Test & Measurement

Eliminating The Dead Zone In Scope Measurement

By Mike Hertz and John Seney

AIM (all instances measurement) has long been the dream of oscilloscope users. To fulfill this dream, scope manufacturers have tried to produce instruments with successively shorter refresh rates or 'dead zones'... with the holy grail of 'zero gap' measurements being the goal. As signals become more complex AIM becomes more essential to the point where, with some signals, measurements with gaps are useless.

The good news is that a nonlinear increase of oscilloscope acquisition memory has produced a new operational model. Now in a single acquisition more than 126 miles of contiguous scope screens can be captured.

Scope designs have always focused on accurate portrayals of signal activity. Regardless of trigger rate, acquisition dead times occur between each trigger leaving large time gaps of missing information. The solution for gaps is to use one trigger with very long memory.

Signals are longer and more complex than ever before. Previously, a scope with a one million sample point acquisition memory was considered long while scopes with only 50 kpoints were considered to have short memory. But a 'short' memory scope that sampled at 1 GS/s (one sample per nanosecond) into 50 kpoints of memory captures exactly the same amount of signal length as a new 20 GS/s (20 samples per nanosecond) that has 1 Mpt. Both of them are short memory — they can only capture a short period of time, 50 usec, at their maximum sample rate. The recent advance of acquisition memory now allows for 100 million sample points (100 Mpts) to be captured in a single acquisition.

Consider equation 1: Each 10.4" diagonal scope screen displays 8" of waveform data horizontally. Viewing a 3.125 Gb/s differential XAUI signal, 15 bits will be shown when the timebase is 500 ps/div or 5 ns across the display. At 20 GS/s, this timebase setting corresponds to 100 samples being displayed.

With 100 Mpts acquired instead, the scope

$$\left(\frac{100Mpts}{acquisition}\right)\bullet\left(\frac{8''\,display}{100pts}\right)\bullet\left(\frac{1\,foot}{12''}\right)\bullet\left(\frac{1\,mile}{5280feet}\right)=\frac{126.26\,display\,miles}{acquisition}$$

Equation 1: Converting waveform display to miles.

memory will now contain 15,625,000 consecutive XAUI bits. With timebase settings used in Figure 1, the 100 Mpt acquisition would occupy one million scope screens, or 126 miles of display distance. This 100 MSample record captures 5 ms of data at 20 GS/s. This allows measurement of periodic signal components down to 200 Hz while still maintaining the ability see spectral

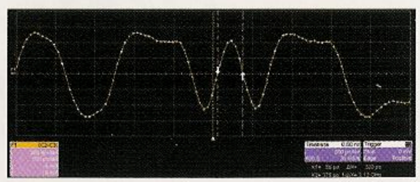

Figure 1: 100 waveform sample points displayed at 500 ps/div.

components up to 10 GHz. A long continuous acquisition is the best way to simultaneously observe both low frequency components (jitter due to power supply noise or low frequency modulation) or high frequency content (cycle-cycle jitter, intersymbol interference) of a complex signal.

Long Memory Scopes

It is not practical to manually pan through one million scope screens. Long memory scopes with All-Instance Measurements (AIM) can supply the complete statistical picture for any measurements selected, and can hold the AIM data for additional processing operations.

Tracks are time-correlated trends of parameter measurements. This makes finding signal aberrations fast and easy. The data acquisition memory of channel one, the yellow trace, contains all the data samples acquired. The track (blue) trace provides additional insight into signal behavior that cannot be determined from the yellow trace alone.

Another advantage of long acquisitions is the elimination of trigger jitter from timing measurements. In every long acquisition, all the samples have the same time displacement due to trigger jitter. Any relative time measurement automatically removes this common displacement, thereby eliminating trigger jitter from the measurement.

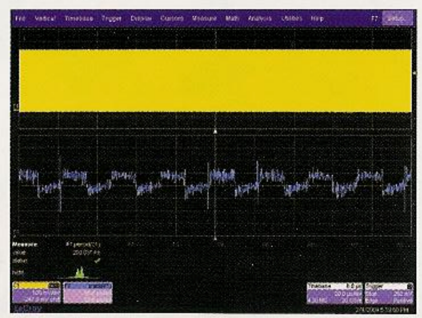

Figure 2: Track view of underlying frequency modulation.

Track vs. Persistence

Using a short acquisition memory, a persistence display generates a visual trace history as shown in Figure 3. This method is limited by a number of factors. A persistence display cannot show the signal aberrations that appear in Figure 2. The order of occurrence in the underlying modulation in Figure 2 is invisible to persistence. The track view provides information not available from simple viewing methods like persistence.

Statistically Significant

The long memory trace below contains 40 million sample points of a 500 MHz clock. Notice in Figure 4 there are almost one million risetime and

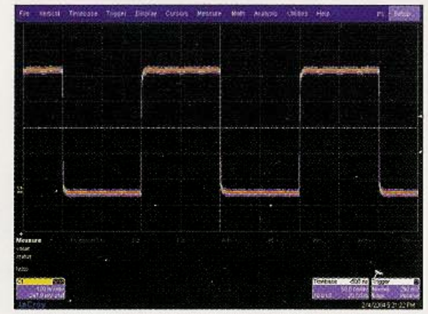

Figure 3: Persistance display of the same signal from Figure 2.

period measurements collected from a single trigger. Histograms for each measurement reveal additional insight about the signal's true dynam-

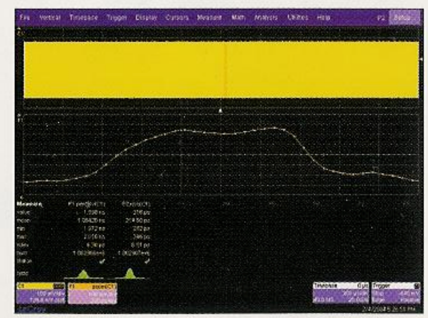

Figure 4: Statistics from a 40 million sample point acquisition.

ics. Note that zooming still allows traditional cycle-by-cycle viewing, showing one millionth of the original record, with the 50 ps resolution per point clearly seen.

(continued on page 20)

All-Instance Measurements (AIM) can supply the complete statistical picture for any measurements selected, and can hold the AIM data for additional processing operations.

Tracks are time-correlated trends of parameter measurements. This makes finding signal aberrations fast and easy. The data acquisition memory of channel one, the yellow trace, contains all the data samples acquired. The track (blue) trace provides additional insight into signal behavior that cannot be determined from the yellow trace alone.

26 display miles acquisition

Another advantage of long acquisitions is the elimination of trigger jitter from timing measurements. In every long acquisition, all the samples have the same time displacement due to trigger jitter. Any relative time measurement automatically removes this common displacement, thereby eliminating trigger jitter from the measurement.

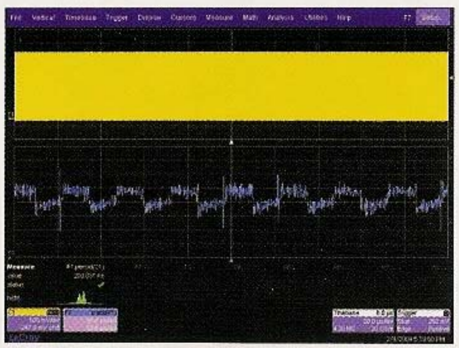

Figure 2: Track view of underlying frequency modulation.

Track vs. Persistence

Using a short acquisition memory, a persistence display generates a visual trace history as shown in Figure 3. This method is limited by a number of factors. A persistence display cannot show the signal aberrations that appear in Figure 2. The order of occurrence in the underlying modulation in Figure 2 is invisible to persistence. The track view provides information not available from simple viewing methods like persistence.

Statistically Significant

The long memory trace below contains 40 million sample points of a 500 MHz clock. Notice in Figure 4 there are almost one million risetime and

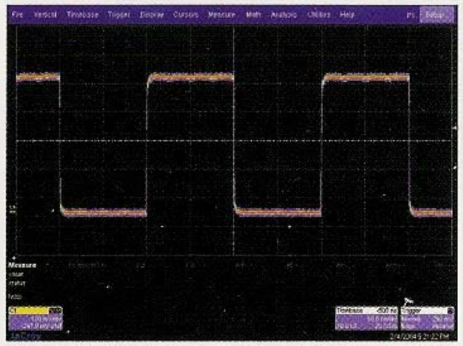

Figure 3: Persistance display of the same signal from Figure 2.

period measurements collected from a single trigger. Histograms for each measurement reveal additional insight about the signal's true dynam-

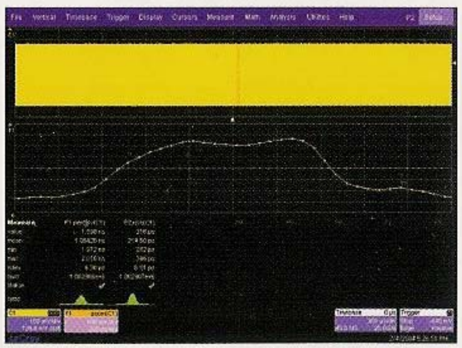

Figure 4: Statistics from a 40 million sample point acquisition.

ics. Note that zooming still allows traditional cycle-by-cycle viewing, showing one millionth of the original record, with the 50 ps resolution per point clearly seen.

(continued on page 20)

Test & Measurement

Serial Data Analysis

(continued from page 18)

Here is another example of a long memory record. This eye pattern display is generated from a 3.5 Gb/s SERDES chip. The traditional approach to collecting this data was to use a sampling scope in persistence mode. The screen image below (Figure 5) is unique in that the data was taken with

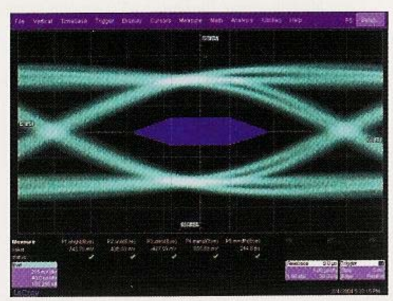

Figure 5: Eye pattern generated from a single trigger.

just one long memory acquisition. This single block of data was then partitioned into unit intervals and overlayed to create this eye pattern. Unlike a standard persistence method, this display is a result of exactly one acquisition and therefore contains no trigger jitter.

Because the entire record is stored in memory, all of the data is available to perform BER analysis, ISI, random and deterministic jitter, and identification of which exact bits were the source of each mask failure. Additionally, this process is over 1000 times faster than traditional scopes.

Summary of Long Memory Benefits

Long memory provides the following benefits: elimination of multi-acquisition dead time, identification of problems that are invisible in a persistence mode display, elimination of trigger jitter, increased statistical accuracy, simultaneous measurement and analysis of both high and low frequency signal content, and allows tracks that reveal anomalies from any measurable parameter.

With the complexity of today's signals, long memory scope records reveal information not available from any other method.

Mike Hertz and John Seney are with LeCroy Corp.

Circle CE 219