for input resistance measurements.

In the left part there are the function generator parameters, in the middle part the DMM ones. The DMM works as an ammeter to measure the current generated by the generator voltage. The software computes resistance as V/I ratio. The choice of voltage parameters can be useful to find complex impedances.

To measure rising or falling time, the best thing is to apply a test pulse waveform and to individuate when the outputs reaches the 10% and the 90% of the maximum value. Function generator and oscilloscope can do it, as shown in Fig. 5.

Displaying of transfer function needs function generator and oscilloscope, as shown in Fig. 6. In this case the software must also process measured data.

The voltage offset measurements need only the multimeter. It measures output voltage. The virtual instrument refers the offset to the input, dividing it by amplifier gain.

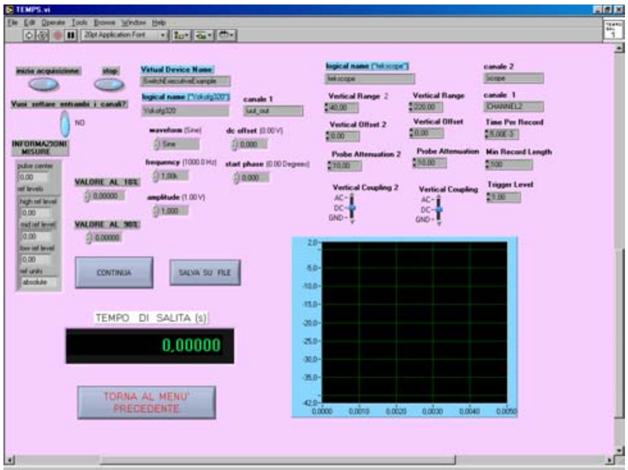

Fig. 5. Front Panel for rising time measurements.

The slew-rate is the maximum variation of the output voltage that an operational amplifier can produce. Its measurement can be obtained if the input of the amplifier is stimulated by a pulse waveform. Slew-rate is the experimental slope (amplitude/time ratio) measured on the output waveform displayed by the oscilloscope.

To make possible an off-line analysis, all the available configuration contains a save on file option.

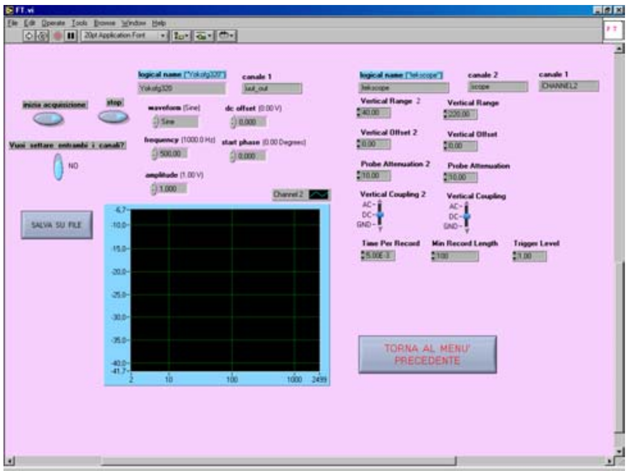

Fig. 6. Front Panel for tansfer function measurements.

The switch card can solve the problem to dynamically select several connections of the multi-channel instruments. In particular, we can provide to the user all the combination between the oscilloscope and the function generator.

When we developed the system, a switch device was not available. So we configured some simulation drivers for IviSwtch class through the MAX Virtual Device utility. For example, we worked with a simulated 4 row by 8 column SCXI-1127.

Due to IVI driver simulation feature, the entire system was able to manage the above measurements, also without a portion of expected hardware.

3. CONCLUSIONS

We realized an hardware-independent measurement system that can vary on the basis of user choices. It is possible not only to substitute instruments of the same class, but also to change the configuration of the system and to add new measurements.

The instruments are chosen in automatic mode, and there is no need to re-design the software, due to the use of IVI driver. User interface is easy and it is possible to rapidly obtain the desired measurements.

In the future, it will be possible integrate this system in a web site for the creation of a remote measurement system.

The same measurement system can involve several laboratories that can also have different instruments, on condition that these instruments are IVI-compliant.

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