

# Agilent 81200

## Measuring Jitter with the Agilent E4874A Characterization Software Components

Product Note

### 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  $\mu$  and the standard deviation  $\sigma^1$  (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."

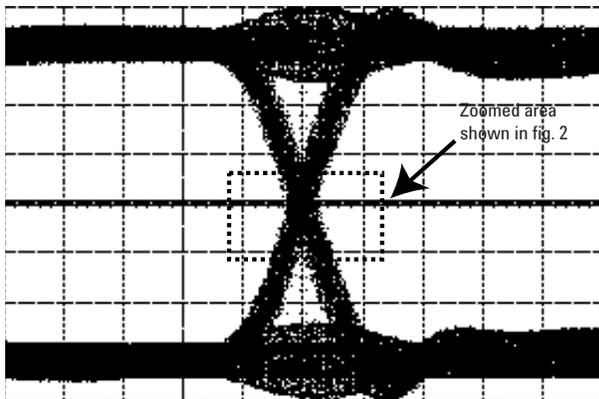


Figure 1: Jittered data signal measured with the Agilent 54120

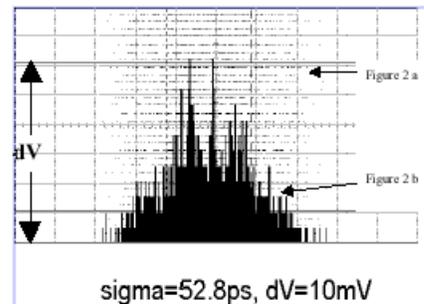


Figure 2: Zoomed edge and histogram(edge probability density)

<sup>1</sup> The terms medium value  $\mu$  and standard deviation  $s$  stem from the gaussian distribution formula where 67% of all samples fall within an interval of  $\pm 1 \sigma$  around  $\mu$  and approx. 99.7 % fall within the interval of  $\pm 3s$ , the reason why this number is taken as the pp-jitter.



**Agilent Technologies**

Innovating the HP Way

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.

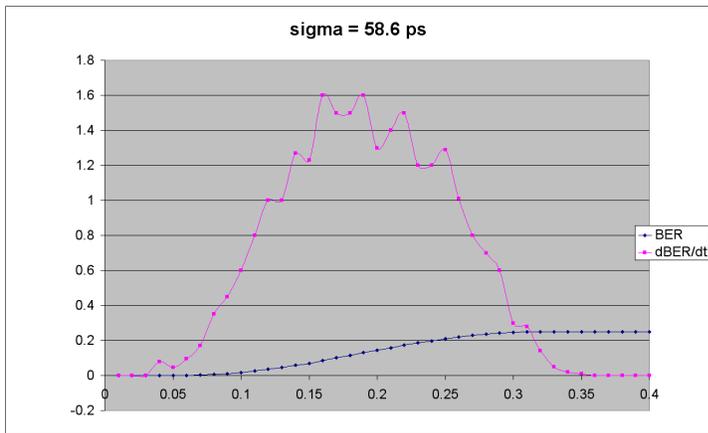


Figure 3: BER vs. time and abs (dBER/dt)

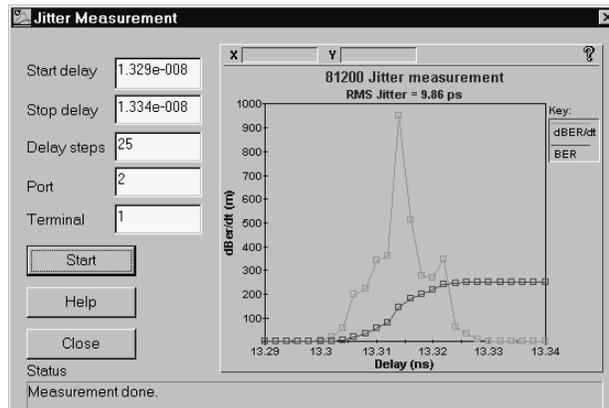


Figure 4: Example of a jitter measurement generated with the E4874A Characterization Software Components

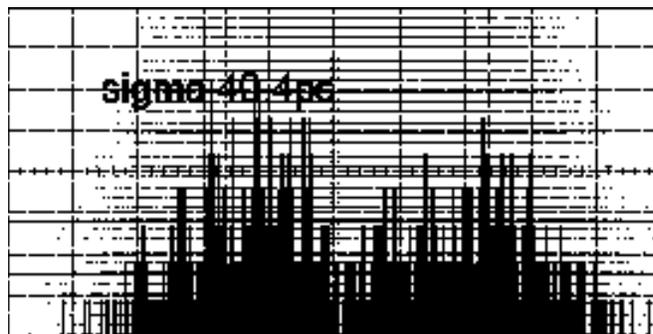


Figure 5: Bimodal histogram through wrong zooming

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.

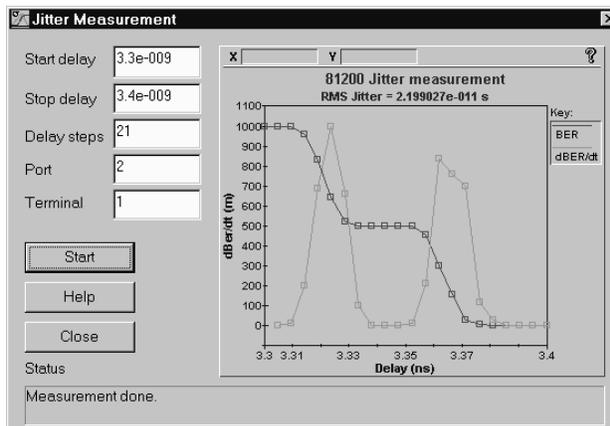


Figure 6: Bimodal histogram through wrong threshold setting

### 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).

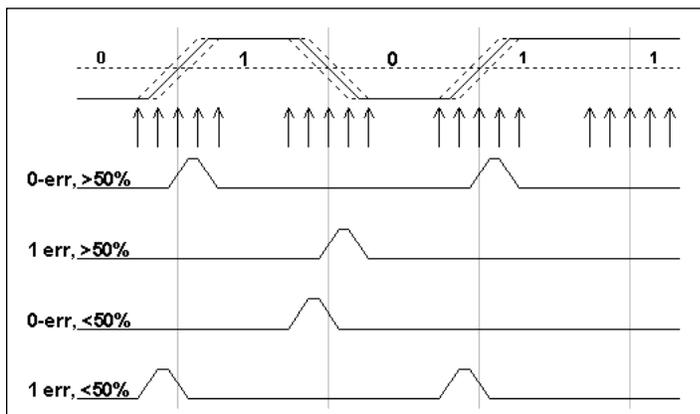


Figure 7: Selectively measuring jitter on a rising or falling edge with the Agilent 81200's extended BER capabilities

## Related Literature

<i>Agilent 81200 Data Generator/ Analyzer Platform</i> , brochure	5965-3416E	By internet, phone, or fax, get assistance with all your test and measurement needs.
<i>Agilent 81200 Data Generator/ Analyzer Platform</i> , data sheet	5965-3415E.	<b>Online Assistance</b> <a href="http://www.agilent.com/find/assist">www.agilent.com/find/assist</a>
<i>Agilent 81200 Data Generator/ Analyzer Platform</i> , configuration guide	5965-3417E	<b>Phone or Fax</b> United States: (tel) 1 800 452 4844
<i>Agilent 81200 IC/Circuit Characterization Package</i> , brochure	5968-4260E	Canada: (tel) 1 877 894 4414 (fax) (905) 206 4120
<i>Agilent E4874A Characterization Software Components for the 81200 Data Generator/ Analyzer Platform</i> , data sheet	5968-4259E	Europe: (tel) (31 20) 547 2323 (fax) (31 20) 547 2390
<i>Agilent E4839A Test Fixture</i> , data sheet	5968-3580E	Japan: (tel) (81) 426 56 7832 (fax) (81) 426 56 7840
<i>BestLink/81200 Simulation Data Link for the Agilent 81200 Data Generator/Analyzer Platform</i> , data sheet	5968-2548E	Latin America: (tel) (305) 269 7500 (fax) (305) 269 7599
<i>Data Transfer between Design, Simulation and the Agilent 81200</i> , product note	5967-6276E	Australia: (tel) 1 800 629 485 (fax) (61 3) 9272 0749
<i>Panel Link Chip Set Test</i> , product note	5968-3024E	New Zealand: (tel) 0 800 738 378 (fax) (64 4) 495 8950
<i>How to use the Agilent 81200 Data Generator/Analyzer Platform together with Agilent VEE for Signal Integrity Analysis</i> , product note	5968-3857E	Asia Pacific: (tel) (852) 3197 7777 (fax) (852) 2506 9284

Product specifications and descriptions in this document subject to change without notice.

Copyright © 1999, 2000 Agilent Technologies  
Printed in U.S.A. 6/00  
5968-6033E

For more information, please visit:  
[www.agilent.com/info/ic\\_characterization](http://www.agilent.com/info/ic_characterization)



**Agilent Technologies**

Innovating the HP Way