

▶ **SBench 6 Academic Guide**

Academic Guide to SBench 6 – Introduction

Spectrum's SBench 6 is a fast and easy to use data acquisition software package, running under either Windows or Linux, which supports Spectrum digitizers and generators. Using built-in demo modes it offers the ability to create, display, measure and process waveforms in the time, frequency and statistical domain without having physical hardware. In the academic environment it offers a free and easy to use work bench for studying basic signal processing methods and results.

What Can You Do with SBench6?

Generate Waveforms

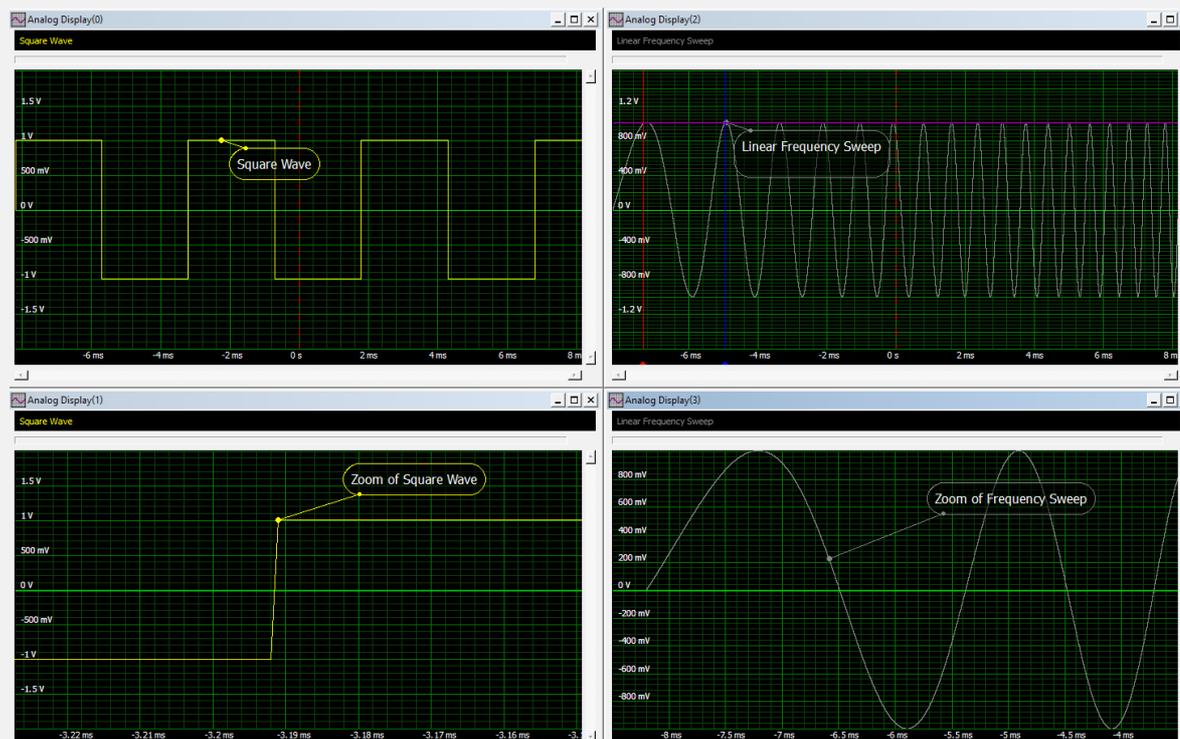


Figure 1: SBench 6 can create simple or complex waveforms

SBench 6 can create a broad range of waveforms, from simple classical waveforms like sine and square waves to complex modulated waveforms.

Basic waveforms like sine, square, or triangle waves can be created using a simple function generator tool called Easy Generator. For more complex waveforms the Function Generator tool can be used to create waveforms using equations. Figure 1 shows some examples, a square wave and a linear frequency sweep along with zoomed views of both waveforms. Waveforms from other sources can be imported as ASCII, WAVE, or binary files. Waveforms can be scaled to read vertical values in common engineering units. Once created waveforms can be displayed singly or overlaid. Comments can be added and moved anywhere on the display grid. Created waveforms can also be exported in ASCII, WAVE, and binary file formats.

▶ **SBench 6 Academic Guide**

Arithmetically Manipulate Waveforms

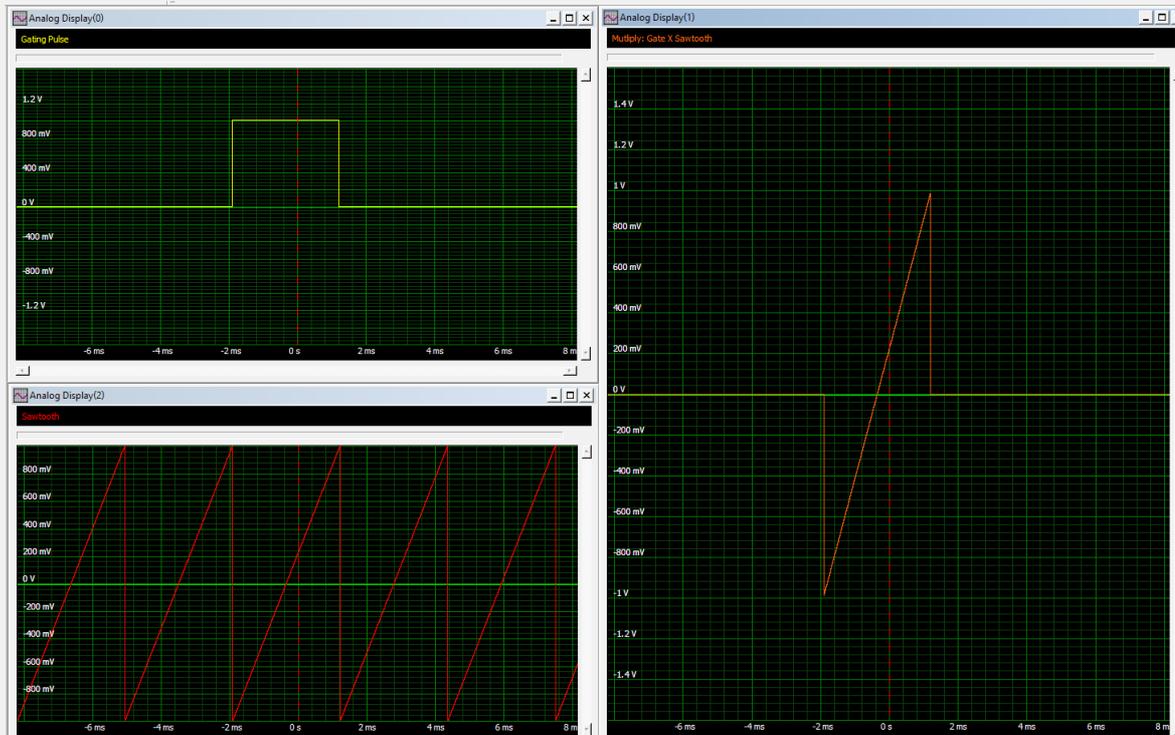


Figure 2: Using waveform multiplication to gate a single cycle of a sawtooth waveform by multiplying it by a unit pulse.

Once created waveforms can be arithmetically processed by adding, subtracting, multiplying or dividing them. Figure 2 provides an example of a sawtooth waveform being gated by a unit amplitude pulse using multiplication. The result is a single sawtooth. In a similar manor two waveforms can be subtracted from each other to form their differential signal or current and voltage waveforms can be multiplied to produce a power waveform.

▶ **SBench 6 Academic Guide**

Measurements on Waveforms



Figure 3: Measurement example showing the use of cursor and a small sample of measurement parameters applied to a half wave rectified sine waveform.

Time domain waveforms display amplitude information versus time. Dual cursors, on each display grid, offer a simple means of measuring the amplitudes and their respective time differences. In addition, a large number of amplitude and timing measurement parameters are available to provide information about the waveforms. Figure 3 provides an example of a half wave rectified sine waveform. Cursors measure the width of a pulse at half amplitude while parameters are used to measure the signal's maximum, peak to peak, average, and effective amplitudes along with the frequency and number of full cycles.

► **SBench 6 Academic Guide**

Filter Signals

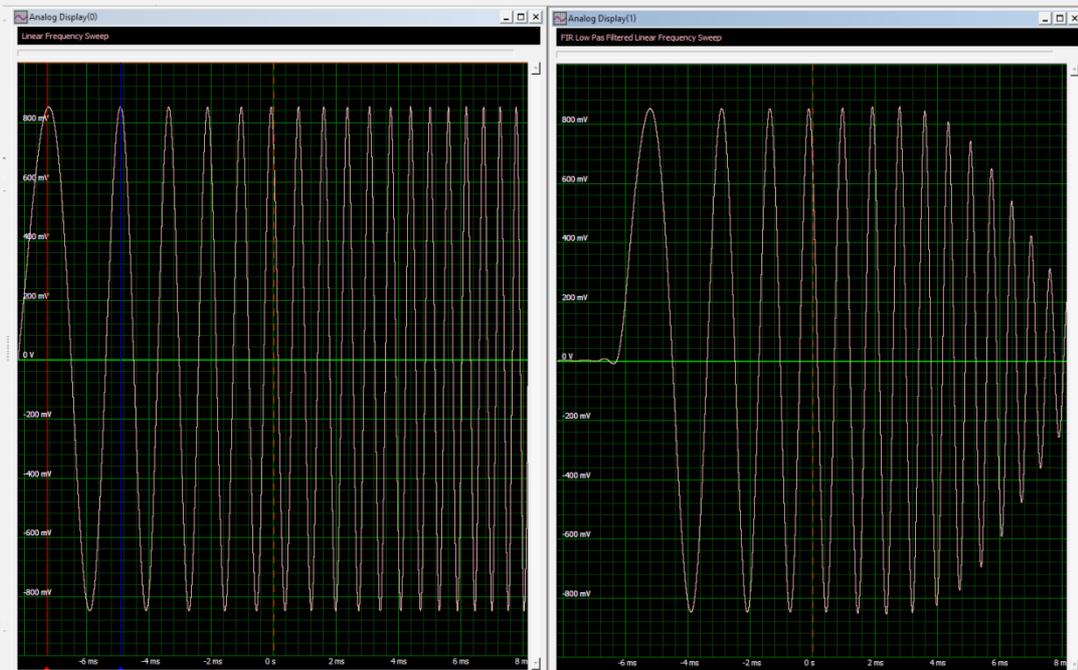


Figure 4: A 1.5 kHz low pass filter applied to a linear frequency sweep. Low, high, bandpass FIR filters are available

SBench 6 offers the ability to create, study, and apply low pass, high pass, bandpass and custom finite impulse response (FIR) filters. Figure 4 shows a linear frequency sweep applied to a 1.5 kHz low pass filter and the resultant filtered output. Filtering is an easy way to remove noise from a signal within selected frequency ranges. It can be used to improve signal-to-noise ratios and effectively increase measurement resolution even for single shot acquisition.

► **SBench 6 Academic Guide**

Signal Averaging

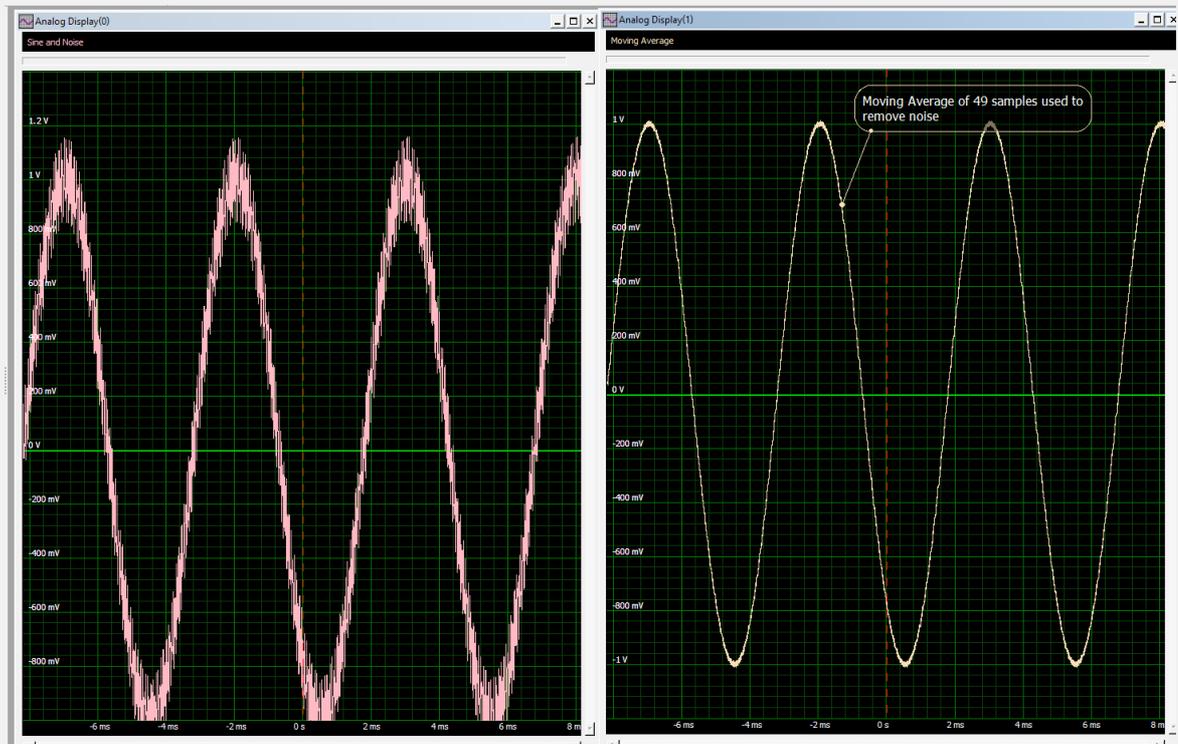


Figure 5: Using a moving average to remove noise from a sine wave.

SBench offers the choice of ensemble or moving averaging on signals or their spectra. In Figure 5 a moving average is used to remove noise from a sine wave. Like filtering averaging improves the signal to noise ratio, raising signals out of background noise.

► **SBench 6 Academic Guide**

Spectrum Analysis

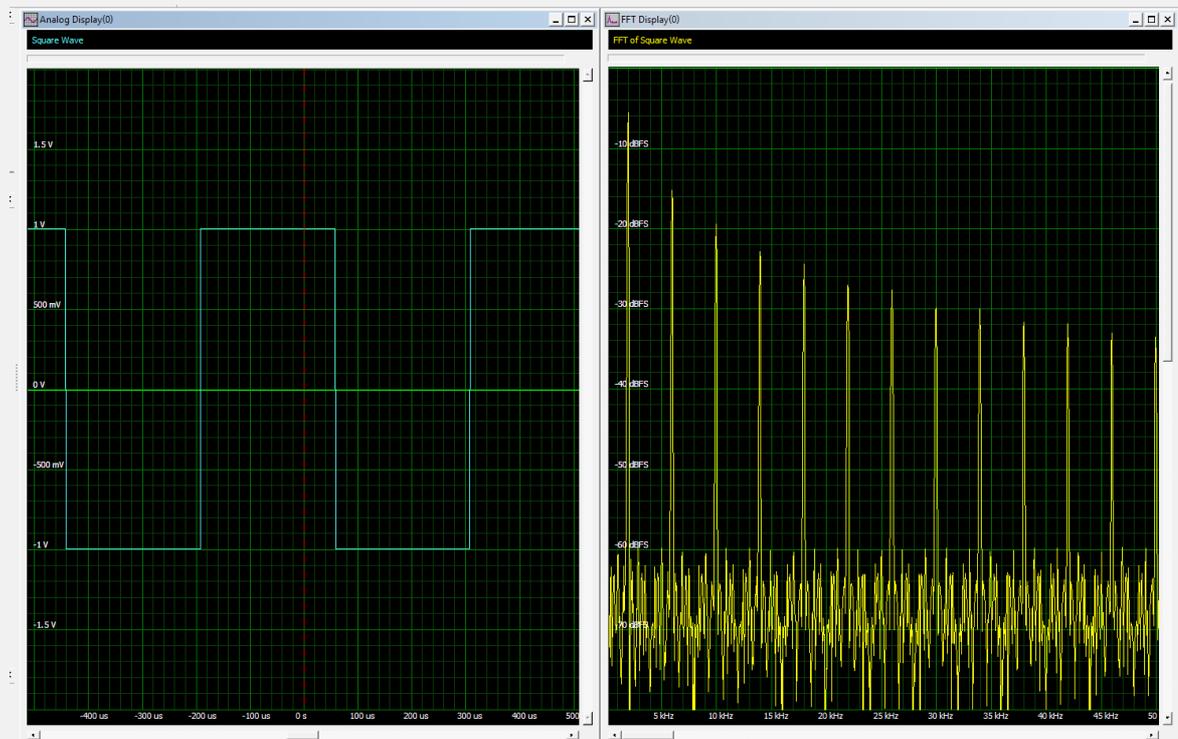


Figure 6: Using the Fast Fourier Transform to view the frequency content of a square wave.

SBench 6 includes Fast Fourier Transform (FFT) to view the signals you create in the frequency domain. An FFT allows you to look at the frequency content of a signal, determine the frequency response of filters and other signal processing functions.

Convert Signals between the Analog and Digital Domains

Analog Signals can be converted into digital signals using SBench 6 to view them in the digital domain. These same digital versions of the signal can also be converted back into the analog domain with a different digital resolution as shown in Figure 7. This allows you to evaluate the effects of digital resolution on you signal.

▶ **SBench 6 Academic Guide**

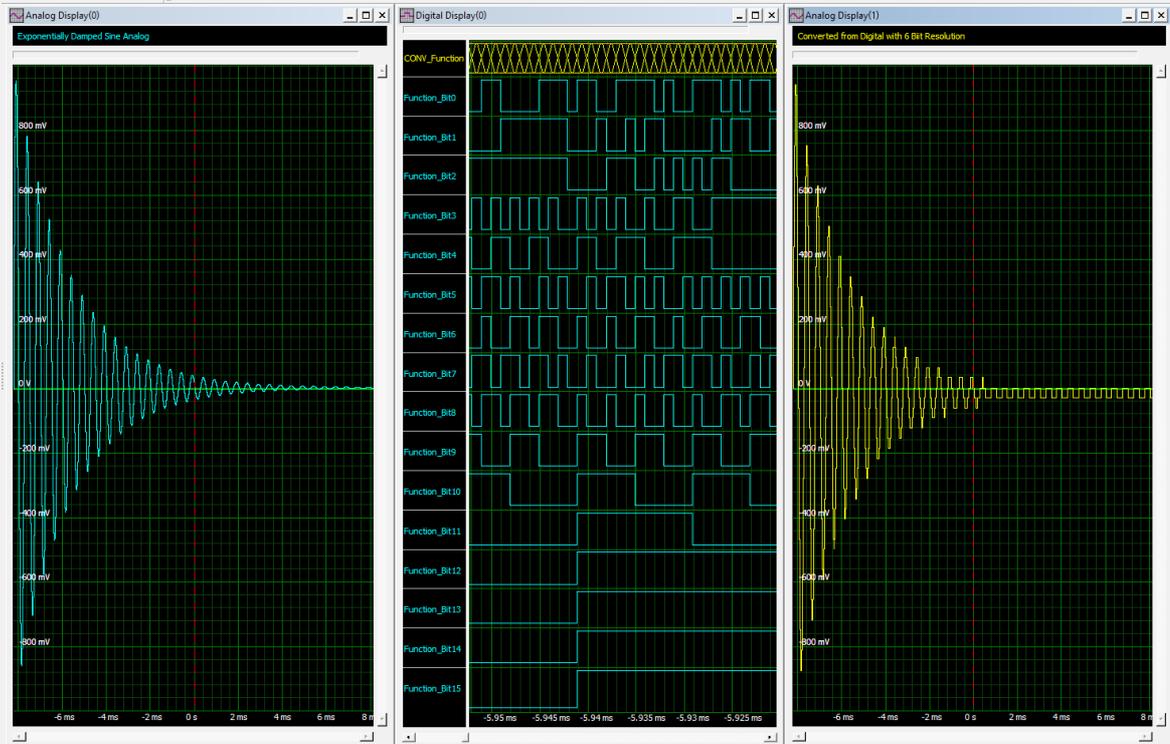


Figure 7: An analog signal converted into a 16 bit digital signal and then converted back to the analog domain with only 6 bit resolution. Note the loss of detail at lower amplitude levels.

The analog signal on the right side of Figure 7 was converted from the digital domain with only 6 bit resolution. Notice the effect on the low amplitude signal components.

Histograms

Histograms provide a view of the signal in the statistical domain. They show the probability that a given sample within the signal is within a fixed voltage range. The histogram is an estimation of the probability density function (PDF) of the waveform. SBench 6 can also show the histogram of a waveform like the histogram of a noisy sine wave shown in Figure 8.

▶ **SBench 6 Academic Guide**

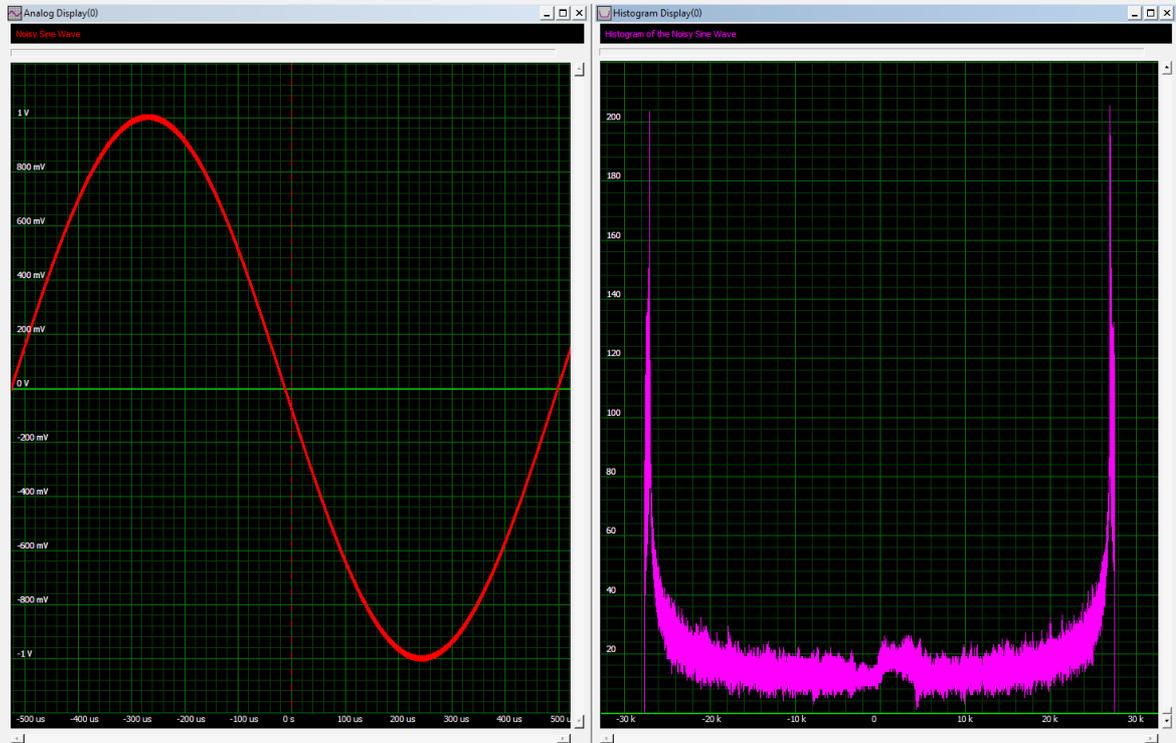


Figure 8: A noisy sine wave and its histogram

The histogram of a sine wave is 'saddle' shaped with peaks on either extreme representing the amplitude peaks. At the peaks the sine's rate of change is very low and there are many more samples taken. The 'seat' of the saddle represents the areas on the slopes of the sine where the rate of change is much higher (peaking at the zero crossing) and few samples are taken. Noise tends to broaden the histogram.

Conclusion

SBench 6 offers a host of waveform creation and analysis tools for engineering students who want to learn about signal processing and analysis.

The accompanying manual and application notes provide insight into how to use SBench 6's tools:

- SBench 6 Data Acquisition Software for Windows and Linux Software Manual
- Creating Waveforms in SBench 6 Using Formulas
- SBench 6, a Powerful, Interactive Software Tool for Acquiring and Analyzing Digitizer Data
- Signal Processing for Digitizers
- Teaming an Arbitrary Waveform Generator with a Modular Digitizer for a Stimulus-Response Test System