LeCroy

STATISTICAL ANALYSIS
(WR_XI NOTE 1)

WaveRunner Xi brings WaveRunner class performance to the large screen–small footprint configuration pioneered in the award winning WaveSurfer oscilloscopes. Among the many features that are included in the WaveRunner Xi is statistical analysis. The standard configuration includes histogramming up to 1000 values and LeCroy's exclusive Histicons. The optional WRXi-STAT package increases the maximum population to 2 billion parameter values and adds 18 statistical parameters to help interpret the data.

Histograms, such as the example shown in Figure 1, plot a count of the number of measured parameter values in a range of values (called bins) versus the parameter value. In Figure 1 the histogram of the measured frequency shows a distribution of values around the average or mean value of frequency. The bell-shaped distribution function, called a Gaussian or Normal distribution is a characteristic of random processes. The mean value of the frequency being measured is 10 MHz, which can be read from the parameter P1 statistics readout. The distribution, in this case, is centered about the mean value. The standard deviation (sdev) is a statistical value that indicates the dispersion of the measured values around the mean value. A smaller standard deviation means the histogram is more tightly centered around the mean value. Figure 2 shows a

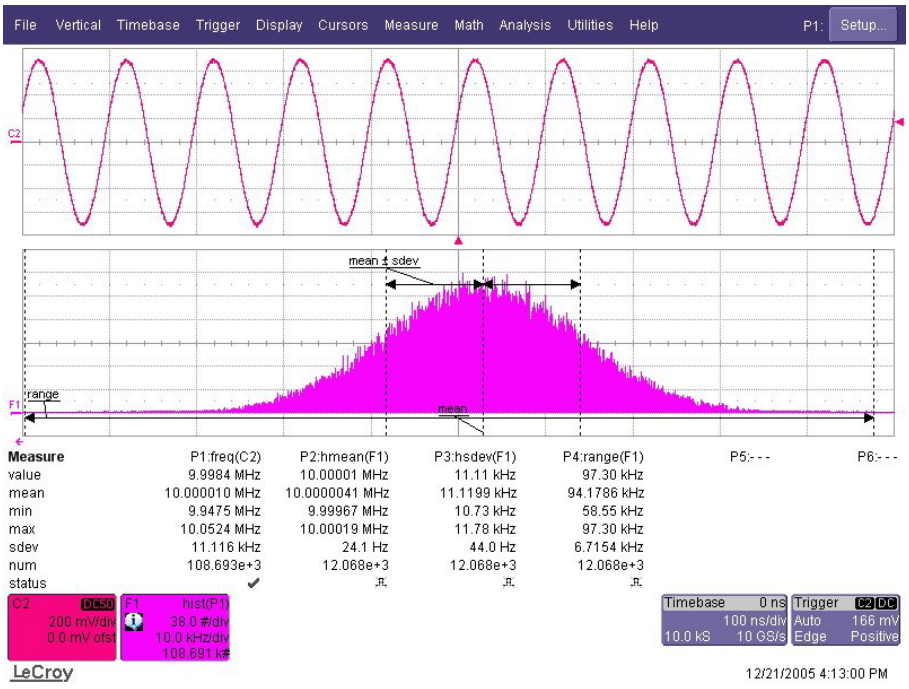

Figure 1: A histogram of the frequency parameter showing a Gaussian or Normal distribution characterized by histogram parameters.

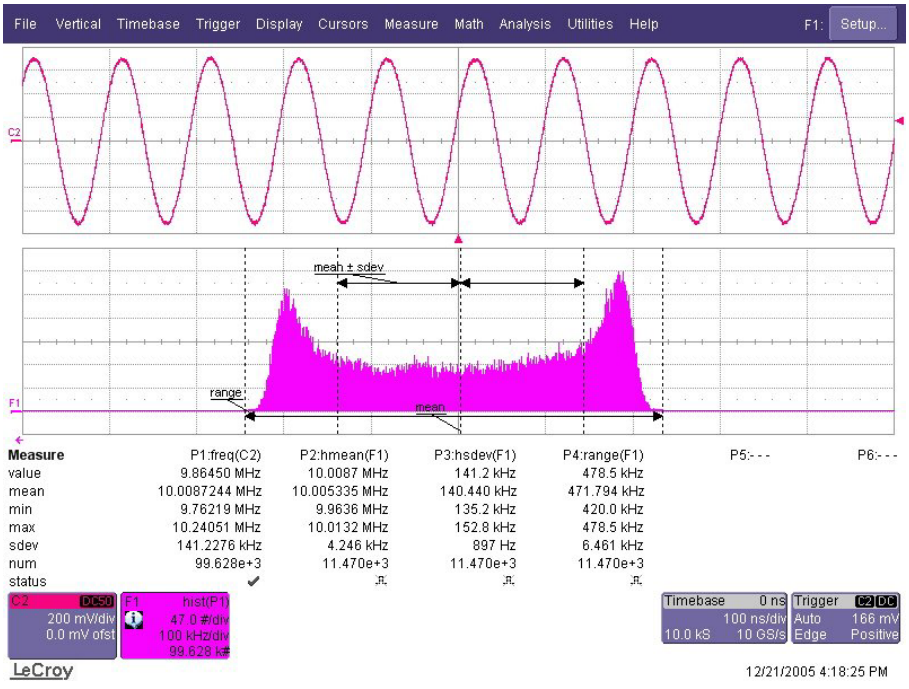

Figure 2 – Sinusoidal modulation of the 10 MHz carrier results in a totally different distribution.

different distribution. This distribution is the result of sinusoidal modulation of the 10 MHz carrier. Note that the statistics show that both waveforms have the same mean value but that they differ in the standard deviation. That is because the frequency of the modulated waveform is shifting over a range of frequencies, which, in this case, happens to be about 400 kHz. The range parameter reads the difference between the highest (max) and lowest (min) parameter value encountered.

Clearly, the ability to see the distribution provides invaluable insight into the underlying process that no single numeric readout can equal. Keep in mind that histograms of parameter values are a unique feature of LeCroy scopes. Most other manufacturers only provide display based histograms, which can only show the distribution of edges.

Another commonly encountered distribution is shown in Figure 3. This is a uniform distribution that is found in timing measurements. In this distribution any of a range of values is equally possible. Distributions like this arise when you try to synchronize devices operating on different clocks.

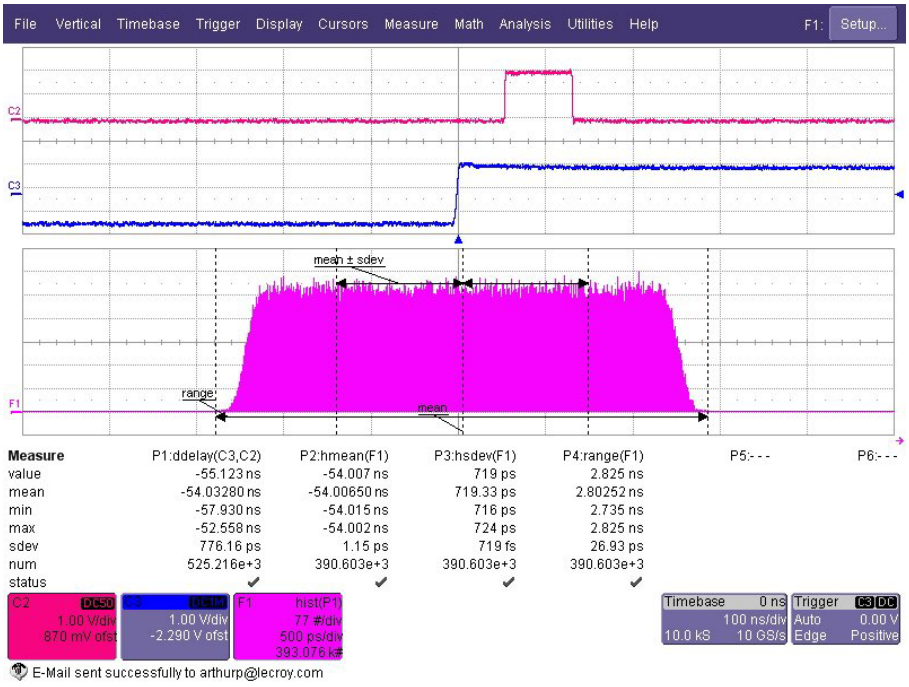

Figure 3: An example of a uniform distribution

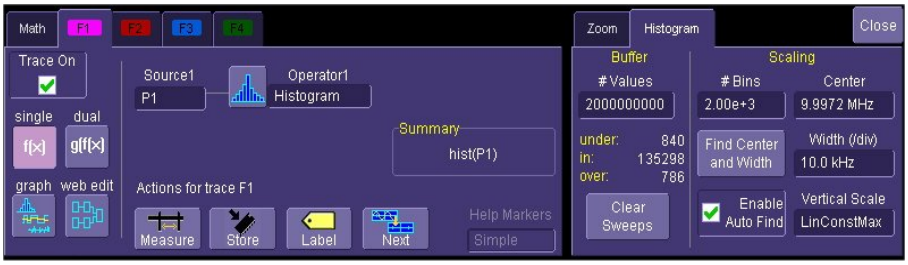

Figure 4: The dialog box for setting up a histogram

Figure 4 shows the dialog box used to set up the histogram. The source for a histogram can be any parameter value or the sample values of any waveform. Standard WaveRunner Xi scopes include histograms with up to 1000 values. The optional WRXi-STAT package increases the maximum number of values to 2 billion. While this may seem like a very large number, keep in mind that whenever you do statistical analysis the larger the number of measurements included the better the results. All of the examples above used greater than 100,000 parameter values.

The number of bins can be set by the user to anywhere from 20 to 2000 bins in a 1-2-5 sequence. In general we recommend using 200 bins for amplitude and 2000 bins for timing related parameters.

The Find Center and Width button will automatically center the histogram on the display. If the user wishes, checking the Enable Auto find check box will re-center the histogram after each acquisition. These are extremely helpful features that get the histogram on the screen without having to search for them.

Histograms offer a simple graphical display of a large amount of data and an alternative view of the data that often reveals hidden problems. Your next scope should include this feature.