**Introduction**

Jitter is a well-known performance characteristic of (high-speed) telecom and datacommunication applications. As clock rates of computer systems and communication links increase, jitter is becoming a more important performance characteristic, because the already small timing margins are being consumed by this timing distortion. Today, leading manufacturers in the semi-conductor industry perform similar tests to the one featured in this product note.

Several methods are known to measure jitter. This product note describes the one using the Agilent Technologies 81200’s RTC (Real Time Compare) and BER capabilities, with reference made to one of the more traditional methods (using a high-speed sampling oscilloscope).

**Undersampling technique using a high bandwidth sampling scope**

Figure 1 shows the oscillogram of a jittered data signal, which was generated using a high-bandwidth-sampling oscilloscope.

To determine the signal’s rms- or pp-jitter, usually a zoom with respect to time and amplitude is carried out upon the pre-selected edge, which results in a display as shown in figure 2(a). In addition, a histogram, figure 2(b), is produced showing how many samples fall into the user-defined voltage window at every point in time.

This histogram (fig. 2) represents the edge probability density.

If you integrate this curve over time, the result would represent the edge probability.

Applying some mathematics to the histogram, the mean value μ and the standard deviation σ (the rms jitter) can be calculated.

**Using the 81200’s BER measurement capabilities to determine rms jitter**

While the oscilloscope uses a slow but precise A/D converter (12 or more bits) behind the input sampling gate to reconstruct the waveform, the 81200’s input stage only consists of a comparator with programmable threshold voltage (a 1bit A/D converter). The result of the comparison however, can be precisely clocked into the following stages for RTC and error counting with a resolution of less than 2 ps. By measuring the BER for subsequent timing points (not necessarily with the finest possible resolution), this feature can be used to generate a curve as shown in figure 3, which represents the opposite of the signal edge probability, i.e. “1-the signal edge probability.”

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1 The terms medium value μ and standard deviation σ stem from the gaussian distribution formula where 67% of all samples fall within an interval of ±1σ around μ and approx. 99.7 % fall within the interval of ±3σ, the reason why this number is taken as the pp-jitter.
Differentiating this curve over time and taking its absolute value (which doesn’t make any difference to calculating \( \mu \) and \( \sigma \)) reveals the edge probability density, i.e. the histogram shown in figure 2. If we then apply the same mathematical calculations, we gain the rms- and pp- jitter as above.

To make both results comparable, the voltage window for the histogram on the oscilloscope must be set as large as the 81200 comparator sensitivity.

**Selectively measuring the rising and falling edge with the Agilent 81200**

To achieve the result as shown in figure 2, some care in zooming the signal around its crosspoint and setting the histogram’s voltage is necessary. This is possible, as the signal (and by this the crosspoint) can be clearly seen on the screen while setting the voltage window. Wrong zooming results in a curve as shown in figure 5, which appears as a bimodal histogram.

Attempting to take the same measurement with the 81200 requires the same care in setting the 81200’s comparator threshold at the crosspoint. This is not such an easy task, as the signal cannot be seen as with an oscilloscope, so it is likely to result in a curve, as shown in figure 6.
However, through making use of the 81200’s capability to selectively count 1-errors or 0-errors, it is possible to selectively measure jitter of a rising or falling edge as shown in figure 7. When measuring at the end of a clock period (>50%) with counting only 0-errors, the jitter of the rising edge can be determined, whereas counting 1-errors lets you examine the falling edge. For measurements at the beginning of a clock period (<50%), everything is inverse. This method is not only a way to avoid the necessity of a precise comparator threshold setting, but gives additional information data to the user.

Effective jitter in the target application
Let us assume that in the target application, the stage driven by the DUT has a well-known threshold (and by this, we mean a behavior which is very similar to the 81200’s input comparator stage). In this case, the measurement of all errors is the right method, because the resulting jitter value with the corresponding threshold best characterizes the DUT’s performance in the target application.

Prerequisites and limitations
The usual measurement setup assumes that the 81200 will stimulate the DUT, from which the output jitter is determined.

If this is not the case, i.e. when the 81200 runs in external clock and external start mode, then the oscillator of the DUT must be very stable. Otherwise, the phase locked loop (PLL) tries to follow these changes, and as a result, the measured jitter is much higher.

The intrinsic timing accuracy of the 81200 (approx. 10 ps rms/ 50 ps pp) allows reliable measurements above 20 ps rms (100 ps pp).
Related Literature

Agilent 81200 Data Generator/Analyzer Platform, brochure

Agilent 81200 Data Generator/Analyzer Platform, data sheet

Agilent 81200 Data Generator/Analyzer Platform, configuration guide

Agilent 81200 IC/Circuit Characterization Package, brochure

Agilent E4874A Characterization Software Components for the 81200 Data Generator/Analyzer Platform, data sheet

Agilent E4839A Test Fixture, data sheet

BestLink/81200 Simulation Data Link for the Agilent 81200 Data Generator/Analyzer Platform, data sheet

Data Transfer between Design, Simulation and the Agilent 81200, product note

Panel Link Chip Set Test, product note

How to use the Agilent 81200 Data Generator/Analyzer Platform together with Agilent VEE for Signal Integrity Analysis, product note

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