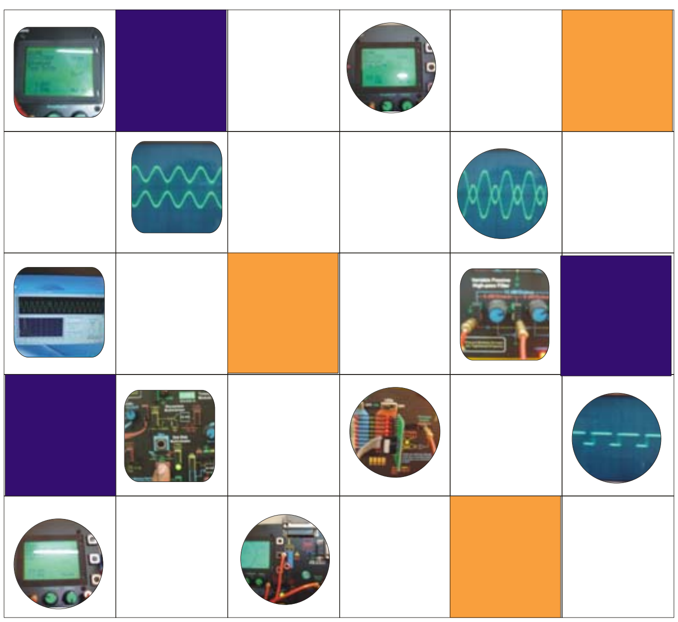
RIMS
Research Instrumentation
& Measurement Systems

DEV-2787

Virtual Instrumentation & Fundamental DSP Trainer

EXPERIMENTS

PART NO. 2787-00-321



COMPREHENSIVE AND ILLUSTRATED EASY EXPERIMENTS STARTUP LAB MANUAL

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Welcome to RIMS Virtual Instrumentation & Fundamental DSP Trainer

- ☑ ACQUIRING SERIAL DATA
- ☑ SOUND CARD BASE DATA ACQUISITION USING SOUNDAQ
- ☑ ACQUIRING DC VOLTAGES BY USING RIMS SOUNDAQ
- ☑ VIRTUAL OSCILLOSCOPE (EXAMPLE OBJECTIVE)
- ☑ SIGNAL CONVOLUTION AND CORRELATION

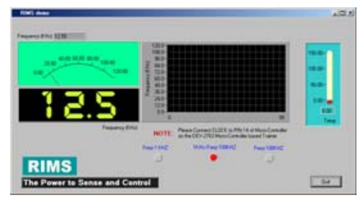
Product Title: EXPERIMENTS
Document Code: DEV2787-00-321
Revision 2.0.0 dated June 2006

STEP 1	ACQUIRING SERIAL DATA

Objective
To understand the concept of data acquisition, going through the whole process of signal acquisition, conversion and beyond.

Apparatus
DEV-27XX Development CD, DEV-2787E VI trainer

Procedure
In this lab you would do the same experiment but this time from a data acquisition and virtual instrumentation point of view. Upload the 'frequency' program in a microcontroller and place it in the DEV-2787E Trainer. Connect the DEV-2787E to the PC using a serial interface cable. Connect the **Waveform** to the pin number 12 of the microcontroller using a circuit patching wire. On the computer side open the application 'VMS' provided in the DEV-27XX Development CD.



Frequency Demo GUI

Now note that there is also a frequency being displayed on the LCD of the DEV-2787E. This frequency is the same as that being displayed on the Virtual Instrument on the PC. The frequency displayed on the LCD is an example of hard instrument, while the one being displayed on the Virtual instrument is an example of Virtual instrument. As you can see now we can do much more with the frequency in a VI: display it on a graph, gauge or display, have indicators for various ranges, and also record the data for future reference. Thus once the data has been acquired serially, it can be processed in a number of manners.

Lab Discussion
In this lab you were given a small intro on how to acquire data serially and display it on a virtual instrument. Details of how to make Virtual instruments depends on what software platform you will be using for development. The most famous ones are LabVIEW and LabWindows/CVI. You may learn both these tools using their reference manuals provided by National Instruments.

STEP 2	SOUND CARD BASED DATA ACQUISITION USING SOUNDAQ

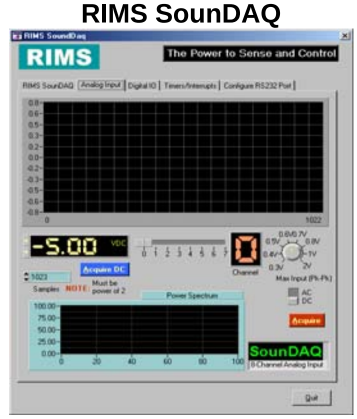
Objective
To get the student familiarized with the SOUNDAQ

Apparatus
PC, DEV-2787E Trainer

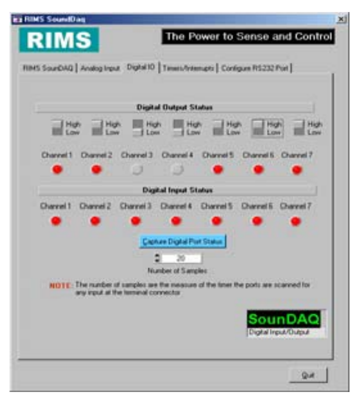
Procedure
As mentioned previously, SounDAQ is a data acquisition device with eight analog input channels and six digital I/O channels. For a start, take a BNC- to- thin point connector. Connect the BNC to the analog input channel of the SounDAQ and connect the other end to WAVEFORM in of the DEV-2787E with the other pin to the GND connector. Start the SounDAQ software. The GUI would be as shown in the above figures.
Click on the Analog Input tab, and then the Acquire tab to acquire the analog waveform from the DEV-2787E. The scope displays the waveform, the power spectrum of the wave acquired is also calculated and displayed in the allocated graph and the gain of the generated waveform can be calculated by selecting the Max Input dial. The DC offset in the waveform can also be explicitly selected and filtered from the waveform, along with its value measured. Selecting the number of samples can scale the waveform.
Now click on the Digital I/O tab. Change the **Number of Samples** in the digital I/O panel to 20 as shown in figure 33.Take a wire 8" long and strip off its ends. Connect one end of the wire to the +5VDC connector on the trainer and connect the other end to any one of the digital inputs of SounDAQ. Click on the **Capture Digital Port Status.** The inputs would change the status as you place the wire on the various digital inputs. Similarly, the status of the digital outputs can be changed using the switches on the SounDAQ GUI.

Lab Discussion
This lab served as a basic introduction to the SOUNDAQ, which can be employed as an excellent data acquisition tool. Once data has been acquired using the SOUNDAQ, any kind of signal processing can be applied to it. This is what we would practice in the coming labs.

RIMS SounDAQ



SounDAQ GUI

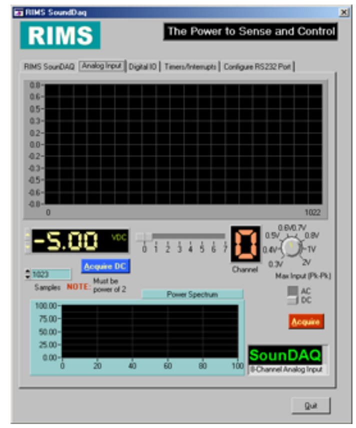


RIMS SounDAQ Digital Channels

STEP 3	ACQUIRING DC VOLTAGES BY USING RIMS SOUNDAQ

Objective
To acquire a DC voltage level by using the SOUNDAQ.

Apparatus
PC, SOUNDAQ terminal board, DEV-2787E VI trainer, circuit patching wire



Analog Inputs for SounDAQ

Procedure
Take a circuit patching wire and connect one end to the **Variable** Reference +VE supply on the DEV-2787E. Connect the other end of the wire to any of the analog input channels on the SOUNDAQ terminal board. Open the SOUNDAQ software, and go to the Analog Input Tab.

Click on the **Acquire DC** button; it would acquire the DC voltage level and display it in the Display. Read the displayed level. Now take a multimeter and measure the DC Voltage level at the **Variable Reference +VE.** The voltage level displayed by SounDAQ and that measured by a multimeter should be same. Now change the value from the knob and make another measurement. Both the measurements would coincide.

Lab discussion
Let's take a closer look at what is happening in this lab. The SounDAQ has an 8-bit A-D converter which is being controlled by a microcontroller. Once you click on the **Acquire DC** button you send a request from the PC to the SOUNDAQ to check the current DC voltage level at the input, to convert it into a digital format and to send it to the calling software. These tasks are accomplished by the SoudDAQ's microcontroller and the A/D.

STEP 4

VIRTUAL OSCILLOSCOPE
EXAMPLE OBJECTIVE

To give the students a first hand feels of how virtual instruments can work stand alone, i.e. without the Data Acquisition part. In this lab you would be shown a virtual oscilloscope.

A Virtual Oscilloscope

Apparatus
DEV-27XX Development CD

Procedure
From the development CD open the Scope Demo. The following screen should open up:

This is a demonstration of a virtual oscilloscope. For those not familiar with the oscilloscope, it is an instrument used to observe the waveforms of various signals. The amplitude and frequency of the waveform can be varied by using the Volts/Division and Seconds/Divisions knobs respectively. Normally an oscilloscope has a pair of channels i.e. it can acquire two waveforms and display them. The virtual oscilloscope has been modeled on the original oscilloscope. A virtual sine wave is being displayed on the scope in figure 35. The amplitude and the frequency of the wave can be changed using the two knobs. You can change the values your selves and see what happens.

Lab Discussion
In this lab you were shown another one of the virtual instruments; this one was working without any external interface, i.e. data acquisition. The purpose is to show you that virtual instrumentations don't have their implications in data acquisition only but can be used for a wide variety of purposes.

STEP 5	SIGNAL CONVOLUTION AND CORRELATION

Objective
To demonstrate the concepts of convolution and correlation and demonstrate to the student the power of virtual instruments in signal processing

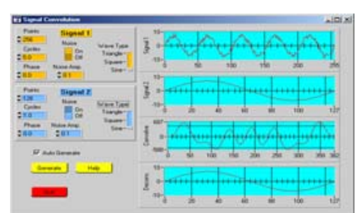
Apparatus
The DEV-27XX Development CD

Theory
Convolution of two signals is defined mathematically as,

$$Y(t)=f(t) * g(t) = \int (f(\tau)\ g(t-\tau)d\tau$$

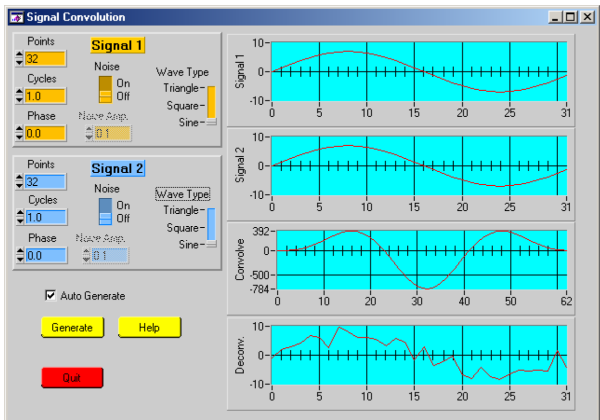
Conceptually, two signals are taken, one of them is flipped and the other is slid over the flipped one. Sliding one signal on the other results in an output signal, which shows the maximum, and minimum values in both the signal related in time. Effectively it is the multiplication of the two signals, when one of the signals is flipped in time.
Deconvolution is the reverse operation of convolution. Deconvolving the output signal y (t) with any one of the input signals results in the other input signal i.e.
y (t) **deconv** f(t) = g(t)
y (t) **deconv** g(t) = f(t)

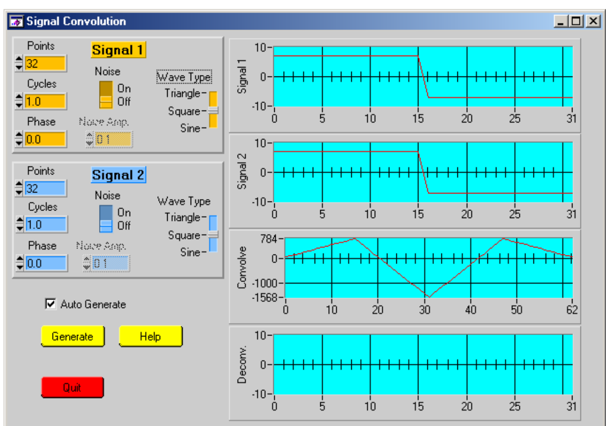
Procedure
Let's take a closer look at convolution using a VI developed in LabWindows/CVI. Open your DEV-27XX Development CD and run the application named **signal Convolution.** The following window would open.

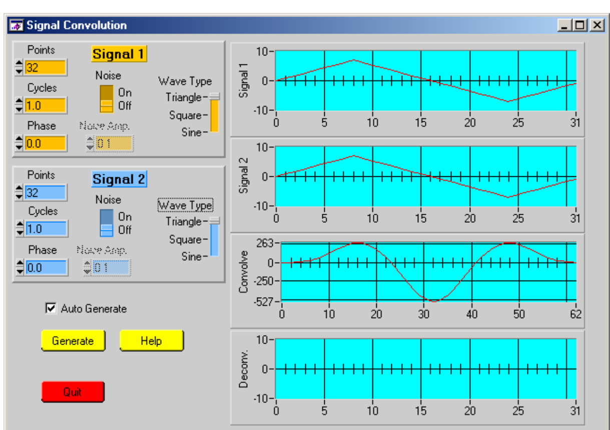


Convolution Example

Signal1 and Signal2 are the two signals, whose convolution and disconsolation are shown in Convolve and Deconv respectively. Settings of both signals can be modified, from their respective property windows. As a first step, remove the noise from signal 1. Modify the number of points of signal 1 and signal 2 to 32 points each and number of cycles to 1. See the resulting convolution. Now change the wave type from sine to square and triangle and observe the result in each case.



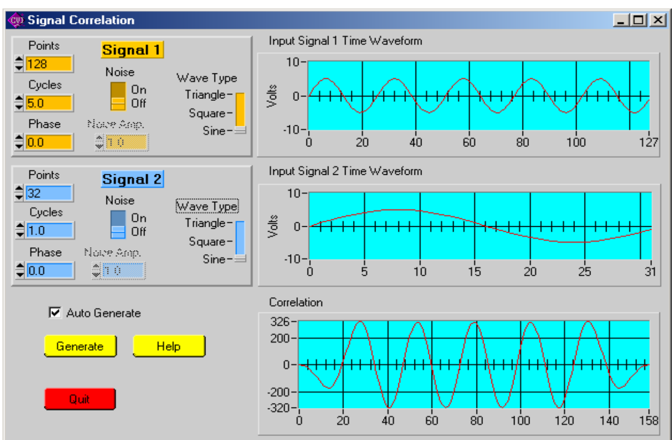




Convolution of square and triangular waves

The convolution is more or less the same, but the disconsolation of square and triangular wave does not exist. This is due to a limitation with the Fourier transform. Change various parameters of the signals and observe the result.

Another interesting function is the '**correlation'**, which, as the name depicts, is a measure of the degree to which two signals are co-related with each other. The basic difference between the two is that in convolution one of the signals is flipped in time whereas in correlation the image flip does not exist; one signal is simply slid over the second one. To observe the concept of correlation visually, open the DEV-27XX Development CD and click on **signal Correlation** application. The following window will open:

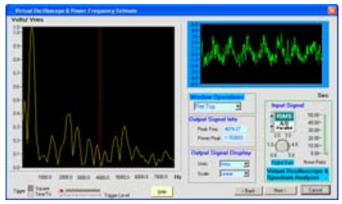


Correlation Example

Again you can change the settings of both signals from the properties window and observe the result.

Lab Discussion

The concepts of convolution and correlation are very difficult to analyze without a visual display. This lab would serve a good purpose in that aspect. In addition this lab was also meant to provoke your interest in VIs. Imagine getting these signals from a real system and then processing it in the way you did. This is what actually what we are going to aim at: acquiring data, displaying it on a virtual instrument and then applying signal processing on that data.



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