Samtec Final Inch™ SE Array® Connector (SEAM/SEAF) 7 mm Stack Height Differential Channel Properties, High Density Vertical Test Case

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Jim Bell, Senior Signal Integrity Engineer

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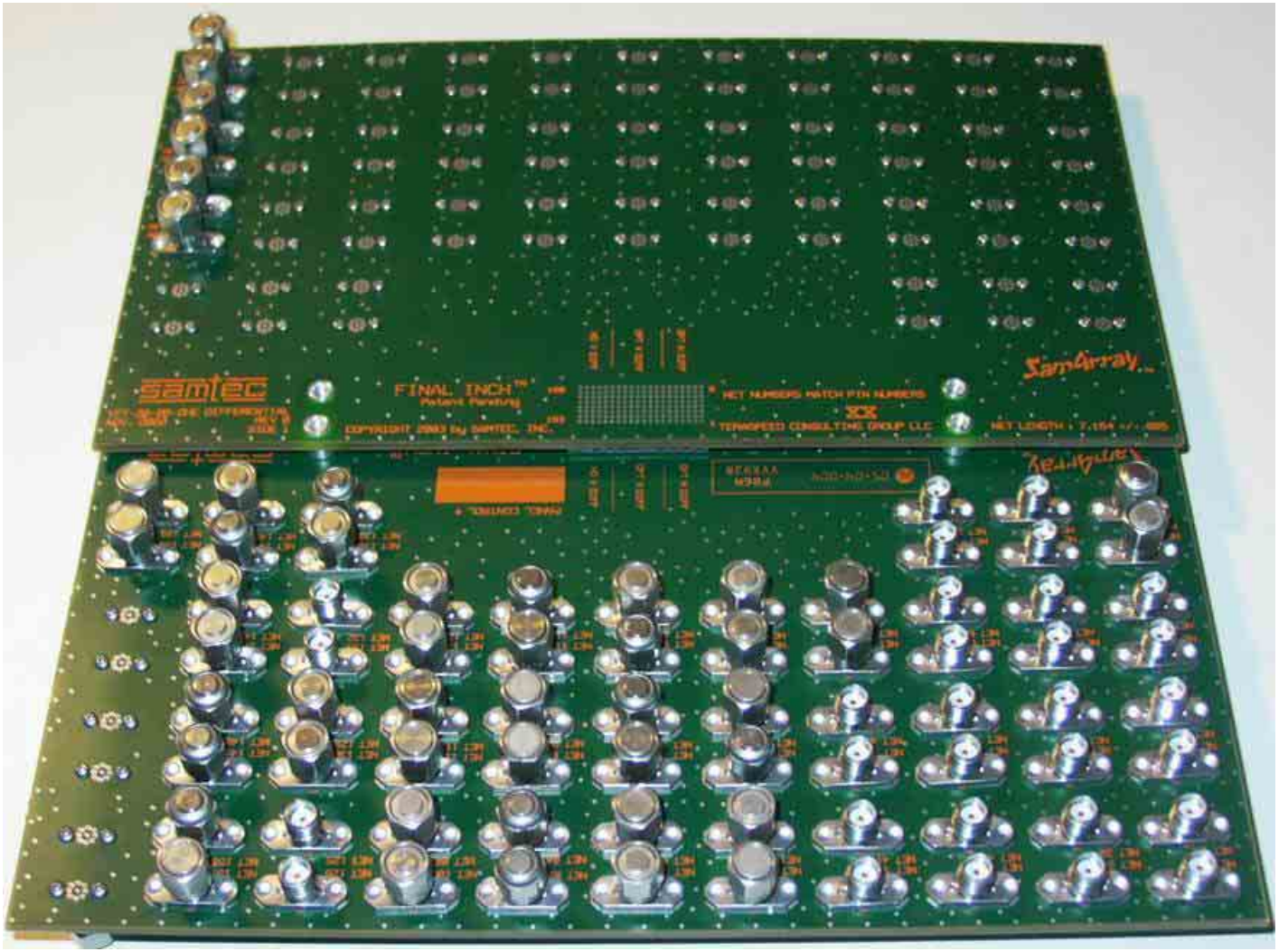
SE Array® Differential Final Inch™ Test & Evaluation Boards



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Documentation Goals

- Provide Information for :
  - Characterization of in-system differential performance of the SE Array® connector system.
    - Provide eye pattern simulations with real system layout and routing effects.
      - Eye simulations performed with worst case adjacent neighbor pairs switching at maximum bit rate and driven victim switching with a pseudo random pattern.
    - Provide frequency domain simulations of insertion loss, return loss and crosstalk.

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Introduction and Philosophy

The "Final Inch™" is not complete without validation of the electrical system performance through signal integrity modeling, simulations and measurements.

- Advanced 2D and 3D modeling methods are used to provide accurate models for all sections of the Final Inch™ boards.
  - SE Array ® connector models are developed through Samtec's advanced modeling process, as found at www.samtec.com.
  - Three dimensional PCB structures, such as SMA launches and vias, are modeled using a combination of CST Microwave Studio and Sigrity BroadBand SPICE.
  - Two dimensional PCB traces are modeled using Ansoft Maxwell 2D FEM Field Solver and Synopsis HSPICE w-element table models.
  - All modeled elements are combined and simulated using Synopsis HSPICE.

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PCB Stackup and Trace Configuration

- 12 layer 0.0862 construction
- Inner layer stripline routing.
- Outer layer escape and breakout
- 4.0 mil trace width, 6 mil separation
- 50 ohm characteristic impedance (single ended)
- 100 ohm differential impedance
- Er = 4.2
- Loss Tangent = 0.0215

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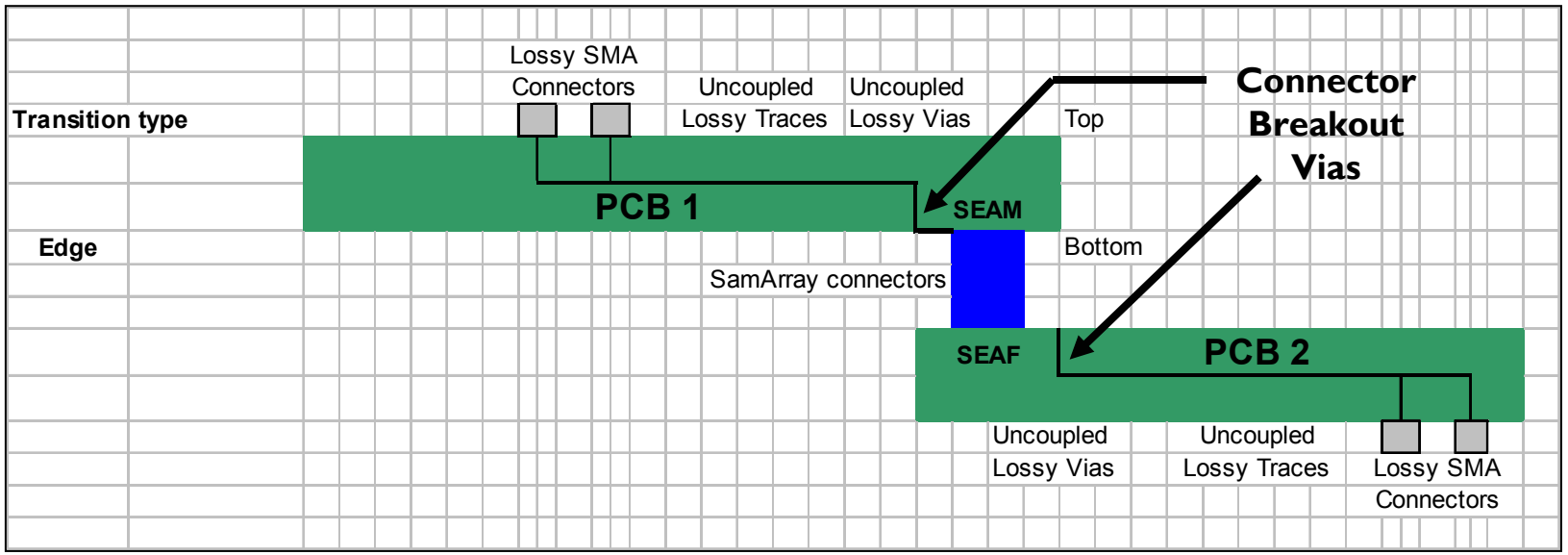
PCB Stackup and Trace Configuration



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Eye Pattern
Configuration

- Signal stimulus +/- 500 mV
- Driven victim and aggressor signals terminated differentially to 100 ohms.
- Eye simulations performed with worst case adjacent neighbor pairs switching at maximum bit rate and driven victim switching with a pseudo random pattern.

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Insertion and Return Loss
Configuration

- Victim Input Stimulus - 1Volt a.c., linearly swept from 100 MHz to 10 GHz
- Victim Signals terminated differentially at measurement point, 100 Ohms.
- Passive Signals terminated at both end points, 50 Ohms to Ground.

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Crosstalk
Configuration

- Victim Input Stimulus - 1Volt a.c., linearly swept from 100 MHz to 10 GHz
- Victim Signals terminated differentially at measurement point, 100 Ohms.
- Passive Signals terminated at both end points, 50 Ohms to Ground.

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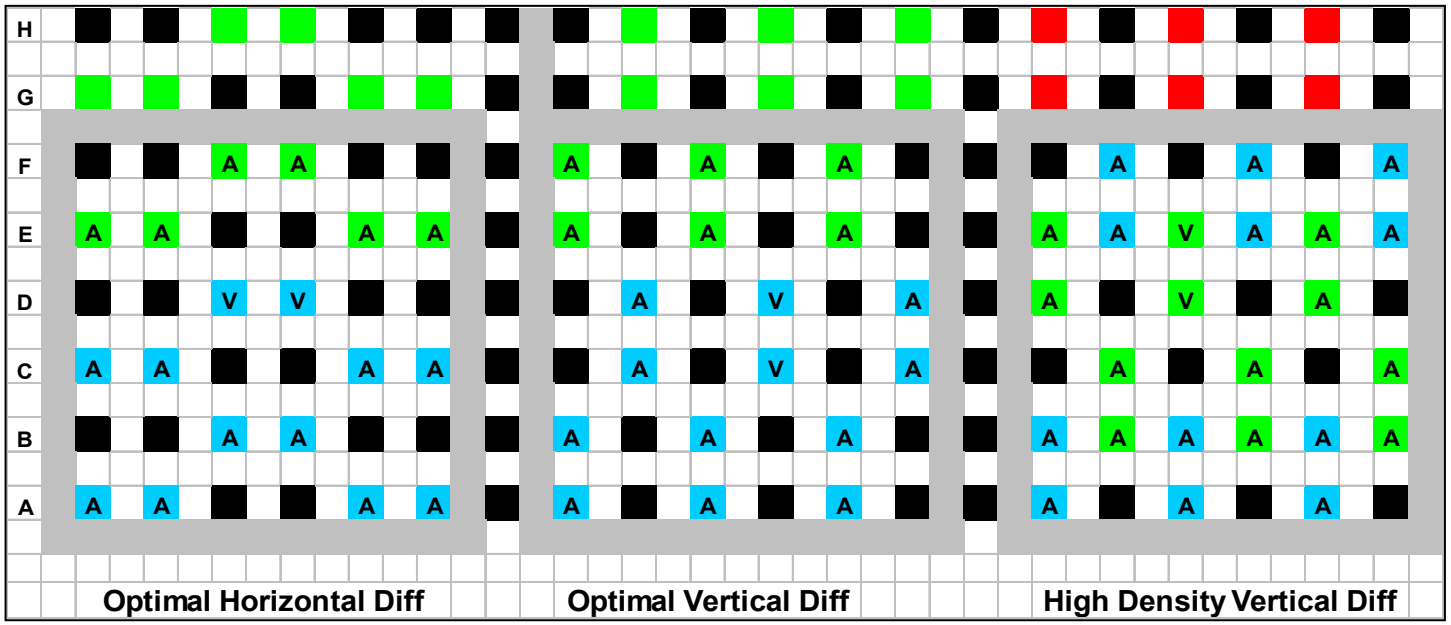
Channel Eye Properties



= Signal Layer 10 (driven by Layer 1 SMAs)

= Signal Layer 8 (driven by Layer 1 SMAs)

= Signal Layer 5 (driven by Layer 12 SMAs)

= Ground

V = Victim pair

A = Aggressor pairs

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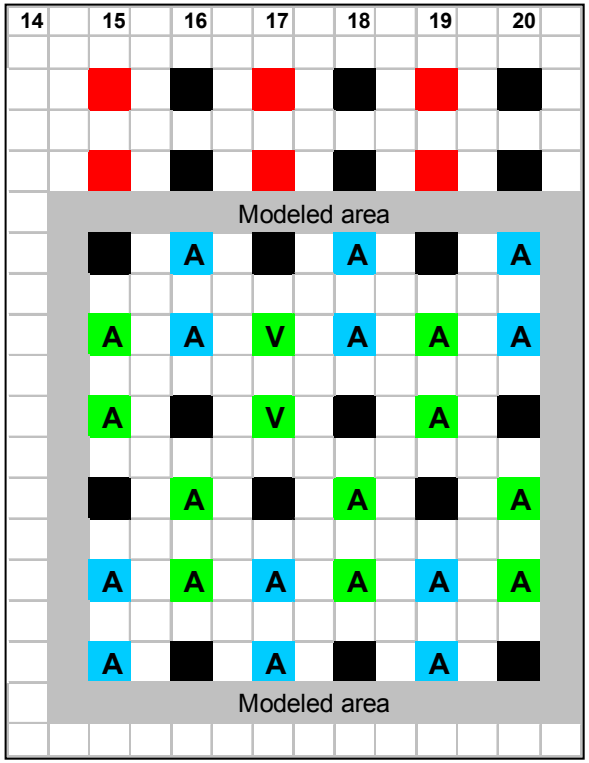
Channel Eye Properties, High Density Vertical Differential



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= Ground

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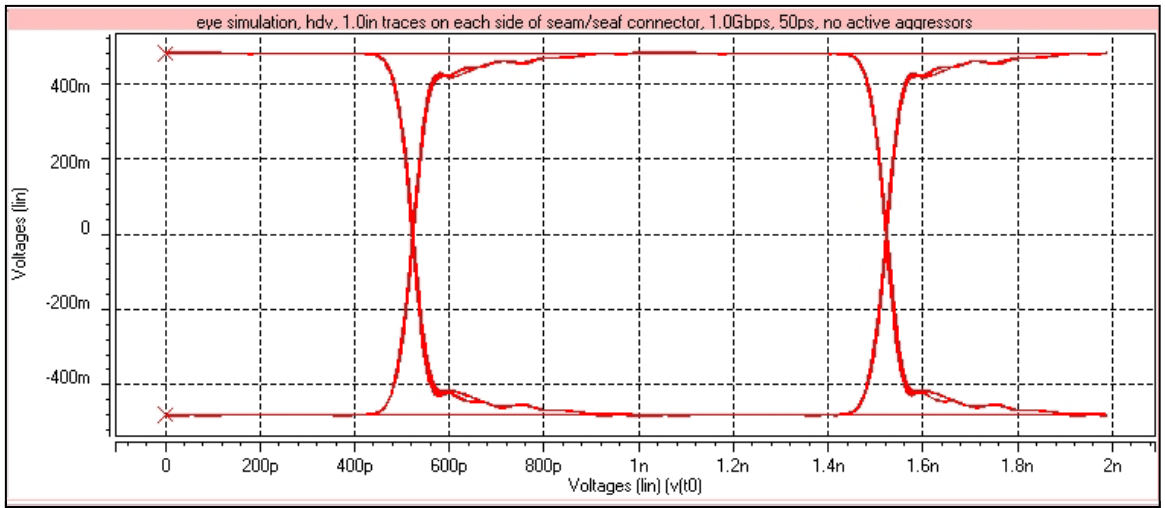
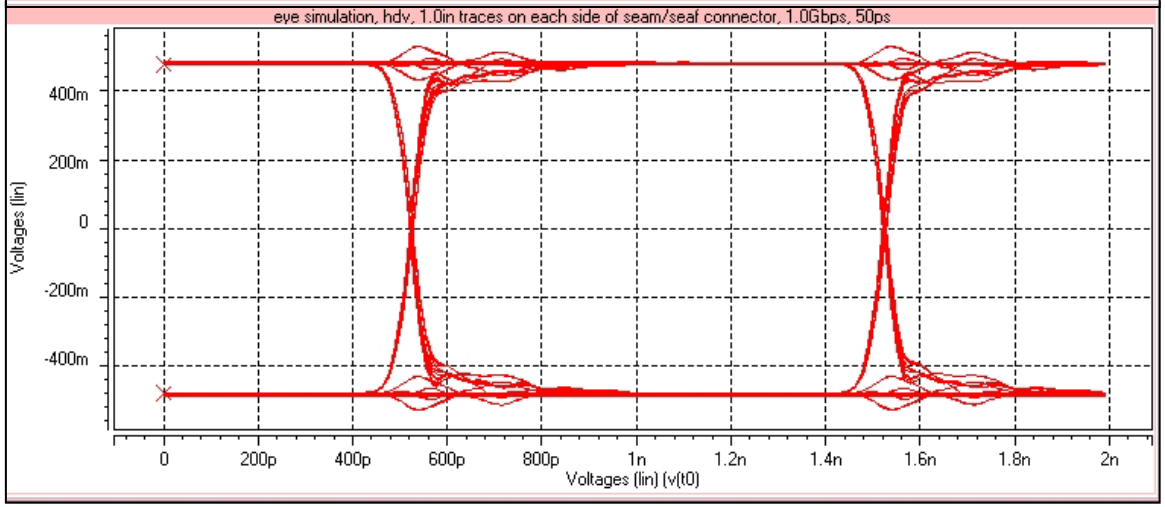
Eye, High Density Vertical Differential - Victim pair, 1Gbps, 50 psec. edges

1 inch Traces

No aggressor pairs active



All aggressor pairs active



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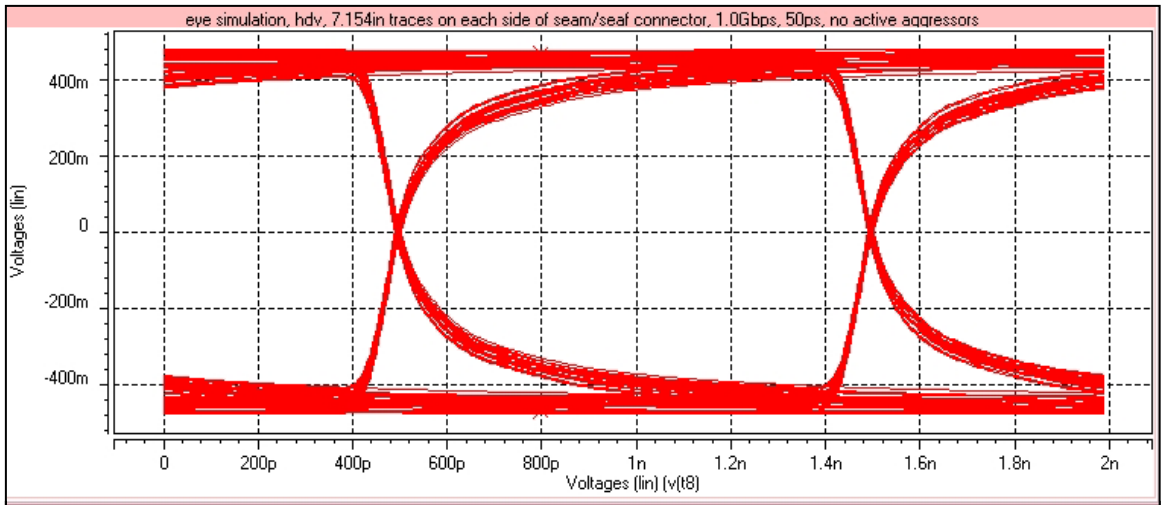
Eye, High Density Vertical Differential - Victim pair, 1Gbps, 50 psec. edges

7.154 inch Traces

No aggressor pairs active



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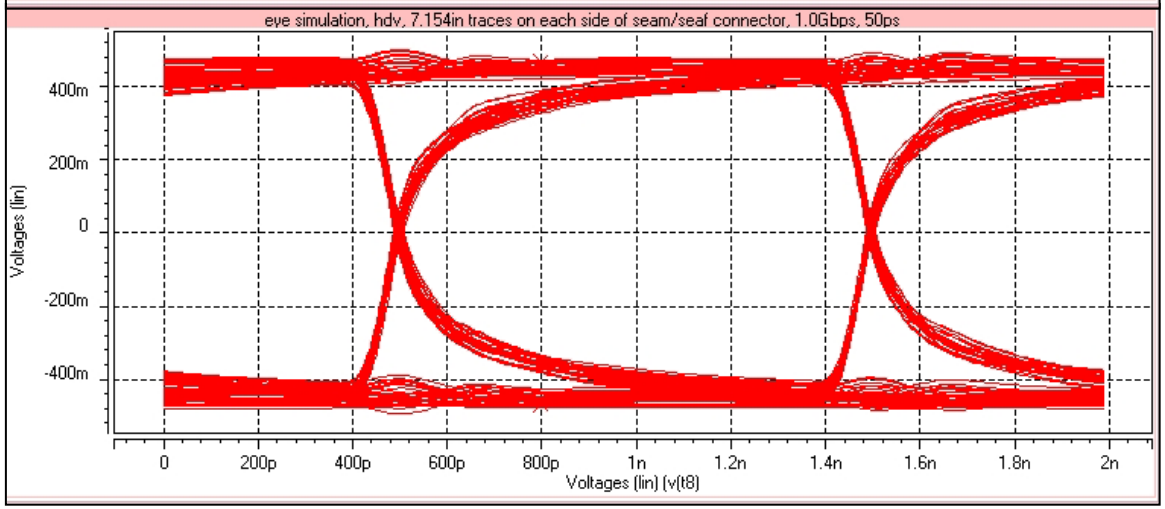

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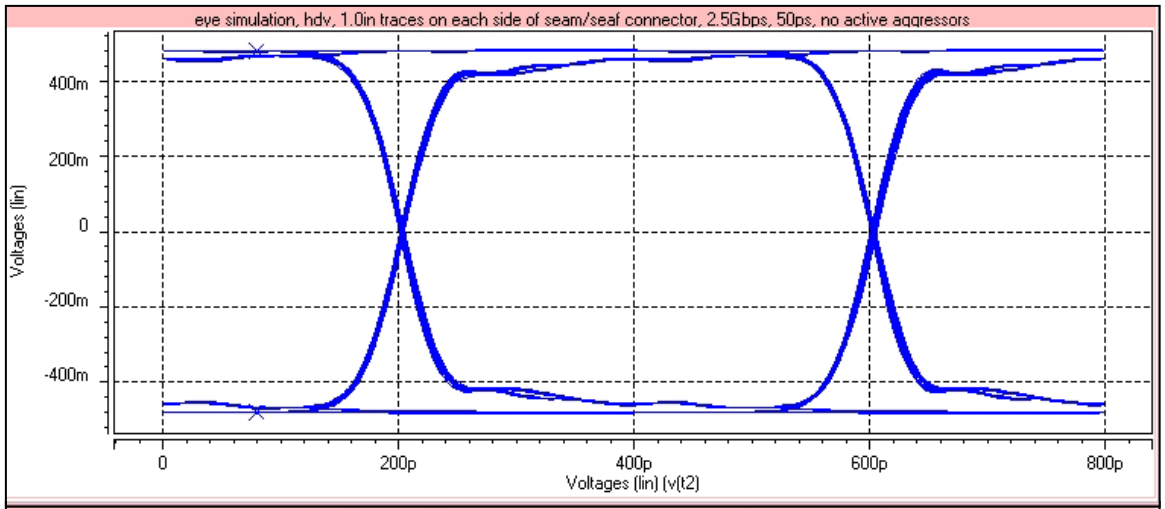
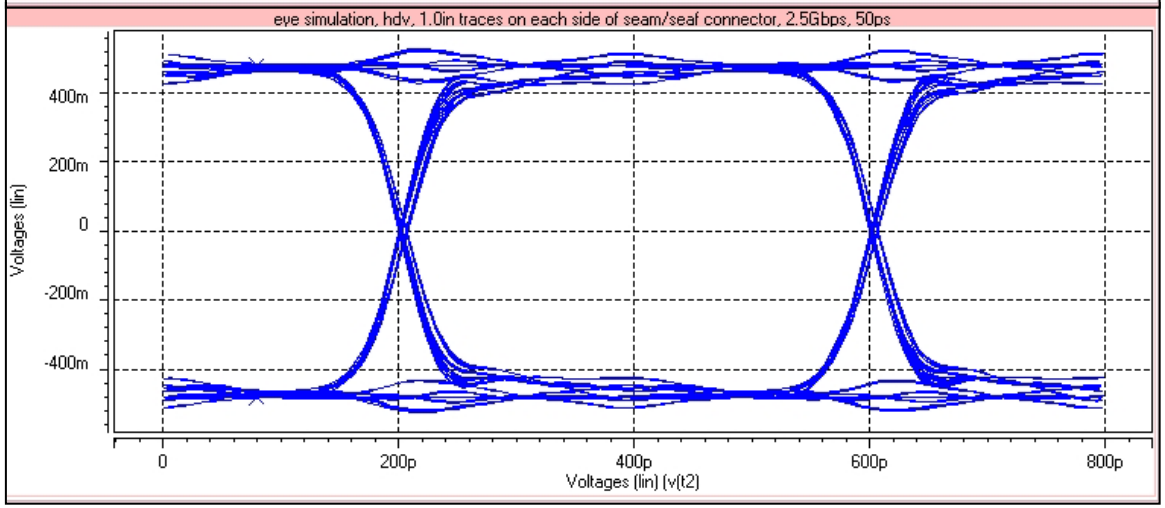
Eye , High Density Vertical Differential - Victim pair, 2.5 Gbps, 50 psec. edges

1 inch Traces

No aggressor pairs active



All aggressor pairs active



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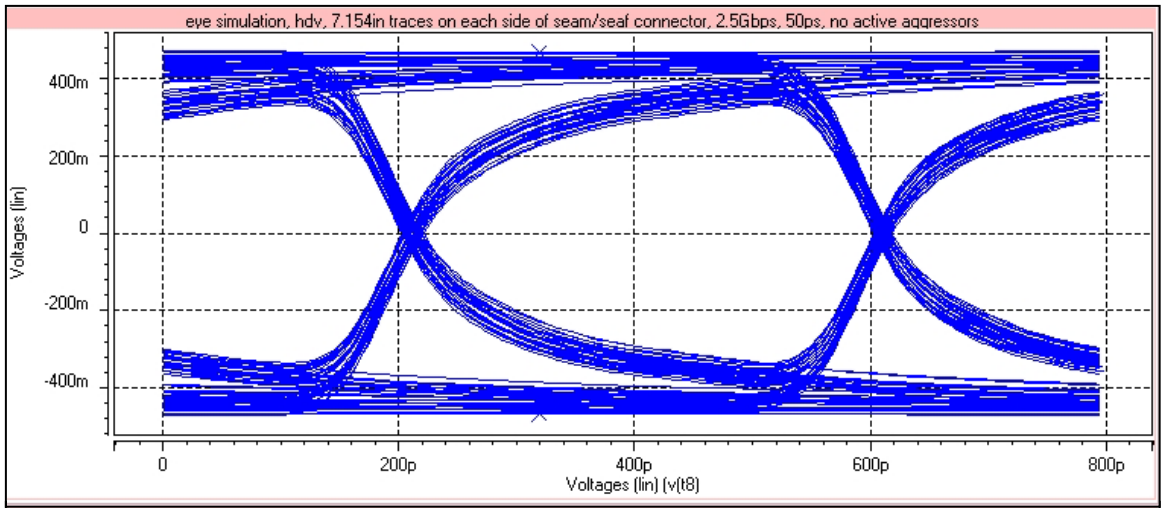
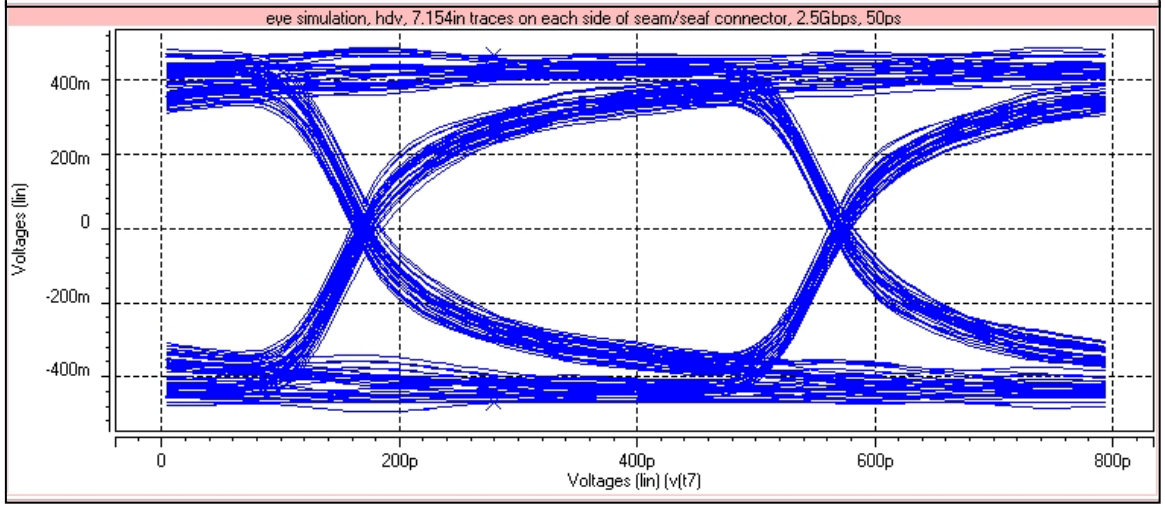
Eye , High Density Vertical Differential - Victim pair, 2.5 Gbps, 50 psec. edges

7.154 inch Traces

No aggressor pairs active



All aggressor pairs active



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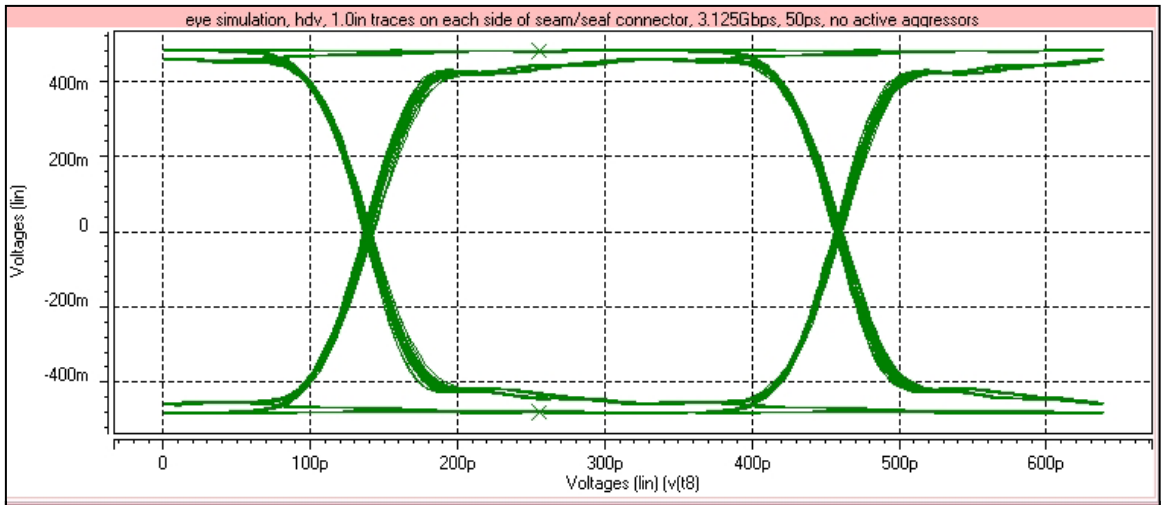
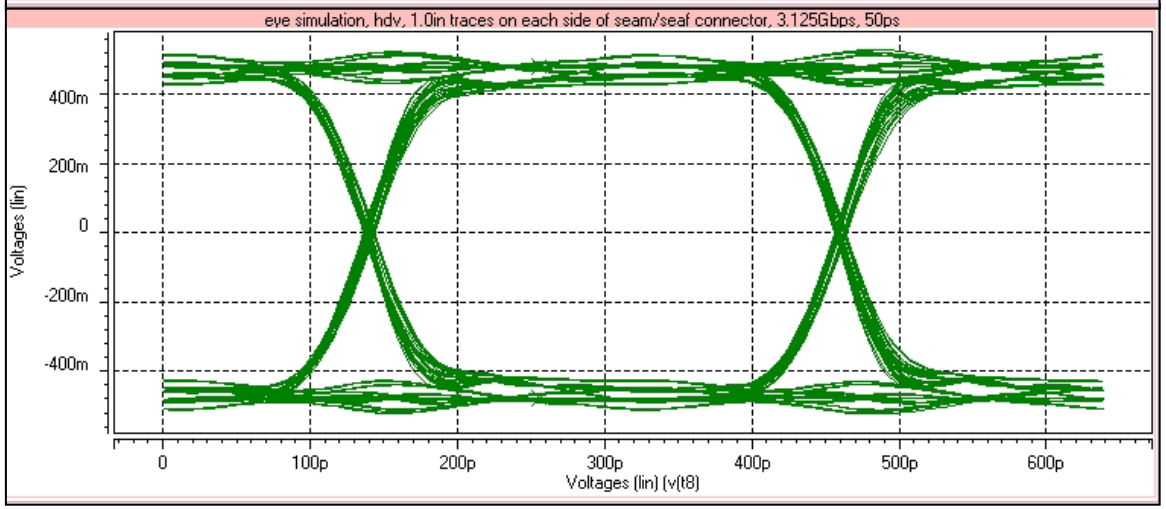
Eye , High Density Vertical Differential - Victim pair, 3.125 Gbps, 50 psec. edges

1 inch Traces

No aggressor pairs active



All aggressor pairs active



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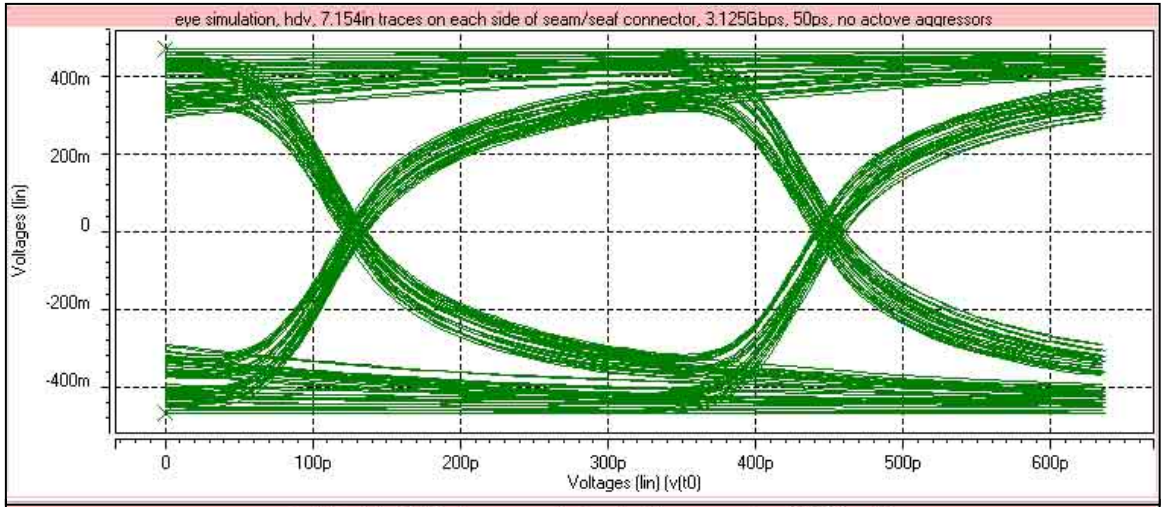
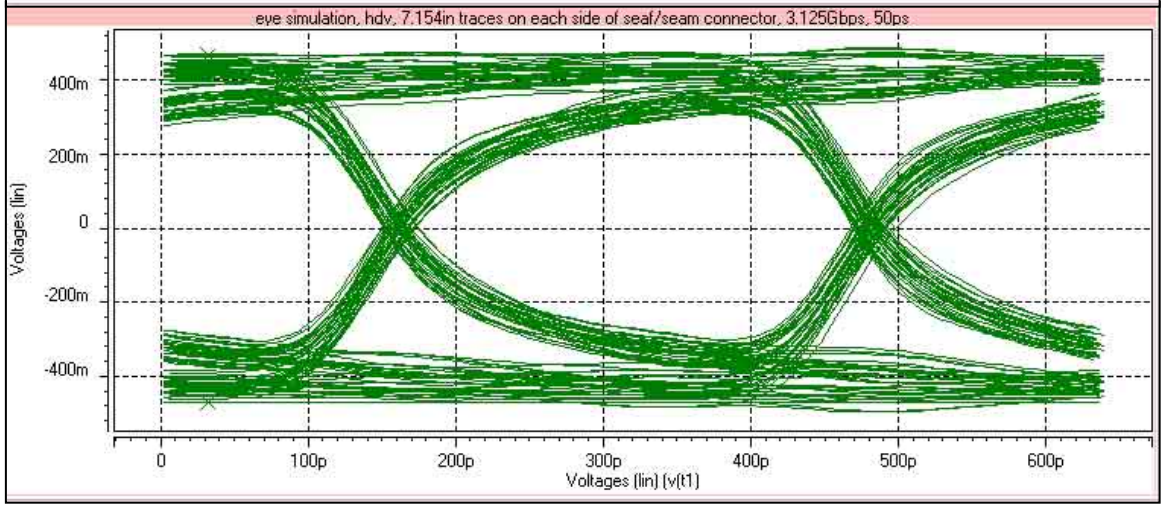
Eye , High Density Vertical Differential - Victim pair, 3.125 Gbps, 50 psec. edges

7.154 inch Traces

No aggressor pairs active



All aggressor pairs active



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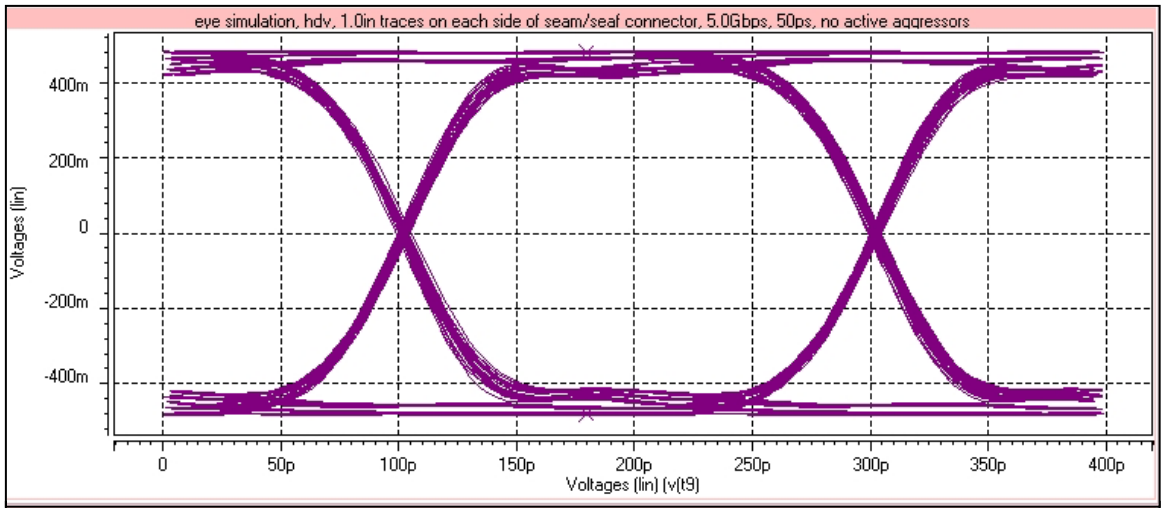
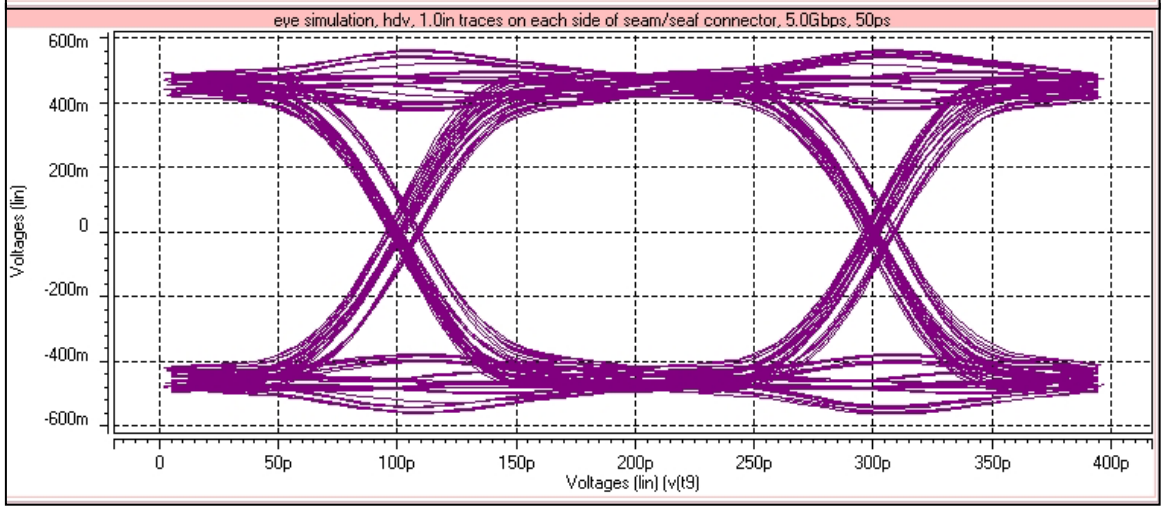
Eye , High Density Vertical Differential - Victim pair, 5.0 Gbps, 50 psec. edges

1 inch Traces

No aggressor pairs active



All aggressor pairs active



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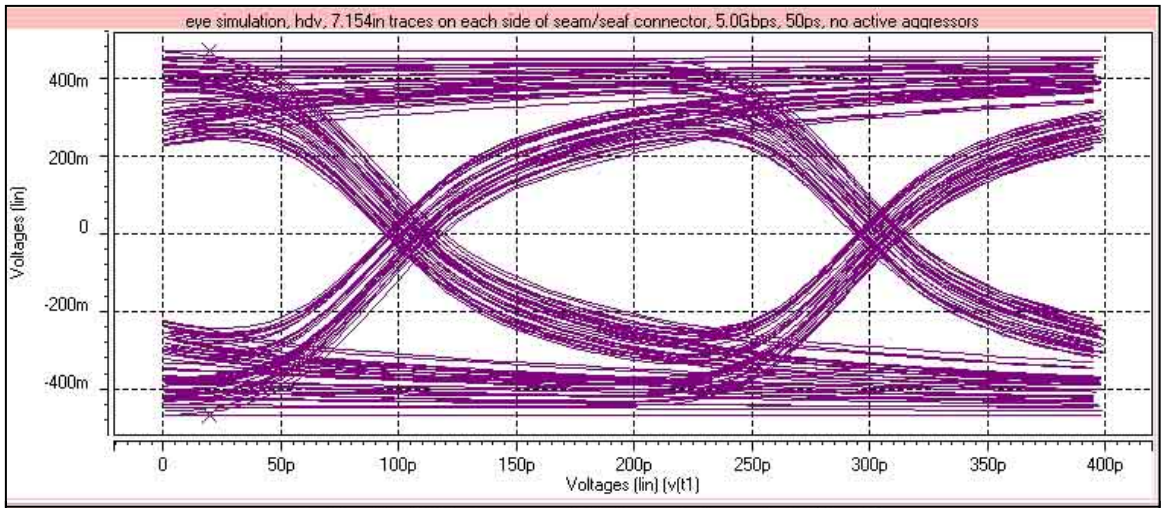
Eye , High Density Vertical Differential - Victim pair, 5.0 Gbps, 50 psec. edges

7.154 inch Traces

No aggressor pairs active



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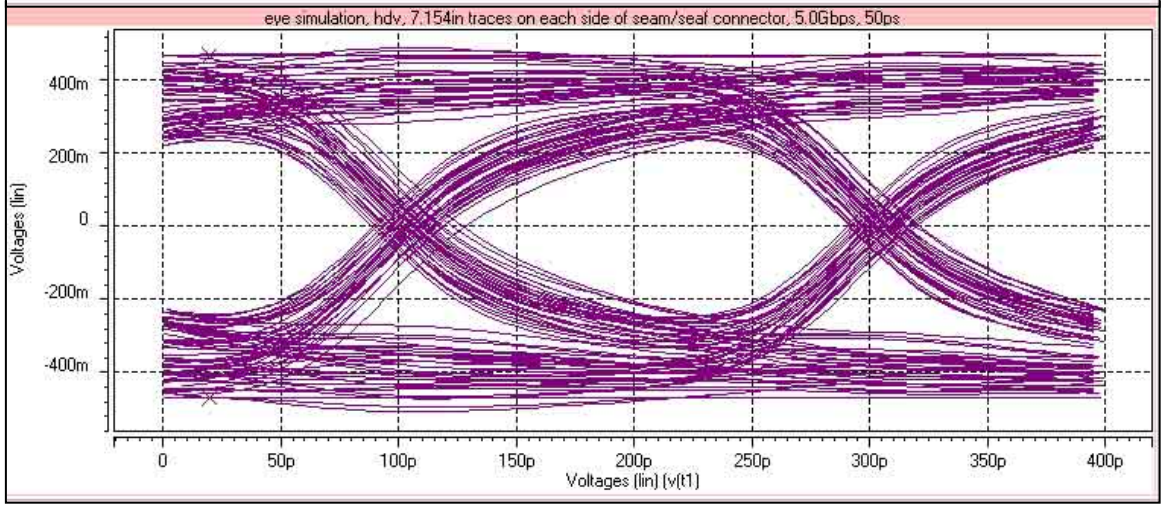

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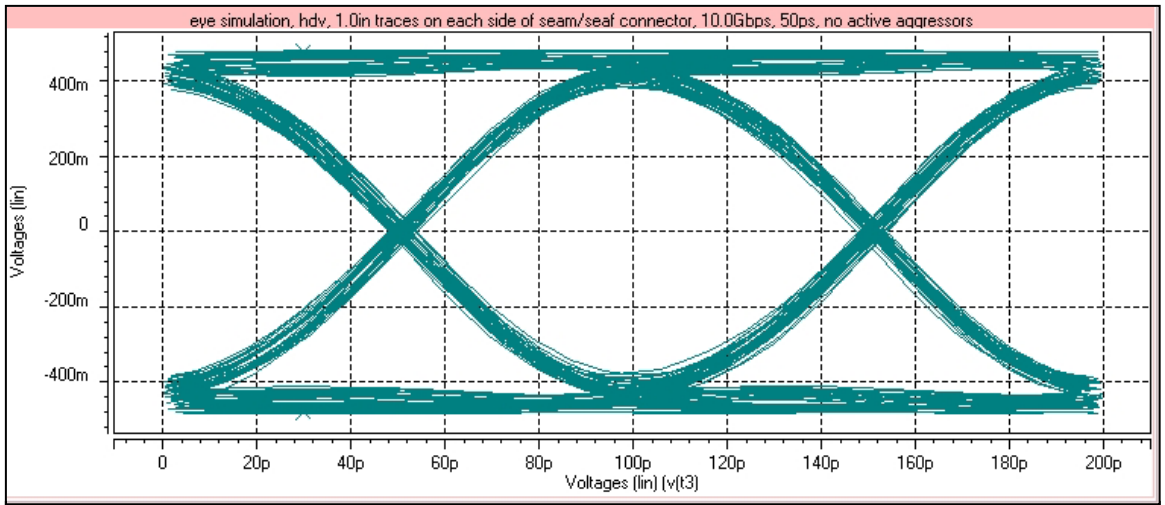
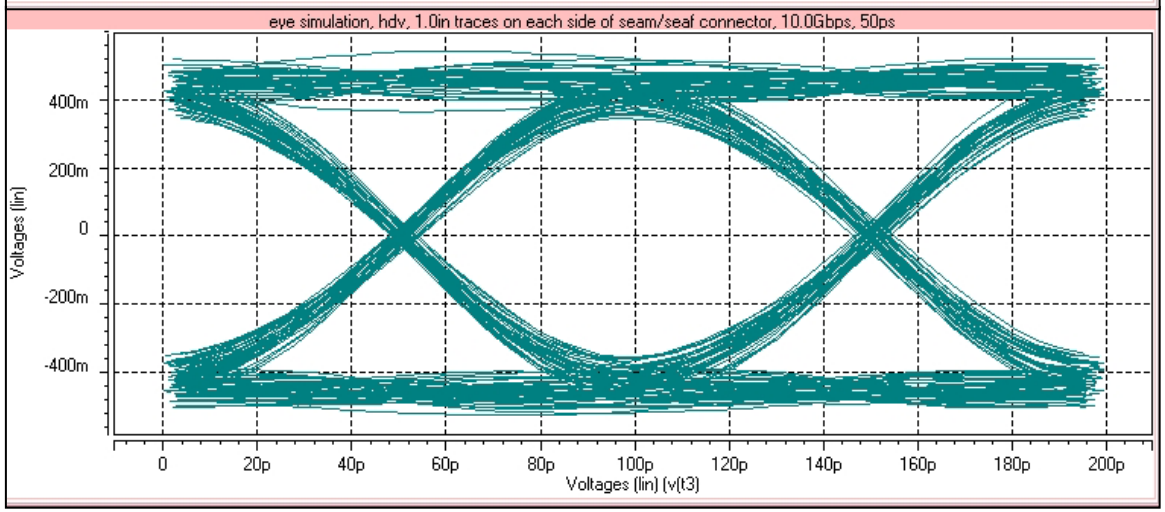
Eye , High Density Vertical Differential - Victim pair, 10.0 Gbps, 50 psec. edges

1 inch Traces

No aggressor pairs active



All aggressor pairs active



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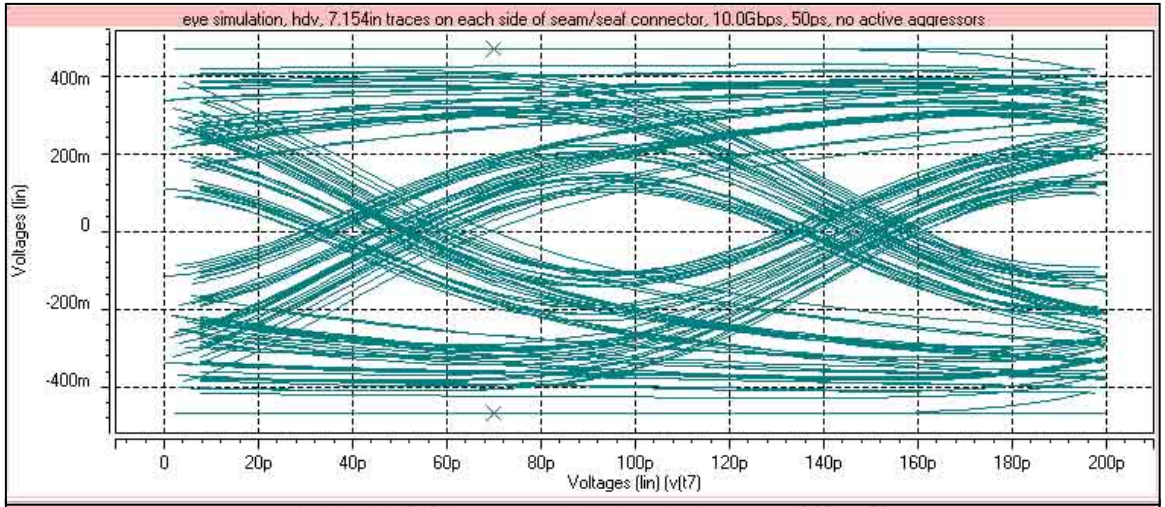
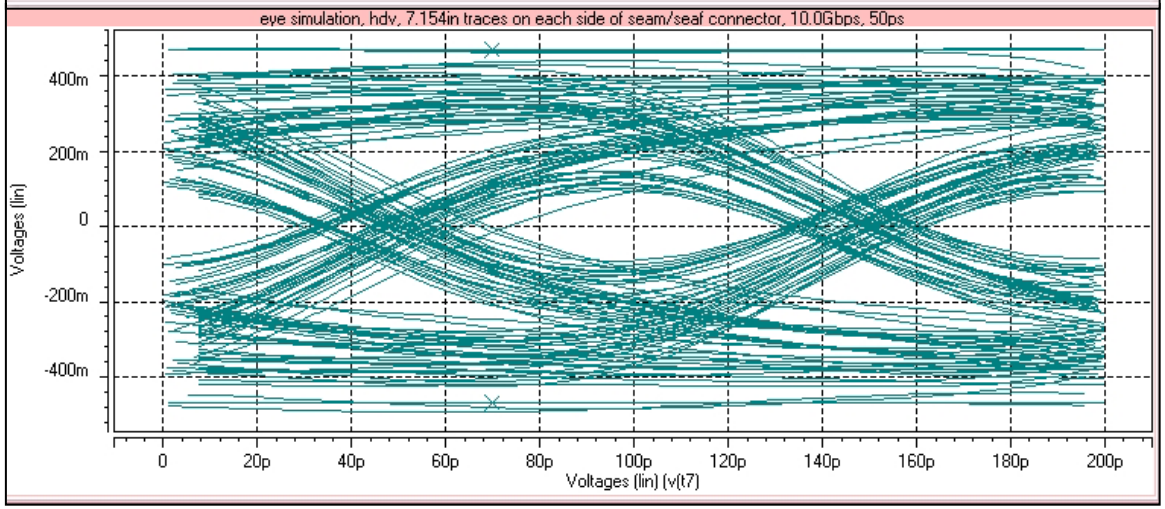
Eye , High Density Vertical Differential - Victim pair, 10.0 Gbps, 50 psec. edges

7.154 inch Traces

No aggressor pairs active



All aggressor pairs active



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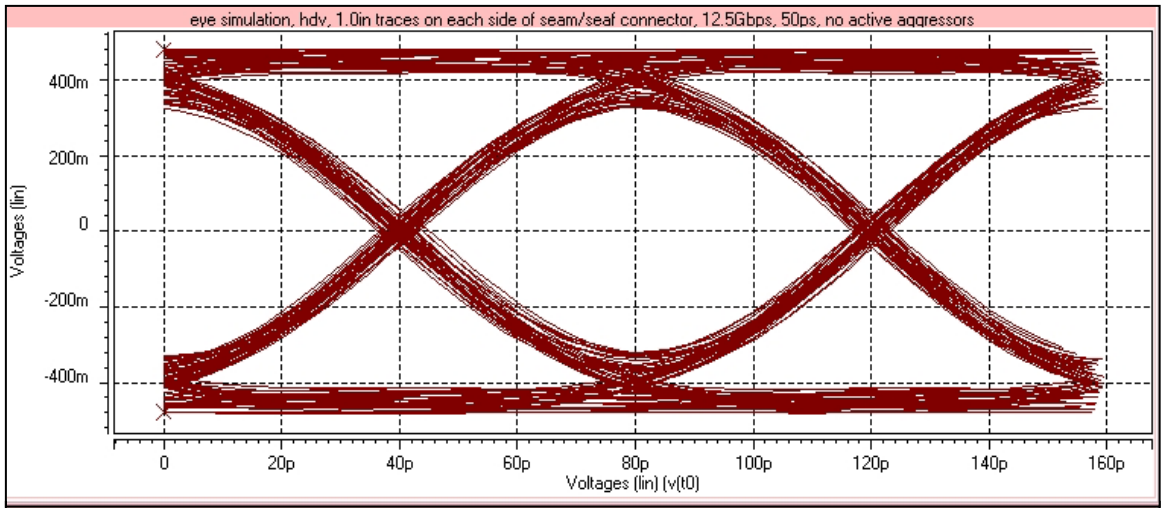
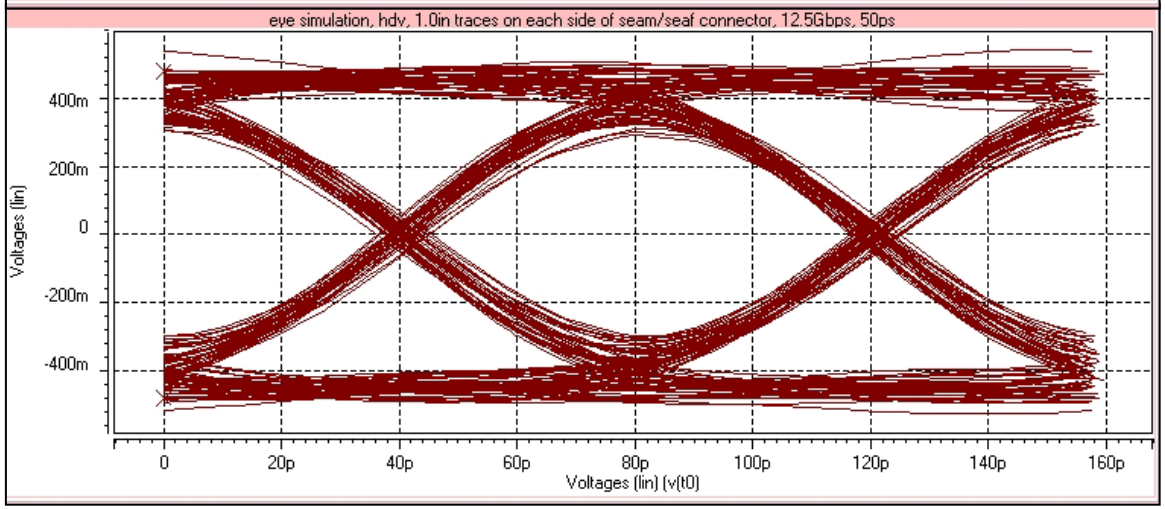
Eye , High Density Vertical Differential - Victim pair, 12.5 Gbps, 50 psec. edges

1 inch Traces

No aggressor pairs active



All aggressor pairs active



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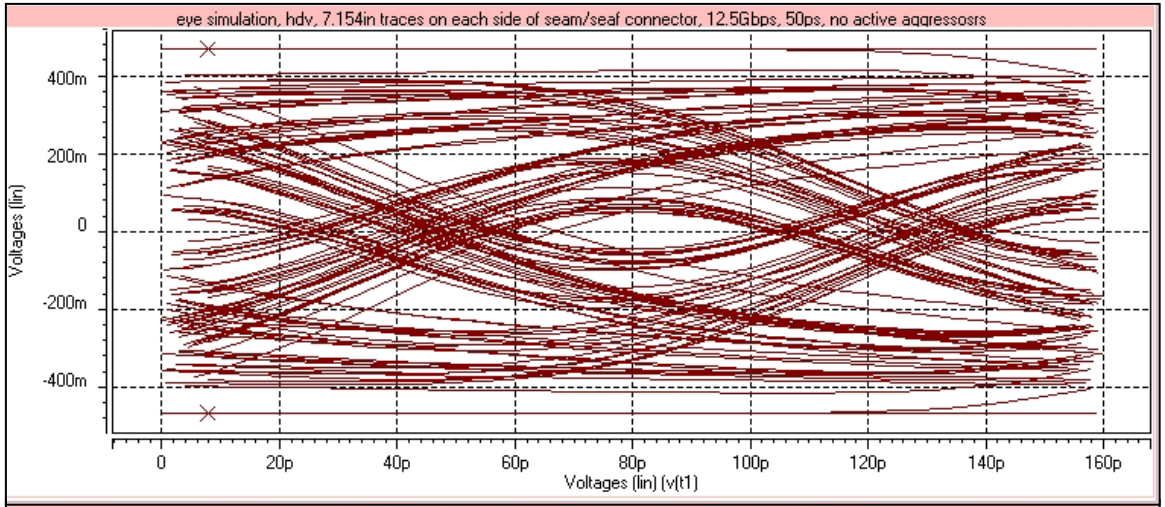
Eye , High Density Vertical Differential - Victim pair, 12.5 Gbps, 50 psec. edges

7.154 inch Traces

No aggressor pairs active



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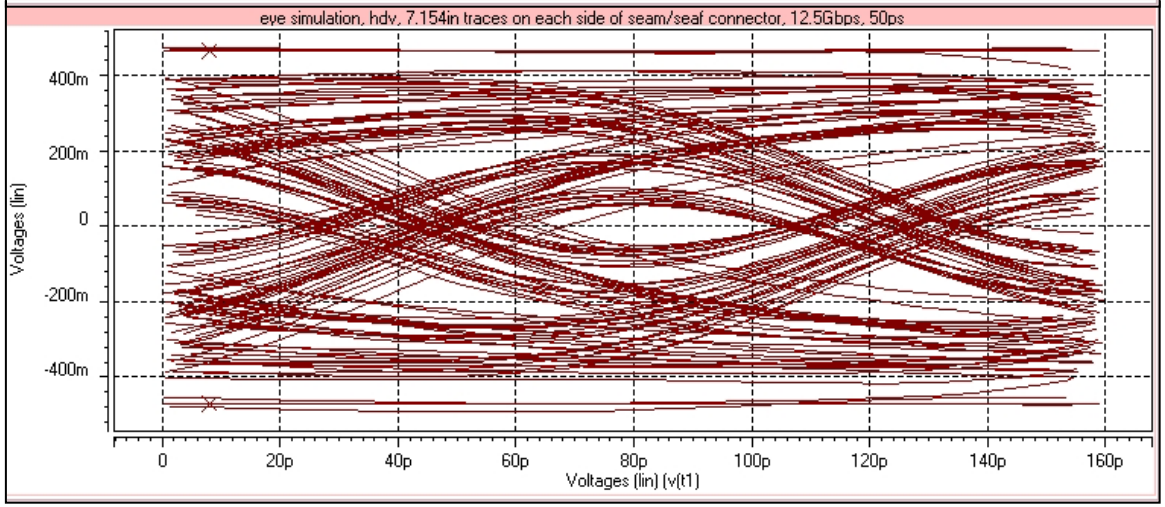

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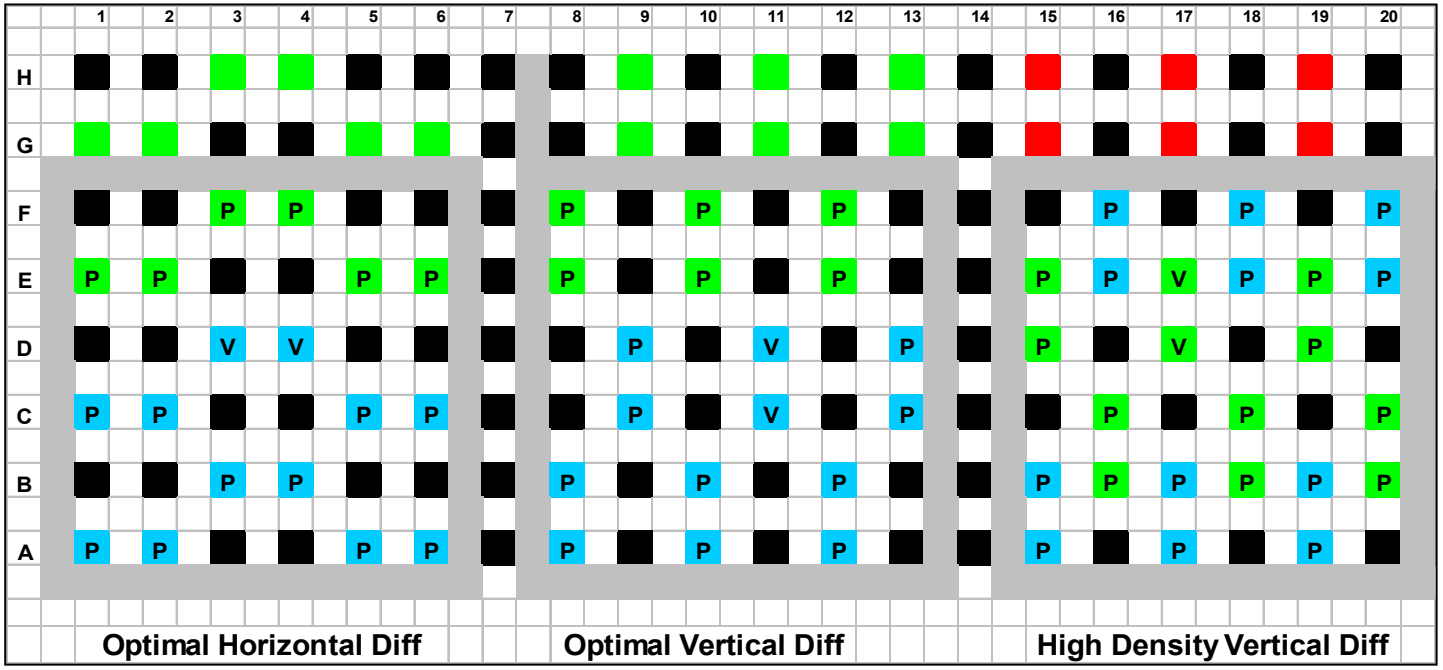
Channel Loss



= Signal Layer 10 (driven by Layer 1 SMAs)

= Signal Layer 8 (driven by Layer 1 SMAs)

= Signal Layer 5 (driven by Layer 12 SMAs)

= Ground

V = Victim pair

P = Passive pairs

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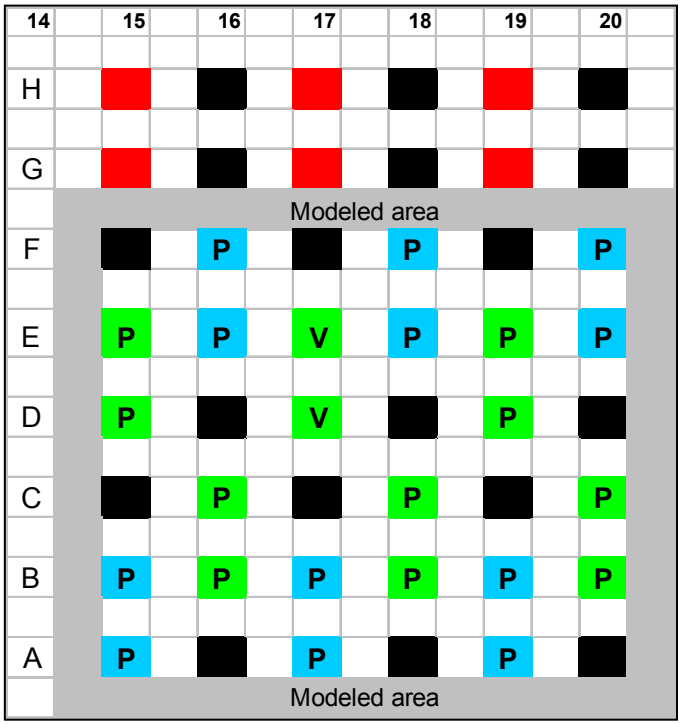
Insertion Loss , High Density Vertical Differential



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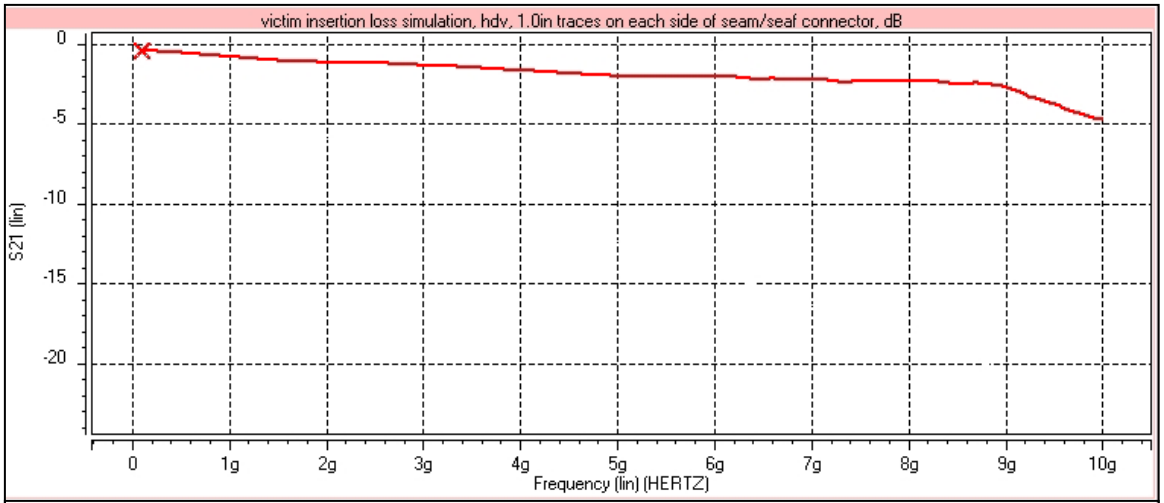
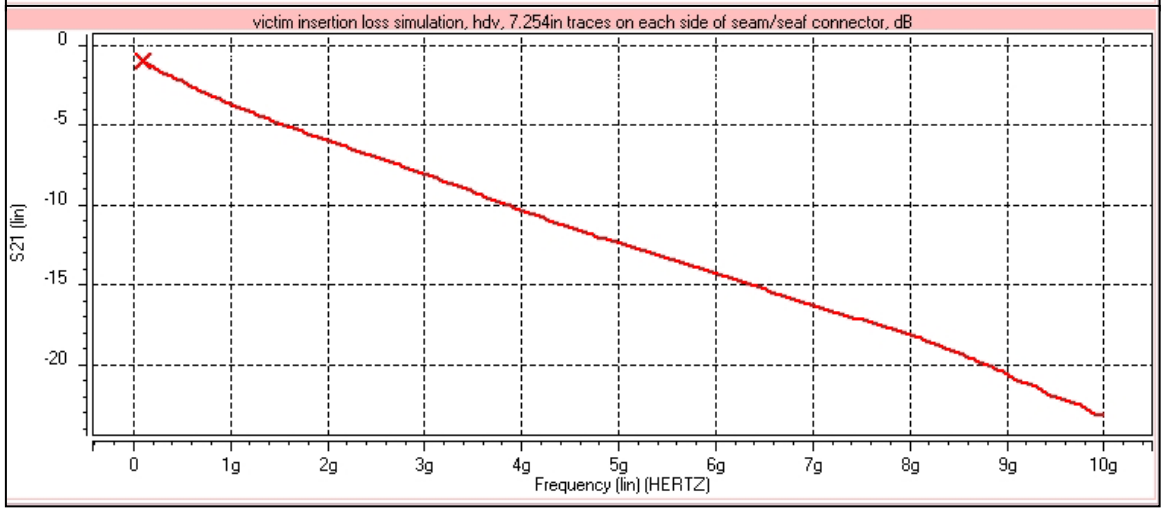
Insertion Loss , High Density Vertical Differential

dB vs. Frequency

1 inch Traces



7.154 inch Traces



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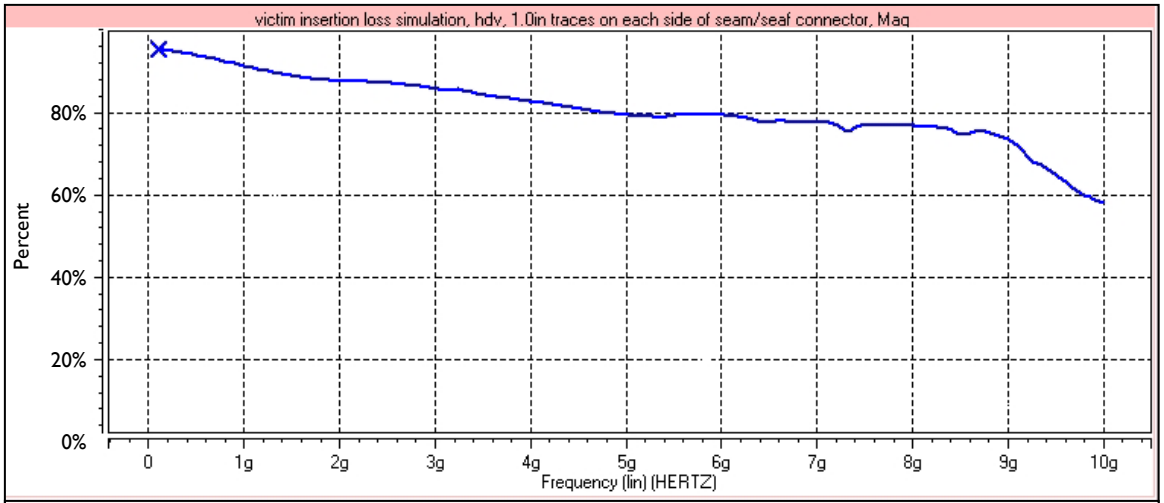
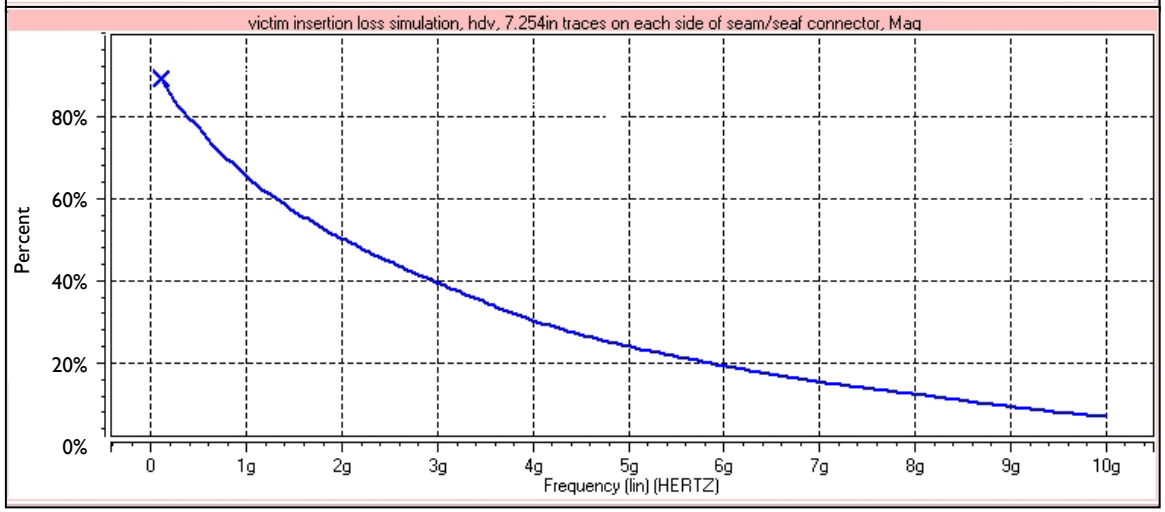
Insertion Loss , High Density Vertical Differential

1 inch Traces



7.154 inch Traces



% vs. Frequency

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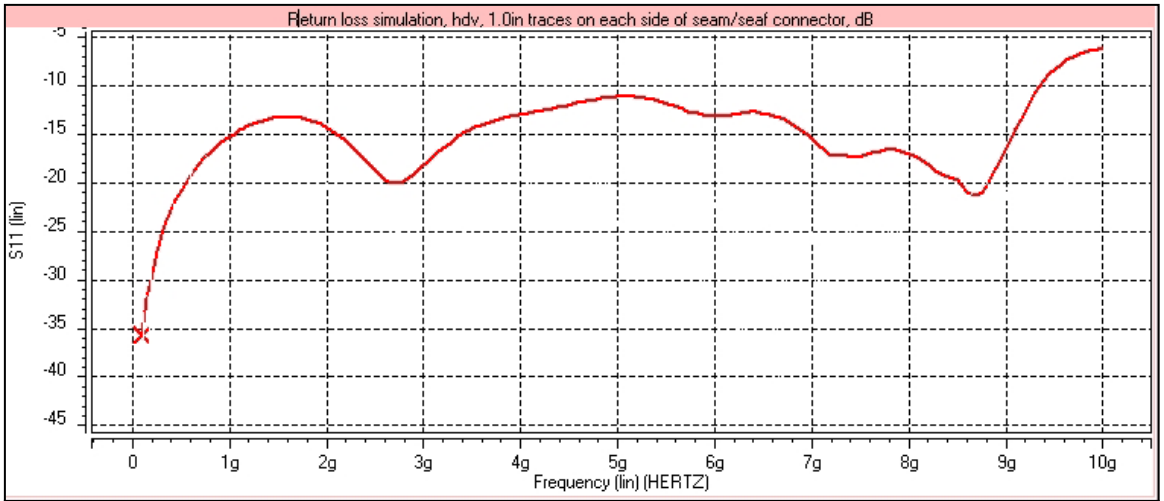
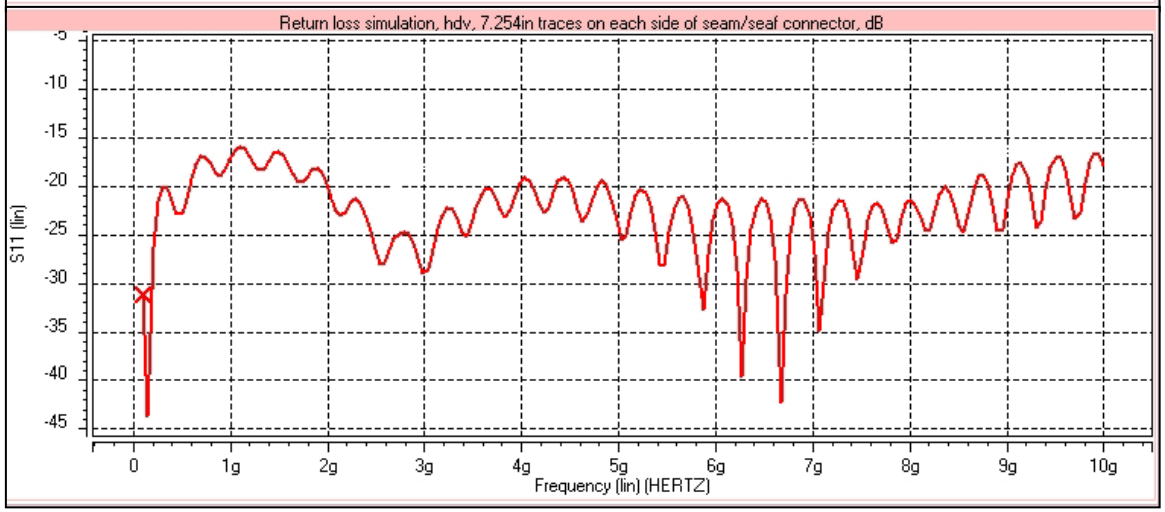
Return Loss , High Density Vertical Differential

dB vs. Frequency

1 inch Traces



7.154 inch Traces



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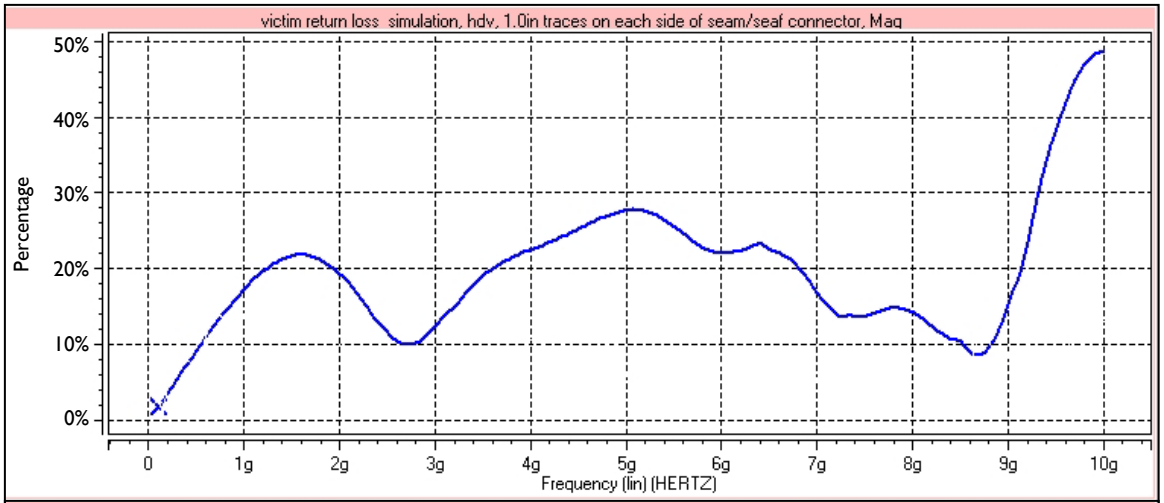
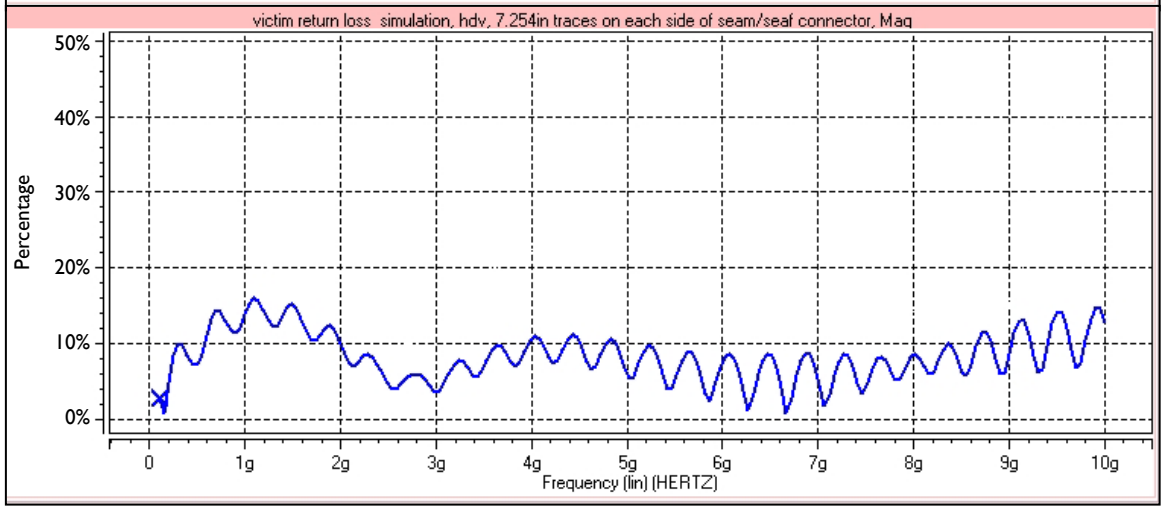
Return Loss , High Density Vertical Differential

1 inch Traces



7.154 inch Traces



% vs. Frequency

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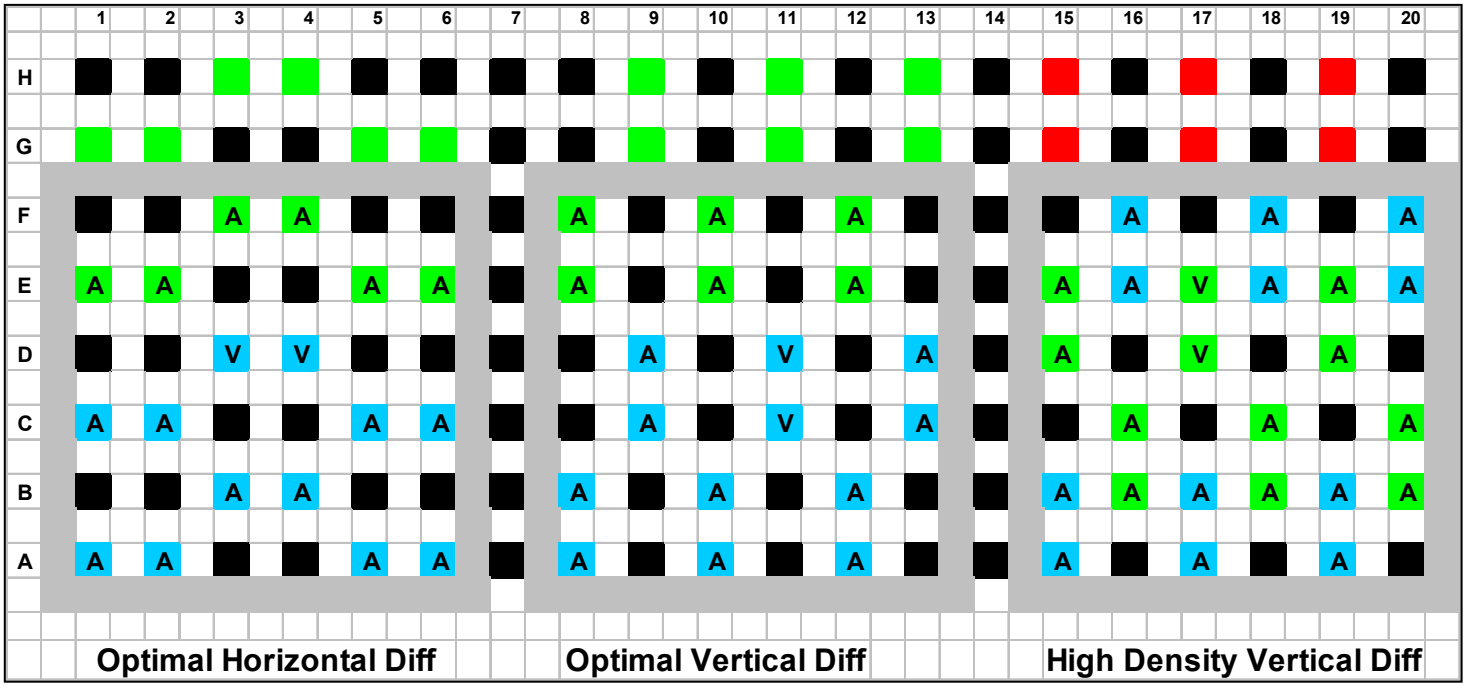
Channel Crosstalk



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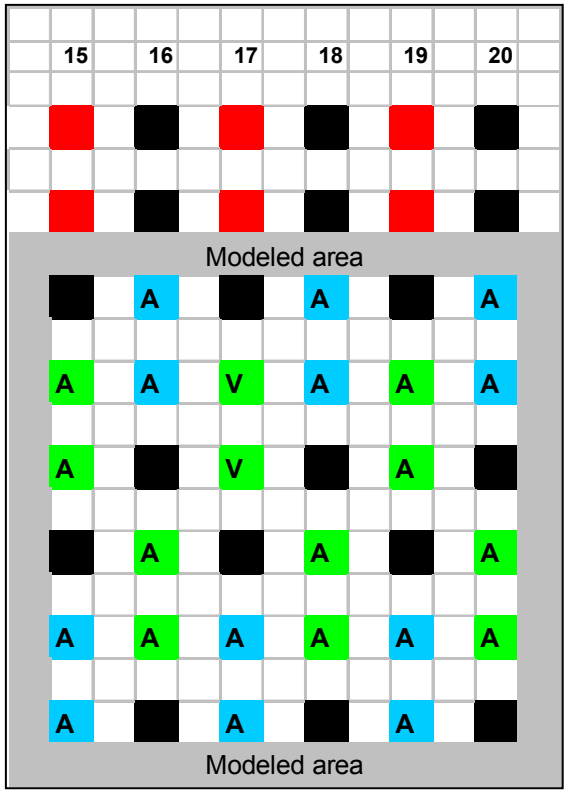
Crosstalk, High Density Vertical Differential



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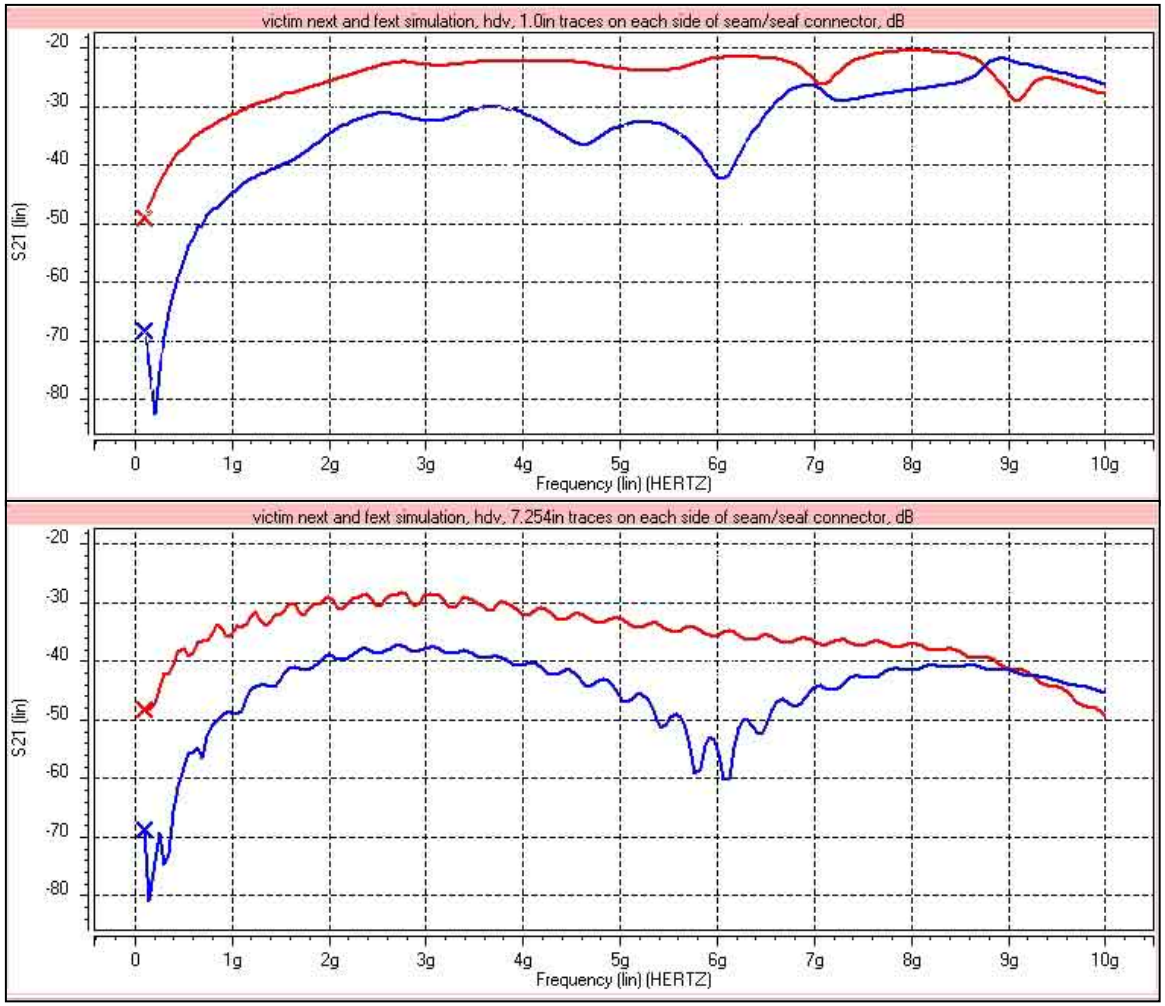
Crosstalk, High Density Vertical Differential

1 inch Traces

7.154 inch Traces



dB vs. Frequency

Red = NEXT

Blue = FEXT

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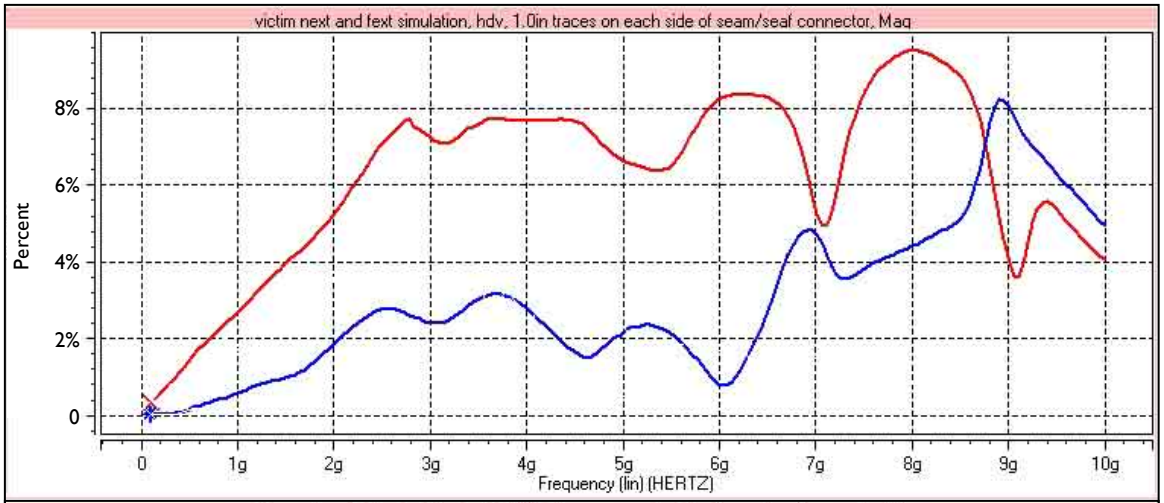
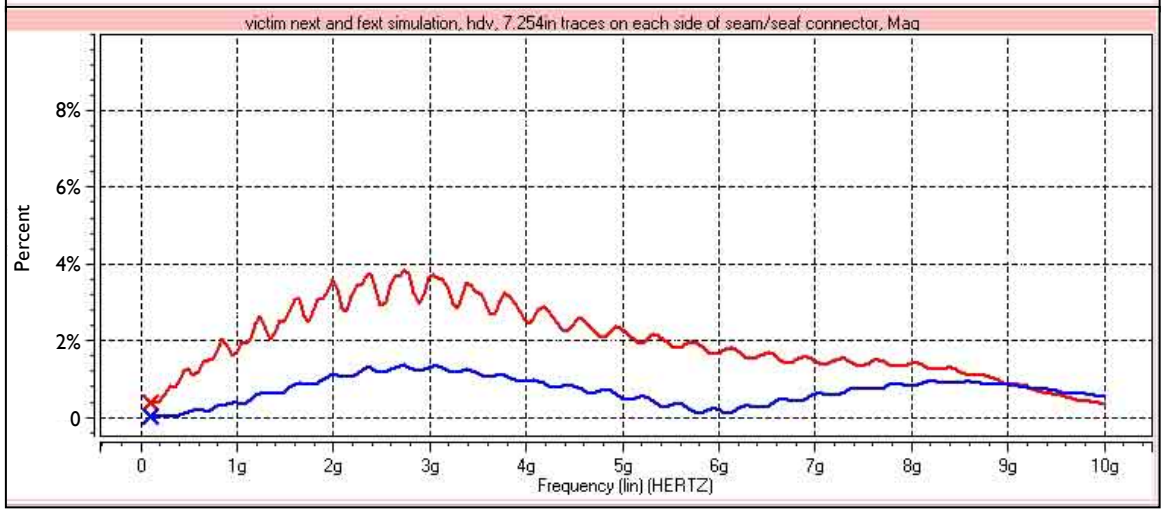
Crosstalk, High Density Vertical Differential

1 inch Traces



7.154 inch Traces



% vs. Frequency

Red = NEXT

Blue = FEXT

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SE Array® Final Inch™ High Density Vertical Differential Test Case - Conclusions

- SE Array® connectors used in the high density vertical differential configuration show excellent performance in simulated applications between 5 and 10 Gbps.

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