# IsoBER

**TECHNICAL BRIEF**

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## Summary

*This paper provides an overview of the IsoBER technology, and explains how it can be applied for detailed insight into serial data applications.*

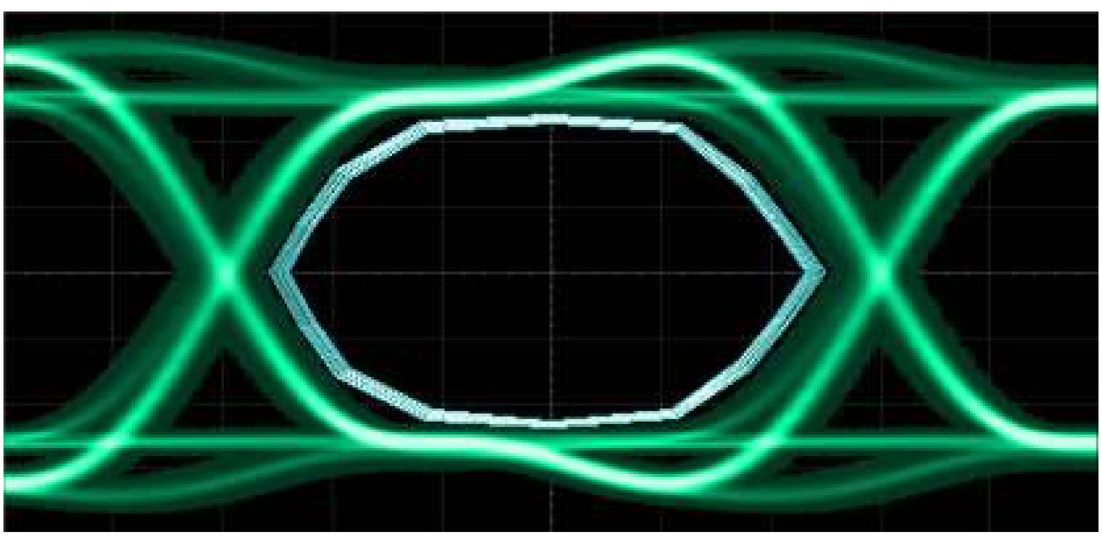
IsoBER ("Iso" meaning equal, and "BER", an acronym for Bit Error Ratio), is a tool used for estimating jitter and amplitude variations. IsoBER technology advances serial data analysis a step beyond both eye patterns and bathtub curves, which are briefly described below.

An eye pattern displays a plot in which the x-axis typically includes 1.25 unit intervals (bit periods) of time, while the y-axis encompasses a voltage range that includes the peak-to-peak voltage of the acquired waveforms. Color or intensity grading is used to display a persistent overlay of thousands (or millions) of collected bits.

A bathtub curve is a plot of estimated bit error rate, in which the y-axis displays bit error ratio, ranging from $10^{-0}$ to $10^{-16}$, while the x-axis range is one unit interval.

A bathtub curve can extrapolate results for decreasing BER, but can only estimate jitter, and does not account for signal amplitude variations. An eye pattern displays both amplitude variations and jitter, but cannot extrapolate results for decreasing BER.

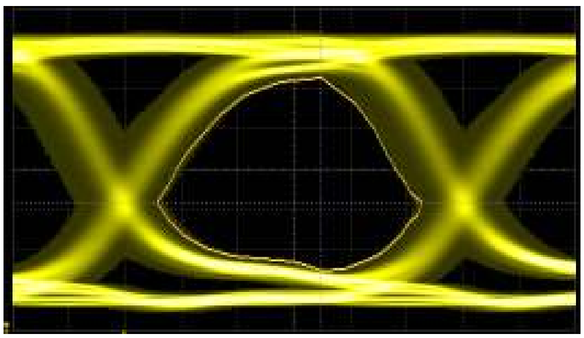
The IsoBER is able to both display both amplitude variations and jitter, as well as extrapolate the results for decreasing BER.



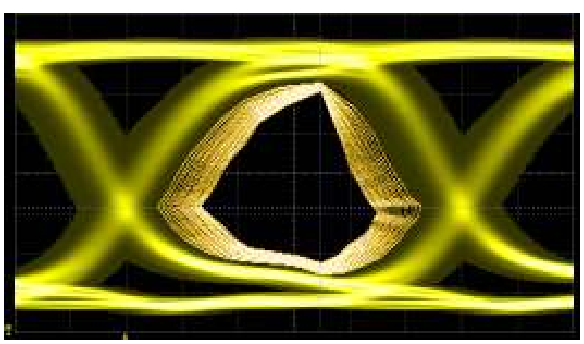
## Significance of the IsoBER Contour Map

The IsoBER displays a contour map, where each concentric ring drawn in the IsoBER represents a constant bit error ratio value.

In the IsoBER plot shown below, one ring, at $10^{-3}$ BER is selected. If the sampling point for a digital receiver were set for the coordinates of any point along the IsoBER contour ring shown below, the probability of a bit error would be approximately 1 part in 1000. An alternate interpretation of this same IsoBER ring is to show the estimated eye closure of the eye pattern after collecting 1000 UI (unit intervals, or bits) in the eye pattern.



An IsoBER contour ring at $10^{-6}$ BER would correspond to the probability of a bit error of approximately 1 part in 1,000,000 for receiver data sampled along the $10^{-6}$ BER ring, and would also show the estimated eye closure of the eye pattern after collecting 1,000,000 UI in the eye pattern. Shown below is the same waveform data with IsoBER contours displayed from $10^{-3}$ to $10^{-21}$.

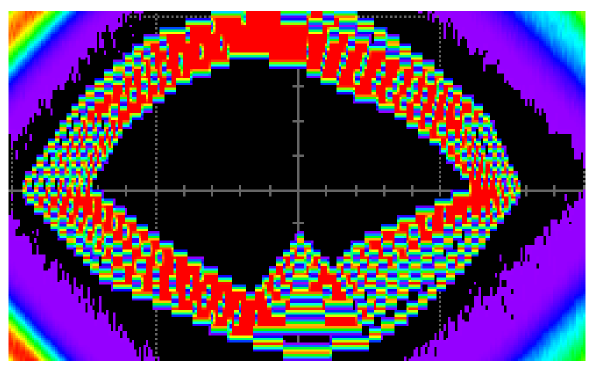


## IsoBER Identifies Crosstalk

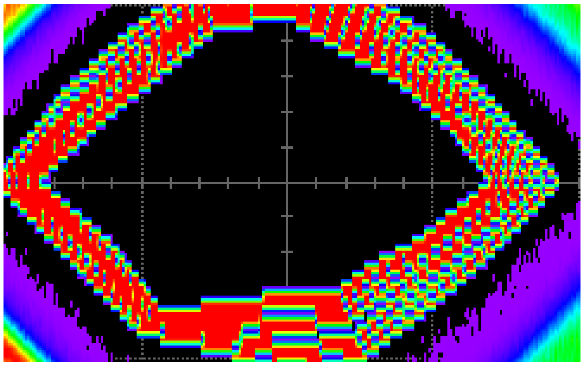
Because the IsoBER allows the ability to see amplitude as well as jitter effects, it becomes a powerful tool for identifying crosstalk problems. Crosstalk occurs during transitions of the aggressor, which are often not coincident with the transition of the victim line. This results in very small waveform amplitude spikes on the victim line.

Because the aggressor transition was not coincident with the transition of the victim line signal, it will therefore not be detected as jitter. An eye pattern is unlikely to detect the problem either, because the amplitude variation caused by the aggressor line was subtle, and buried deep within the persistence display of the eye, not visible to the observer. The IsoBER however, is sensitive to low probability amplitude effects, and can easily detect the small amplitude shift caused by crosstalk from the aggressor.

Shown below is a real SAS 3G signal with a delayed aggressor. The IsoBER plot shows the contribution of crosstalk pushing each concentric ring toward the center of the eye.



Shown next is the same SAS 3G signal with no aggressor.  Notice that the IsoBER plot easily identifies the cases in which crosstalk is present.



Another application, in which the IsoBER is useful, is to characterize eye measurements at decreasing BER values.  Many emerging standards including XAUI, SATA 3G, and others are currently specifying a minimum eye amplitude measurement at $10^{-12}$, which is accomplished quickly using the IsoBER plot.

## Conclusion

The IsoBER is calculated and displayed as a multi-dimensional plot which provides quantitative estimated values as well as a qualitative visualization and insight.  The IsoBER is formed from a 360-degree radial scan which forms contour lines which allow for the characterization of both jitter and amplitude effects.  The diameter and dimensions of each IsoBER ring indicate both the probability of a bit error at a specific sampling coordinate, as well as estimated eye closure for that BER value.   In addition to deterministic and random jitter detection, IsoBER allows for the detection of deterministic and random noise (Rn and Dn).  The IsoBER has many applications into which it provides significant insight, including detection of crosstalk, and the ability to perform high BER eye measurements.