

# Eye Characterization on Idle and Framed Data Traffic: the Bit Recovery Mode

## Application Note

### Introduction

Traditionally, bit error rate testing compares the bits from a Device Under Test (DUT) against a reference data set, called the expected data. The user of Bit Error Ratio Tester (BERT) has to provide this expected data and load it into the tester.

The BERT then samples the incoming data signal with a sampling point that can be varied over time and voltage, to measure the BER. Software on the BERT can create graphics, such as the eye opening, from the information gathered during sampling. A compare circuit counts the differences between the bits of the incoming data stream and the expected data.

### The Bit Recovery Mode

Now there is a mode that removes the need for the user to provide expected data, while still allowing one and two-dimensional measurements, such as the eye opening. This is the Bit Recovery Mode (BRM).

This has two benefits: the user does not need to worry about the expected bits, which makes a setup easier and faster. Secondly, and possibly more importantly, the BERT can measure non-deterministic data streams. This means it is no longer necessary to force a device into a specific test mode. It

can run in or close to its normal operation. If a device like PCIe or FC sends 8b/10b coded frames interspersed with random idle sets, or a 10Gb/s device sends dynamic frames that include scrambled data or forward error correction (FEC), the BERT can now check the eye opening under real conditions. It also makes it possible to watch non-deterministic events and their influence on the eye opening, and to check the influence of occasional events, which can be hard to capture on a scope.

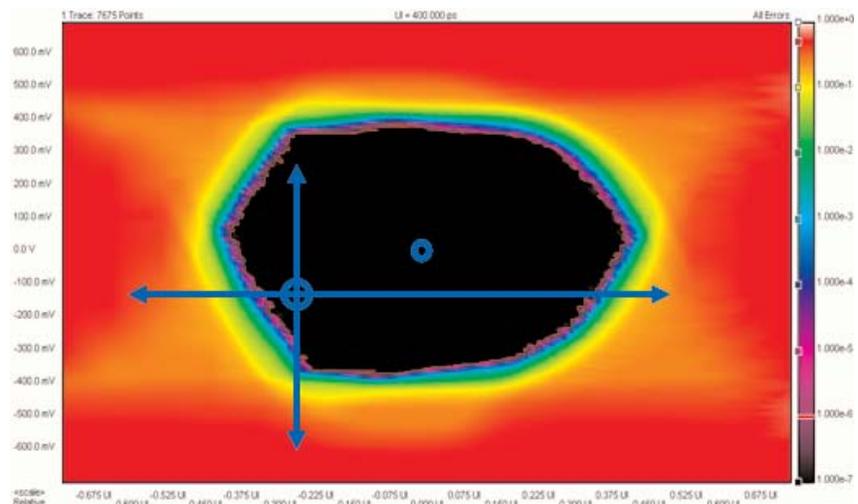


Figure 1: Two sampling points, one assigned to the sweet spot, the other is flexible in time and voltage

## How it works

Bit recovery mode uses a second sampling circuit in the BERT analyzer to always sample at the sweet spot of the eye (typically at 50% of eye opening in time and voltage). This is shown as the blue dot in figure 1. The sampled data from this second sampling circuit acts as a reference and is passed to the compare circuitry, instead of the expected data.

## Relative BER

This means the BER is now a relative figure. Taking the bit from the sweet spot of the eye cannot verify if this bit is correct in itself, it can just use it as a reference for any bit sampled in the border area of the eye. Bit recovery mode makes one and two-dimensional sweeps possible to sample in the border area of the eye and find out how the BER value increases. From this we can derive the random and deterministic ( $R_j$  and  $D_j$ ) characteristics.

We can also take the eye opening with a known, deterministic test pattern and compare it with operational data, where a device idles or provides scrambled data, or there are asynchronous events like hand-shake signals.

## Implementation

Relative BER is realized by adding a second sampling circuit with its own sampling threshold and delay adjustment to ensure the same flexibility of time and voltage positioning as the first one. There also needs to be a way of switching the input of the compare circuit between the memory for the expected data and the data from the second sampler. The diagram in figure 2 shows a simplified structure, with the circuit for the first sampling point shown in pink, the circuit for the second sampling point in yellow, and the data processing in blue. This omits details such the circuitry that ensures the two bits arrive at the compare circuitry simultaneously.

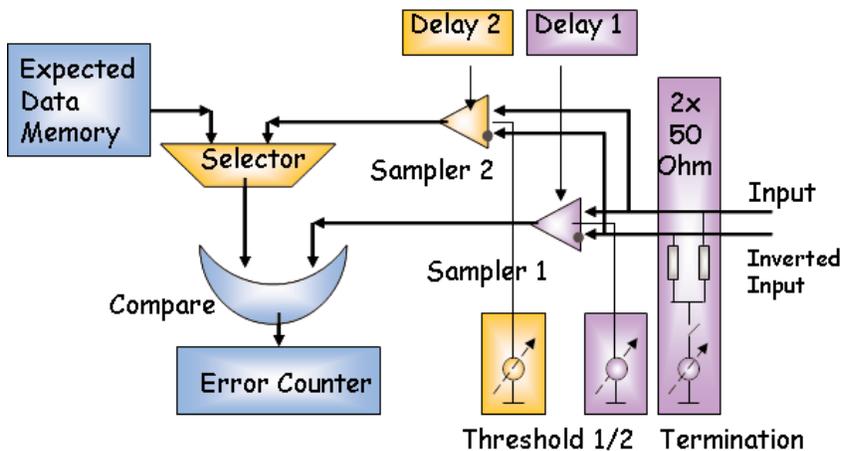


Figure 2: Architecture Bit Recovery Mode

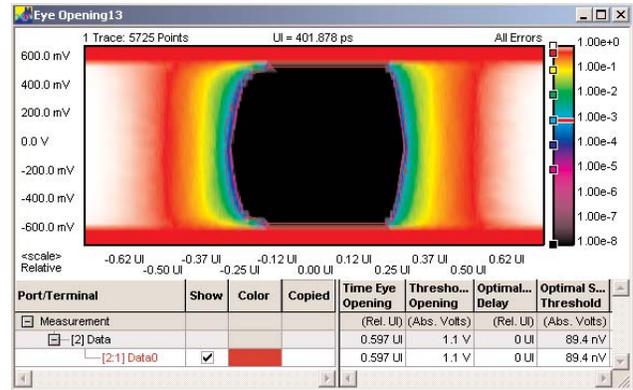
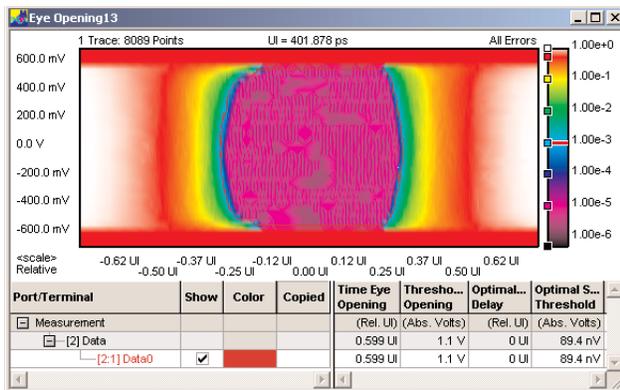
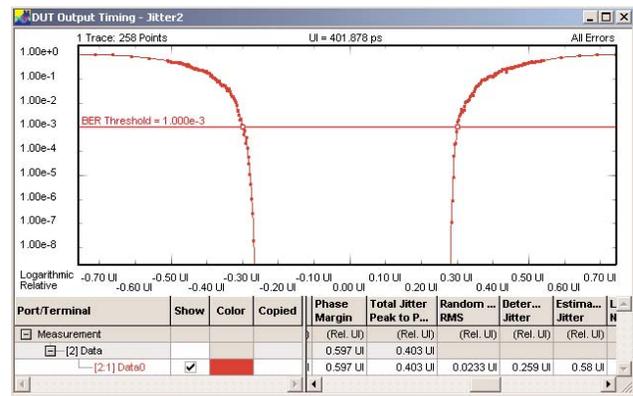
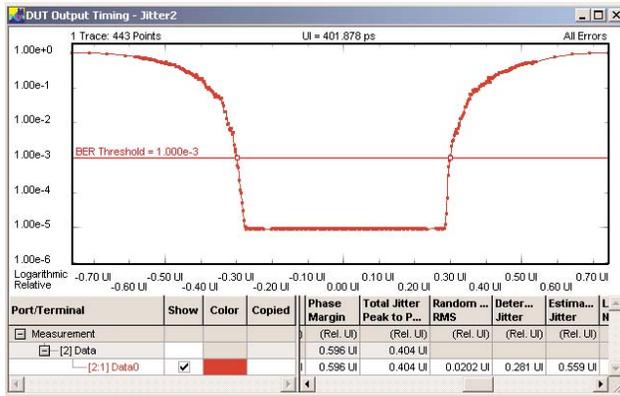
## Limitations

Obviously, the Bit Recovery mode should not be used if the absolute BER figure is needed. The mode also requires a minimum eye opening; an eye that is too narrow cannot be processed. Care also needs to be taken if there is a good eye opening but there is a finite BER inside the eye. Figure 3 shows a data signal with a BER of  $1e-5$ . Comparing the data stream against expected data shows the finite BER. The graphs to the right, based on bit recovery mode, do not show this.

## Availability

The bit recovery mode is available on the N4903A High Performance Serial BERT. It can be used with all one and two-dimensional BERT scan measurements of the measurement suite on this tester, except the Fast Total Jitter measurement. All measurement based on bit recovery mode show this on the screen, to ensure users always know when they are working with a relative BER.

### Expected data ↔ Bit Recovery Mode



## Related Literature

## Pub Number

Agilent Physical Layer  
Test Brochure

5988-9514EN

Agilent ParBERT 81250  
Product Overview

5968-9188E

N4901B Serial BERT  
13.5 Gb/s Data Sheet

5989-0398EN

N4902B Serial BERT  
7 Gb/s Data Sheet

5989-0399EN

Jitter Fundamentals:  
Agilent N4900 Serial BERT  
Injection and Analysis Capabilities  
Application Note

5989-0089EN

Jitter Solutions for  
Telecom, Enterprise,  
and Digital Design  
Brochure

5988-9592EN

Jitter Fundamentals:  
Jitter Tolerance Testing

5989-0223EN

Jitter Fundamentals:  
Agilent 81250 ParBERT

5988-9756EN

Fast Total Jitter Test Solution  
Application Note

5989-3151EN

Next Generation I/O Bus  
PCI-Express BER Test Solution  
Application Note

5989-2690EN

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