

Virtual Signals Lab.

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Category:

Academic

Products Used:

LabVIEW™

The Challenge:

To build a signals lab that can be used by students and professionals to experiment and learn the behavior of different kind of algorithms, variables and parameters in signals processing with the only aid of a personal computer.

The Solution:

A National Instruments LabVIEW software comprising more than 60 instruments each one designed to simulate and experiment with a different aspect of digital signals processing.

Abstract:

The digital signals processing field has its roots in the mathematics of centuries 17th and 18th and has become an important tool on many fields of science and technology due to the vertiginous development of digital computers.

In digital signals processing we represent the signals by a sequence of numbers or symbols and then we process these sequences.

This virtual signals lab is a collection of many (more than 60) instruments, each one designed to experiment and evaluate a different signal process.

For example in the picket fence effect VI, (see figure N° 1)

The user can generate a sinusoidal signal between 100 and 101 Hz. and see what happens to the magnitude of the amplitude spectrum in the frequency bins around 100 Hz. He can also experiment with phase variations in the signal and with 9 different types of windows.

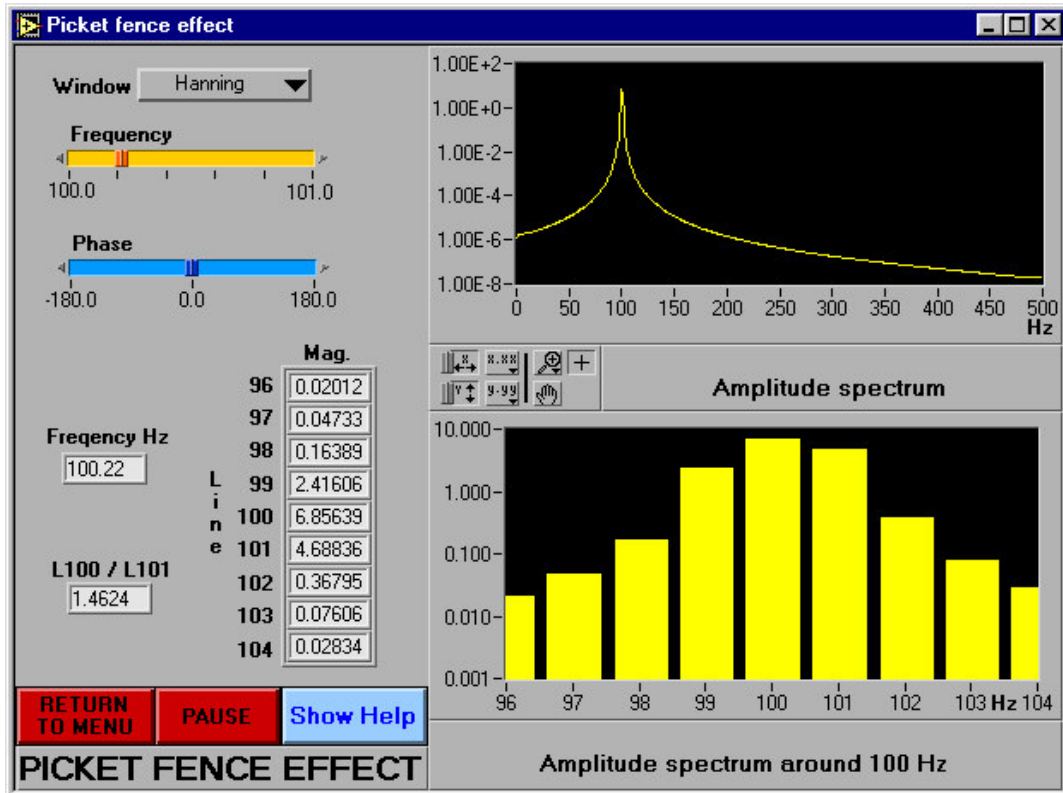


Figure 1. Front panel of the **Picket Fence Effect** simulator.

For every combination of these variables (frequency, phase and type of window) the instrument displays:

- A line graph of log amplitude vs. frequency for frequencies from 0 to 500 Hz.
- A bar graph of log amplitude vs. frequency for frequencies from 96 to 104 Hz.
- A numerical display of the magnitude of the frequency bins from 96 to 104 Hz.
- A numerical indication of the frequency of the signal, and
- A numerical indication of the value of bin 100 divided by bin 101.

Instrument Description:

The main menu serves as an index where the user looks and selects a topic and the instrument shows a list of the VI's related to that, so the user can go to any one of them. Every instrument designed has a help function that describes all the controls and indicators plus a general description of the instruments, its capabilities, its limitations, how it is operated, and a brief theoretical explanation of the process.

The instrument cannot acquire signals from real world, all the signals and processes are simulated and the kind of signals available in each instrument varies and some instruments

like the one described above, works with a sinusoidal signal only, but others work with several type of signals.

A partial list of the instruments is:

2D-FFT	Leakage
Aliassing	Linear Vs Log Amplitude Scales
Amplitude Modulation	Low Pass Filter
Amplitude Vs Power Spectra	Median Filter
Auto-Correlation	Noise and Windows
Bits Vs Resolution	Orbits
Ceptrum	Order Tracking
Clipping	Parsevals Theorem
Coherence	Phase In Time and Frequency Domains
Constant Percentage Bandwidth Filter	Picket Fence Effect
Convolution	Resonance
Cross-Correlation	Ridding and Beating
Deconvolution	RMS-Peak
Delta Function	Scaled Time & FFT
Derivative	Single Pole Filter Step By Step
Even & Odd Functions	Square & Sinc Functions
Fast Fourier Transform	Stroboscope
FFT Bandwidth	Time Displacement
FFT Linearity	Time Domain & Noise Average
FFT On Even & Odd Functions	Time Domain Average
Filter Response Time	Time Vs. Frequency
FIR Windowed Filter	Transfer Function
Frequency Displacement	Transients
Frequency Modulation	Windows & Amplitude
Harmonic Distortion	Windows Overlap
Hilbert Transform	Windows & Resolution
Integration	Windows Comparison
IRR Filter	

The figures 2 to 6 show the front panels of some of these instruments.

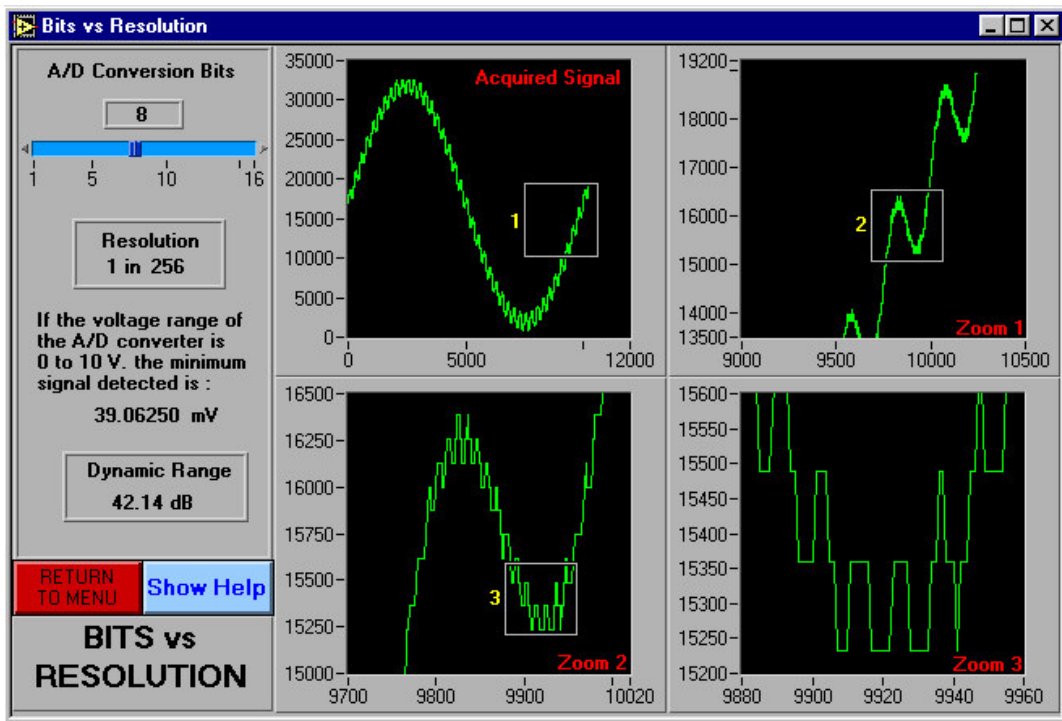


Figure 2. Front panel of the **Bits vs Resolution** simulator.

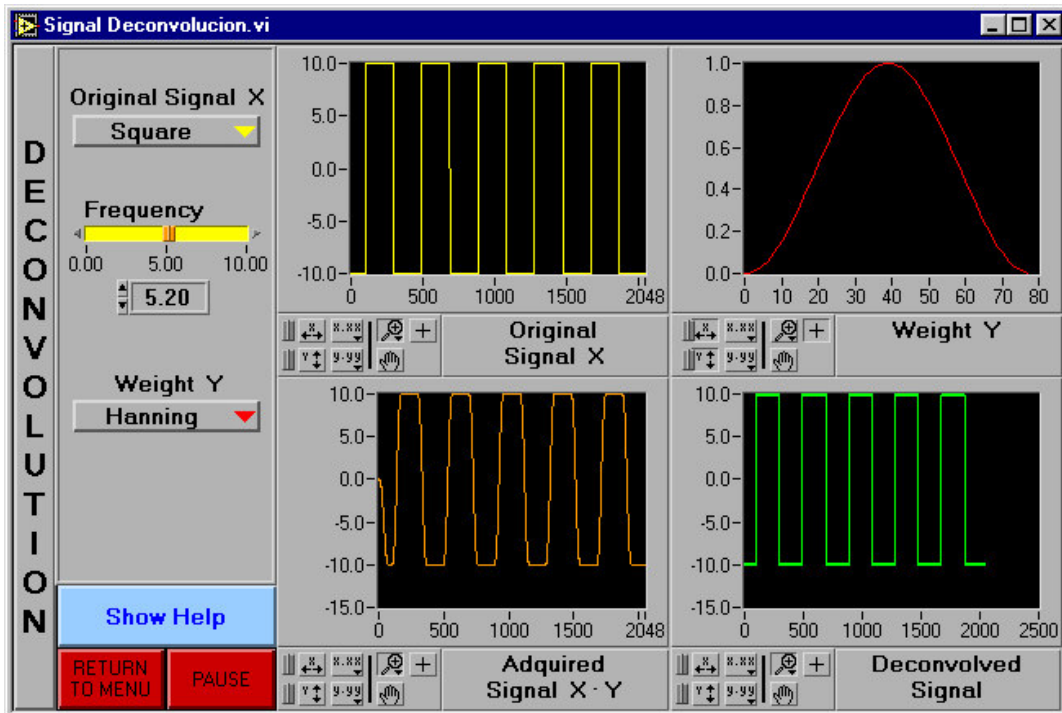


Figure 3. Front panel of the **Deconvolution** simulator.

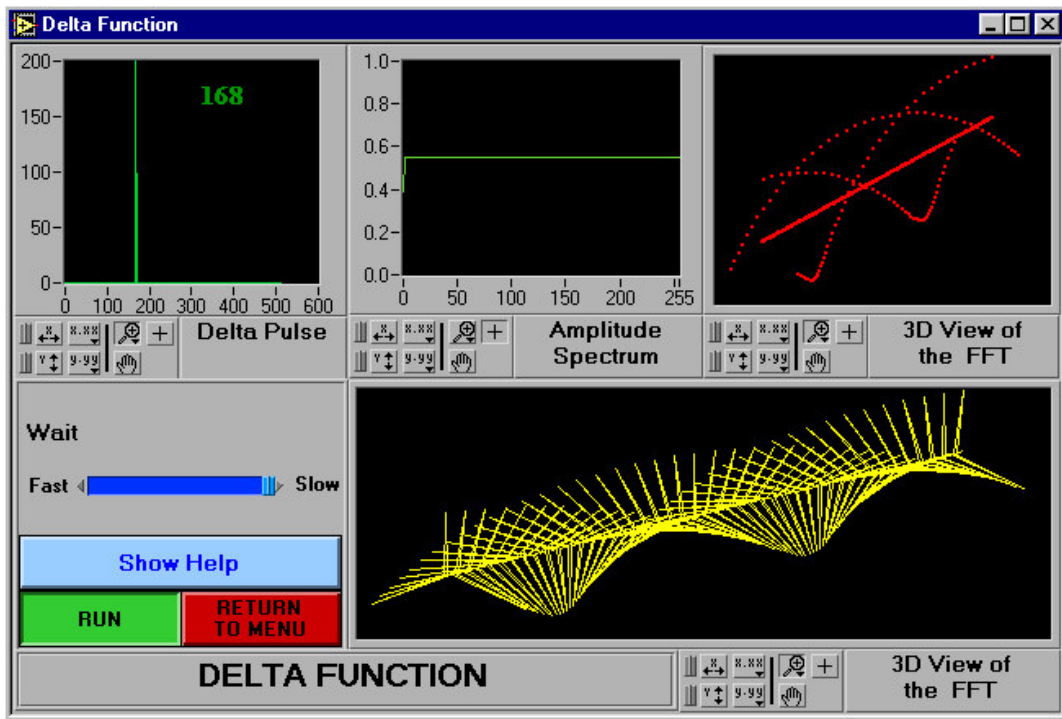


Figure 4. Front panel of the **Delta Function** simulator.

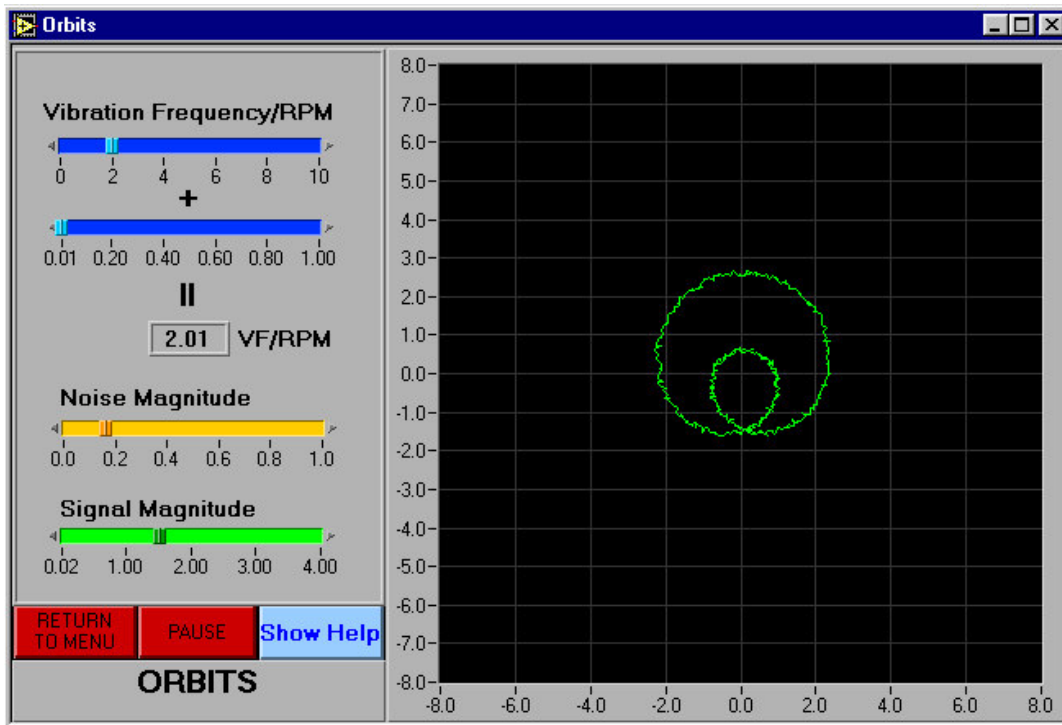


Figure 5. Front panel of the **Orbits** simulator.

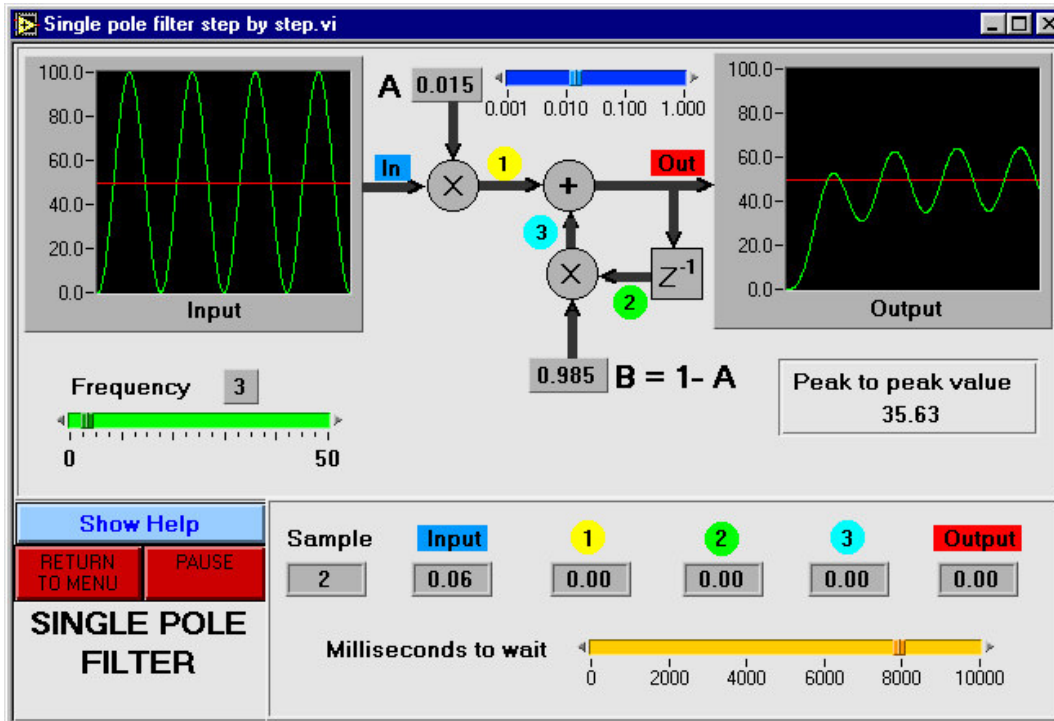


Figure 6. Front panel of the **Single Pole Filter Step by Step** simulator.

Concluding Remarks:

Virtual signals lab is a great help for engineering students taking courses in signals and systems, digital signal processing, analog and digital communications, signal analysis and many other specific courses like vibration analysis. It is also a good help for practicing engineers and scientists working with signals in any area of knowledge.