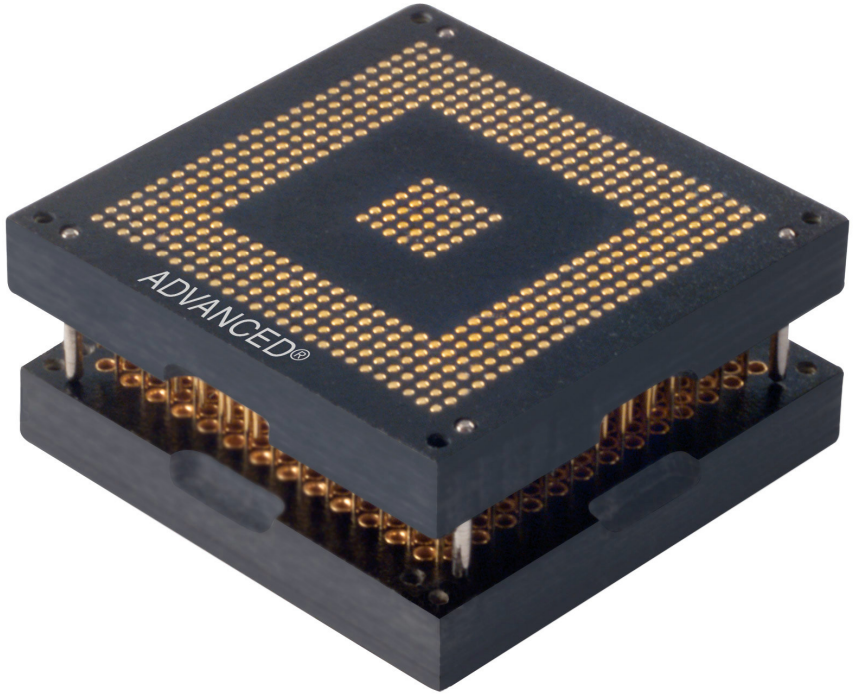
ADVANCED INTERCONNECTIONS®



0.50mm Pitch
BGA Socket Adapter System

SIGNAL INTEGRITY ANALYSIS AND MODELING

Rev. 3

www.advanced.com

ISO 9001

Advanced Interconnections Corp.
5 Energy Way, West Warwick, RI 02893 USA
401.823.5200 • 800.424.9850 • Fax: 401.823.8723

Signal Integrity Data Reporting

At Advanced Interconnections Corporation, our Signal Integrity reporting method differs dramatically from the common industry practice of isolating the *aggressor* and *victim* terminals from each other by introducing dedicated ground terminals between them. We believe this method represents a theoretical, best-case, scenario that does not serve the needs of most systems engineers and circuit designers. An unrealistic number of connector terminals must be assigned to ground in order to achieve this scenario.

Our standard reporting practice is closely aligned with the decision-making processes of most systems engineers and circuit designers. The reported data addresses our customers I/O assignments (net-list) and helps them determine where to best run high-versus-low frequency signals through our connectors. As such, our reporting method represents a more practical net-list scenario. Utilizing our unbiased SPICE™ and IBIS™ files, system designers are able to create and/or debug their net-list quickly and accurately.

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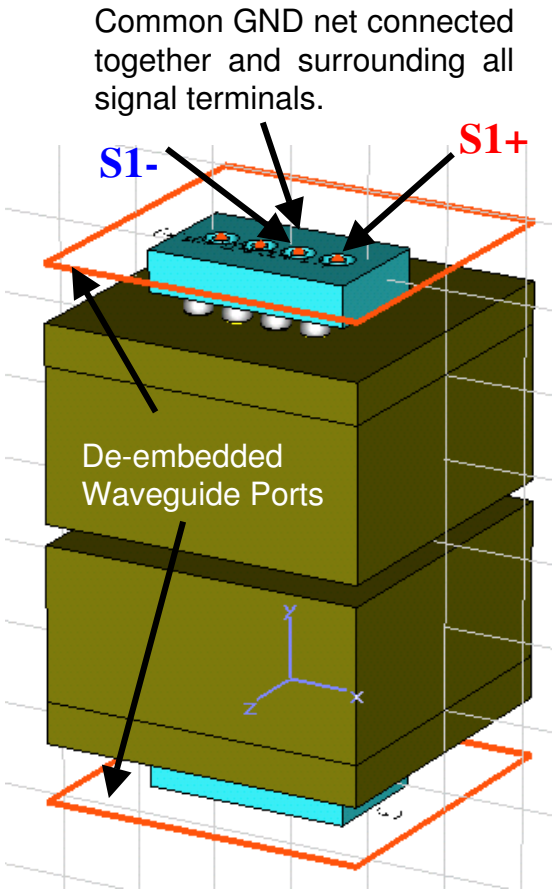
SI Test & Measurement Study

SI Test Setup

- The 0.50 mm Socket Adapter was measured from 50 MHz to 20.05 GHz.
- A pin-out of 3 rows and 4 columns was assigned from a 4x4 array:

GND	GND	GND	GND
S1+	S1-	S2+	S2-
GND	GND	GND	GND



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SI Test & Measurement Study

Performance Results

- The test and measurement tasks were completed and the recommended Operational Bandwidth for the Socket Adapter System is as follows:

  - Differential: DC to 1.0 GHz @ -15dB and ~0.7 to 1.1 Gbit/sec.
  - Differential: DC to 1.9 GHz @ -10dB and ~1.2 to 2.1 Gbit/sec.
  - Single-ended: DC to 1.6 GHz @ -15dB and ~1.0 to 1.7 Gbit/sec.
  - Single-ended: DC to 3.3 GHz @ -10dB and ~2.1 to 3.5 Gbit/sec.

- At the above Bandwidths, the Impedance of this connector system is low. This has been attributed to the geometry of the female shell and the proximity of adjacent terminals.

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ADVANCED INTERCONNECTIONS.

SI Test & Measurement Study

Performance Results – continued

- Differential Eye Diagrams were successfully formed at 5 Gbits/sec., with Jitter at 6psec and 12% eye closure.
  - ***The eye opening sustains a Data Mask with a voltage swing of ±175mV @ 100psec period.***

- Single-ended Eye Diagrams were successfully formed at 5 Gbits/sec., with Jitter at 4psec and 8% eye closure.
  - ***The eye opening sustains a Data Mask with a voltage swing of ±125mV @ 140psec period.***

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ADVANCED INTERCONNECTIONS.

SI Test & Measurement Study

Performance Results – continued

	Return Loss ($S_{\omega,\theta}$)	*Insertion Loss* ($S_{\phi,\beta}$)	*Zo @ 200 psec* (10-90%)
Differential *(Terminals S1+, S1-)*	(S1,1) -15.0dB @ 1.0 GHz -10.0dB @ 1.9 GHz	(S2,1) -0.40dB @ 1.0 GHz -0.55dB @ 1.9 GHz	75.0Ω
Single-ended *(Terminals S1+)*	(S1,1) -15.0dB @ 1.9 GHz -10.0dB @ 7.5 GHz	(S2,1) -0.4dB @ 1.9 GHz -2.5dB @ 7.5 GHz	42.8Ω
Single-ended *(Terminals S1-)*	(S3,3) -15.0dB @ 1.6 GHz -10.0dB @ 3.3 GHz	(S4,3) -0.55dB @ 1.6 GHz -0.90dB @ 3.3 GHz	41.8Ω

- A *Return Loss* at -15dB (~18% *Reflection*) is the normally accepted industry standard. Most applications will tolerate data at -10 dB (~32% *Reflection*), however in this instance, performance safety margins may be increased by *de-rating* the connectors Operational Bandwidth and Data Rate.
- A *Insertion Loss* at -3dB (~50% of applied Power & ~71% of applied Voltage arrives at the Output Port) is the normally accepted industry standard.
- An Effective Impedance of 100Ω ±10Ω for Differential and 50Ω ±5Ω for Single-ended is the normally accepted industry guideline. De-rating the signal input risetime will improve the above Zo values.

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ADVANCED INTERCONNECTIONS.

SI Test & Measurement Study

Performance Results– continued

	NeXT @ 200 psec (10-90%)	*FeXT @ 200 psec (10-90%)*	*Eye-Diagram @ 5 Gbit/sec*	*Eye-Diagram @ 5 Gbit/sec with 6 Gbit/sec Aggressor*
Differential ***(Terminals S1+, S1-)***	**1.75%**	**1.1%**	**Peak-to-Peak Jitter = 1 psec Eye-Closure = 7%**	**Peak-to-Peak Jitter = 6 psec Eye-Closure = 12%**
Single-ended ***(Terminals S1-)***	**5.5%**	**1.3%**	**Peak-to-Peak Jitter = 2 psec Eye-Closure = 4%**	**Peak-to-Peak Jitter = 4 psec Eye-Closure = 8%**

- **A *NeXT* at 5% maximum is the normally accepted industry standard. Some customers may specify a value as low as 2% maximum for this attribute. NeXT results are good.**
- **A *FeXT* at 2% maximum is the normally accepted industry standard. Some customers may specify a value as low as 1% maximum for this attribute. FeXT results are excellent.**
- **A successful Eye-opening was created at 5 Gbit/sec and is excellent as this data rate is well within the Operational Bandwidths recommended for this connector system. See note below.**

NOTE: It's not practical to define *pass-or-fail* criteria for Jitter and Eye-Closure. However, guidelines for the connector's transmit Data Mask can be defined to quantify the effective performance of the eye formation. For a Differential data mask, the total voltage equals 35% of the eye's applied *peak-to-peak* voltage, (1V in this report), and its period equals 50% of the risetime, (200psec in this report). For a Single-ended data mask, the total voltage equals 50% of the eye's applied *peak-to-peak* voltage, (500mV in this report), and its period equals 70% of the risetime, (200psec in this report).

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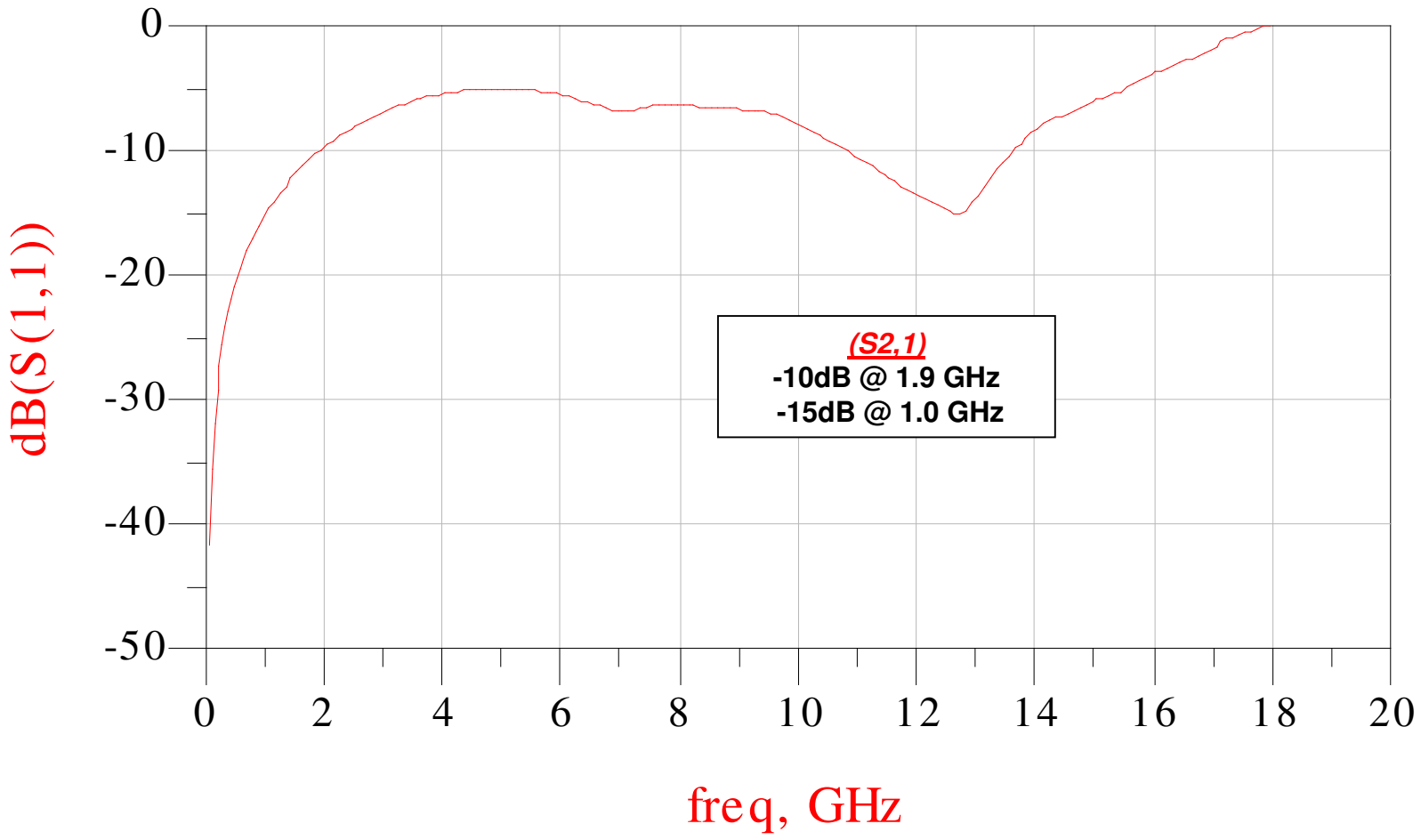
ADVANCED INTERCONNECTIONS.

Differential Return Loss

Plot Range: DC to 20 GHz



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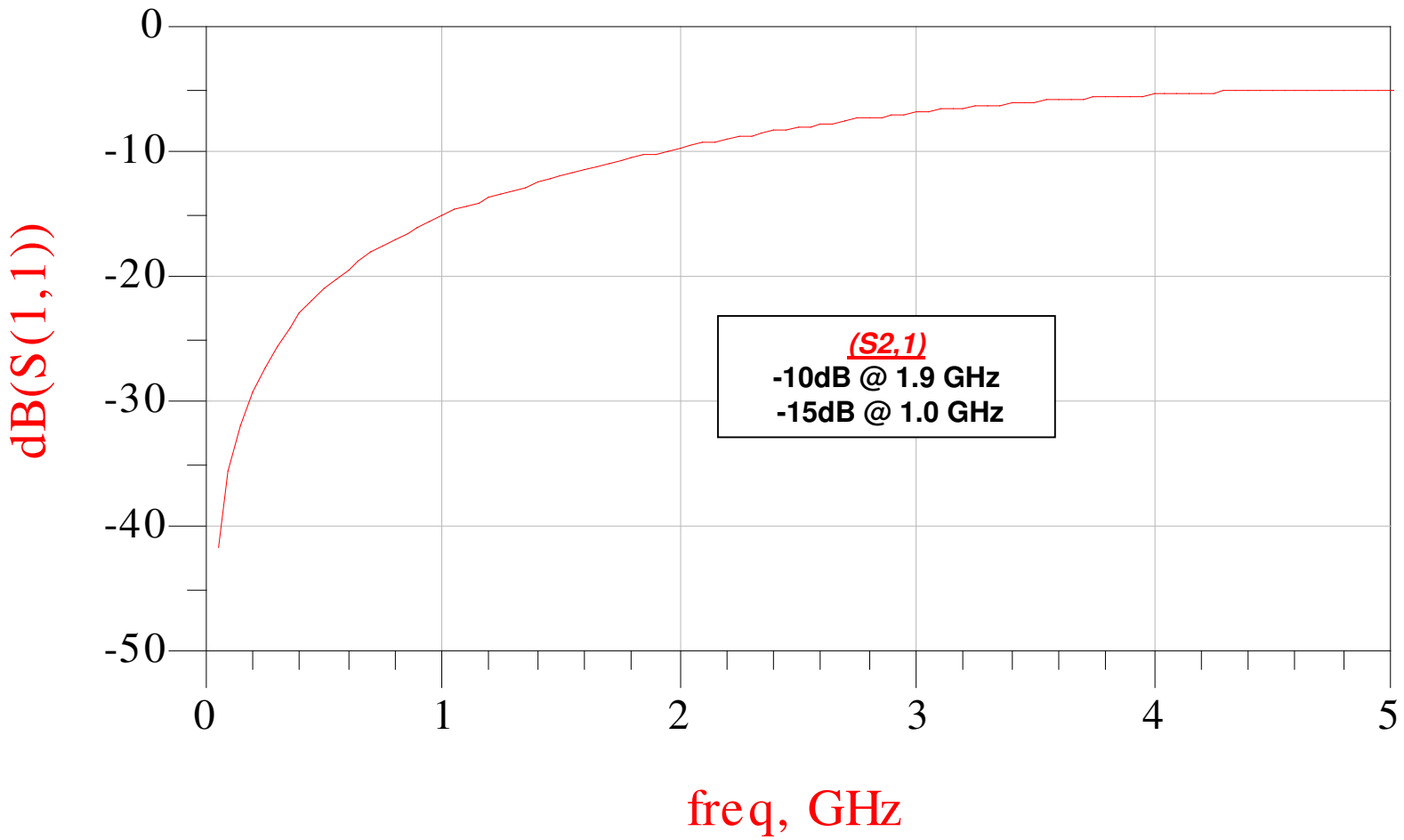
ADVANCED INTERCONNECTIONS.

Differential Return Loss

Plot Range: DC to 5 GHz



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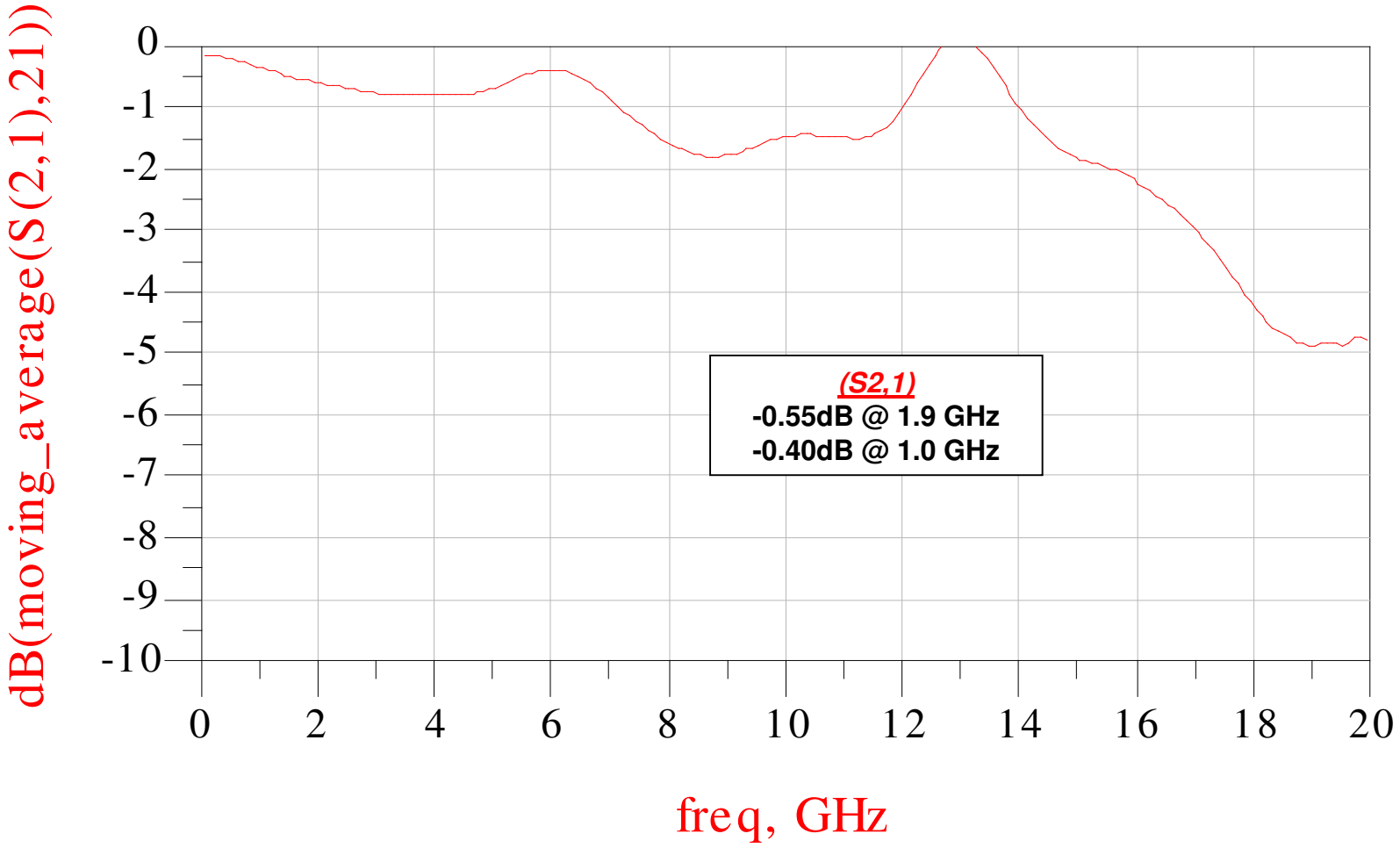
ADVANCED INTERCONNECTIONS.

Differential Insertion Loss

Plot Range: DC to 20 GHz



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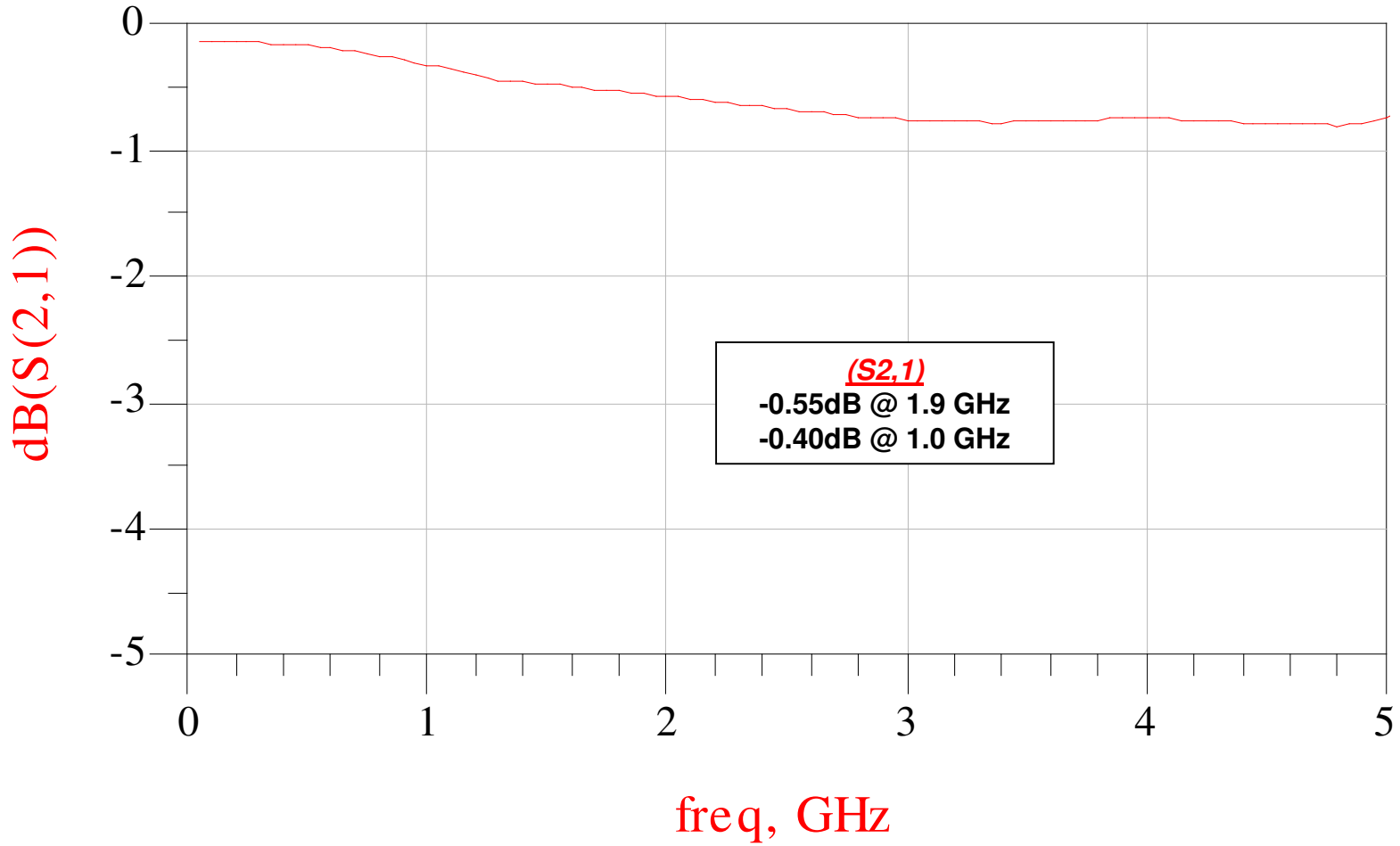
ADVANCED INTERCONNECTIONS.

Differential Insertion Loss

Plot Range: DC to 5 GHz



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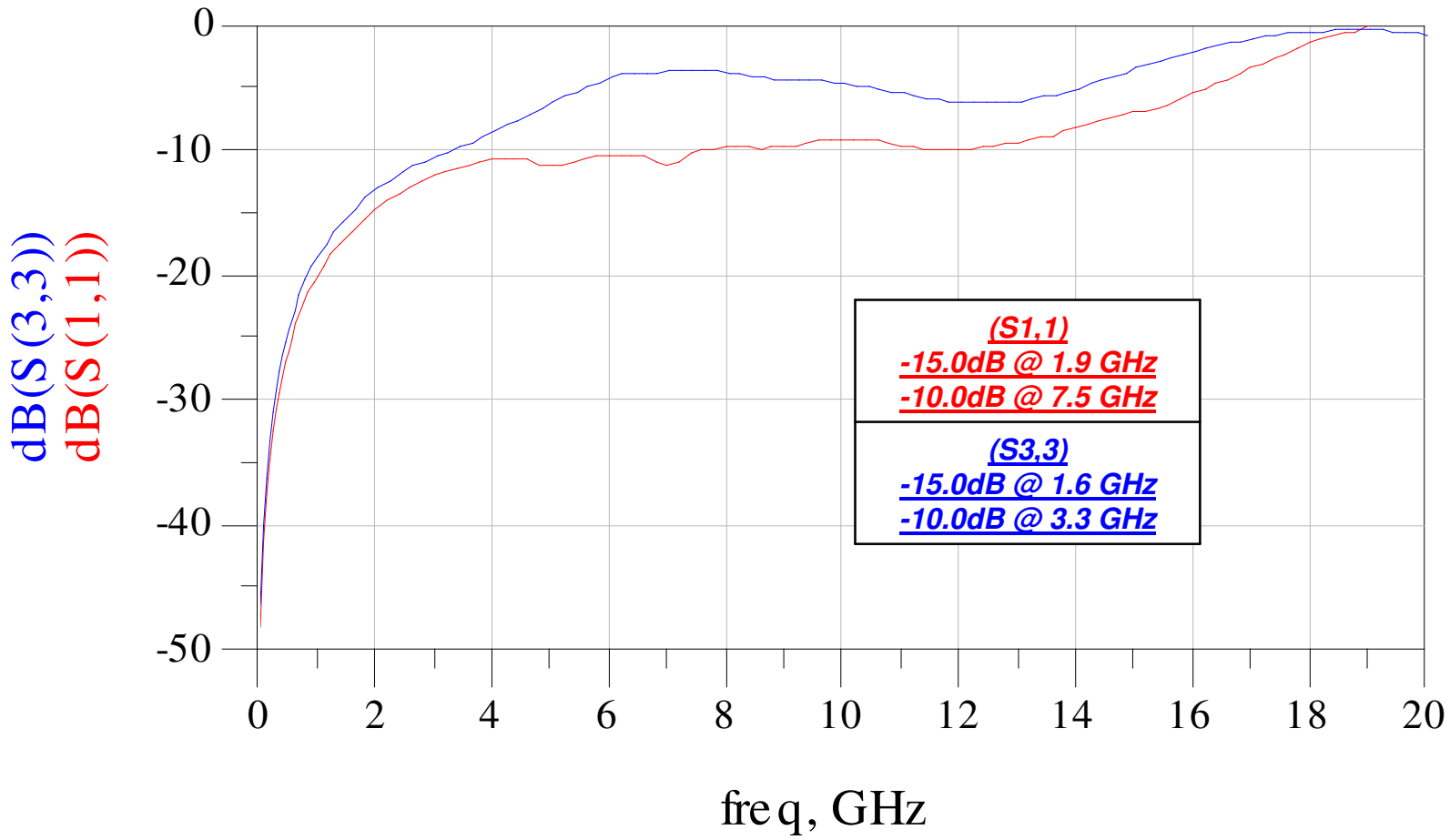
ADVANCED INTERCONNECTIONS.

Single-ended Return Loss for S1+ & S1-

Plot Range: DC to 20 GHz



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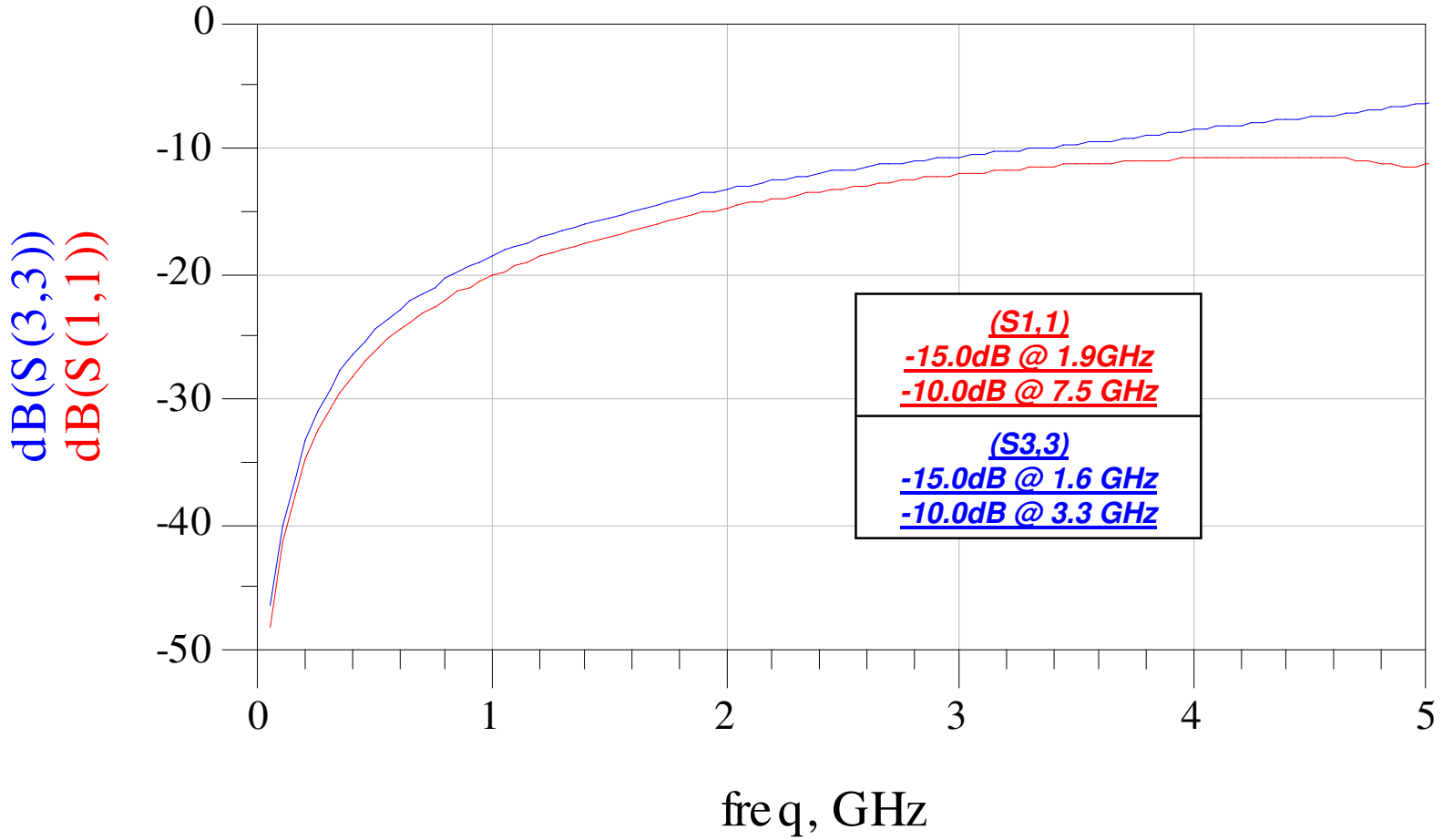

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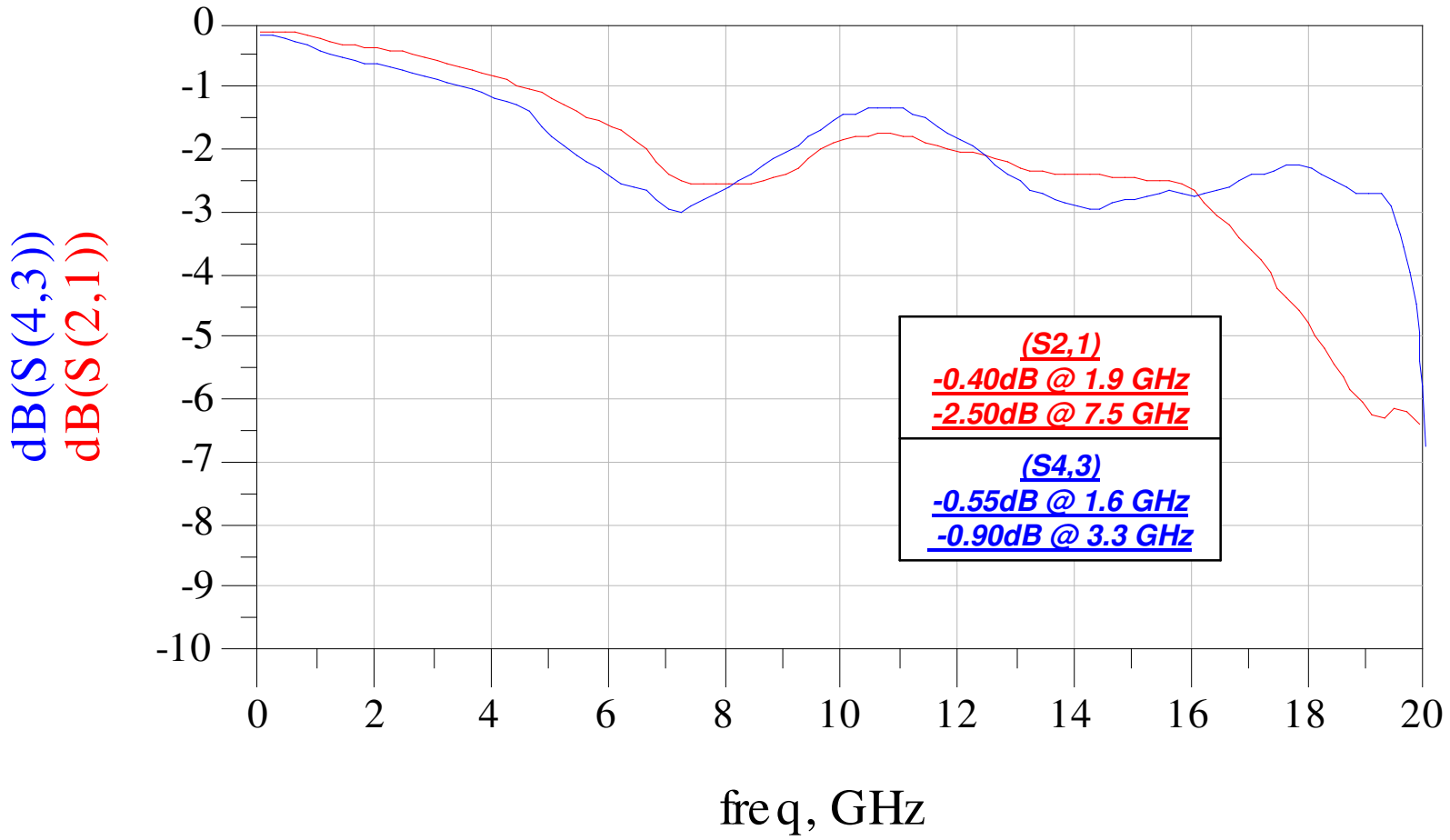
ADVANCED INTERCONNECTIONS.

Single-ended Insertion Loss for S1+ & S1-

Plot Range: DC to 20 GHz



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Single-ended Insertion Loss for S1+ & S1-

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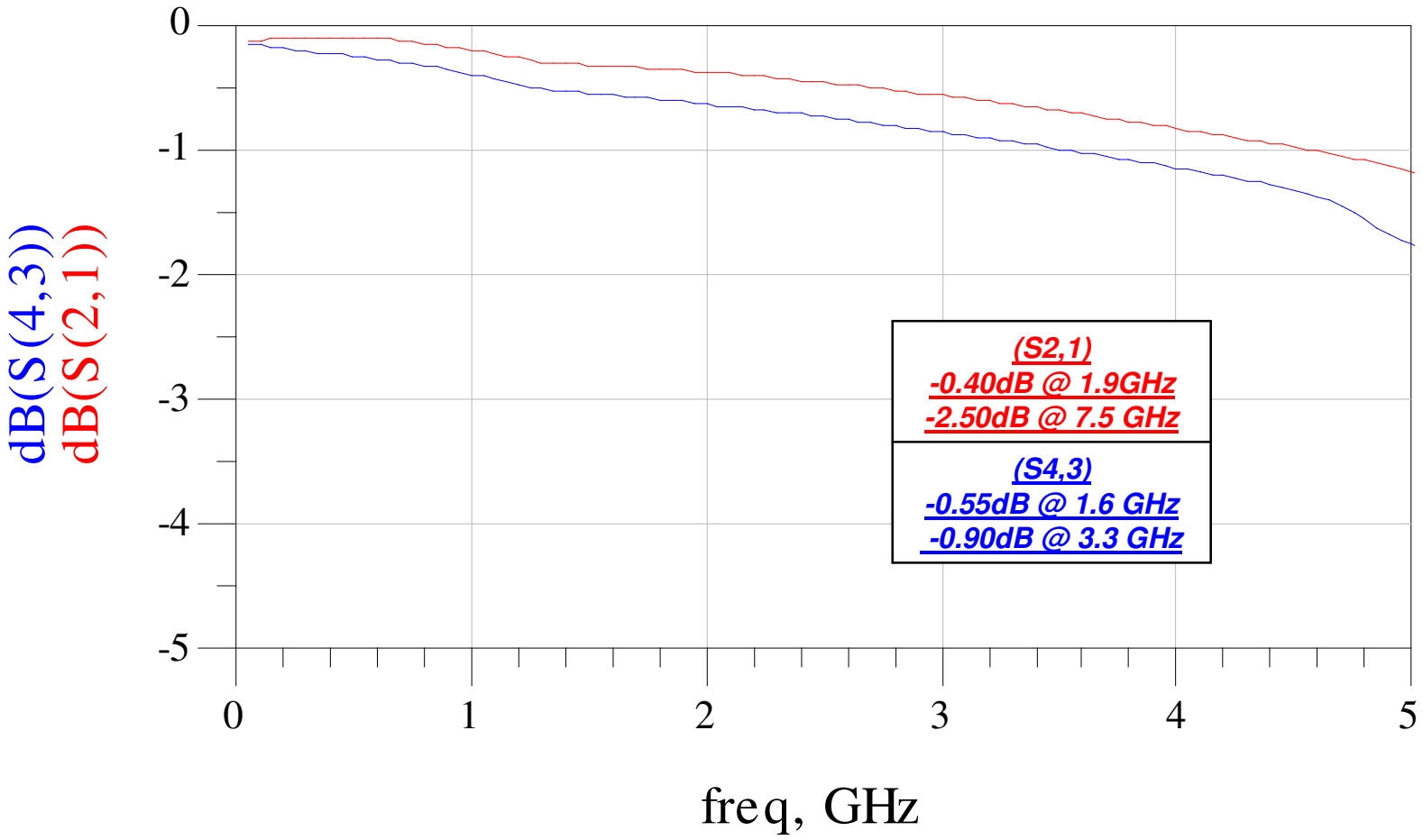

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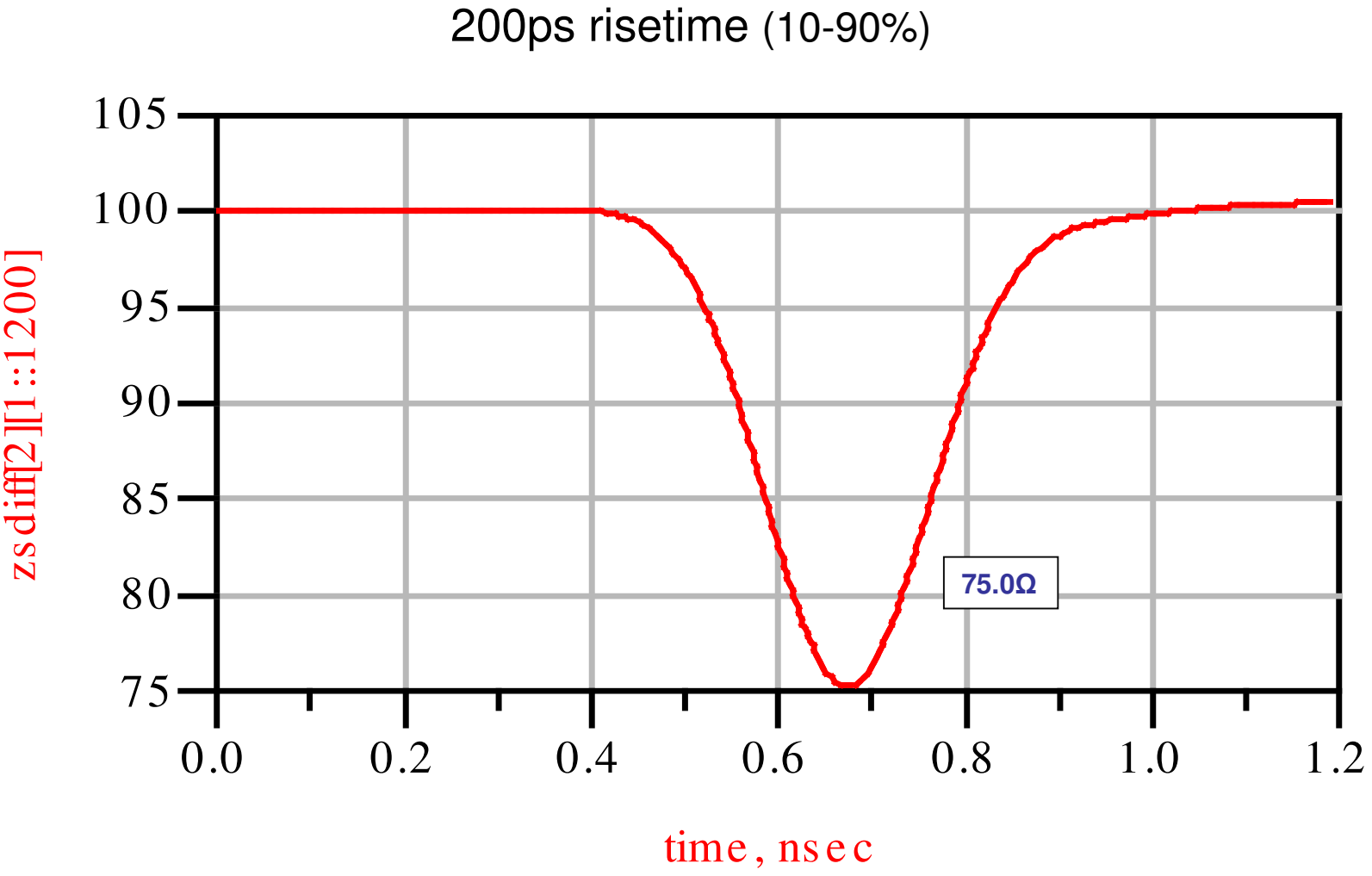
ADVANCED INTERCONNECTIONS.

Differential Impedance Profile



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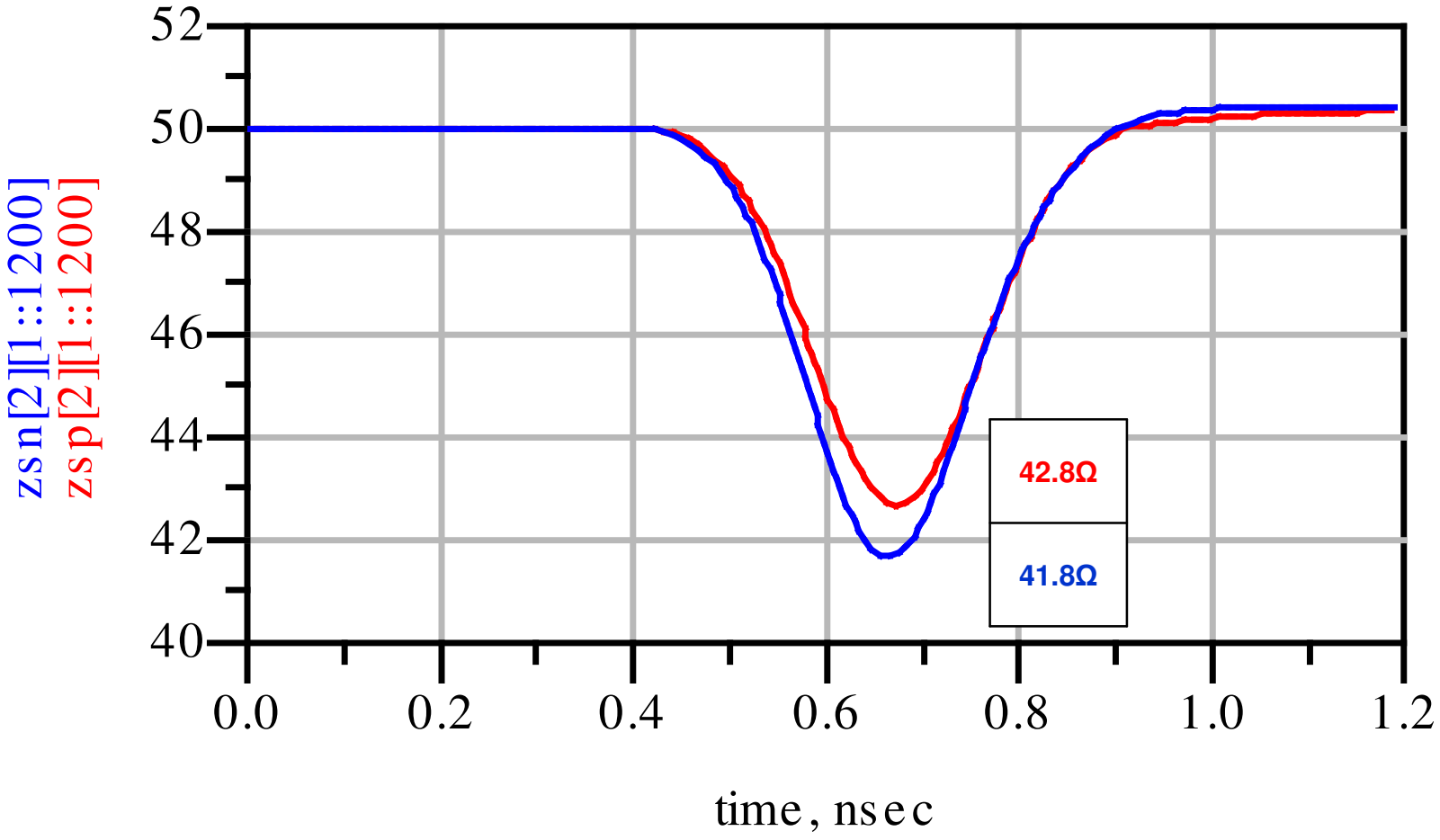
ADVANCED INTERCONNECTIONS.

Single-ended Impedance Profile for S1+ & S1-

Simultaneous Plots at **200 psec** risetime (10-90%)

S1+ (Zsp Edge Terminals) *vs.* S1- (Zsn Interior Terminals)



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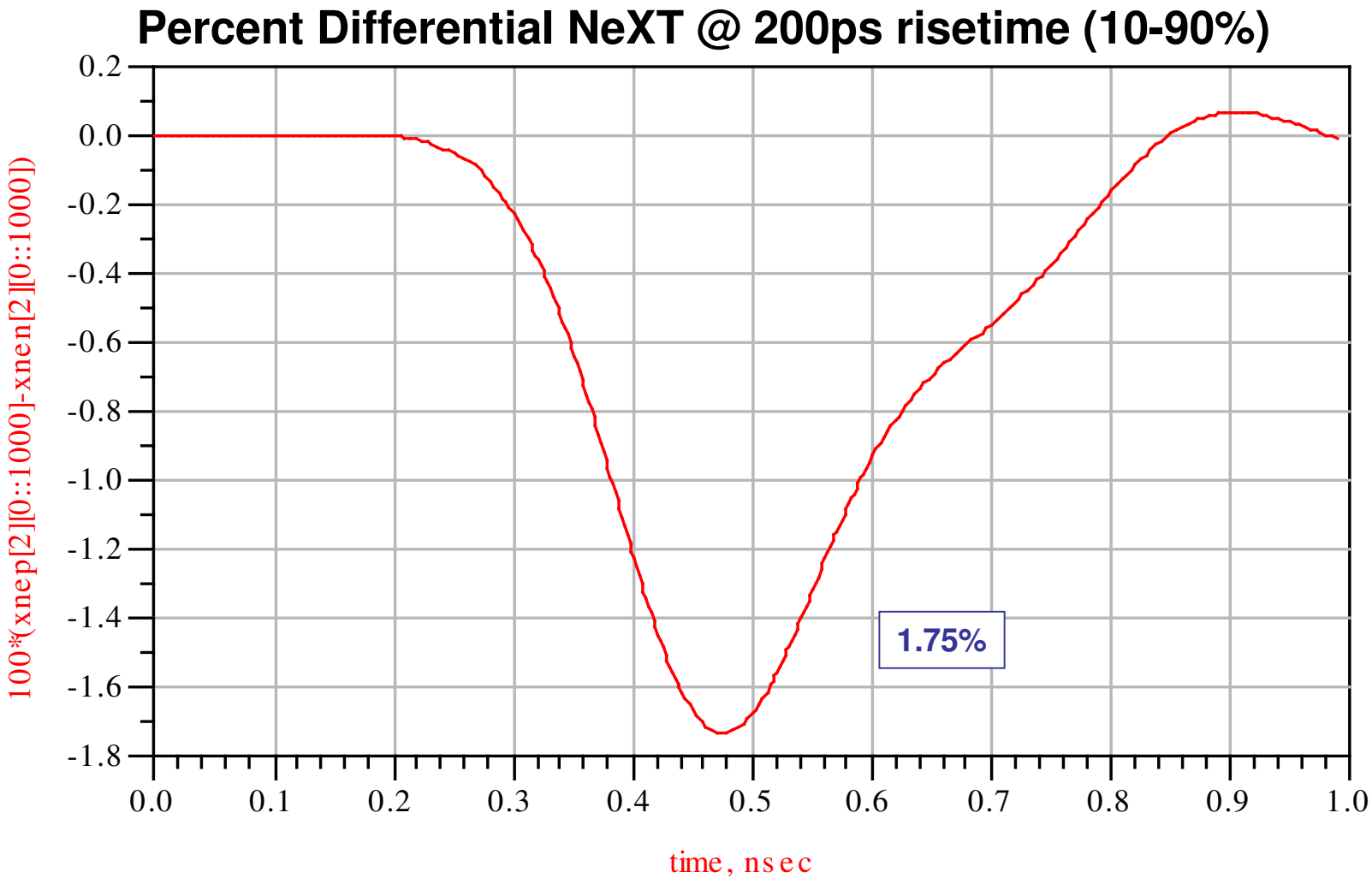
ADVANCED INTERCONNECTIONS.

Differential Near-end Crosstalk (NeXT)



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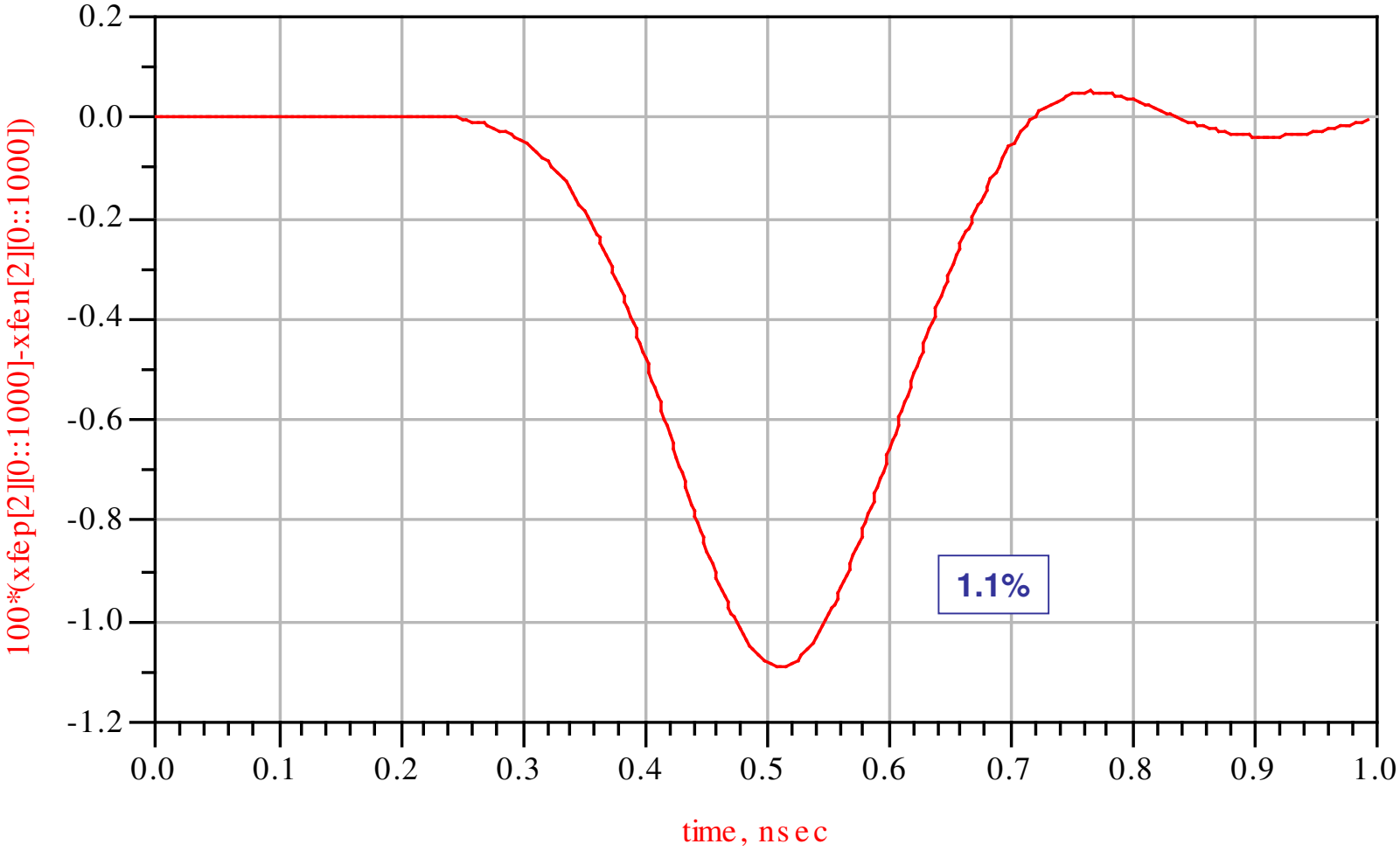
ADVANCED INTERCONNECTIONS.

Differential Far-end Crosstalk (FeXT)

Percent Differential FeXT @ 200ps risetime (10-90%)



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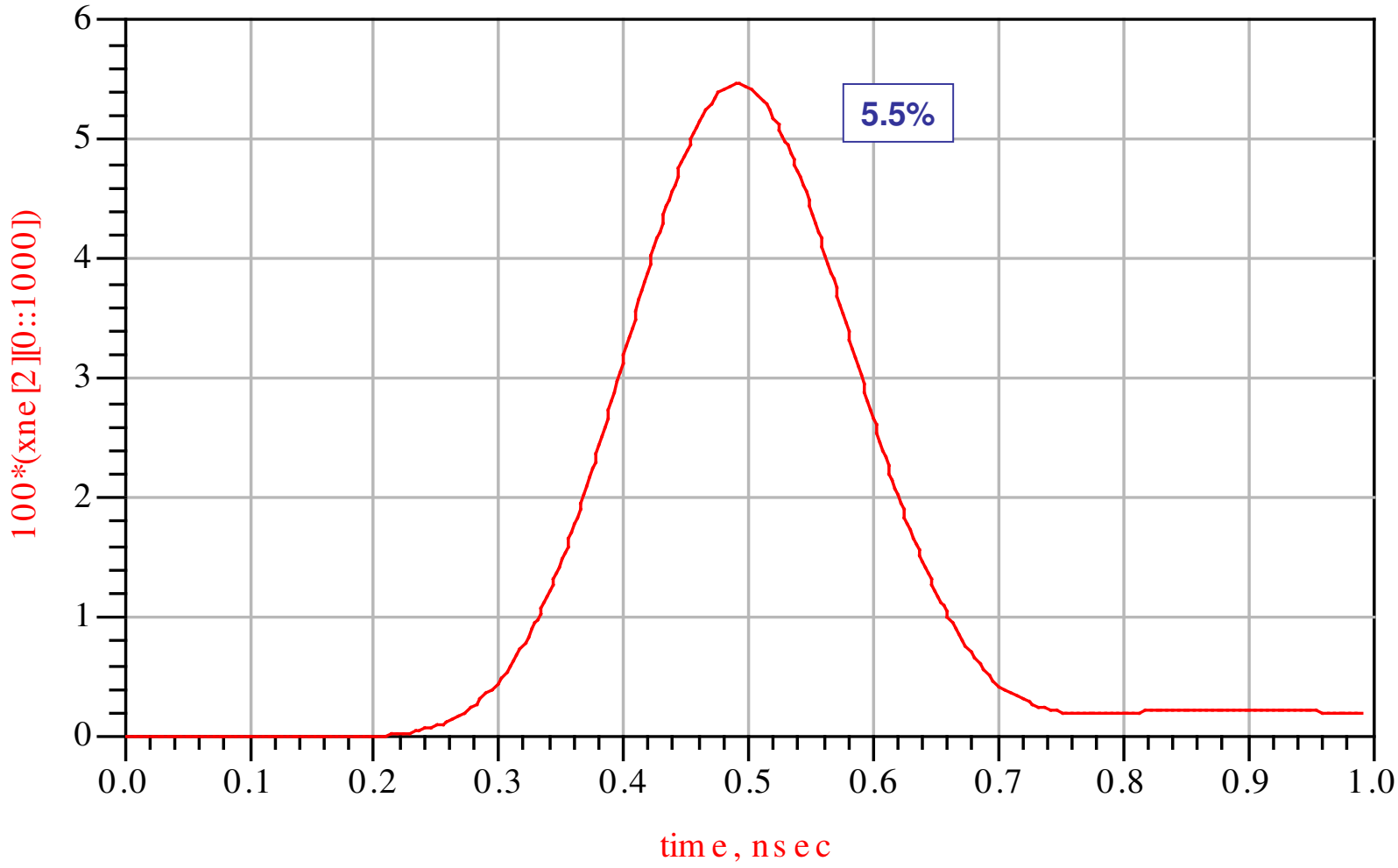
ADVANCED INTERCONNECTIONS.

Single-ended Near-end Crosstalk (NeXT)

Percent Single-ended NeXT @ 200ps risetime (10-90%)



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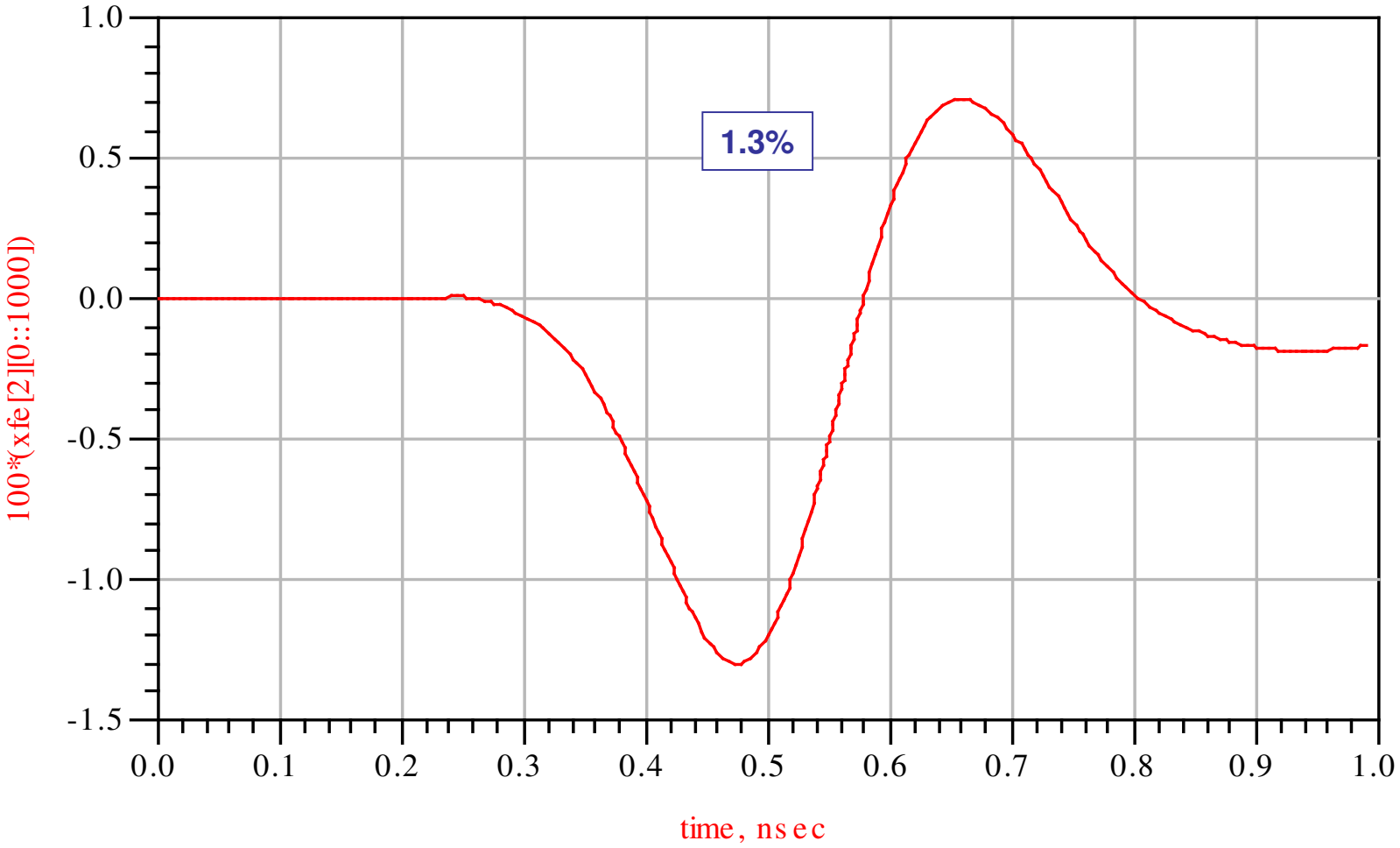
ADVANCED INTERCONNECTIONS.

Single-ended Far-end Crosstalk (FeXT)

Percent Single-ended FeXT @ 200ps risetime (10-90%)



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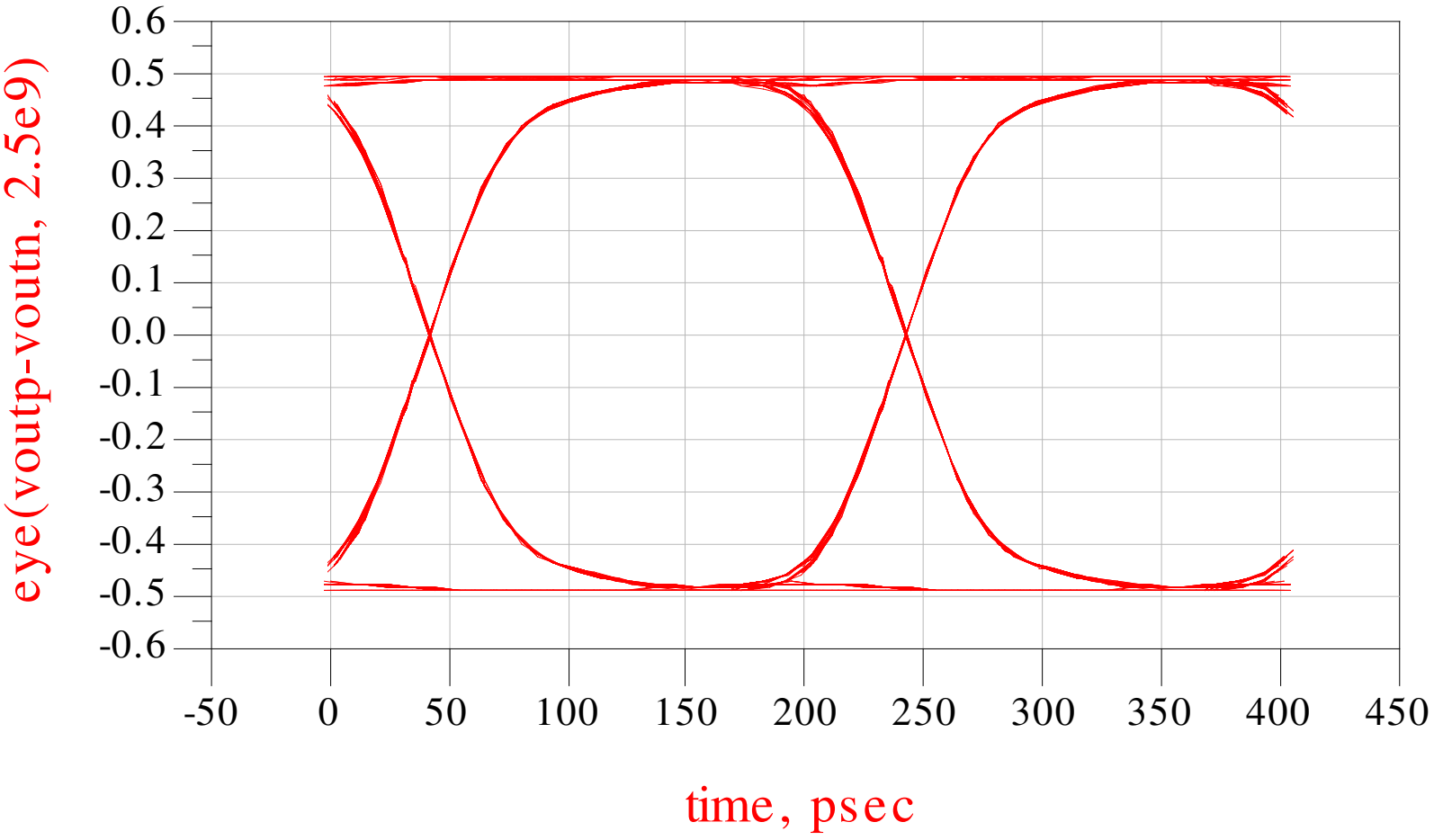
ADVANCED INTERCONNECTIONS.

Differential Eye-Diagram

Eye Opening @ 5 Gbit/sec.

Peak-to-peak jitter is 1 psec and Eye-Closure is 7%



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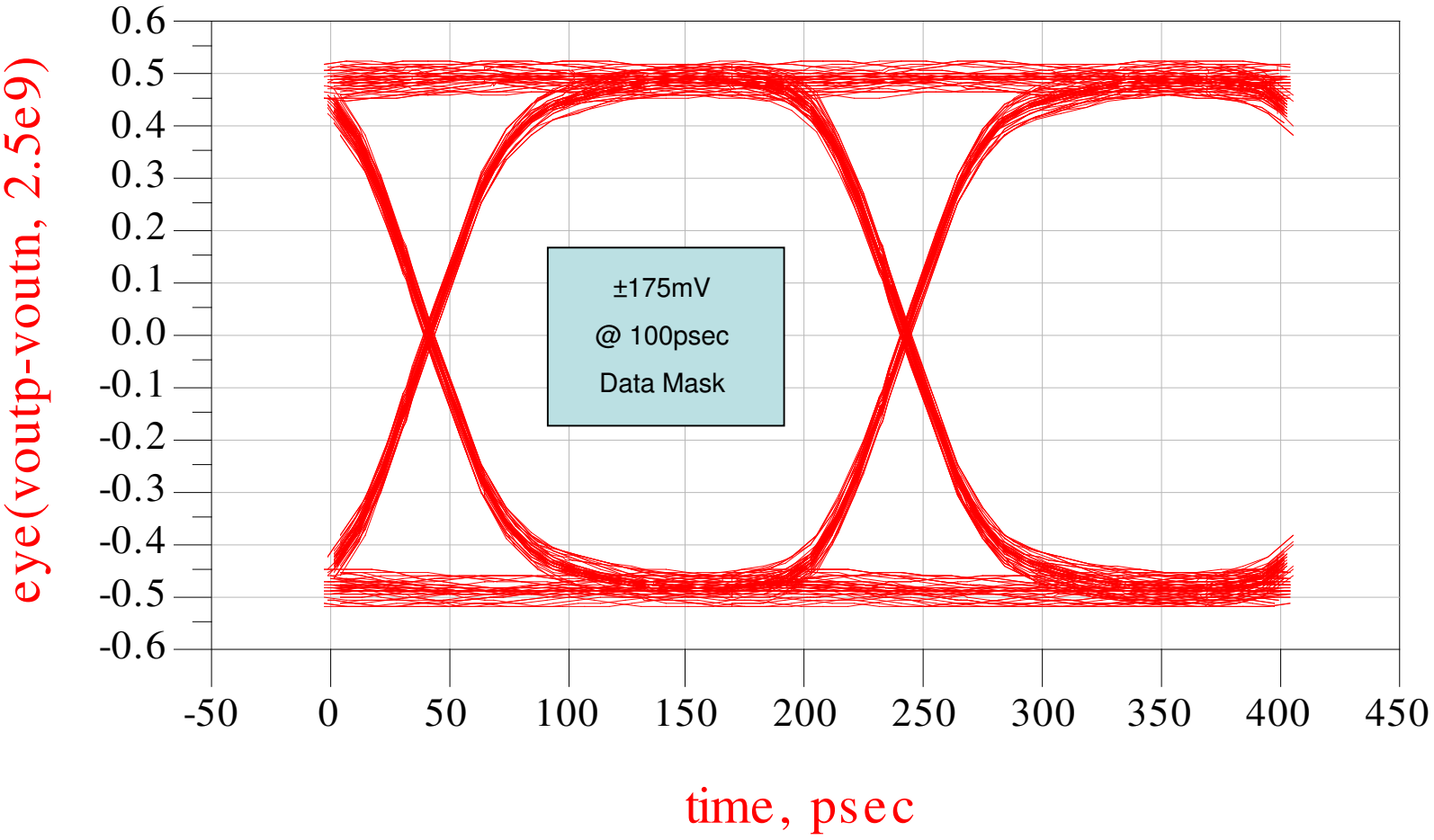
ADVANCED INTERCONNECTIONS.

Differential Eye-Diagram w/Aggressor

Eye Opening @ 5 Gbit/sec with a 6 Gbit/sec Aggressor

Peak-to-peak jitter is 6 psec and Eye-Closure is 12%



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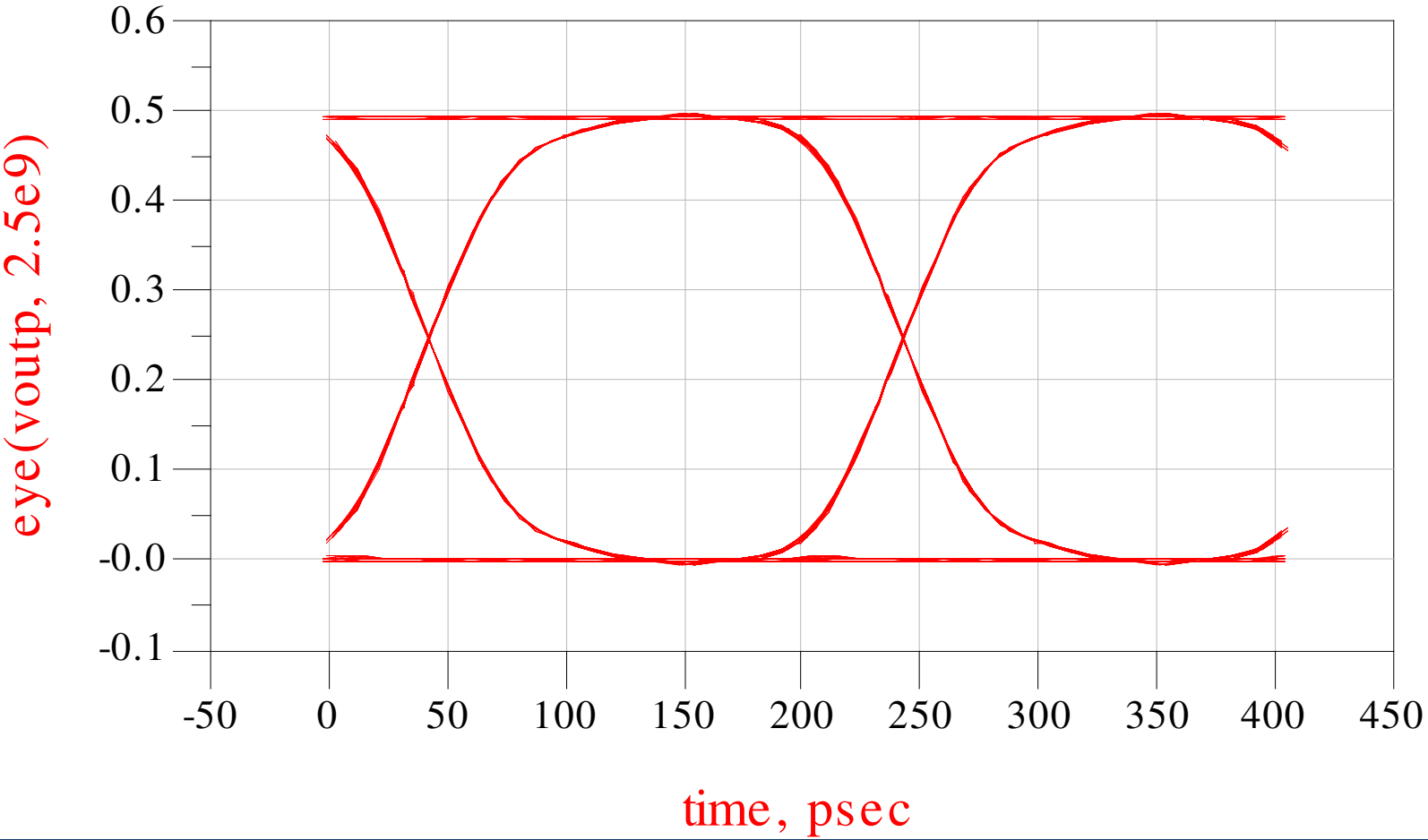
ADVANCED INTERCONNECTIONS.

Single-ended Eye-Diagram

Eye Opening @ 5 Gbit/sec.

Peak-to-peak jitter is 2 psec and Eye-Closure is 4%



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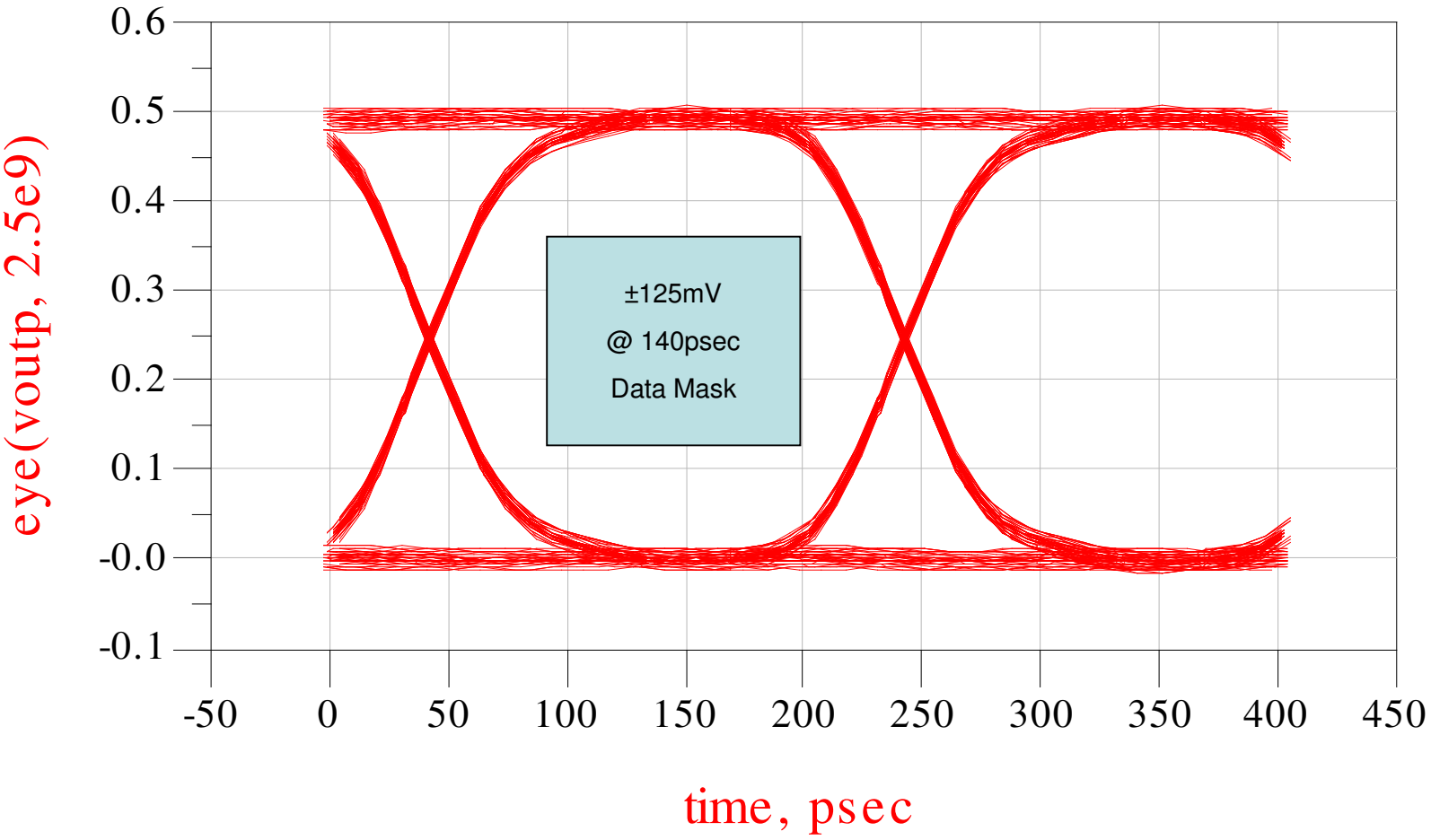
Single-ended Eye-Diagram w/Aggressor

Eye Opening @ 5 Gbit/sec with a 6 Gbit/sec Aggressor

Peak-to-peak jitter is 4 psec and Eye-Closure is 8%



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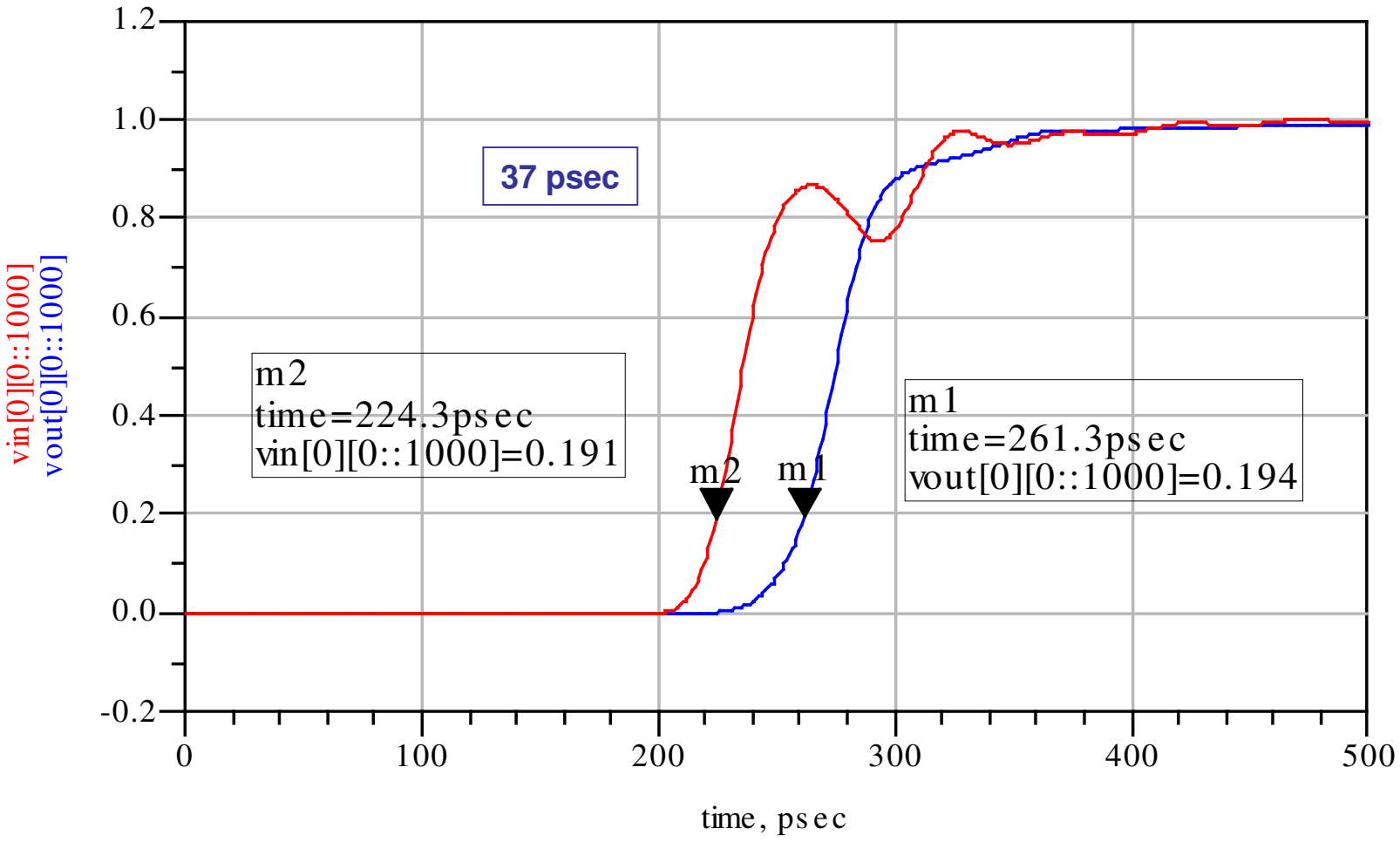
Propagation Delay



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