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Measurement of eye parameter using embedded spec search in SmarTest 8 to reduce the test time

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AGENDA

- Why Eye Diagram?
- Overview of Jitter
- Embedded Spec search
- Implementation of Jitter tool box
- Results
- Conclusion



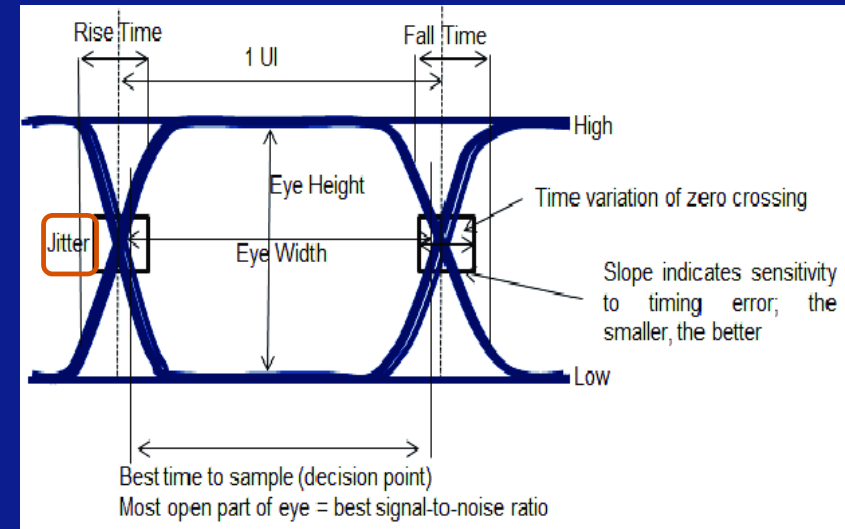
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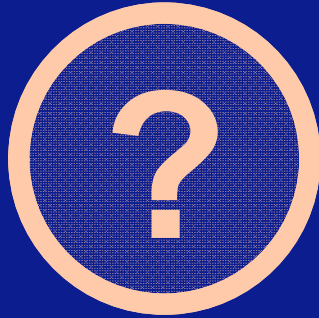
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Why Eye Diagram?

- Validate the high speed signal strength and its integrity.
- **Importance of Jitter:**
 - Analyze High speed interfaces.
 - Necessity in production screening.
 - Crucial for Time-To-Market and Time-To-Volume through ATE.



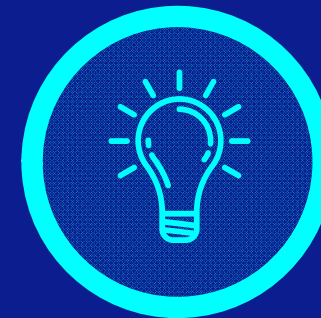
Proposal



Existing Jitter Tool Box is developed in Advantest v93K in the version of SmarTest 7, which takes up more test time.

To Optimize test time, it is proposed in SmarTest 8 by using Embedded spec search.

Implementation of this Jitter Tool Box will reduce the test cost by achieving optimized test time.



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Overview of Jitter

- Short term timing variation in clock or data signal.
- **Jitter Types:**
 - **Random Jitter**
 - Characterized by a Gaussian distribution and it is unbounded.
 - Timing noise that cannot be predicted.
 - **Deterministic Jitter**
 - Characterized by bounded pk-pk value.
 - Repeatable and Predictable.



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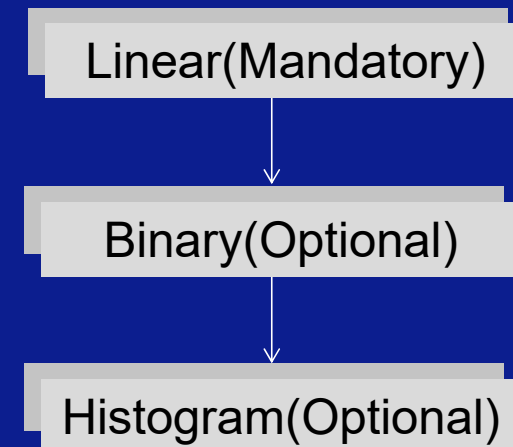
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Embedded Spec search

- Optimized test time.
- Faster search for spec values by leveraging the Fast Adjustment feature.
- Fast Adjustment - Search for the boundaries or middle of the eye in order to find the best strobe.
- **Linear Search** - Scans the specified search range.
- **Binary & Histogram Search** - To refine the search result.

Search Algorithm:



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Implementation of Jitter tool box

- **Tester Platform** : Advantest 93K - SmarTest 8
- **Instrument Used** : Pin Scale Card
(Test Method Supports all Pin Scale Instruments)
- **Methodology** : Embedded spec search
- **Test Method** : Programmed in Java



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Steps Involved

1. Data Acquisition

- Captures the error count data in the bit transition area.

2. Data Postprocessing

- Calculates the random jitter, deterministic jitter and total jitter according to the input of error count.
- Jitter separation done via the Q-factor method.



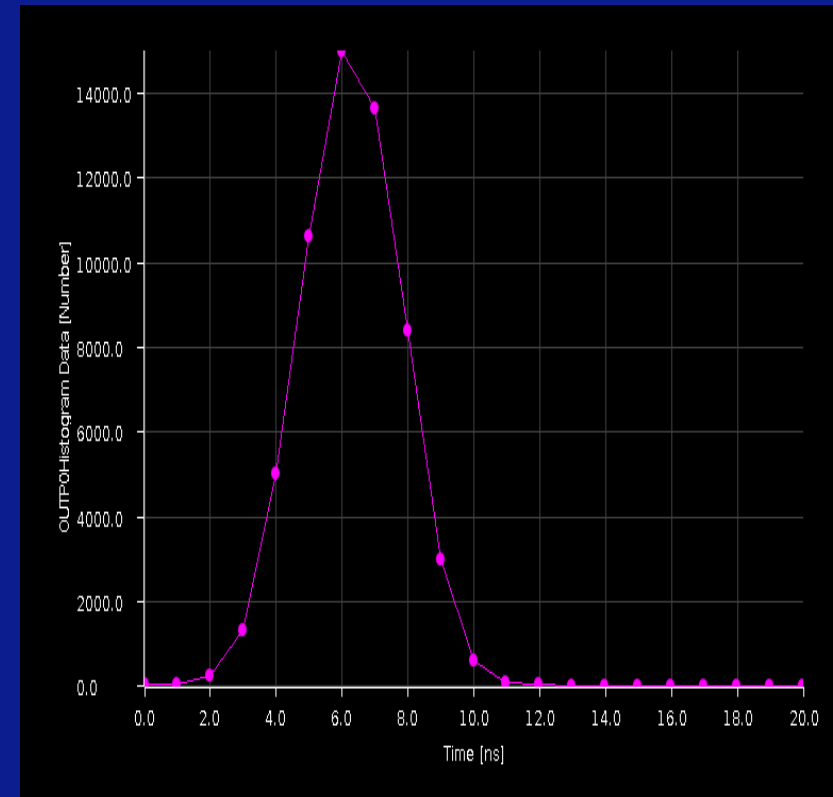
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Jitter Histogram

- Captures the error count in the transition area of a data eye.
- Calculate the peak-peak and RMS jitter values.
- **Peak-Peak Jitter** - Full width of the histogram.
- **RMS Jitter** - Standard deviation of the histogram.



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Jitter Separation (Q-factor Method)

- Starting point of the Q-factor is Bathtub curve of the error count data.
- Bathtub Curve - Provides the timing margin for each possible Bit Error Rate value.
 - To graph Bit Error Rate vs Sampling time throughout the unit interval.
- Bit Error Rate(BER) - Calculated by dividing the recorded error count by the total number of bit in the vector stream.



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Jitter Separation (Q-factor Method)..Contd

- Bathtub curve is transferred to the Q-space for the selected BER range (FittingRange_max, FittingRange_min).

$$Q = \sqrt{2} \cdot \text{erf}^{-1} (1 - (4 / P_B) * \text{BER})$$

erf - Error Function

P_B - Transition Density (ρ_T)

BER - Bit Error Rate



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Jitter Separation (Q-factor Method)..Contd

- Selection of the fitting range is crucial for meaningful jitter separation results.
- Quality of the fitting controlled by the r^2 factor. Perfect fitting is achieved with $r^2 = 1$.
- Q-space curve will be linear for the Random Jitter.



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Random / Deterministic Jitter Calculation

- **Random Jitter:** Average of the left and the right side of the data eye.

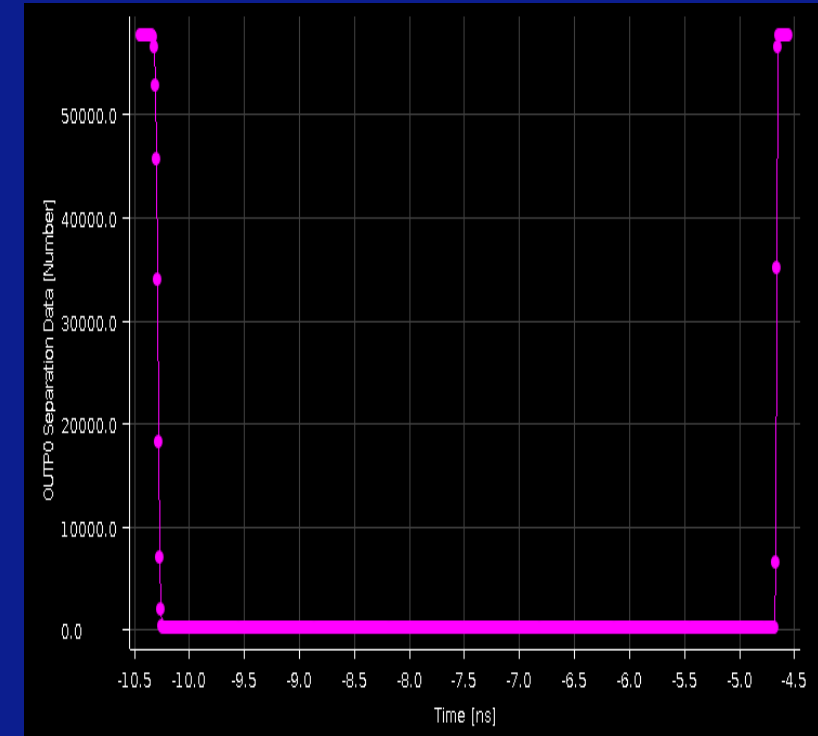
$$RJ = (\partial_{\text{Right}} + \partial_{\text{Left}})/2$$

- **Deterministic Jitter:** Distance of the means of two slopes.

$$DJ = 1UI - (\mu_{\text{Right}} - \mu_{\text{Left}})$$

- **Total Jitter Calculation:**

$$TJ = UI - \text{Eye Width}$$

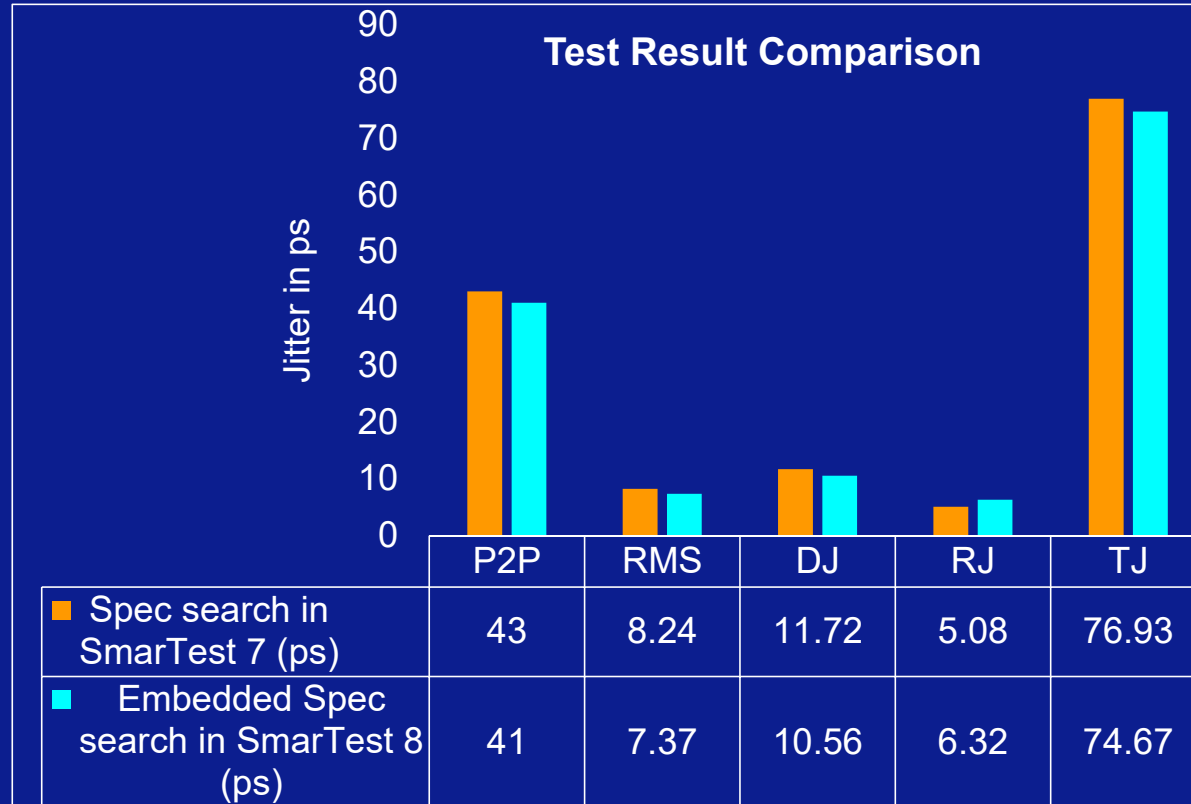


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Results



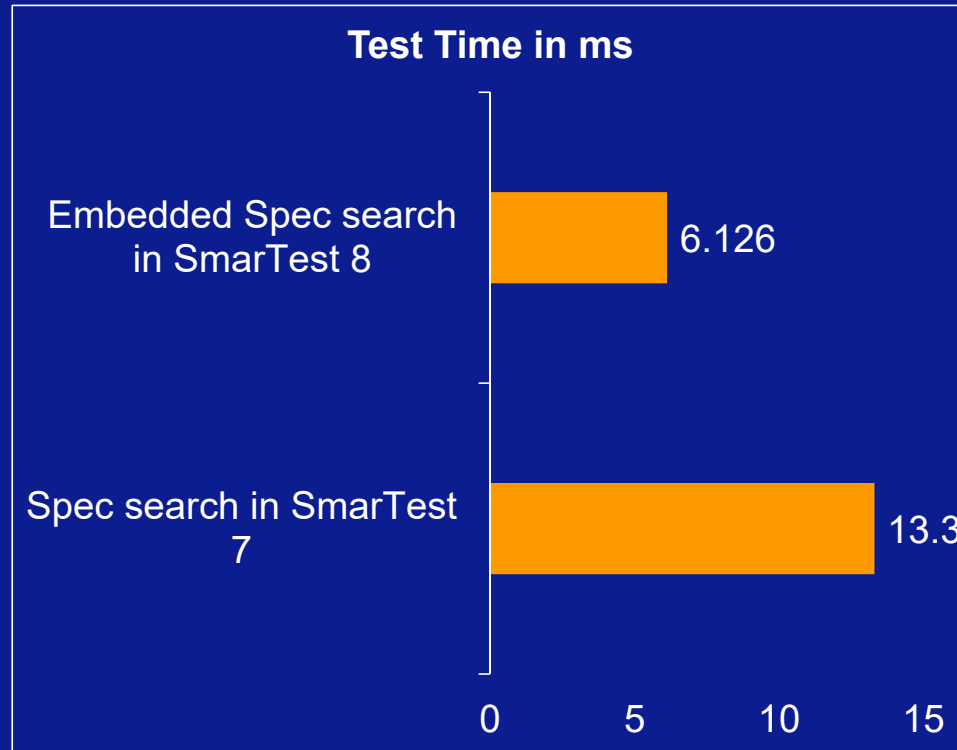
Jitter Tool Box based on Embedded spec search in SmarTest 8 is implemented and validated on the real time product.

P2P : Peak to Peak
RMS : Root Mean Square
DJ : Deterministic Jitter
RJ : Random Jitter
TJ : Total Jitter



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Test Time Comparison



- Saving approximately 7.174ms.
- Assuming 100 million parts with X12 multi- site setup and 5 cents per sec as test cost, the above proposal will save ~ 120K USD.
- Test Method is generic and can be reused in future products.



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Conclusion

- Implementation of this tool to measure Jitter(one of the eye parameter) using Embedded spec search in SmarTest 8, which result in time savings compared to the traditional method.
- Further scope of this technique is to develop tool for measuring all the eye parameters.



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References

- Advantest Technical Document Center
 - Topic No.118691 “Jitter Separation”
 - Topic No.96933 “Jitter Histogram”
 - Topic No.0439882588 “Fast adjustment using the EmbeddedSpecSearch ”



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