Beyond Bit Error Rate Testing

Physical Layer Tests and Error Location Analysis Extend the Capabilities of a BERT

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The Premier Advanced Recording Technology Forum

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Agenda

- Bit error rate (BER) testing background
- Introduction to error analysis
  - Bit errors vs. Burst errors
  - Identifying systematic errors
- Physical layer measurements
  - Eye measurements
  - Jitter measurement

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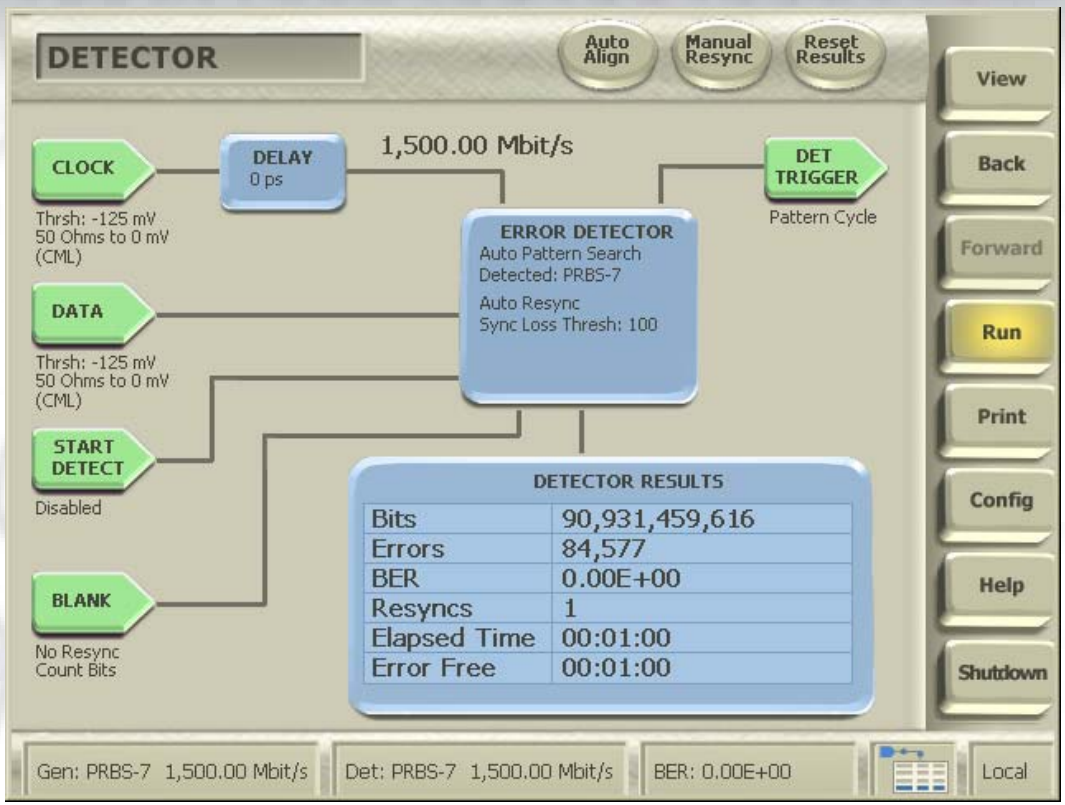
Bit Error Rate

- Setup the Pattern Generator and Error Detector for the right levels, transmit a known pattern through your DUT.
- Set a decision point inside your eye diagram and count errors



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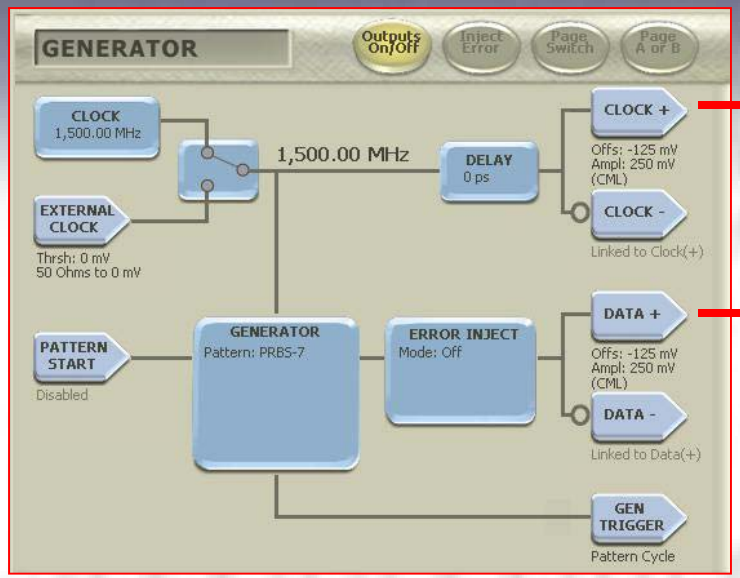
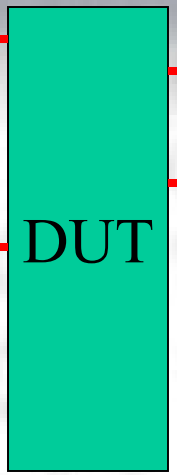
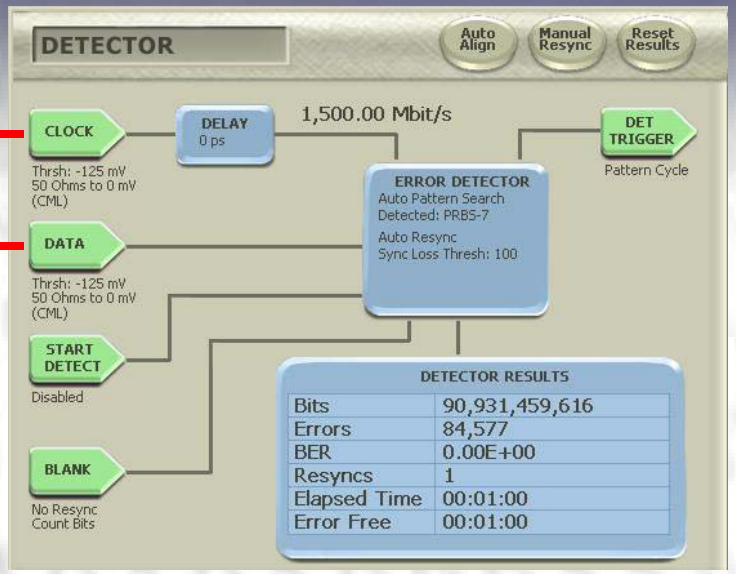
Bit Error Rate







Pattern Generator

- Select internal or external clock source
- Generates Pseudo-random or user-defined test pattern
- Select output logic family

Error Detector

- Select input logic family
- Synchronize to incoming pattern
- Count errors and calculate BER

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Error Analysis

- Records when and where errors occur relative to each other in the data stream
- Provides tools for identifying non-random error mechanisms
- Identifies phenomena that would be difficult to see just looking at BER or an eye diagram

Error Analysis

- By using exact bit error location information, the BitAlyzer® can separately measure
  - Bit errors
  - Burst errors
    - Users can define the burst criteria
  - Total errors
  - Error rates
- Existence of burst errors is the first indicator that errors are not random

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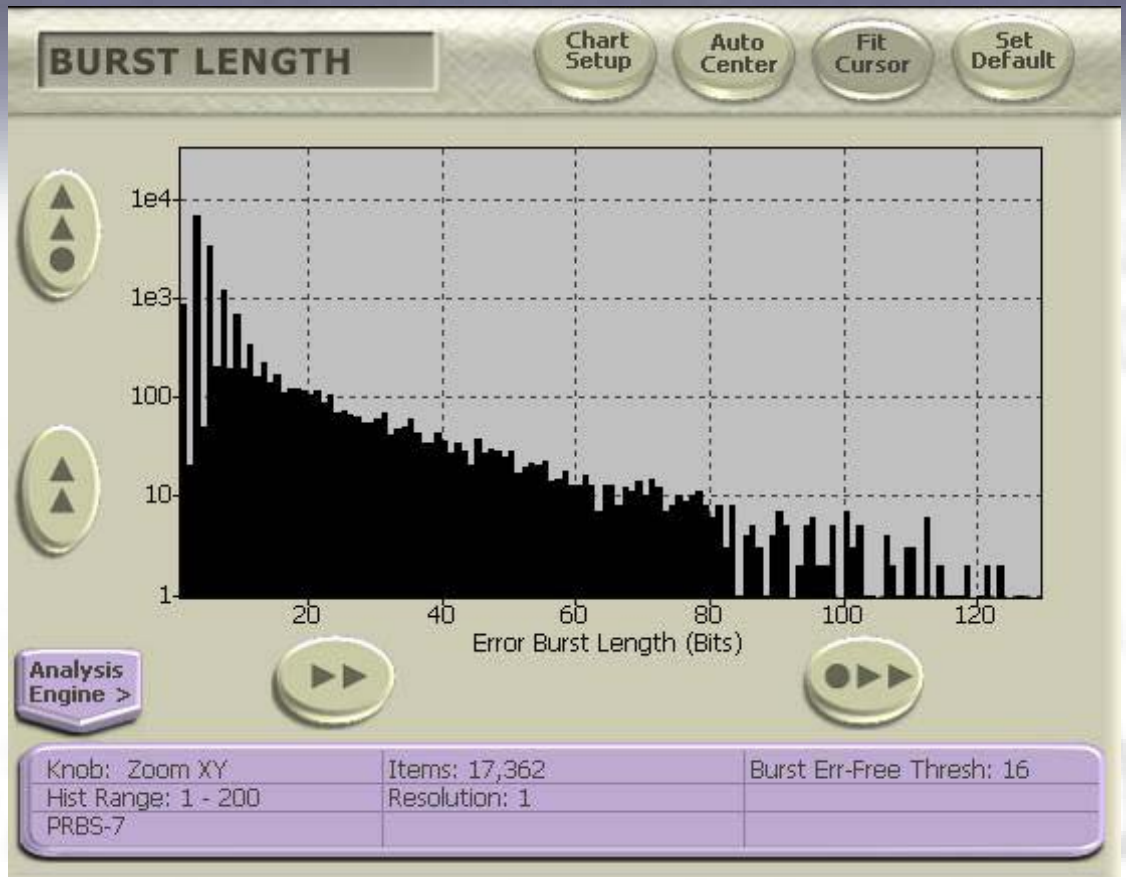
Error Analysis Examples



The Burst Length Histogram view shows the number of times errors of different length have occurred.

Here we see a large number of small errors and fewer larger errors.

This histogram can be scaled to uncover the absolute probability of burst errors of different lengths

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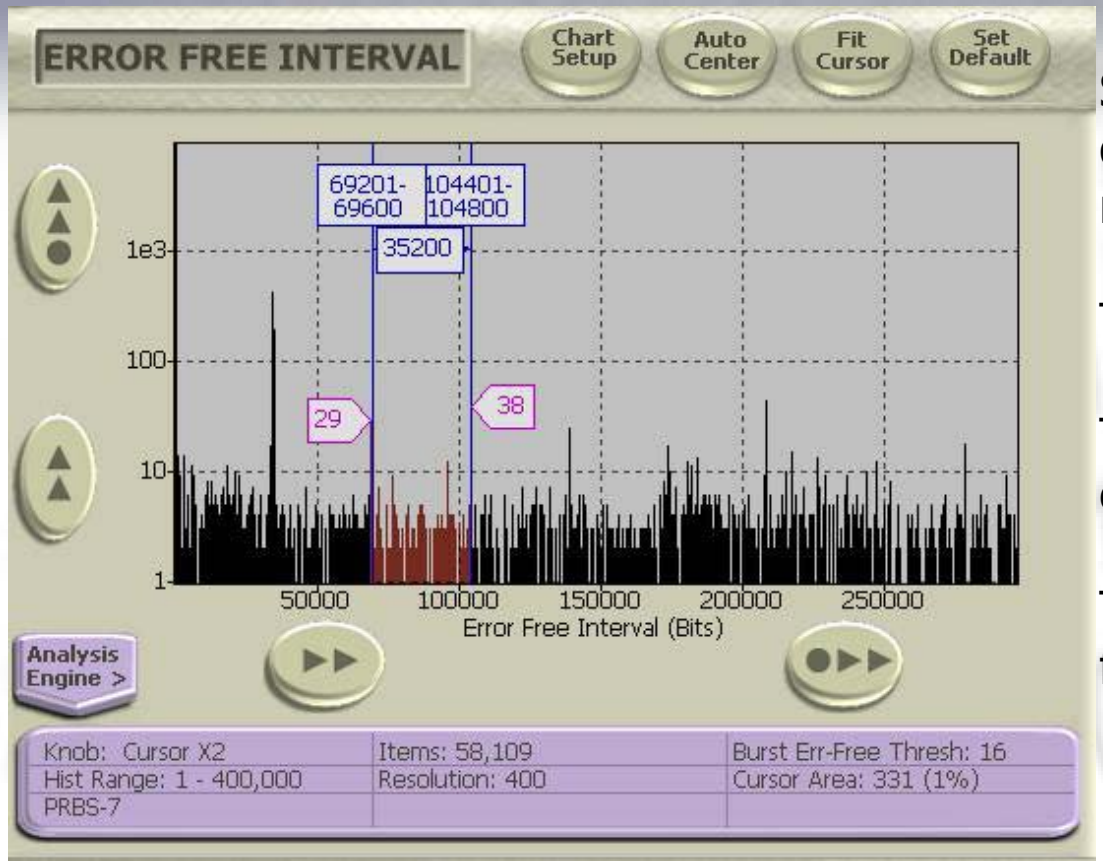
Error Analysis Examples



Some error free intervals in this display occur hundreds of times more often than others.

These errors are systematic.

The frequency of the systematic error corresponds to ~35,000 bits.

This diagnostic information helps find the cause of the error.

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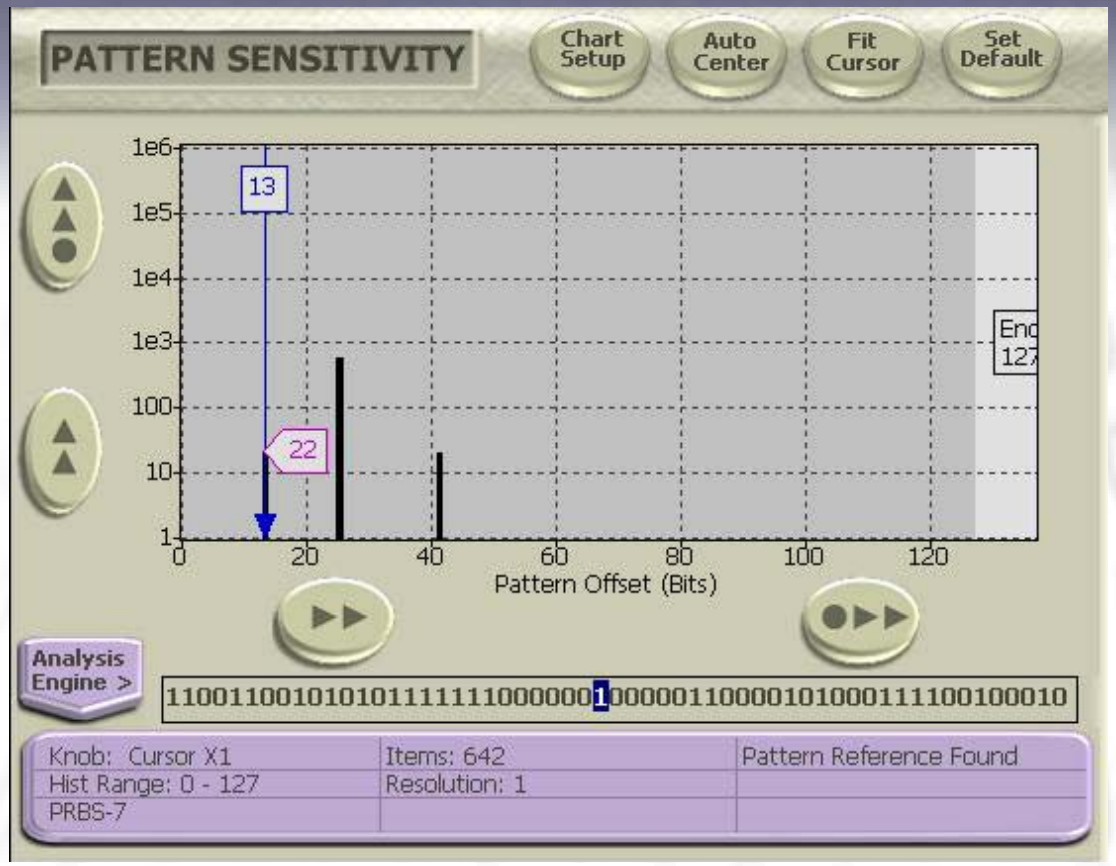
Error Analysis Examples



Pattern Sensitivity

Zooming feature allow users to correlate errors to individual bit positions within the test sequence

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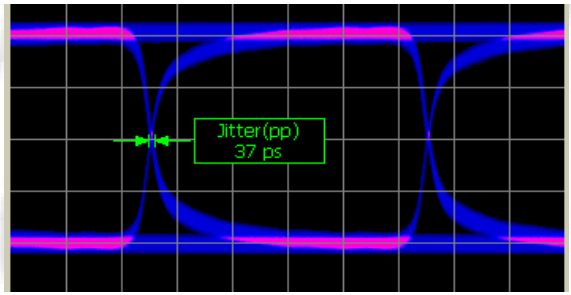
Signal/Data Integrity Testing

Integrity Testing
(Design Validation & Production)

Bit Error Rate

3.45×10^{-12}

Signal Wave shape
- measurements
- mask testing



Jitter

```
Random - 2.5 psec RMS
Deterministic - 11 psec
Total - 3.28 psec RMS
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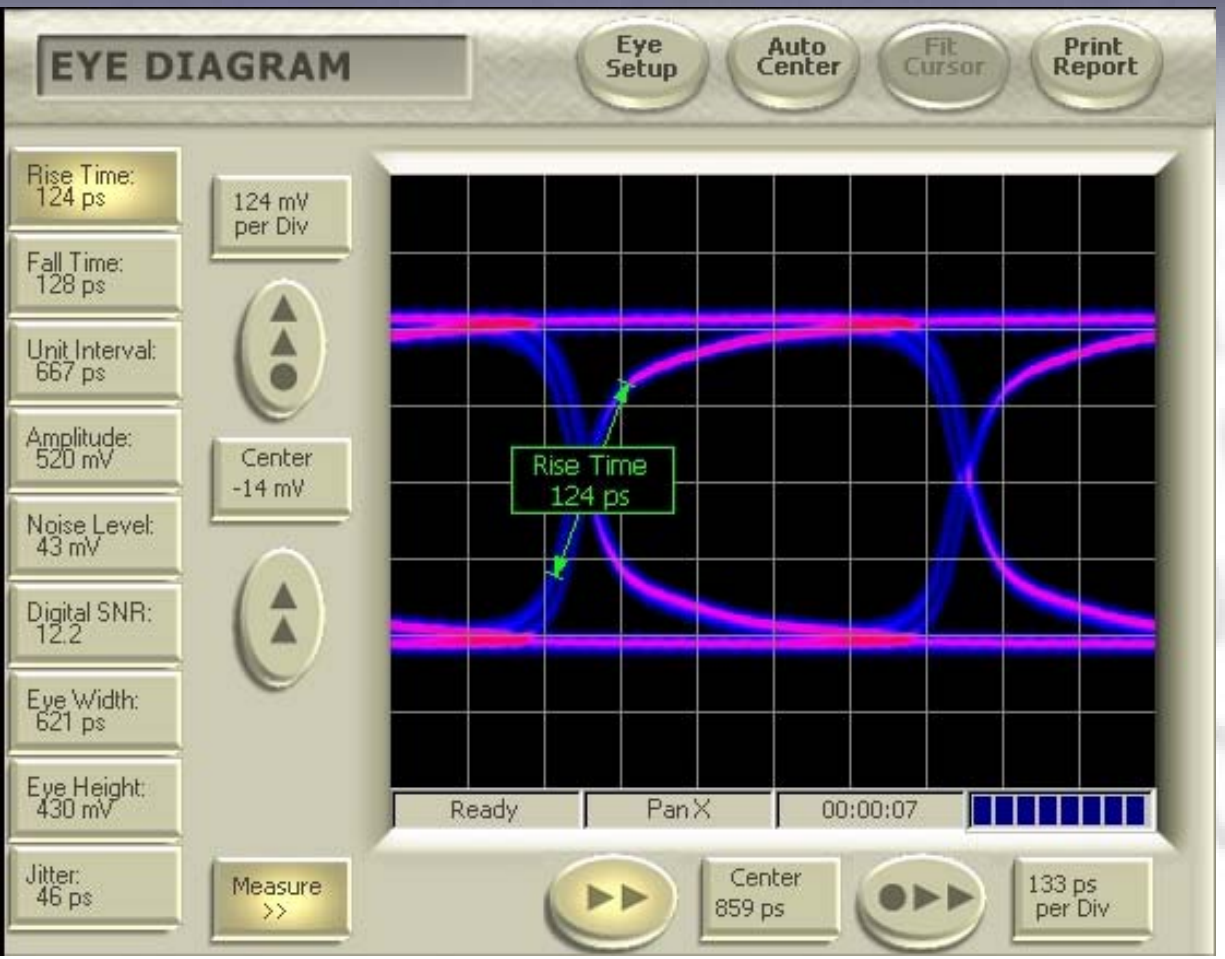
Eye Diagram Display



- Shares sampling electronics with BER function
- Accumulates eye samples faster than oscilloscopes
- automatic eye measurement

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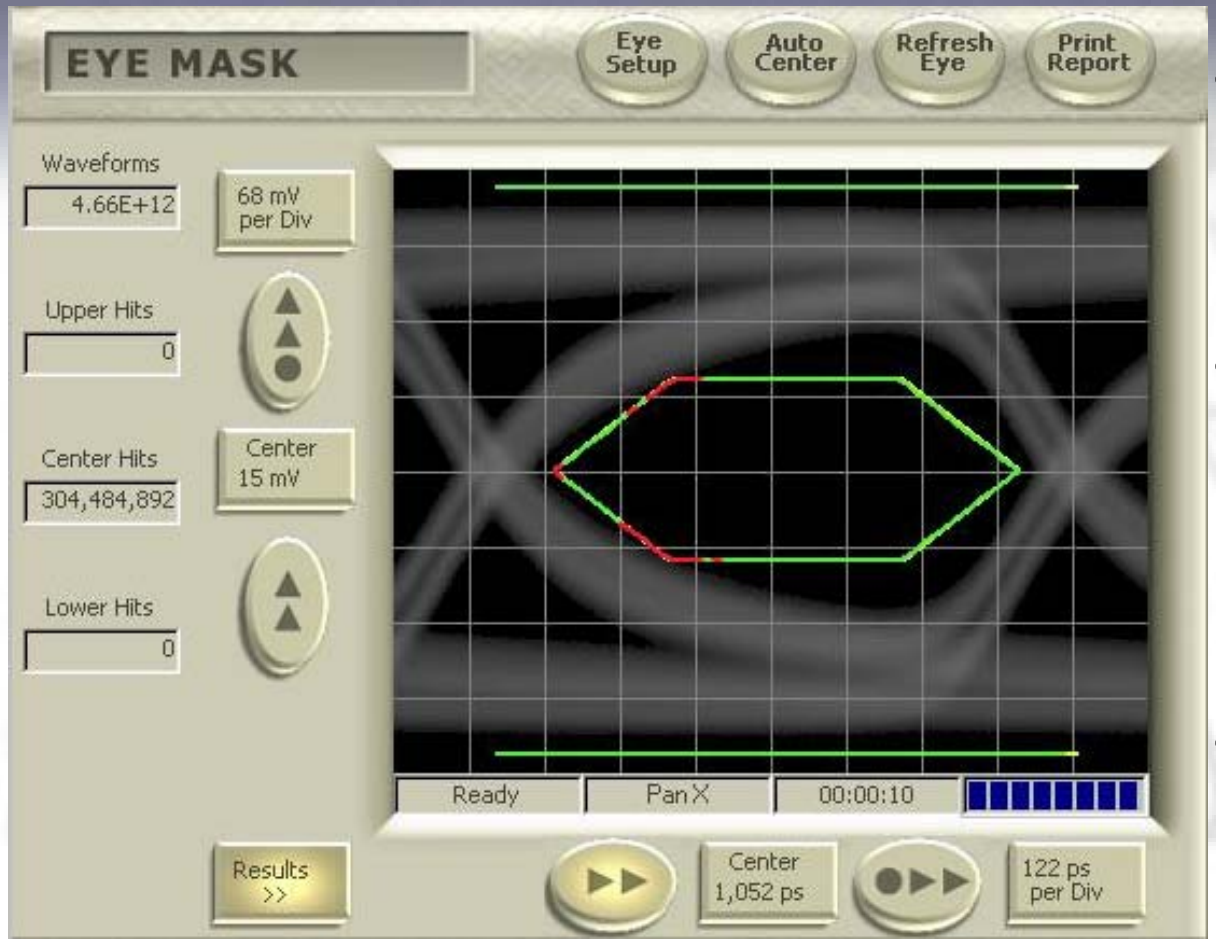
Eye Mask Test



- Tests eye against template for eye shape
- Often used in component manufacturing test
- Accumulates samples at bit rate

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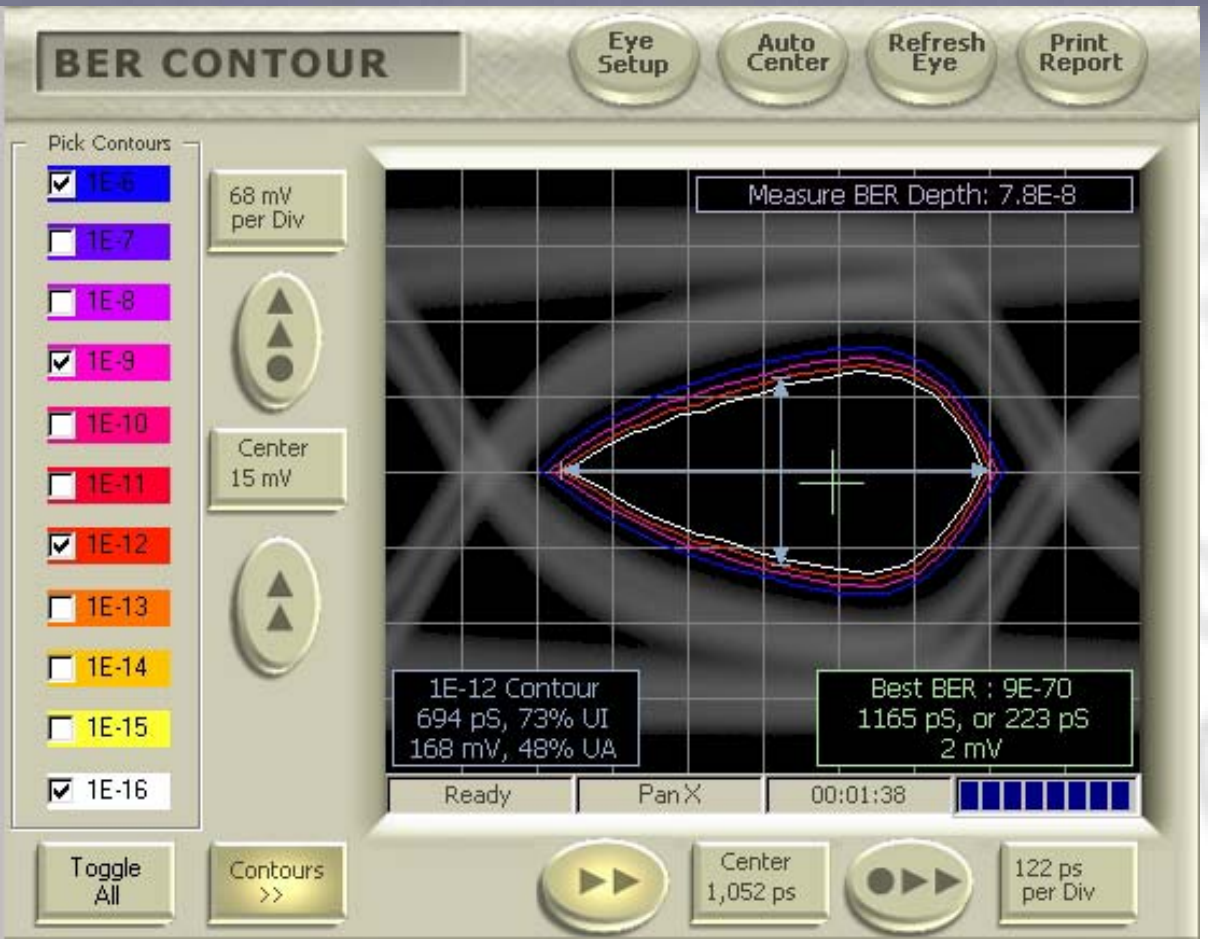
Contour Measurement



- Provides BER contour map of the eye opening
- Specific BER contours can be exported for use with the mask function

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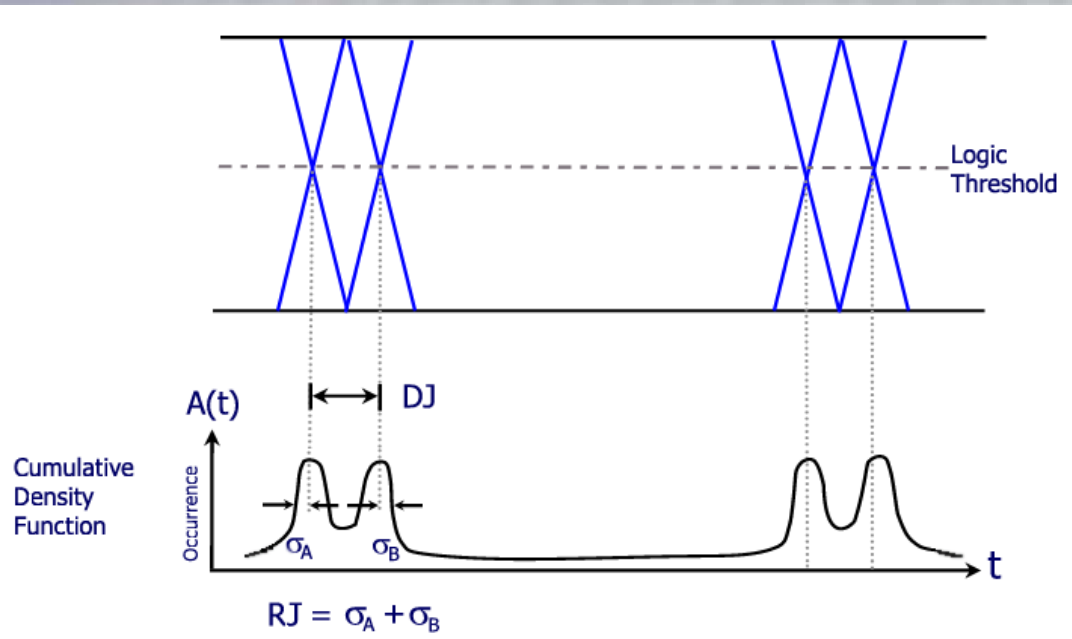
Jitter Measurement



- Datacom jitter measurement requires the separation of random jitter (RJ) and deterministic jitter (DJ)
- Random jitter is Gaussian
- Deterministic jitter is bounded

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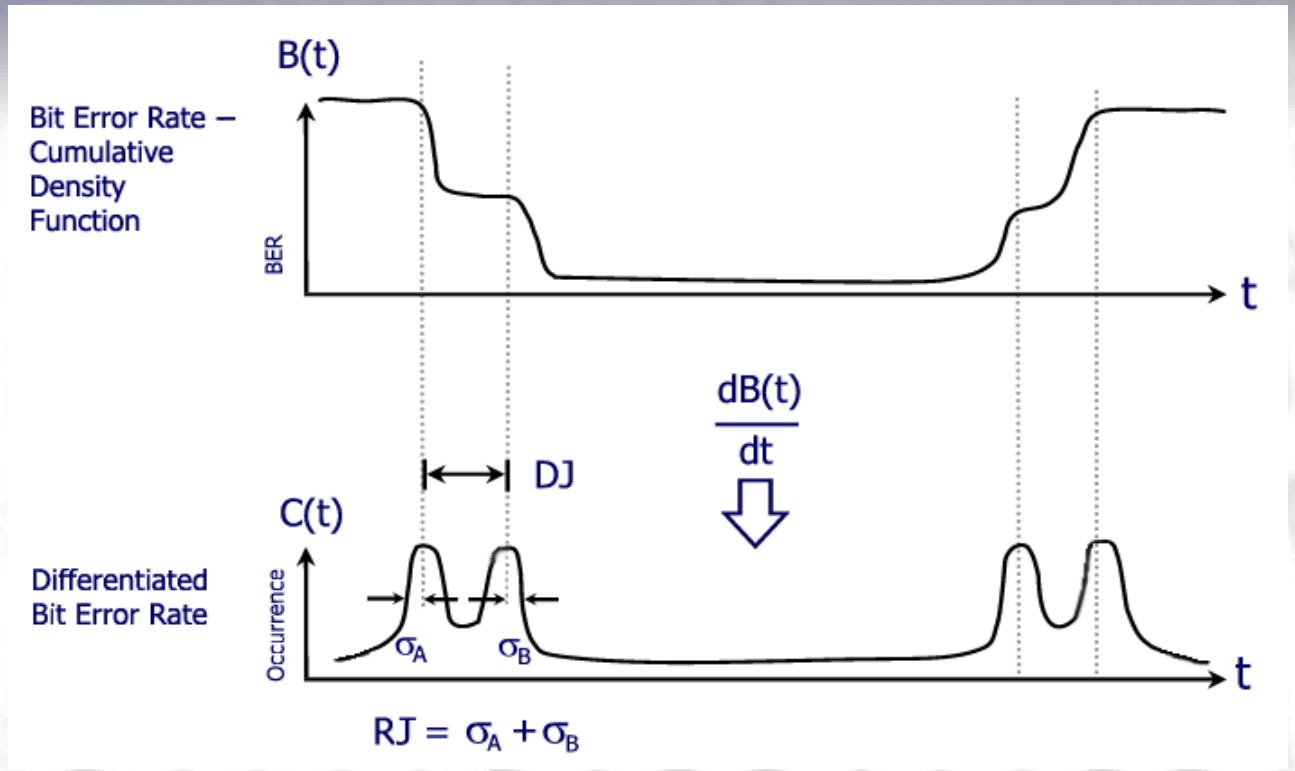
BER CDF vs PDF



A BER scan across the eye yields the BER "bathtub" curves from which the transition probability density function (and hence the jitter) can be derived.

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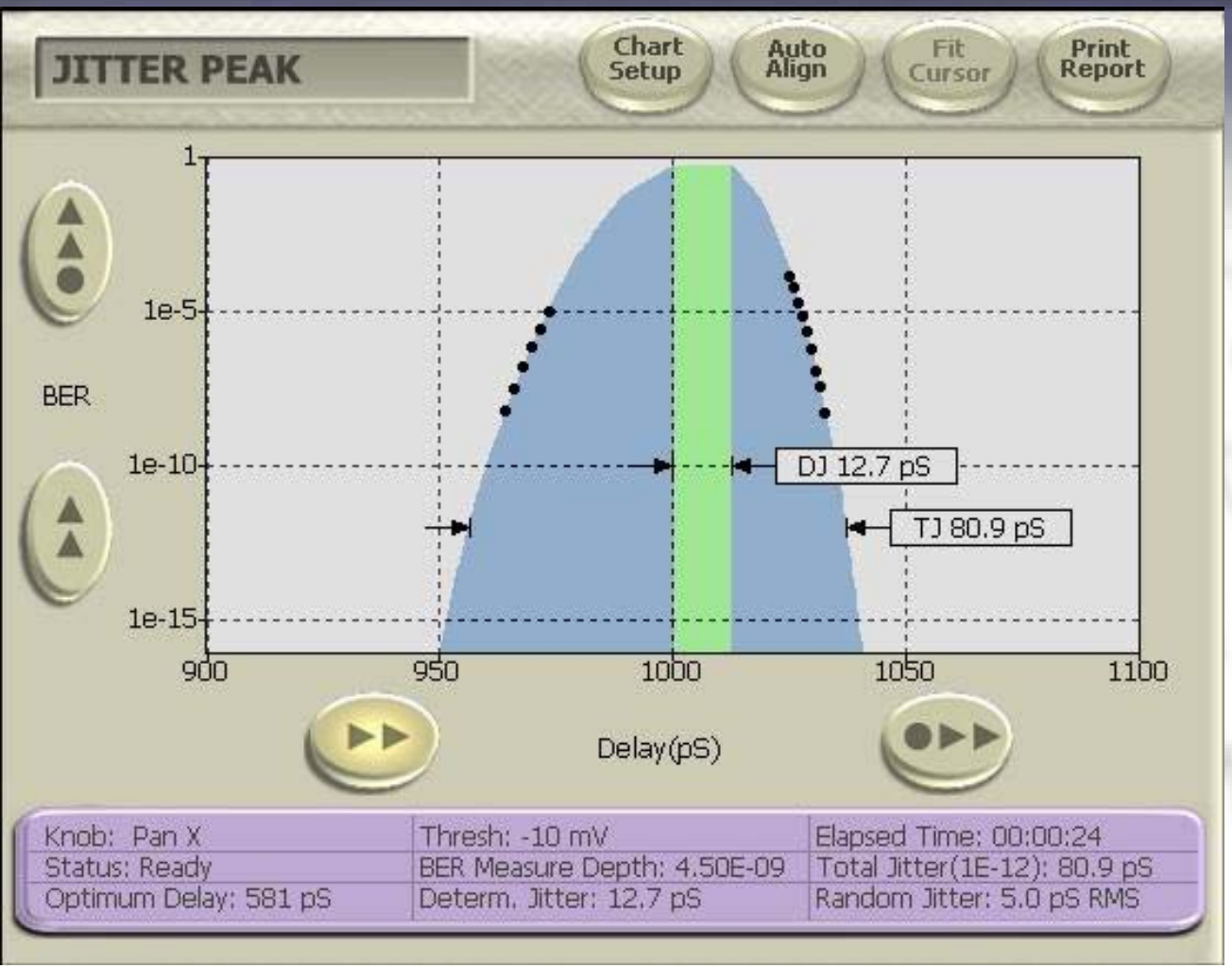
Jitter Measurement



Total jitter is typically measured at the 10^{-12} bit error rate level.

Measurements are extrapolated to this level assuming a Gaussian distribution

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Conclusion

- With this new functionality, the BER tester has become more of a general purpose test and diagnostic tool
  - With error analysis and physical layer test, the BER tester adds many of the functions of an oscilloscope, logic analyzer and time interval analyzer
- More information on these technologies can be found at www.synthesysresearch.com

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