

Jitter Basic

Agenda

- **Why do we measure jitter?**
- **Definition and description of jitter**
- **Total jitter and jitter components**
- **Jitter Measurement Methods**
- **Overview of Keysight Option**

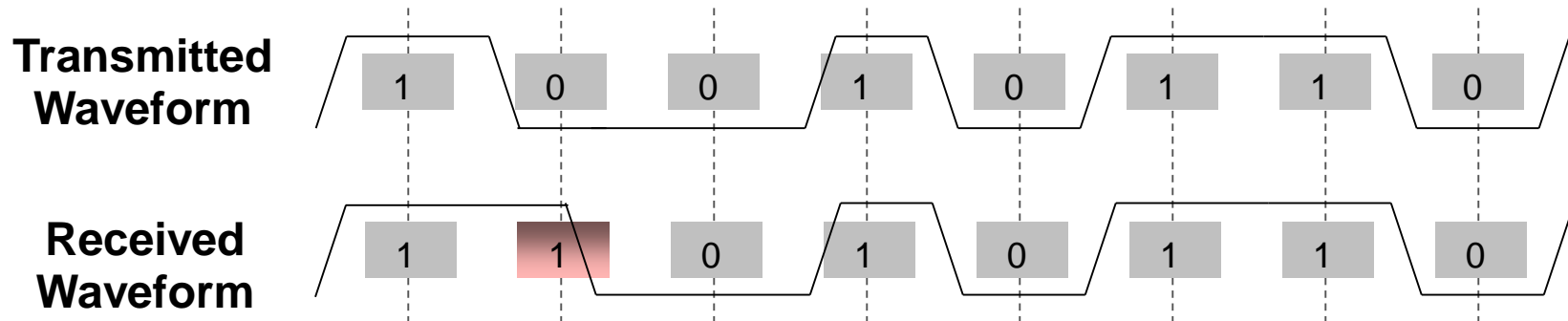
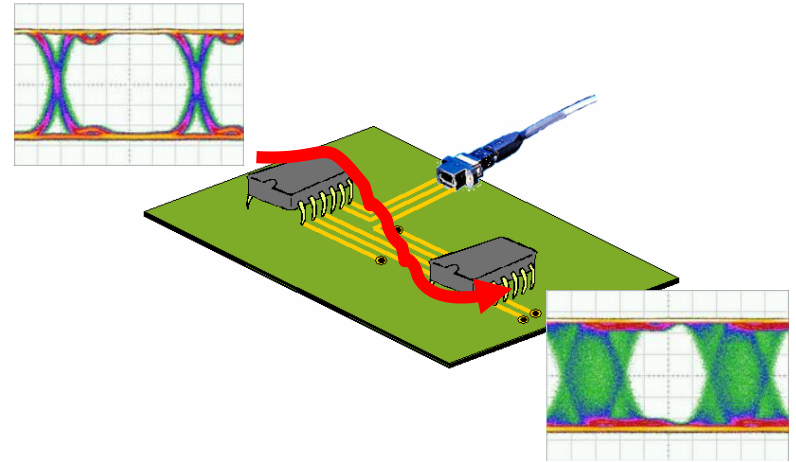
Why Measure Jitter?

Jitter can cause data transmission errors in digital systems

- When data rates were low, designers were mainly concerned with functionality (1s and 0s)
- With rates > 1 GHz, the analog nature of signals becomes significant
 - A timing instability (noise) called ***jitter*** affects system BER

BER = *probability that a transmitted bit will be received in error*

Jitter and Bit Error Ratio



We are interested in Jitter because it causes Bit Errors!

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What is Jitter?

- **A dictionary definition of the verb “jitter”:**

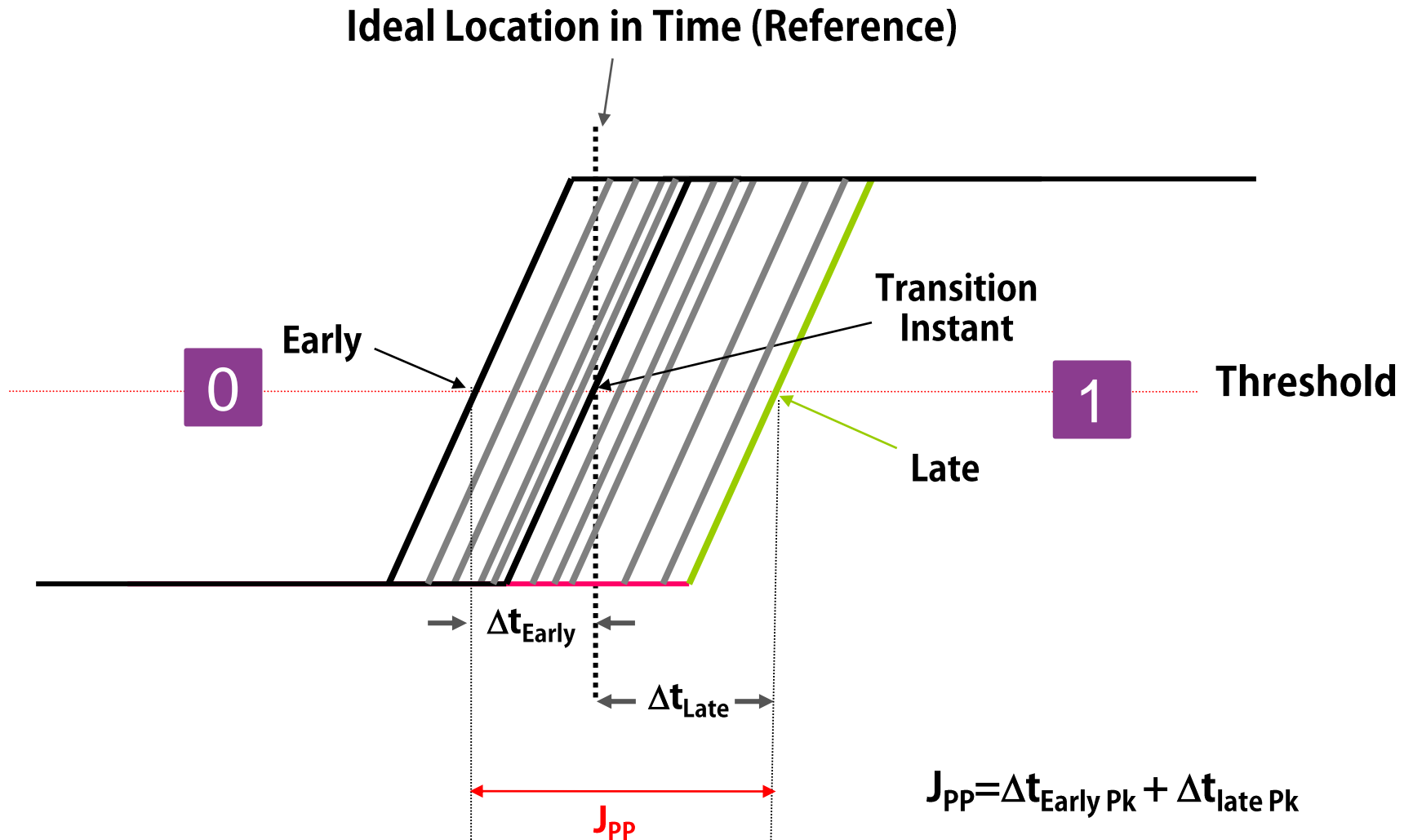
To make small, quick, jumpy movements.

- **In the digital design world, jitter is defined as:**

The deviation of the significant instances of a signal from their ideal locations in time.

- **The significant instances for data signals are the transitions (edges)**
- **The ideal locations for the transitions are determined by the time reference (clock)**

Analyzing a Transition



Expressing Jitter

- **Absolute time:** Example: $J_{PP} = \Delta t_{\text{Early}} + \Delta t_{\text{Late}}$
 $= 60 \text{ ps} + 40 \text{ ps}$
 $= \mathbf{100 \text{ ps}}$

- **Relative to the UI (most common):**

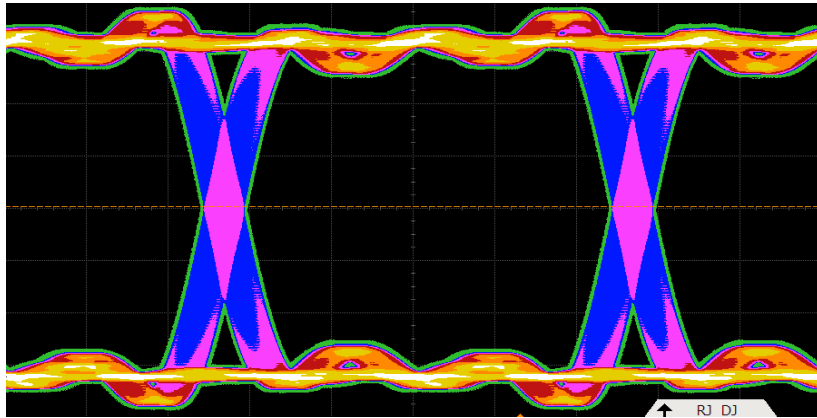
For 2.5 Gb/s data rate, the UI = 400 ps

So $J_{PP} = 100 \text{ ps} / 400 \text{ ps per UI} = \mathbf{.25 \text{ UI}}$

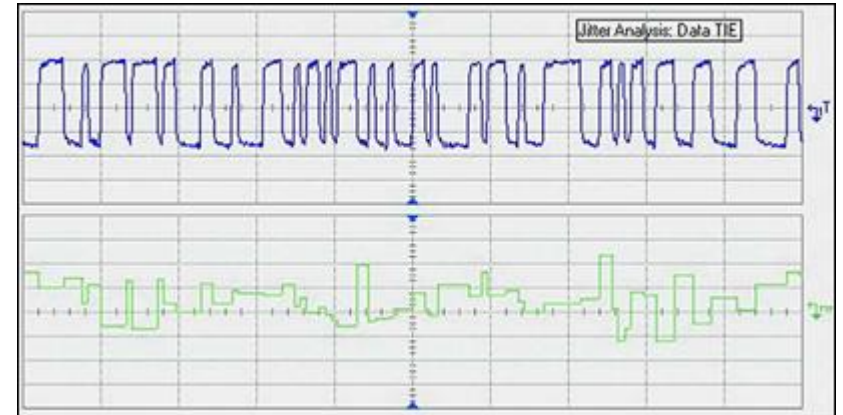
In radians (2π radians per UI):

$$J_{PP} = .25 \text{ UI} \times 2\pi = \mathbf{\pi/2 \text{ radians}}$$

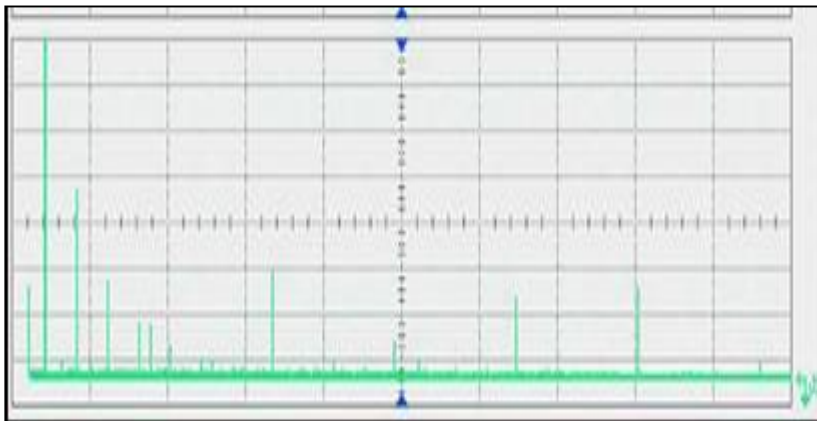
Expressing Jitter



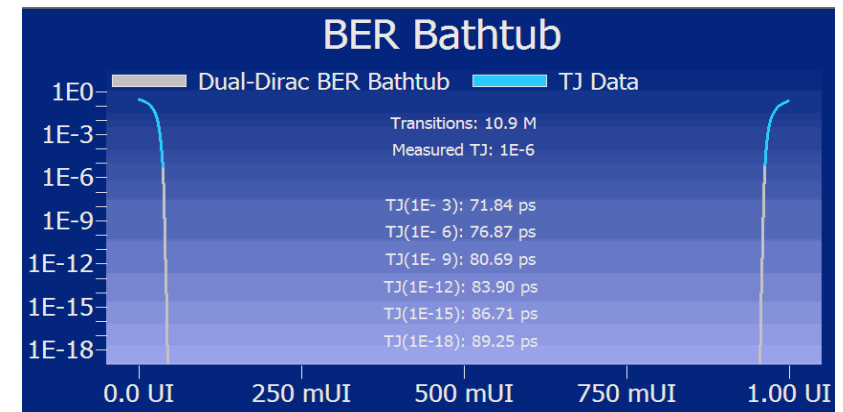
Eye Diagram



Measurement Trend Curve

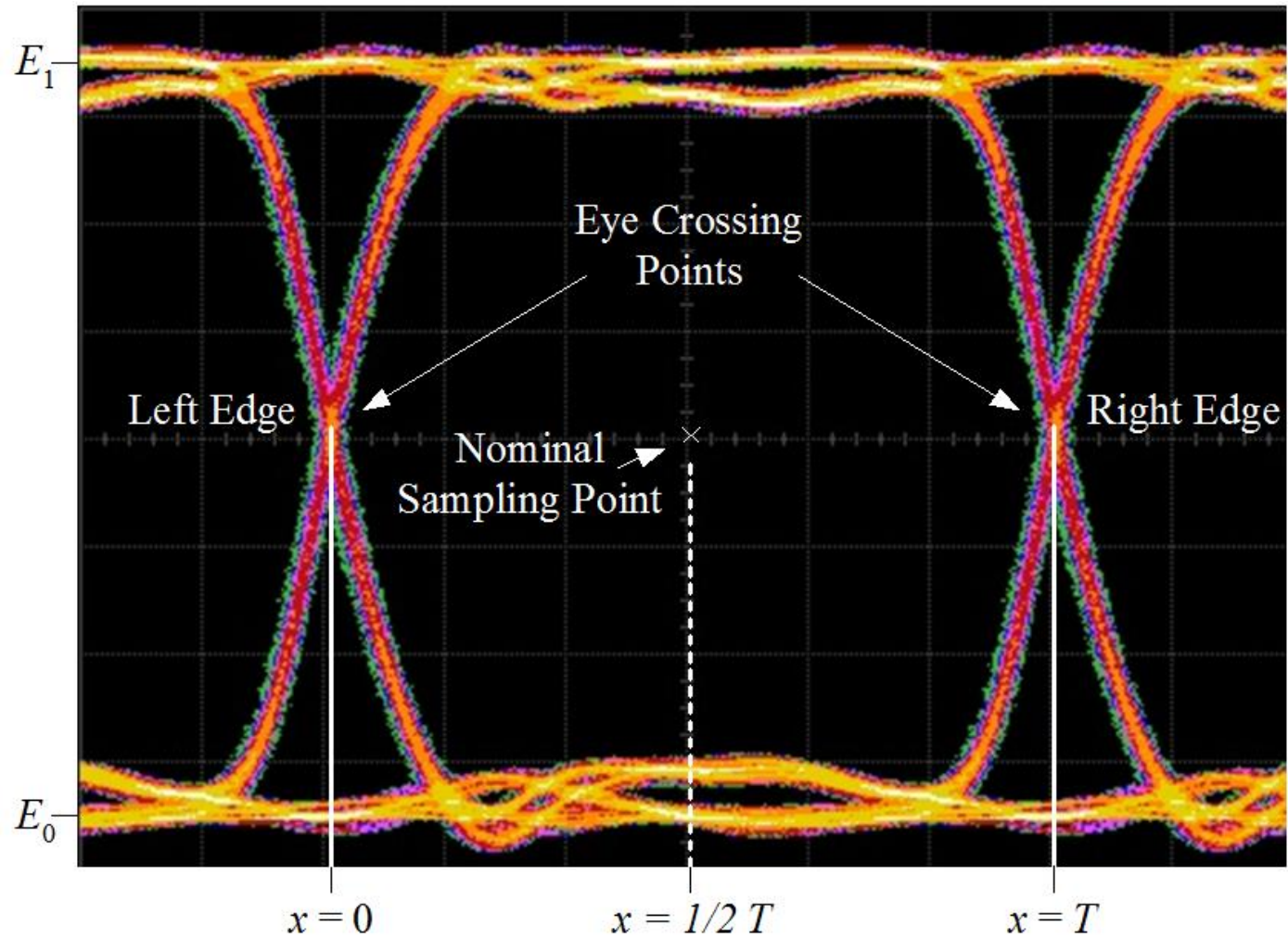


Jitter Spectrum

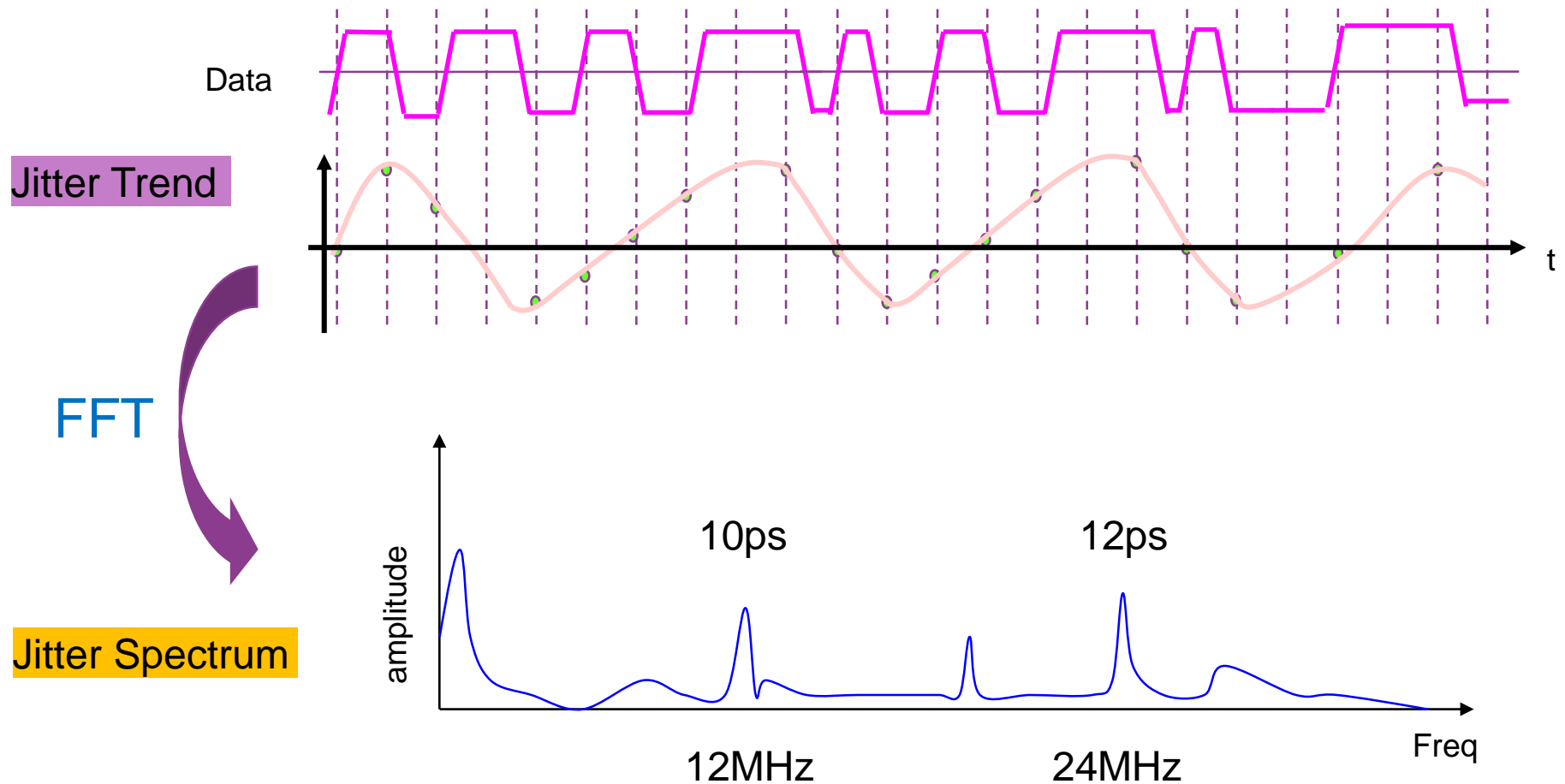


Bathtub Curve

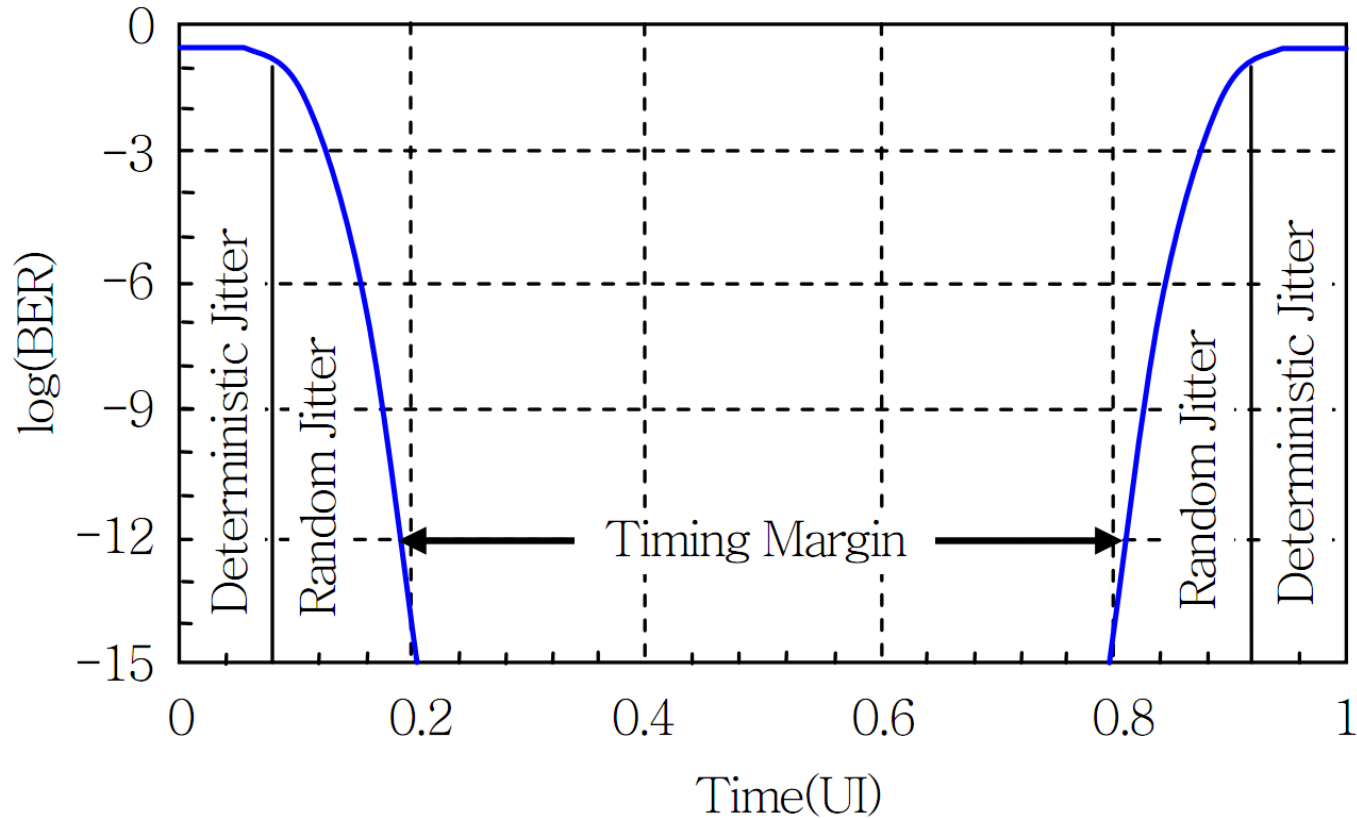
Constructing the Real-Time Eye-diagram



Jitter Trend and Spectrum



Bathtub curve

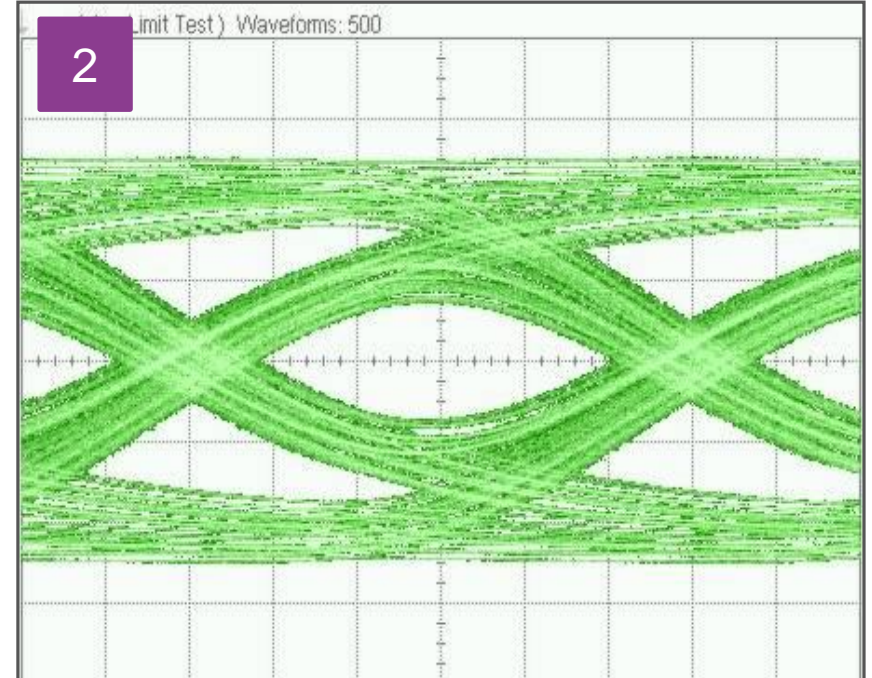
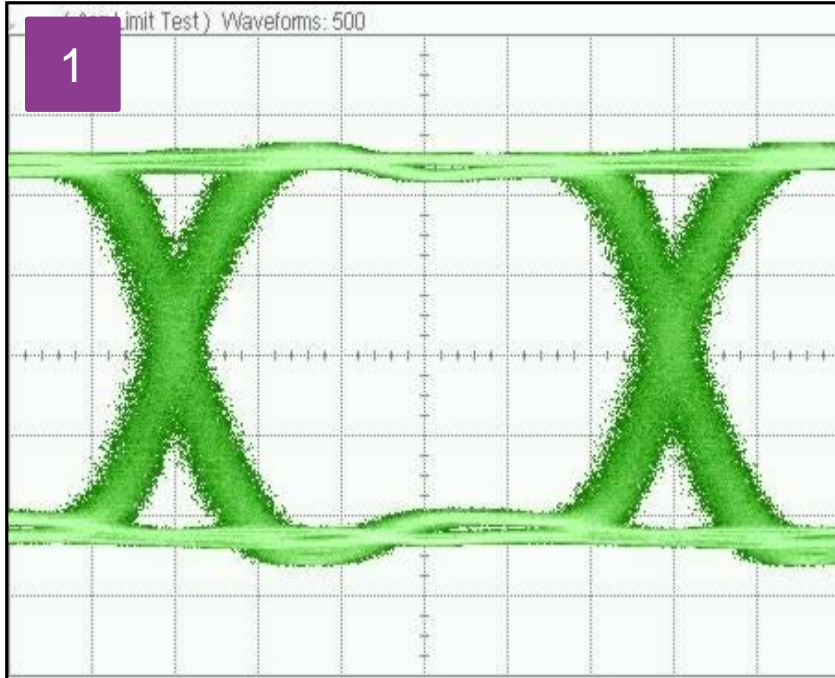


We can estimate Total Jitter at specified BER level

Agenda

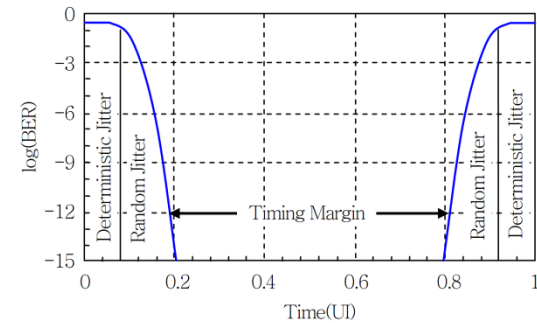
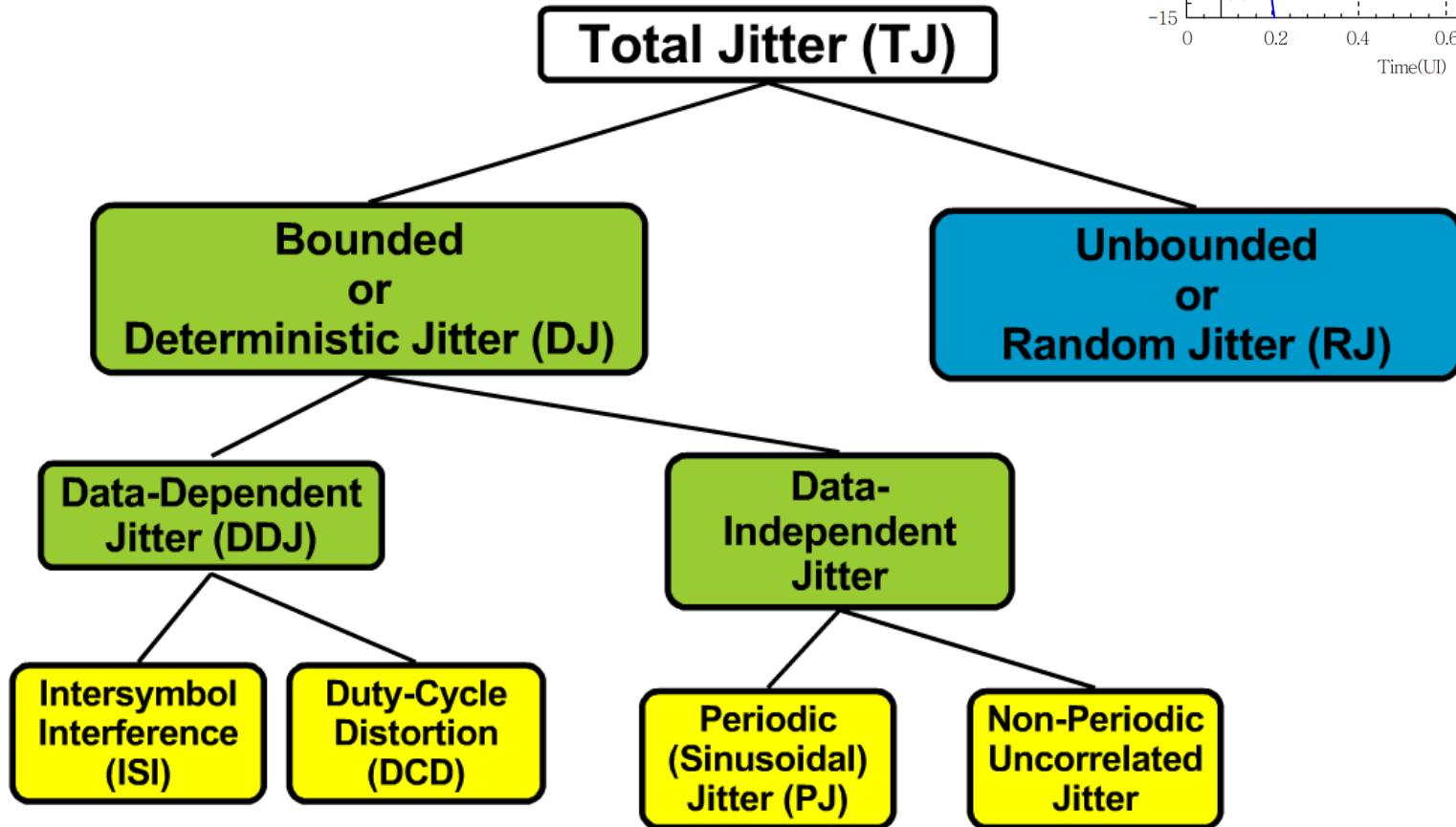
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Question



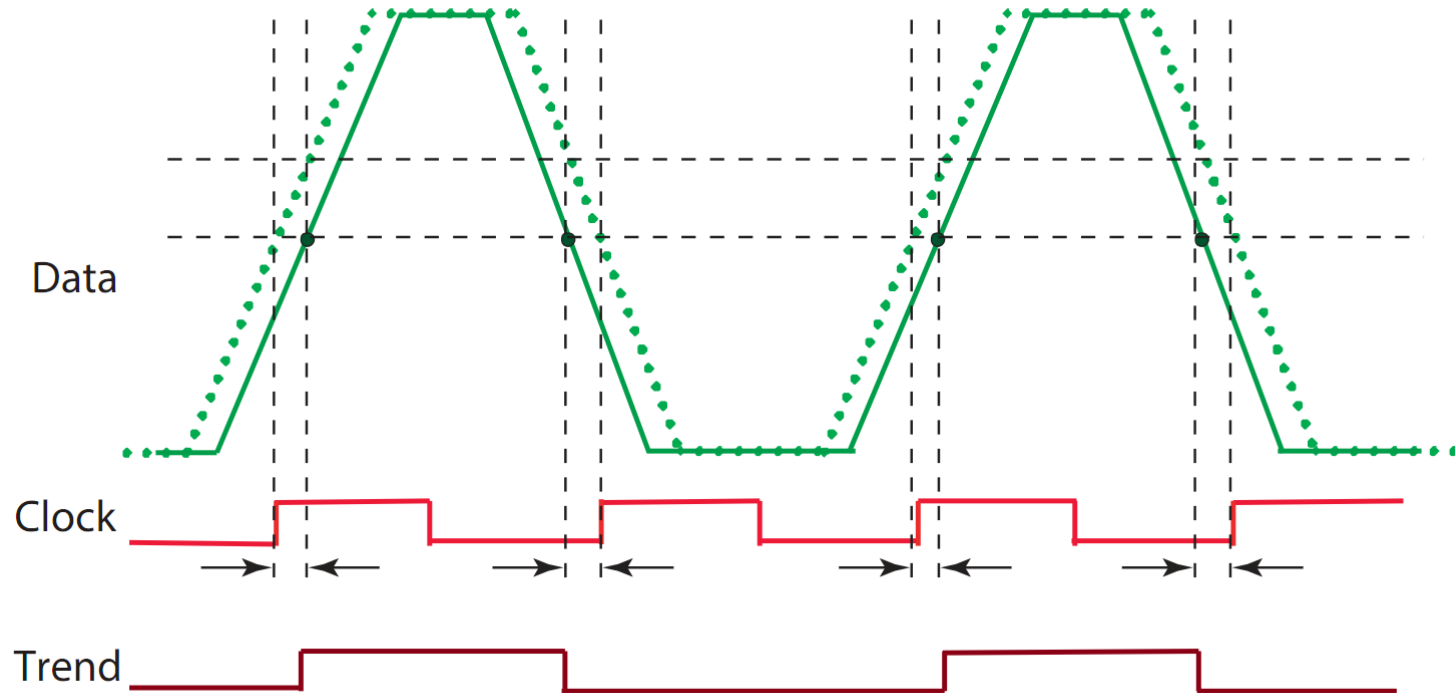
You can't know unless you measure the total jitter or its components!

Decomposing Jitter



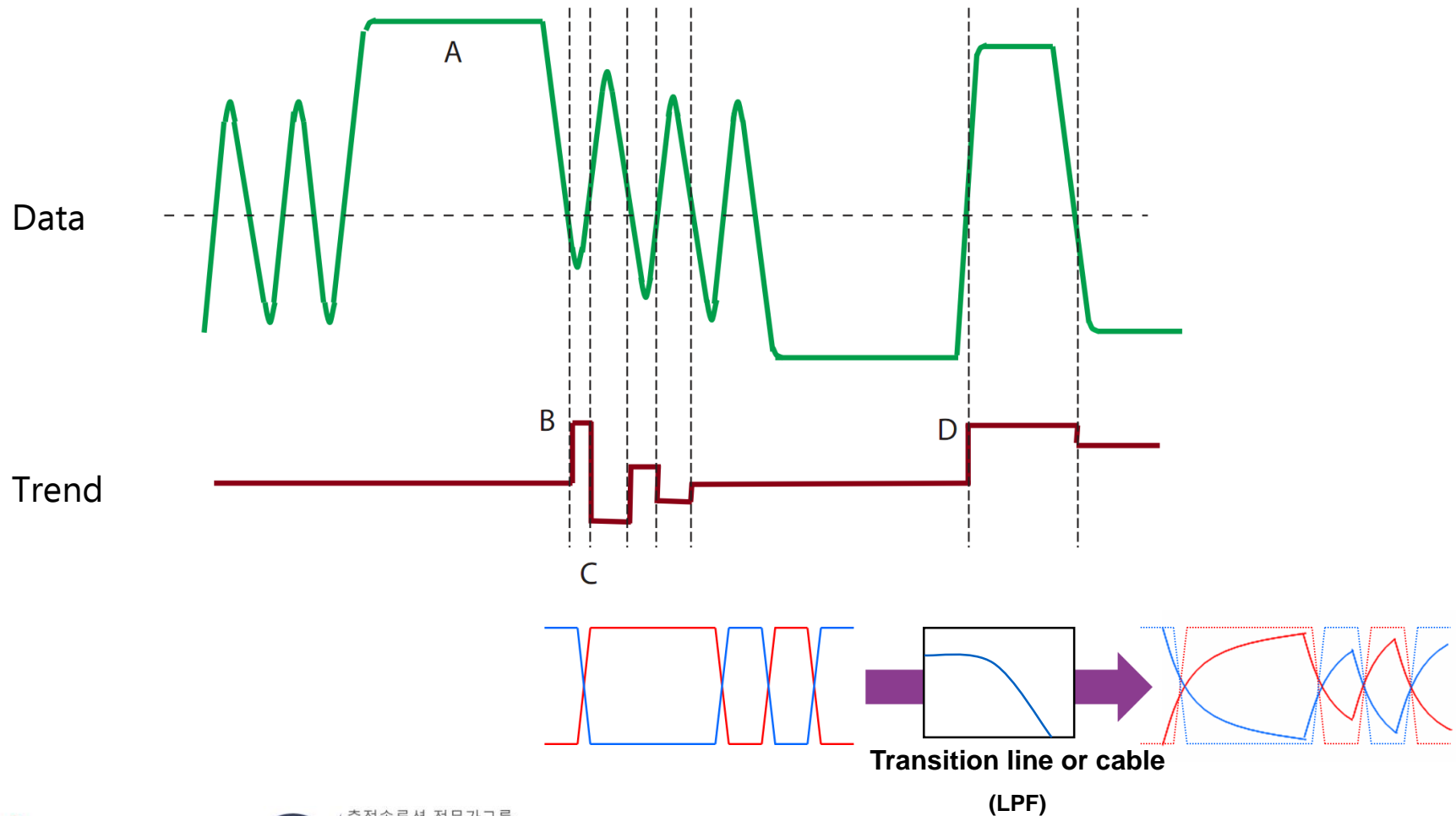
Typical Characteristics of Individual Jitter Components

- Duty Cycle Distortion (DCD)



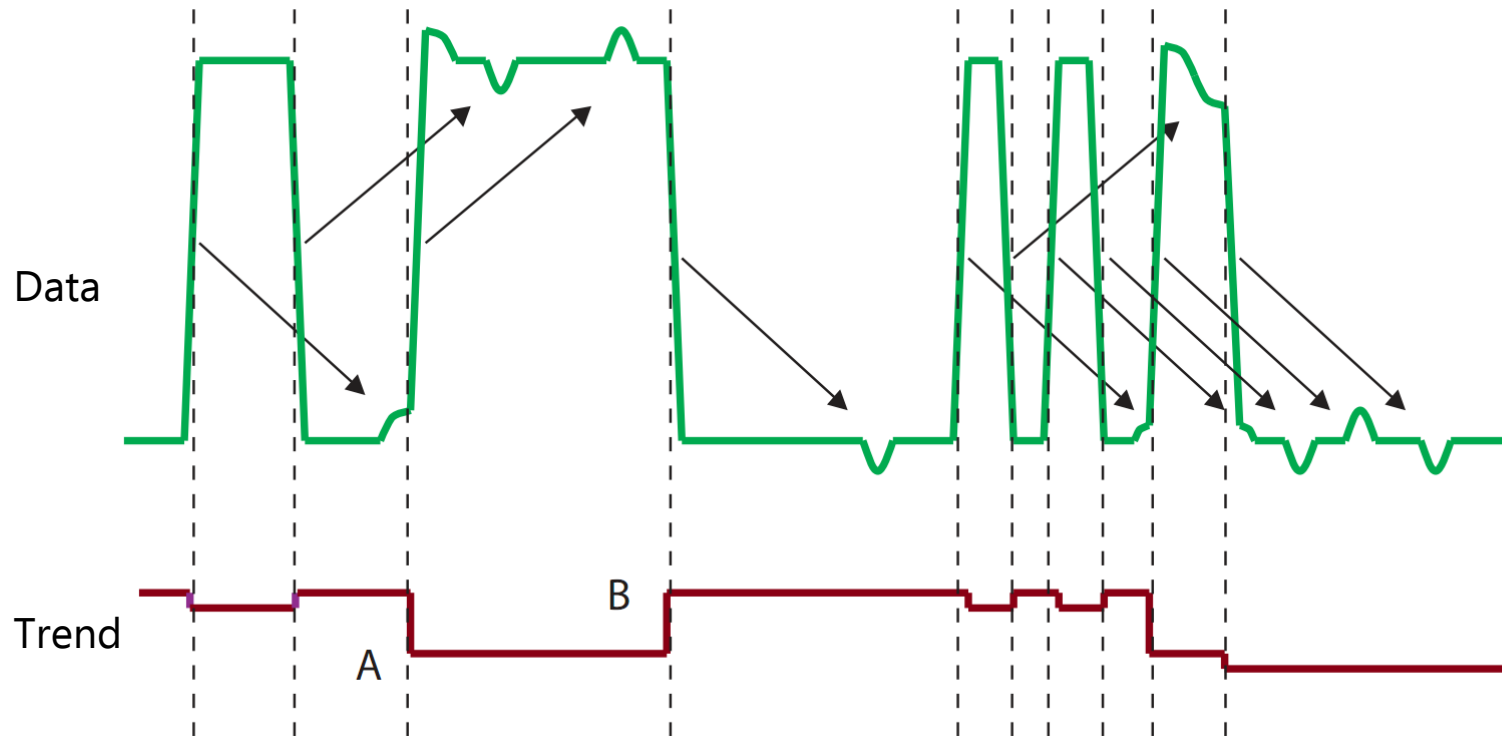
Typical Characteristics of Individual Jitter Components

- Inter-Symbol Interference (ISI) due to BW problem



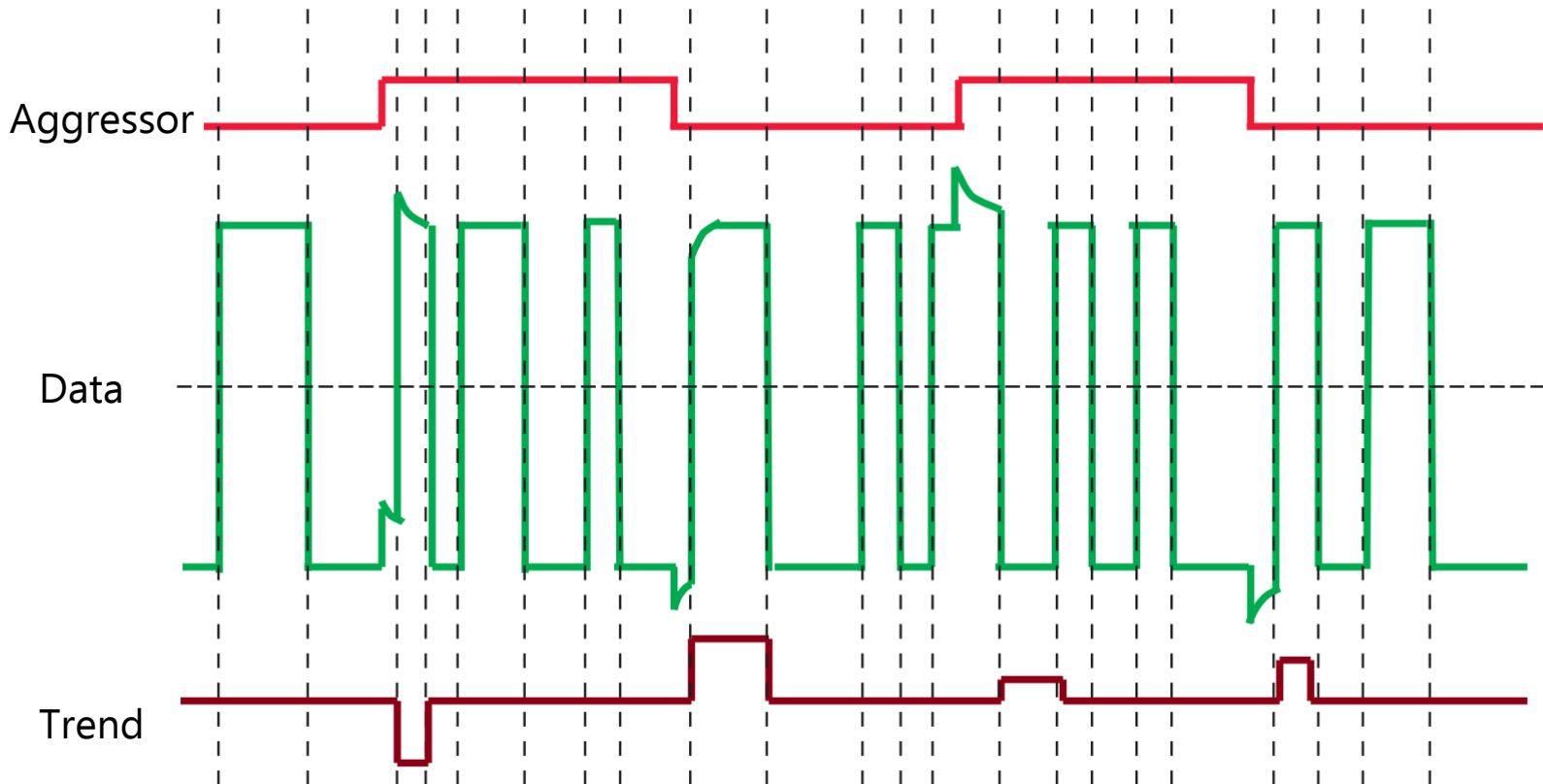
Typical Characteristics of Individual Jitter Components

- ISI due to reflections

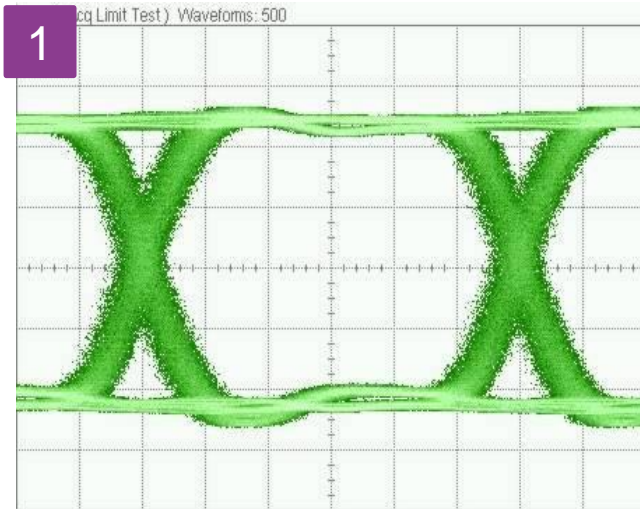


Typical Characteristics of Individual Jitter Components

- Periodic Jitter (PJ) caused by capacitive coupling



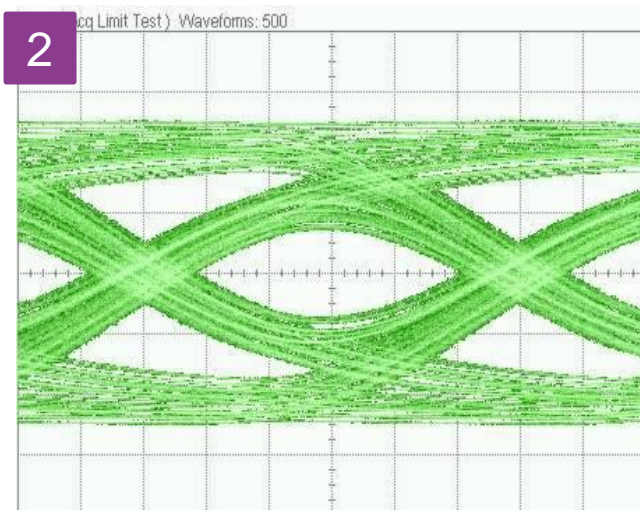
Answer the Question



Random Jitter = 9.74ps rms
Deterministic Jitter \doteq 0ps

$$TJ = 14.1 \times rms + 0 = 137.4 ps$$

Total Jitter \doteq 137.4 ps (BER=10-12)



Random Jitter = 2.03ps rms
Deterministic Jitter = 90.7ps

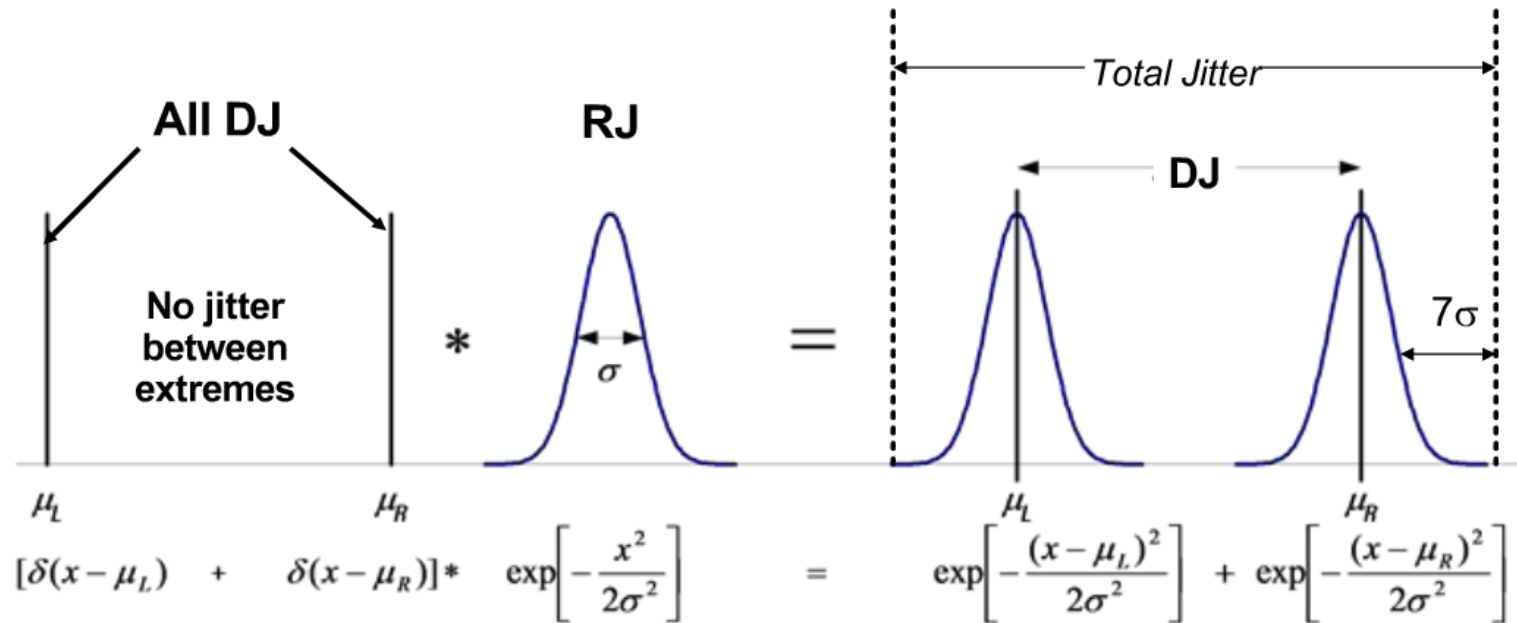
$$TJ = 14.1 \times rms + 90.7 = 119.1 ps$$

Total Jitter \doteq 119.1 ps (BER=10-12)

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The Dual-Dirac Model



- This model is a Gaussian approximation to the outer edges of the TJ distribution, displaced by two Dirac delta functions
- All the TJ estimation methods require that we identify and measure the DJ, estimate the rms value of the RJ distribution (σ) by a measurement, and then combine the two values

The Relationship Between BER, RJ_{pp} and RJ_{rms}

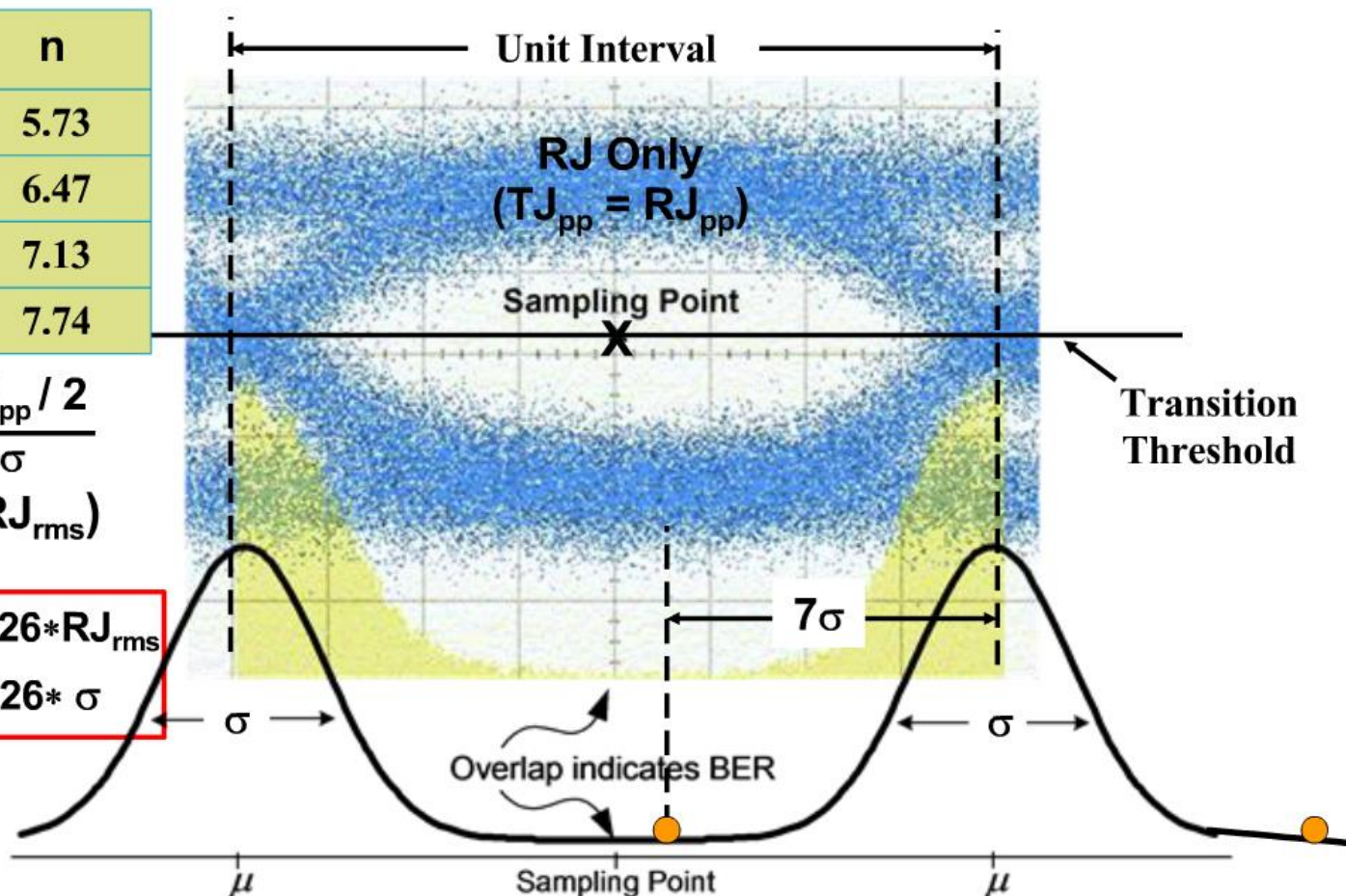
BER	n
1×10^{-8}	5.73
1×10^{-10}	6.47
● 1×10^{-12}	7.13
1×10^{-14}	7.74

$$n = \frac{RJ_{pp} / 2}{\sigma}$$

($\sigma = RJ_{rms}$)

$$RJ_{pp} = 14.26 * RJ_{rms}$$

$$= 14.26 * \sigma$$



Total Jitter Estimate by the Dual-Dirac Model

Total peak-to-peak jitter, $TJ_{pp} = RJ_{pp} + DJ_{pp}$

For $BER = 10^{-12}$, $RJ_{pp} = 14.26\sigma$

And thus, $TJ = 14.26\sigma + DJ$

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Jitter Analysis Software

Jitter Trend, Histogram,
and
Timing Measurements

Advanced
Jitter Decomposition:
RJ/PJ/DDJ/DCD/ISI/ABUJ

Vertical Noise
Analysis and
Decomposition

EZJIT



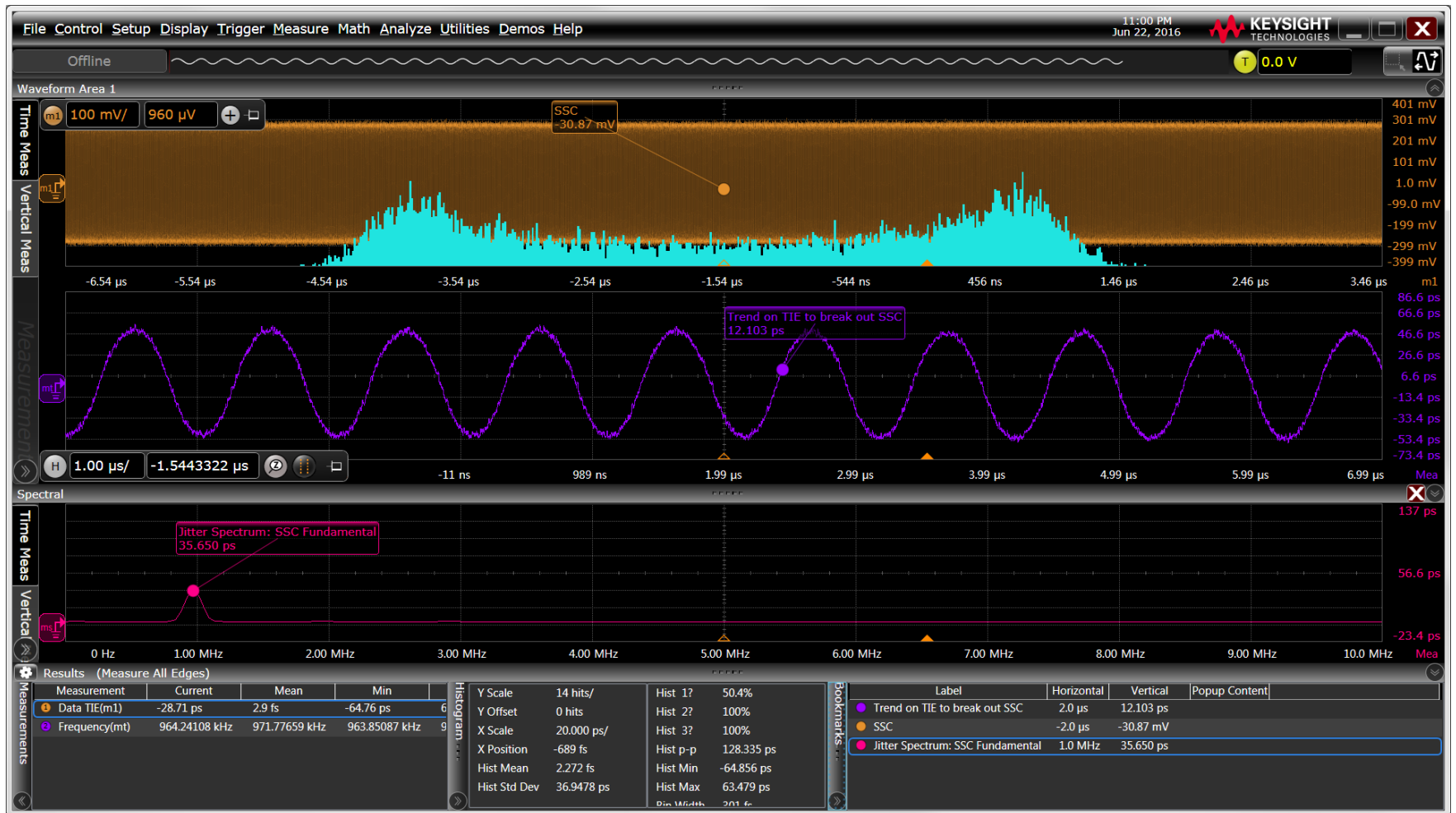
EZJIT Plus



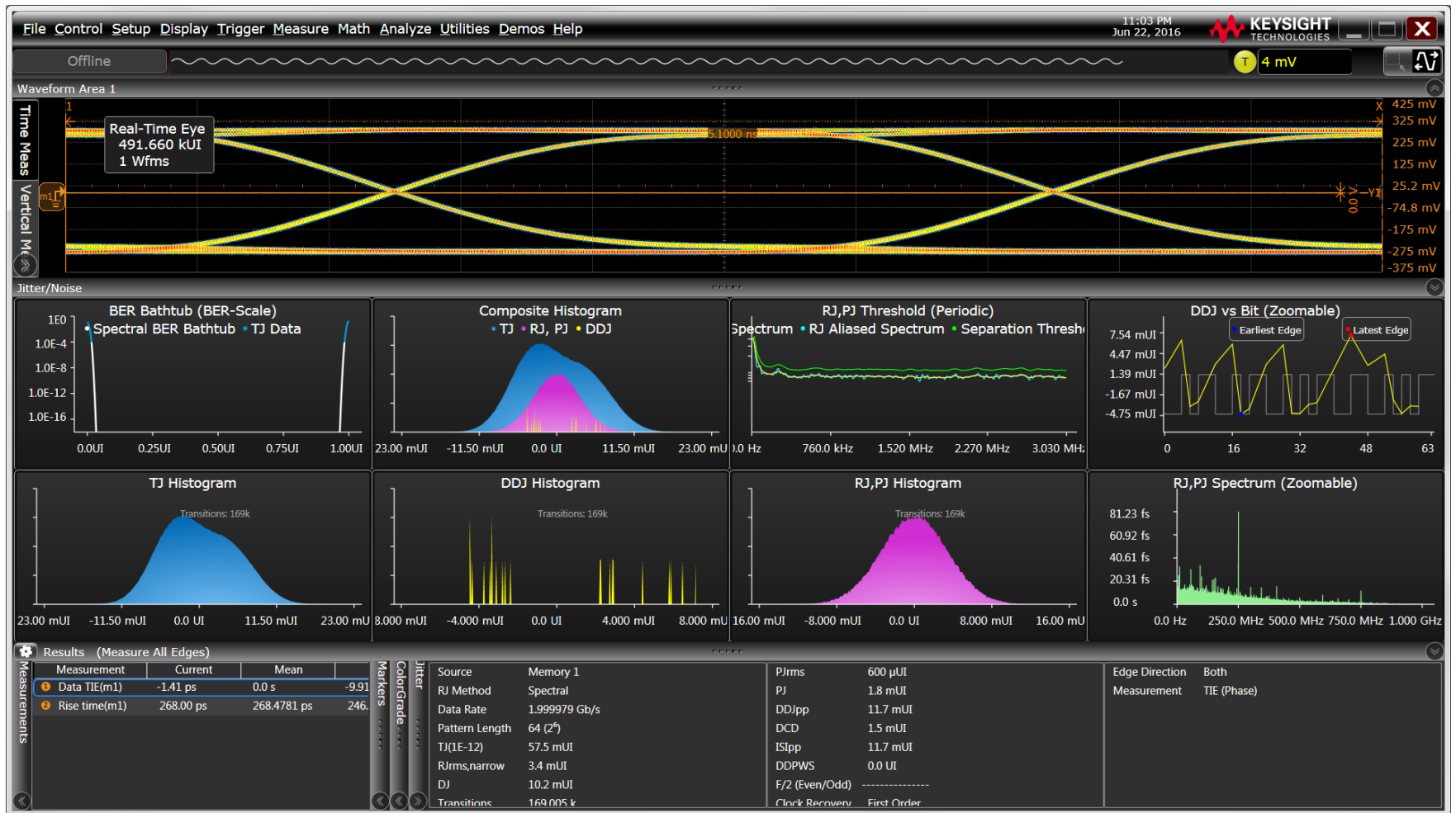
EZJIT Complete



EZJIT



EZJIT plus



EZJIT Complete



(주)제이스 는 Keysight Technologies 의 공식 판매 및 기술지원 대리점입니다.

(주)제이스 는 오실로스코프를 중심으로 한 측정솔루션 전문가 그룹입니다.

(주)제이스 는 단순판매가 아니라 솔루션상담과 기술지원을 우선으로 합니다.

(주)제이스 는 기다리지 않고, 먼저 찾아 가겠습니다.

(주)제이스 는 고객과 함께 날아오르겠습니다.

(주)제이스 를 지켜봐 주십시오.

Thank you !!!