Using Histograms I

Use Statistical Analysis To Characterize Random Events

Electronic measurements produce data that contains both systematic and random variations. For example, the width and period of a clock pulse can be viewed as having a nominal value accompanied by a random variation which we call jitter. Statistical analysis allows engineers to study and characterize these random processes thereby gaining insight as to their causes. The LeCroy Parameter Analysis option, model 93XX-WP03, offers engineers an ideal tool for visualizing and quantifying random processes as shown in figure 1. The histogram display shows the shape of the distribution of parameter values and statistical parameters provide accurate and concise measurements of that distribution.

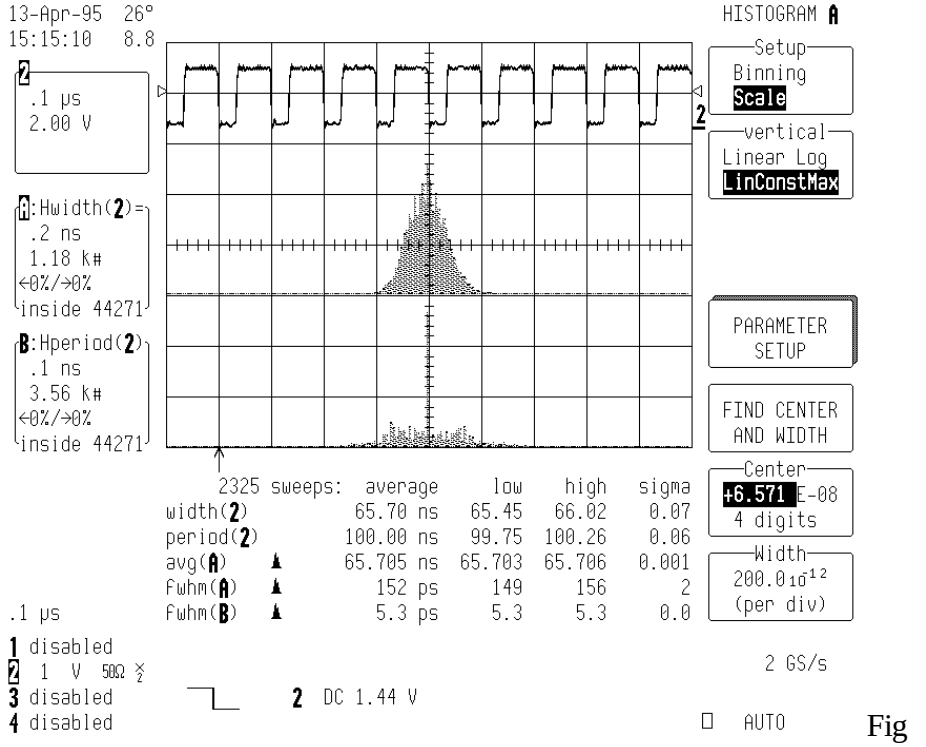

Figure 1-Histograms of the width and period of a clock waveform show different distributions of time jitter

The distribution of measurement values is related to the underlying process which generates the distribution. Figure 2 is an example of a random process than produces a Gaussian or normal distribution of amplitude values. The Gaussian distribution is a good indication that a random process is shaping variations in the measurement.

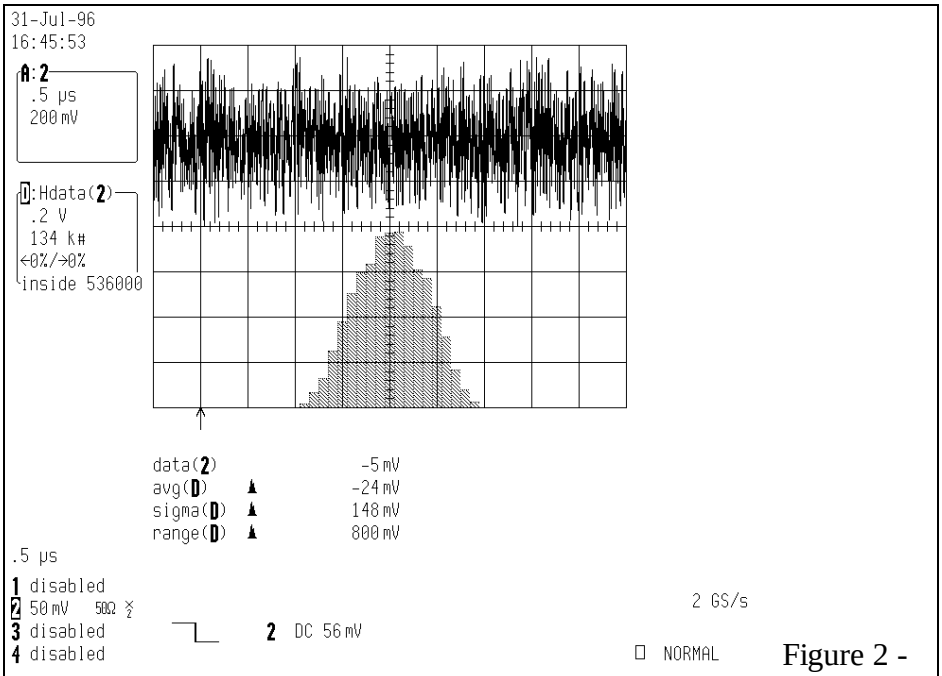

Figure 2 - The Gaussian distribution found in the amplitude values of a random noise generator.

Consider what happens when a Gaussian distributed noise signal is applied to an envelope detector as shown in figure 3. Here the process involves half wave rectification and filtering (simulated in the scope using waveform math) and the distribution of amplitude values changes to a Rayleigh dis-

tribution. The amplitude values are no longer symmetric about the mean value (the effect of rectification). Knowledge of these effects allows calculation of expected noise power related to the input noise levels. Conversely, if the process were unknown measurement of the input and output distributions would help identify it.

Let's look at another distribution. The uniform distribution of delay shown in figure 4 is characteristic of normal operation in a timing synchronizer. This circuit synchronizes a random trigger event with an internal 400 MHz clock (2.5 ns period). If the input signal is independent of the system clock then there is an equal probability of having any value of delay between the input and output over the range of 1 clock period. In this example observe that the primary distribution of the measured delay varies uniformly over a range of 2.5 ns as expected, but occasionally a longer delay occurs. This highlights an advantage of the statistical study of measured data in that it quantifies rarely occurring events which might be otherwise missed.

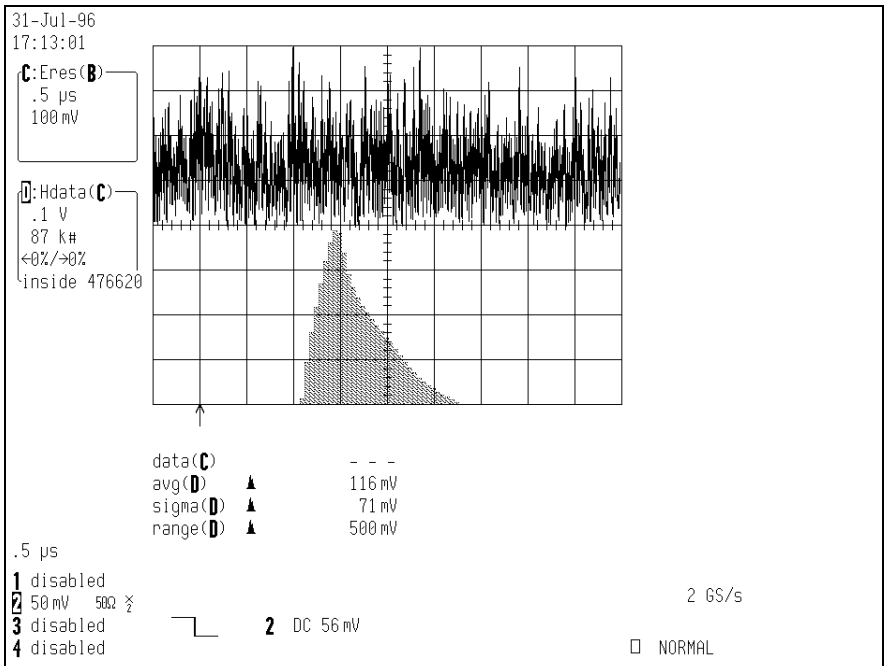

Figure 3 - The effect of passing Gaussian noise through an envelope detector.

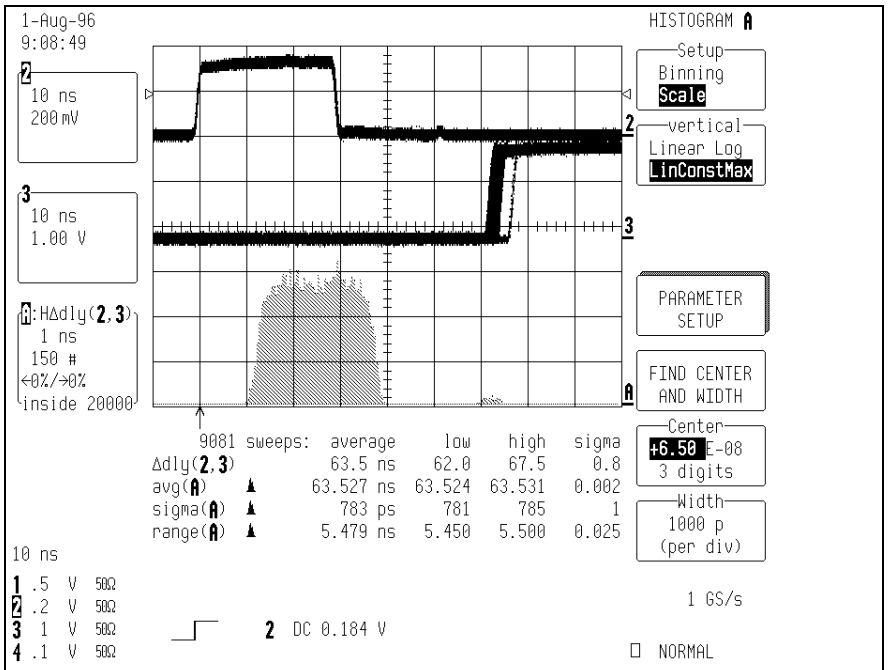

Figure 4 - The uniform distribution of delay due to a properly operating timing synchronizer