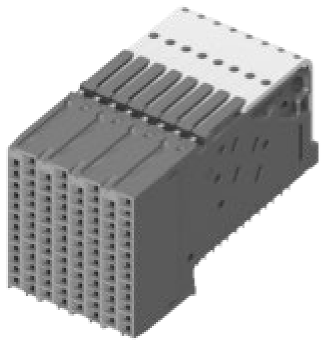
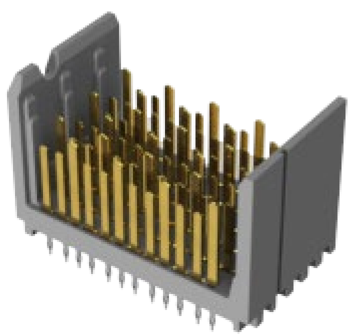
High Speed Characterization Report

HDTF-6-06-S-RA-HS-085



HDTM-6-06-1-S-VT-0-2



Description:
XCede® HD 1.80 mm Backplane Connector,
HDTF Right-Angle mating to HDTM Vertical,
6-Pair, 85-Ohm HS Wafer

Samtec Inc.
520 Park East Blvd.
New Albany IN 47151-1147 USA

WWW.SAMTEC.COM
1-800-SAMTEC-9 (US & Canada)
SIG@samtec.com

Phone: 812-944-6733
Fax: 812-948-5047
Report Revision: 11/20/2020

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Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

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Connector Overview

The HDTx series is XCede® HD 1.80 mm HDTF Right-Angle mating to HDTM vertical Backplane Connector. At the time of testing, the HDTx connectors have 3-, 4-, 6-pairs and 4, 6, 8 columns design. It is available for 85 ohms and 100 ohms options. The data in this report is applicable to 6-pair, 85-ohm HS Wafer option.

Frequency Domain Data Summary

Bandwidth Chart – Differential Insertion Loss

HDTx Connector Series

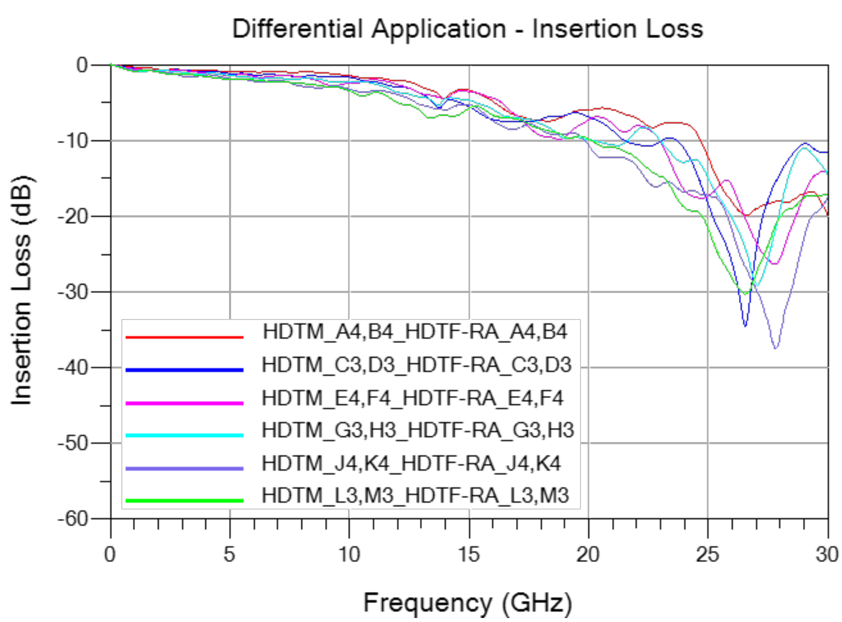

Figure 1

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Time Domain Data Summary

Table 1 - Differential Impedance (Ω)

Driver	Signal Rise-time	30ps	50ps	100ps
HDTM_A4,B4	Maximum Impedance	85.8	85.1	85.0
	Minimum Impedance	61.4	64.1	67.7
HDTM_C3,D3	Maximum Impedance	85.8	85.2	85.0
	Minimum Impedance	60.8	63.5	64.7
HDTM_E4,F4	Maximum Impedance	86.0	85.2	85.0
	Minimum Impedance	58.4	61.0	63.8
HDTM_G3,H3	Maximum Impedance	85.9	85.2	85.0
	Minimum Impedance	60.5	62.5	63.2
HDTM_J4,K4	Maximum Impedance	86.3	85.3	85.0
	Minimum Impedance	56.3	59.1	62.6
HDTM_L3,M3	Maximum Impedance	86.4	85.3	85.0
	Minimum Impedance	58.6	61.3	63.5

Table 2 - Differential Crosstalk (%)

Input(tr)	Driver	Receiver	30ps	50ps	100ps
NEXT	HDTF-RA_A4,B4	HDTF-RA_C4,D4	0.37	0.31	0.23
	HDTF-RA_C4,D4	HDTF-RA_E4,F4	0.32	0.27	0.21
	HDTF-RA_E3,F3	HDTF-RA_G3,H3	0.33	0.28	0.21
	HDTF-RA_G4,H4	HDTF-RA_J4,K4	0.31	0.25	0.20
	HDTF-RA_J4,K4	HDTF-RA_L4,M4	0.32	0.26	0.22
	HDTF-RA_E3,F3	HDTF-RA_G4,H4	0.22	0.14	<0.1
	HDTF-RA_G3,H3	HDTF-RA_J3,K3	0.33	0.29	0.22
FEXT	HDTM_A4,B4	HDTF-RA_C4,D4	0.35	0.26	0.15
	HDTM_C4,D4	HDTF-RA_E4,F4	0.38	0.27	0.16
	HDTM_E3,F3	HDTF-RA_G3,H3	0.40	0.30	0.19
	HDTM_G4,H4	HDTF-RA_J4,K4	0.40	0.27	0.18
	HDTM_J4,K4	HDTF-RA_L4,M4	0.39	0.26	0.18
	HDTM_E3,F3	HDTF-RA_G4,H4	0.12	<0.1	<0.1
	HDTM_G3,H3	HDTF-RA_J3,K3	0.41	0.31	0.21

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Table 3 - Propagation Delay (Mated Connector)	
HDTM_A4,B4_ HDTF-RA_A4,B4	153 ps
HDTM_C3,D3_ HDTF-RA_C3,D3	197 ps
HDTM_E4,F4_ HDTF-RA_E4,F4	228 ps
HDTM_G3,H3_ HDTF-RA_ G3,H3	276 ps
HDTM_J4,K4_ HDTF-RA_ J4,K4	306 ps
HDTM_L3,M3_ HDTF-RA_ L3,M3	352 ps

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Characterization Details

This report presents data that characterizes the signal integrity response of a connector pair in a controlled printed circuit board (PCB) environment. All efforts are made to reveal typical best-case responses inherent to the system under test (SUT).

In this report, the SUT includes the connector pair and footprint effects on a typical multi-layer PCB. PCB effects (trace loss) are de-embedded from test data. Board related effects, such as pad-to-ground capacitance, are included in the data presented in this report.

Additionally, intermediate test signal connections can mask the connector's true performance. Such connection effects are minimized by using high performance test cables and adapters. Where appropriate, calibration and de-embedding routines are also used to reduce residual effects.

Differential and Single-Ended Data

Most Samtec connectors can be used successfully in both differential and single-ended applications. However, electrical performance will differ depending on the signal drive type. In this report, data is presented for both differentially and single-ended driven scenarios.

Connector Signal to Ground Ratio

Samtec connectors are most often designed for generic applications and can be implemented using various signal and ground pin assignments. In high speed systems, provisions must be made in the interconnect for signal return currents. Such paths are often referred to as "ground". In some connectors, a ground plane or blade, or an outer shield, is used as the signal return, while in others, connector pins are used as signal returns. Various combinations of signal pins, ground blades, and shields can also be utilized. Electrical performance can vary significantly depending upon the number and location of ground pins.

In general, the more pins dedicated to ground, the better electrical performance will be. But dedicating pins to ground reduces signal density of a connector. Therefore, care must be taken when choosing signal/ground ratios in cost or density-sensitive applications.

Series: HDTF-RA / HDTM
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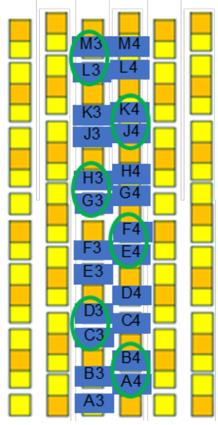
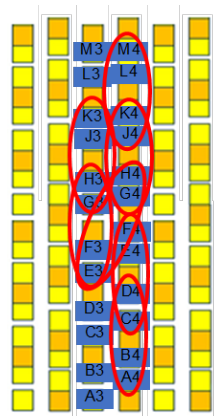
For this connector, the following configurations were evaluated:





Differential Impedance (denoted by green circles)**:**

- GSSG (Ground-positive Signal-negative Signal-Ground)

Differential Crosstalk (denoted by red circles)**:**

- In row: from the terminals to the other terminals on the same row.
- Across row: from one row of terminals to the other row of terminals.

Other configurations can be evaluated upon request. Please contact sig@samtec.com for more information.

In a real system environment, active signals might be located at the outer edges of the signal contacts of concern, as opposed to the ground signals utilized in laboratory testing. For example, in a single-ended system, a pin-out of “SSSS”, or four adjacent single ended signals might be encountered as opposed to the “GSG” and “GSSG” configurations tested in the laboratory. Electrical characteristics in such applications could vary slightly from laboratory results. But in most applications, performance can safely be considered equivalent.

Signal Edge Speed (Rise Time):
In pulse signaling applications, the perceived performance of the interconnect can vary significantly depending on the edge rate or rise time of the exciting signal. For this report, the fastest rise time used was 30 ps. Generally, this should demonstrate worst-case performance.

In many systems, the signal edge rate will be significantly slower at the connector than at the driver launch point. To estimate interconnect performance at other edge rates, data is provided for several rise times between 30 ps and 100 ps.

For this report, measured rise times were at 20%-80% signal levels.

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Frequency Domain Data

Frequency Domain parameters are helpful in evaluating the connector system's signal loss and crosstalk characteristics across a range of sinusoidal frequencies. In this report, parameters presented in the Frequency Domain are Insertion Loss, Return Loss, and Near-End and Far-End Crosstalk. Other parameters or formats, such as VSWR or S-Parameters, may be available upon request. Please contact our Signal Integrity Group at sig@samtec.com for more information. Frequency performance characteristics for the SUT are generated directly from network analyzer measurements.

Time Domain Data

Time Domain parameters indicate Impedance mismatch versus length, signal propagation time, and crosstalk in a pulsed signal environment. The measured S-Parameters from the network analyzer are post-processed using Keysight Advanced Design System to obtain the time domain response. Time Domain procedure is provided in Appendix E of this report. Parameters or formats not included in this report may be available upon request. Please contact our Signal Integrity Group at sig@samtec.com for more information.

In this report, propagation delay is defined as the signal propagation time through the connector and connector footprint. It includes 0.56 mm of PCB trace on the HDTF-RA and HDTM each. Delay is measured at 100 picoseconds signal risetime. Delay is calculated as the difference in time measured between the 50% amplitude levels of the input and output pulses.

Crosstalk or coupled noise data is provided for various signal configurations. All measurements are single disturber. Crosstalk is calculated as a ratio of the input line voltage to the coupled line voltage. The input line is sometimes described as the active or drive line. The coupled line is sometimes described as the quiet or victim line. Crosstalk ratio is tabulated in this report as a percentage. Measurements are made at both the near-end and far-end of the SUT. Data for other configurations may be available. Please contact our Signal Integrity Group at sig@samtec.com for further information.

As a rule of thumb, 10% crosstalk levels are often used as a general first pass limit for determining acceptable interconnect performance. But modern system crosstalk tolerance can vary greatly. For advice on connector suitability for specific applications, please contact our Signal Integrity Group at sig@samtec.com.

Additional information concerning test conditions and procedures is located in the appendices of this report. Further information may be obtained by contacting our Signal Integrity Group at sig@samtec.com.

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Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Appendix A – Frequency Domain Responses

Differential Application – Insertion Loss

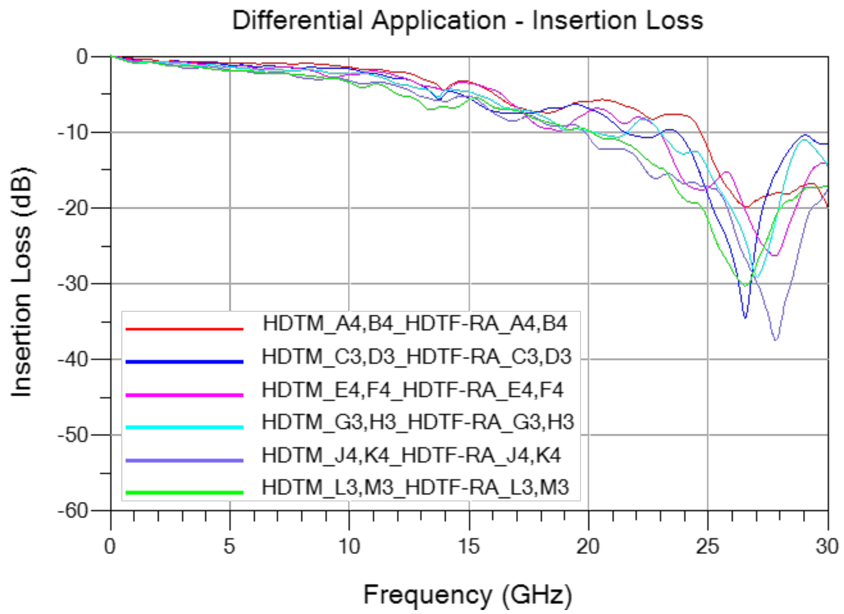

Figure 2

Differential Application – Return Loss

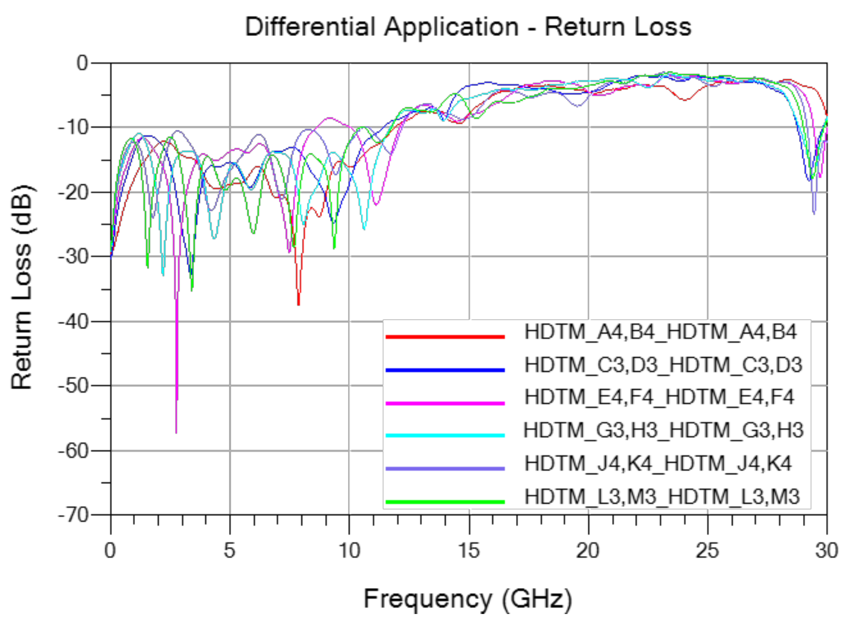

Figure 3

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – NEXT Configurations

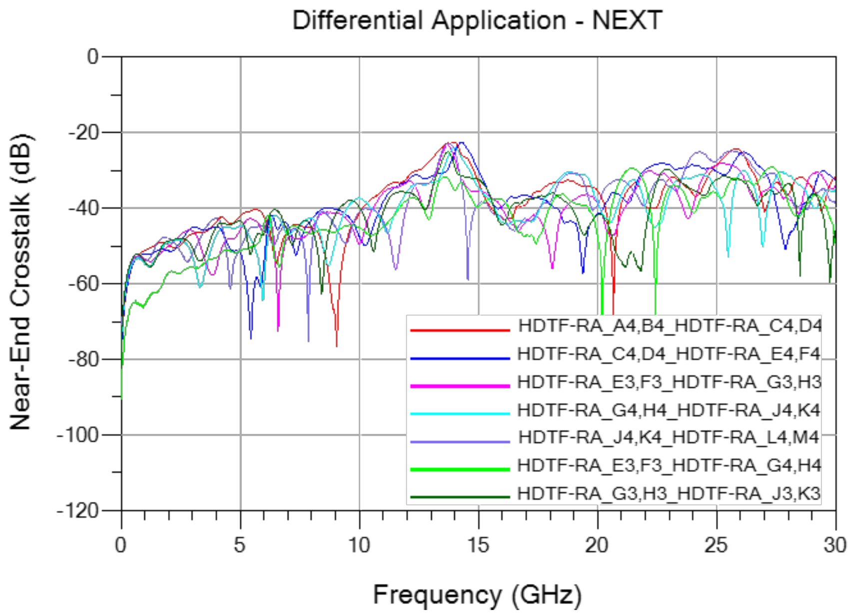

Figure 4

Differential Application – FEXT Configurations

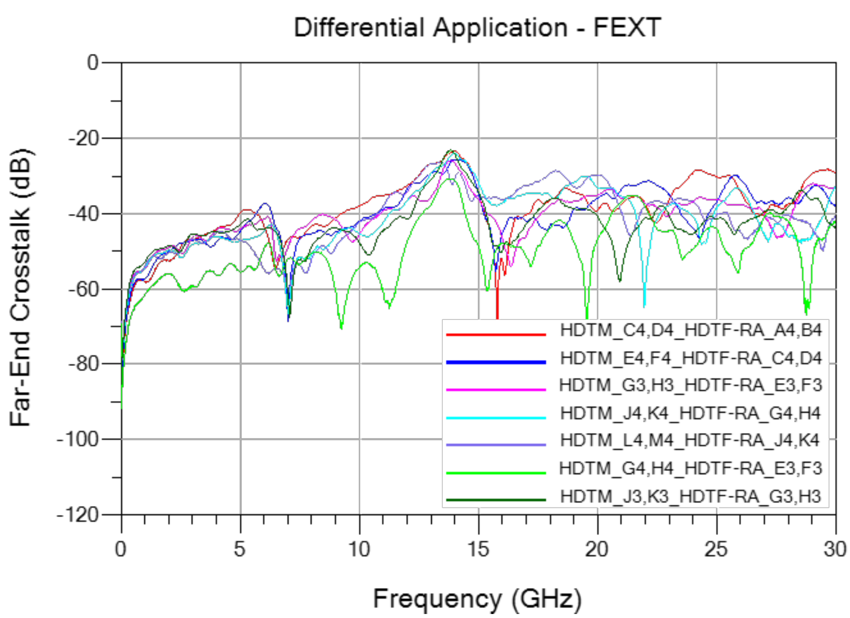

Figure 5

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Appendix B – Time Domain Responses

Differential Application – Impedance

HDTM_AB4-HDTF-RA_AB4

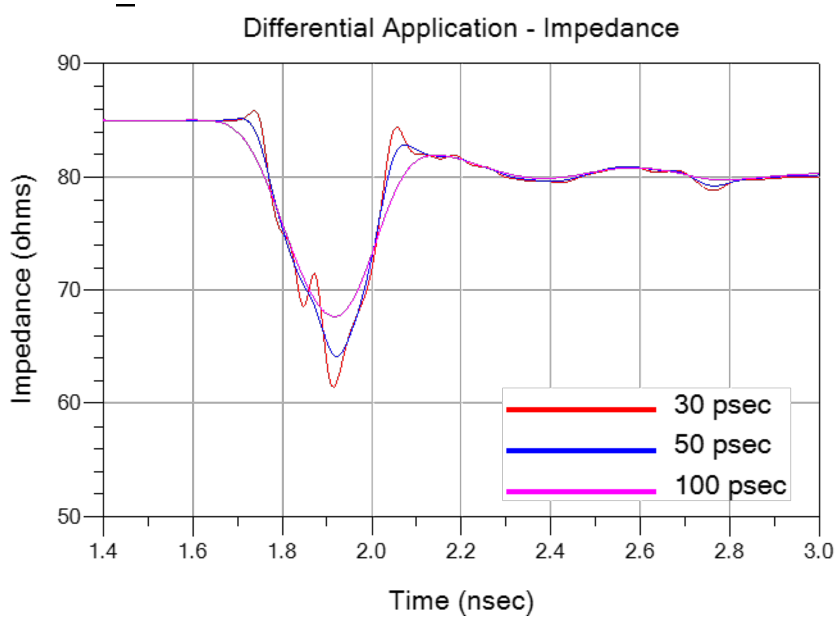

Figure 6

HDTM_CD3-HDTF-RA_CD3

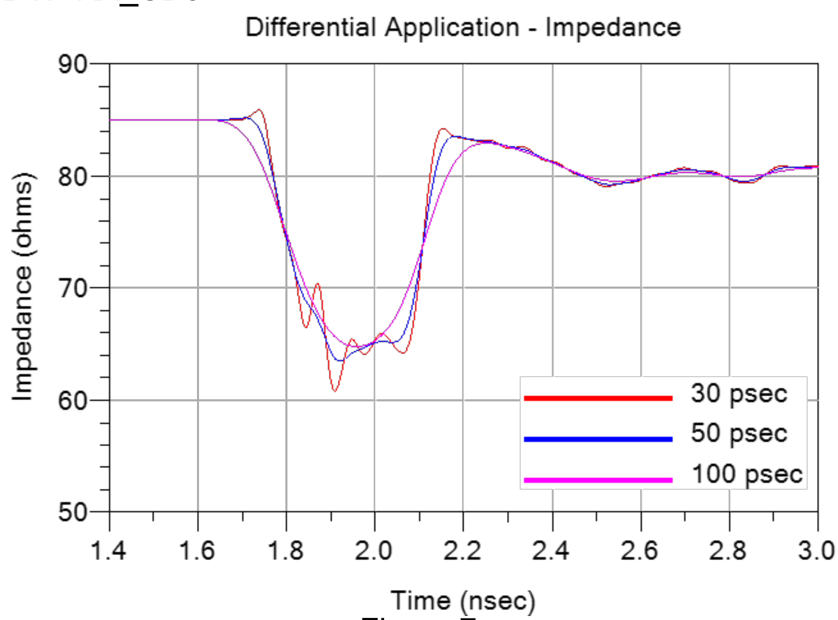

Figure 7

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

HDTF-RA_EF4-HDTF-RA_EF4

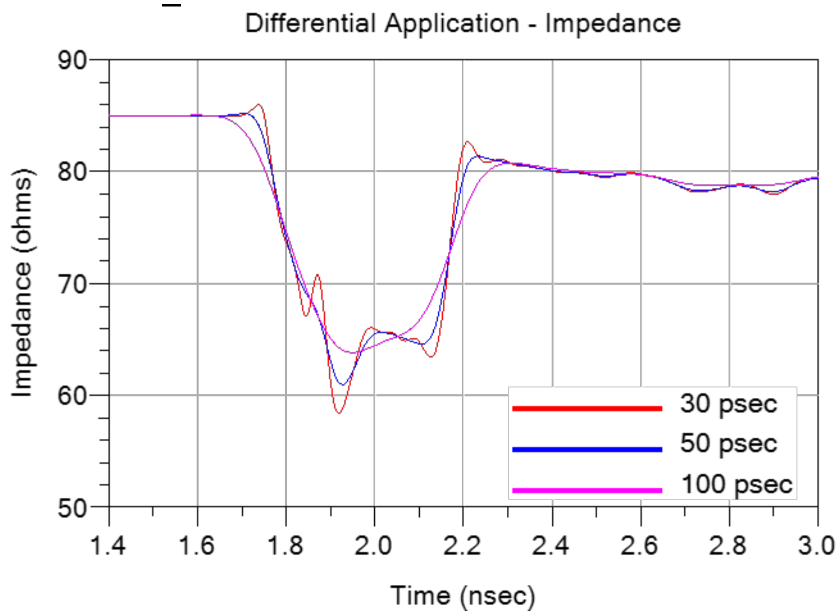

Figure 8

HDTM_GH3-HDTF-RA_GH3

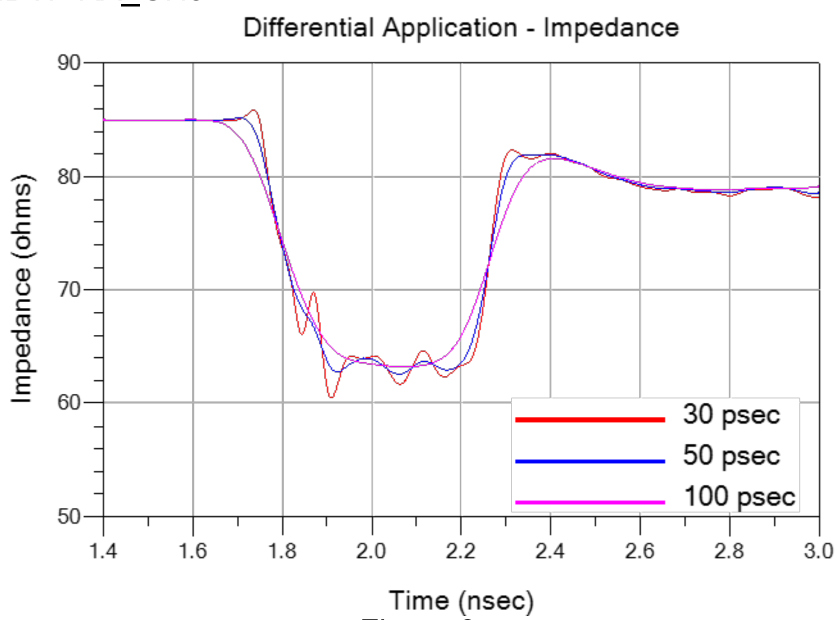

Figure 9

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

HDTM_JK4-HDTF-RA_JK4

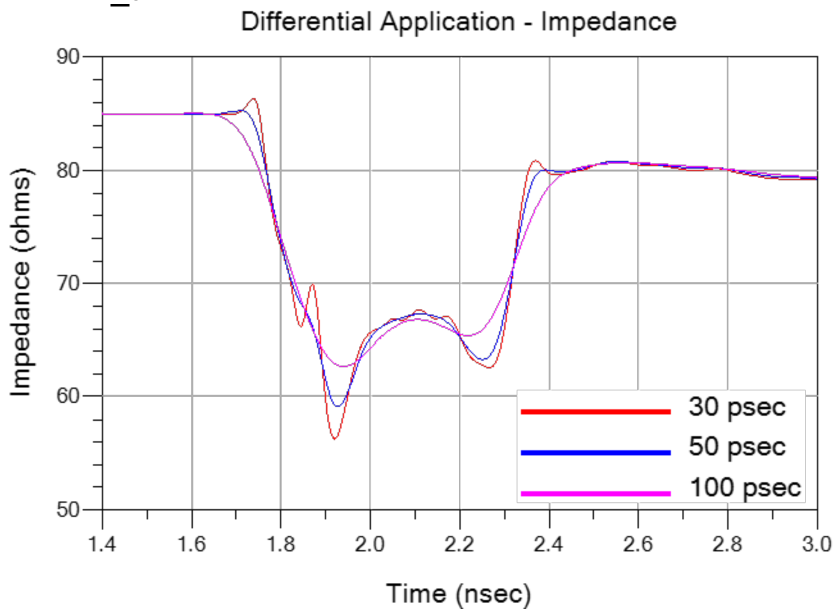

Figure 10

HDTF-RA_LM3-HDTF-RA_LM3

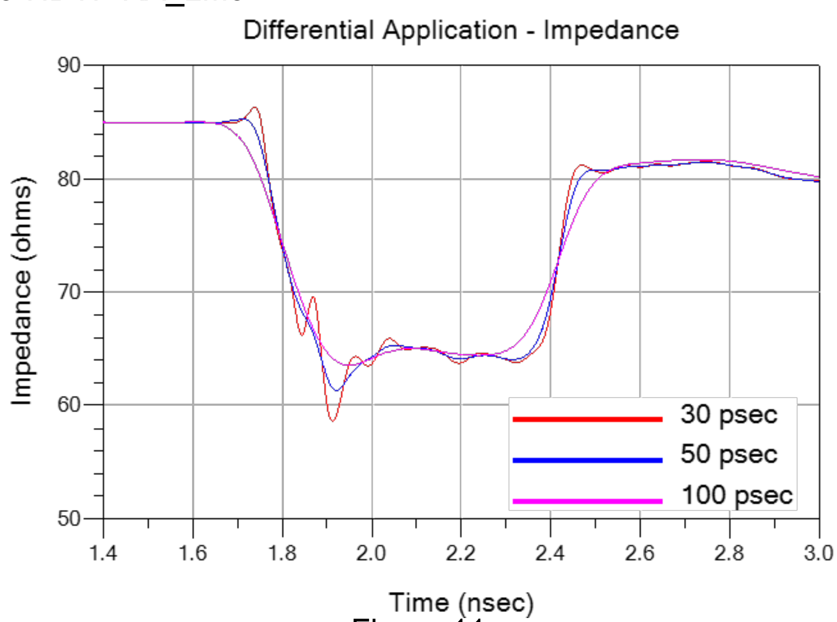

Figure 11

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – Propagation Delay

HDTM_AB4-HDTF-RA_AB4

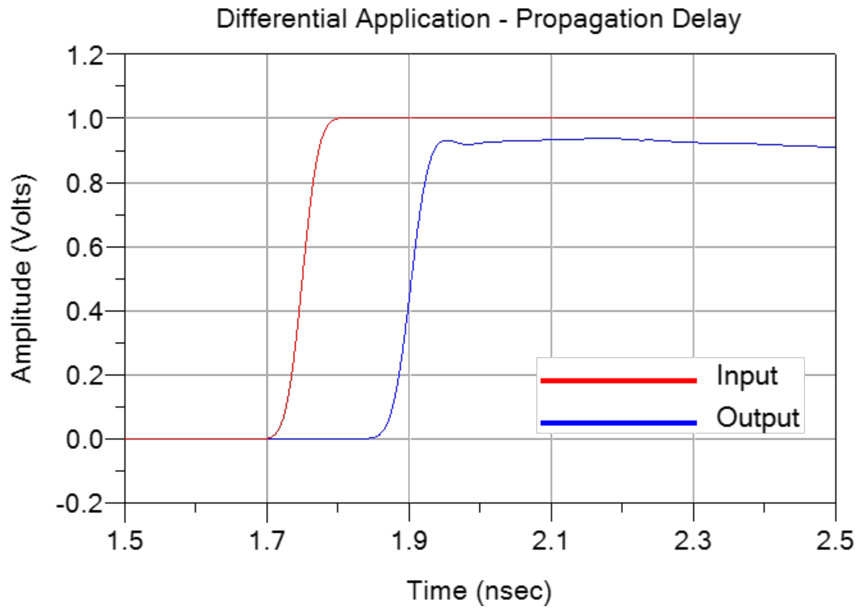

Figure 12

HDTM_CD3-HDTF-RA_CD3

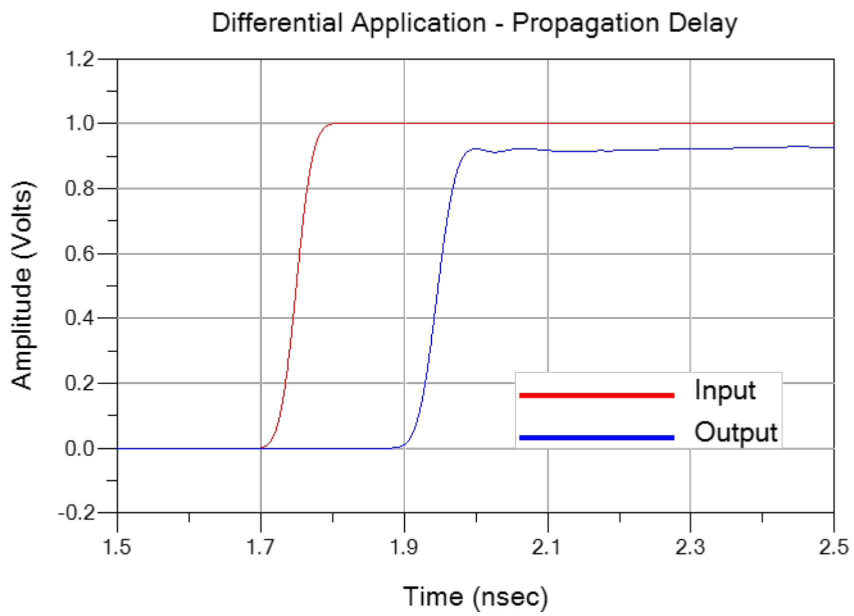

Figure 13

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

HDTF-RA_EF4-HDTF-RA_EF4

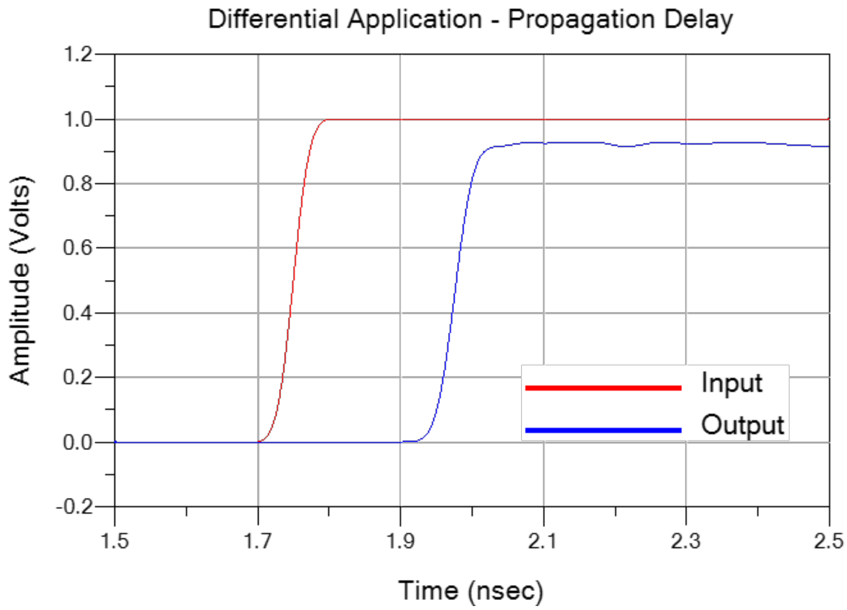

Figure 14

HDTM_GH3-HDTF-RA_GH3

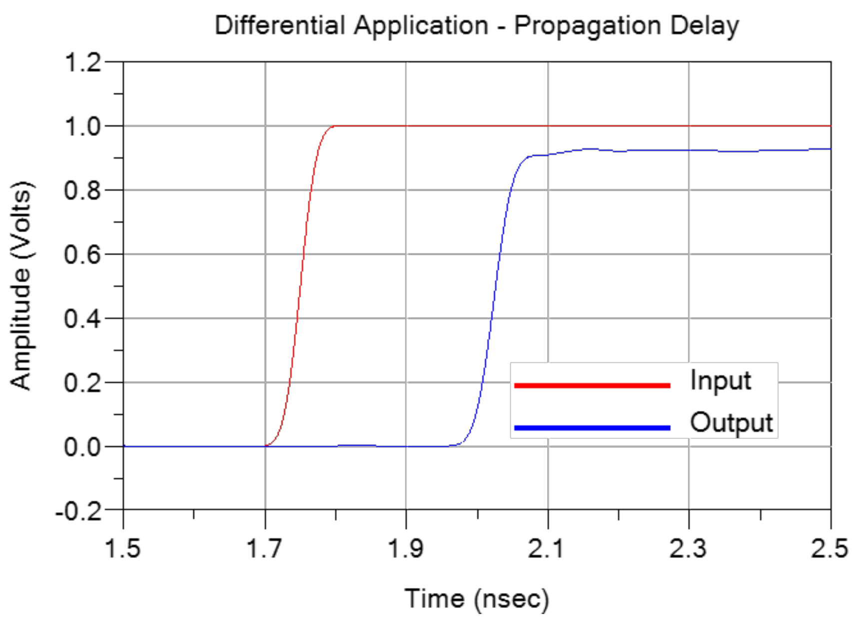

Figure 15

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

HDTM_JK4-HDTF-RA_JK4

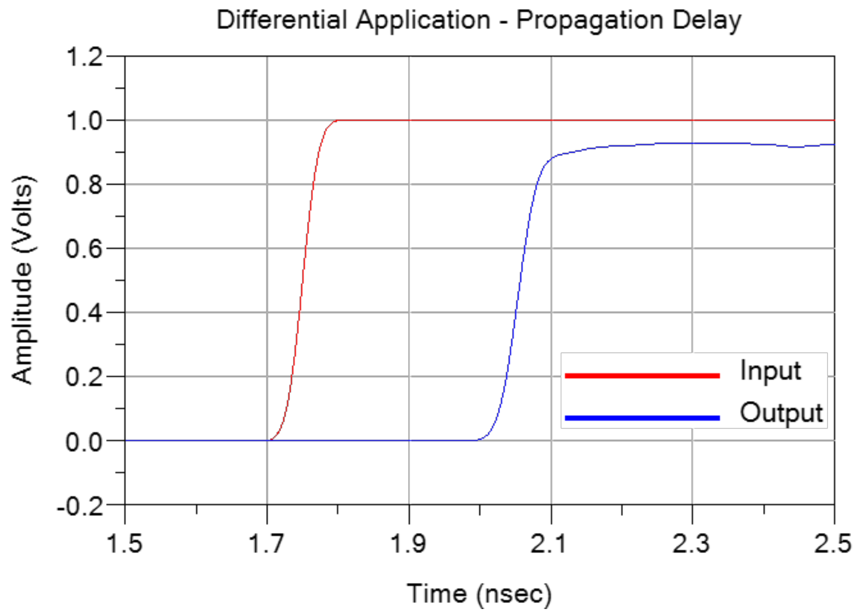

Figure 16

HDTF-RA_LM3-HDTF-RA_LM3

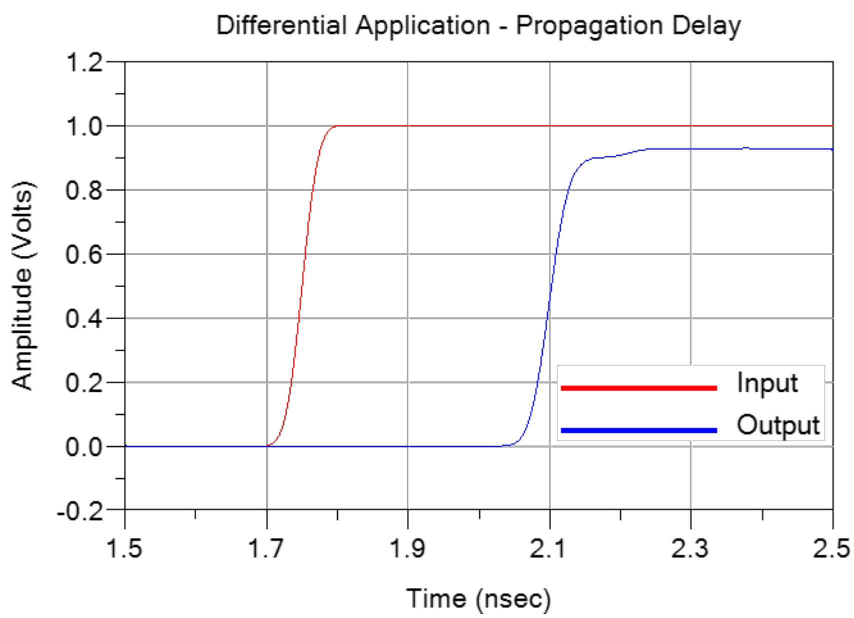

Figure 17

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – NEXT, HDTF-RA_A4B4_HDTF-RA_C4D4

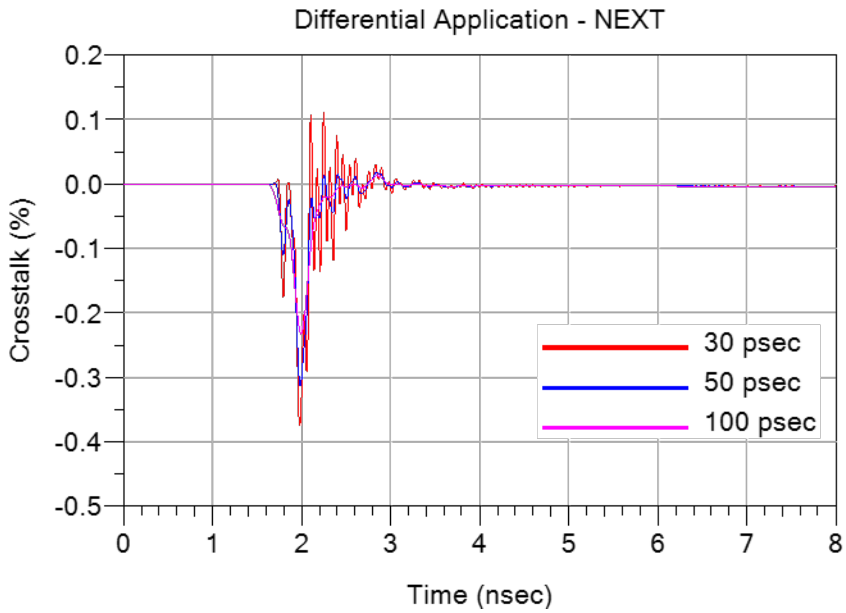

Figure 18

Differential Application – NEXT, HDTF-RA_C4D4_HDTF-RA_E4F4

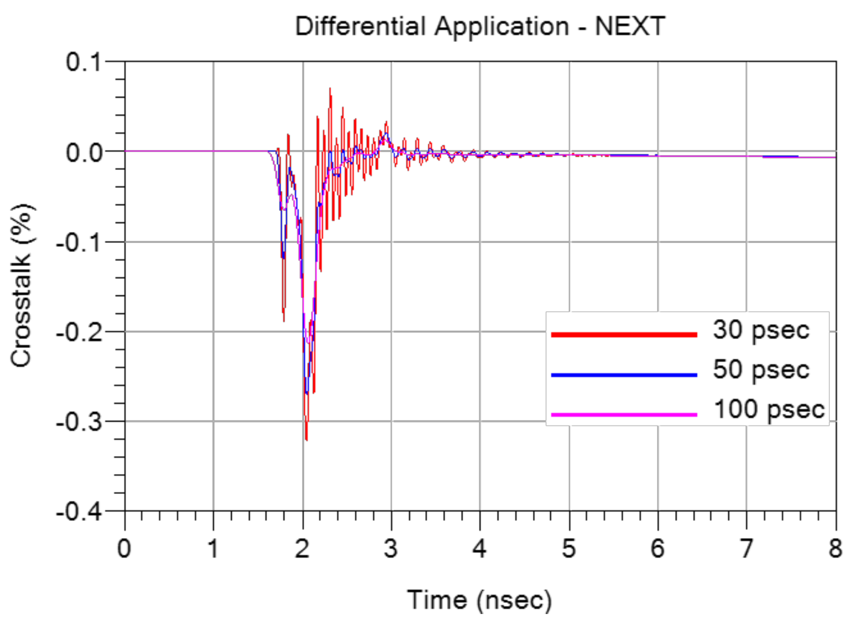

Figure 19

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – NEXT, HDTF-RA_E3F3_HDTF-RA_G3H3

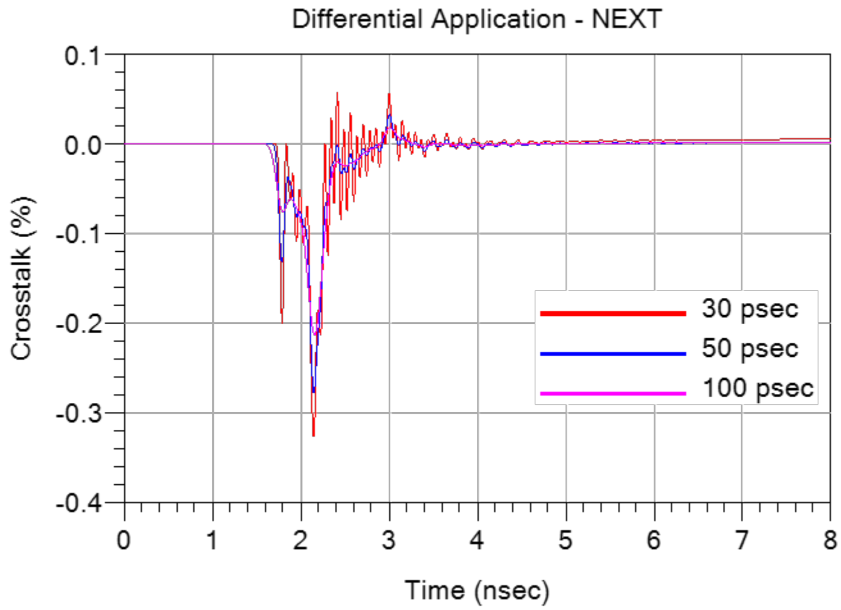

Figure 20

Differential Application – NEXT, HDTF-RA_G4H4_HDTF-RA_J4K4

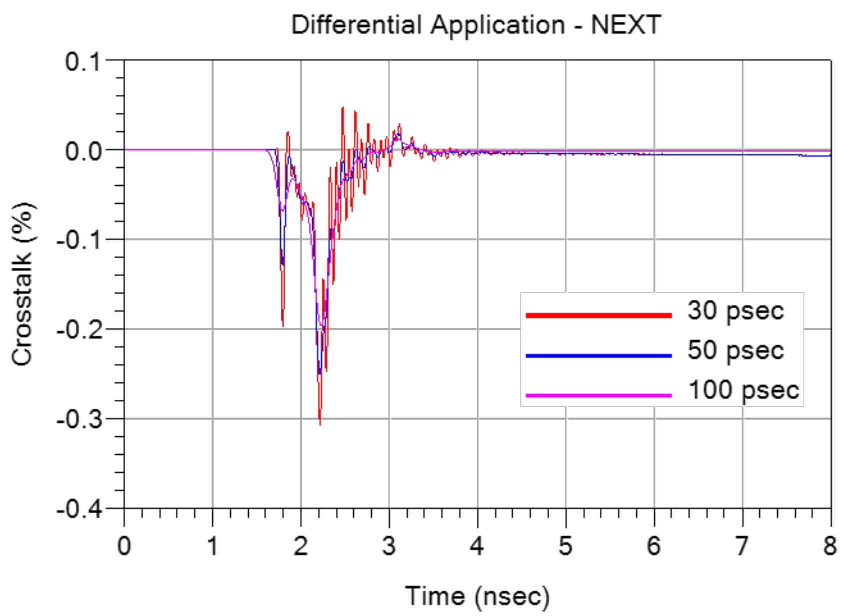

Figure 21

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – NEXT, HDTF-RA_J4K4_HDTF-RA_L4M4

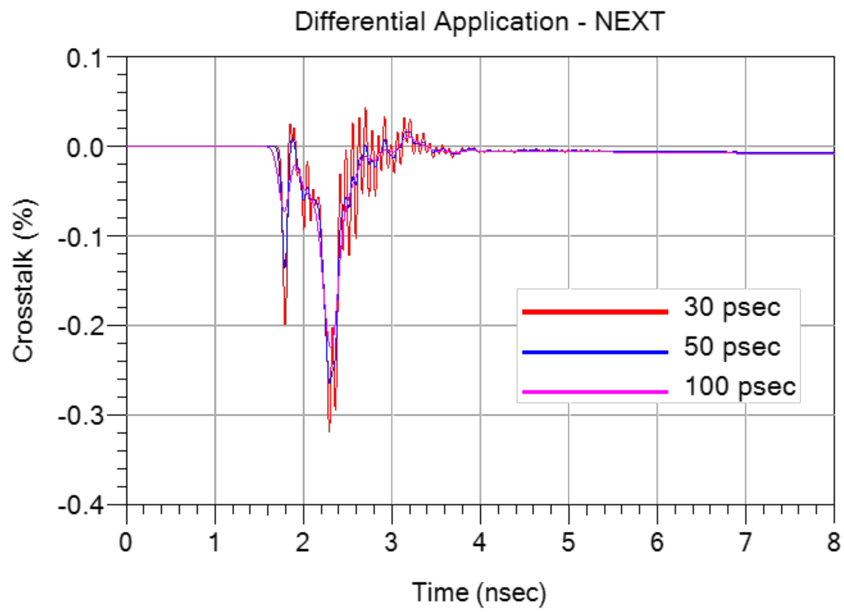

Figure 22

Differential Application – NEXT, HDTF-RA_E3F3_HDTF-RA_G4H4

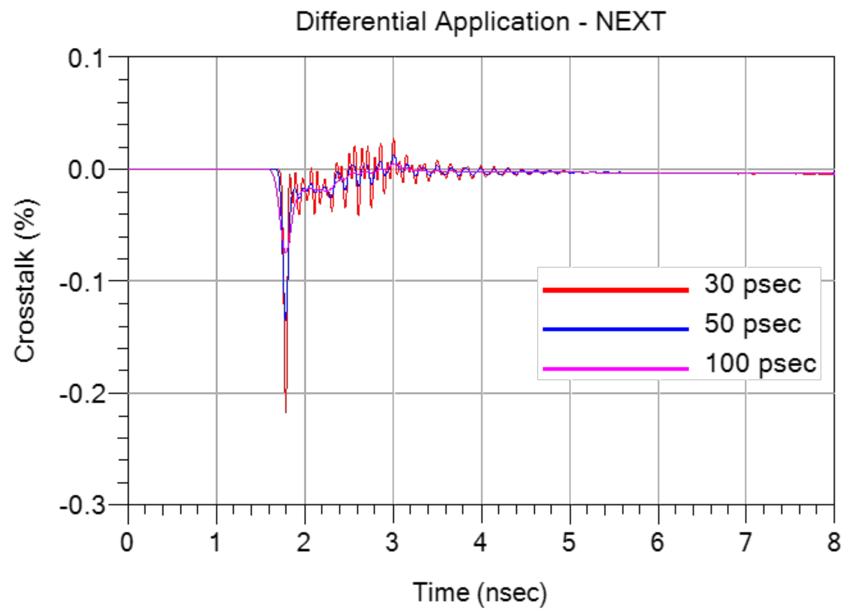

Figure 23

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – NEXT, HDTF-RA_G3H3_HDTF-RA_J3K3

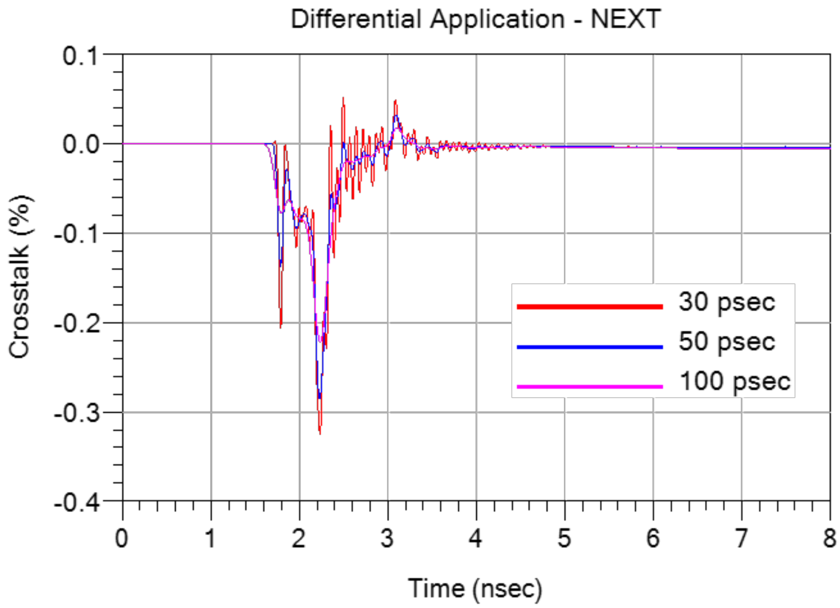

Figure 24

Differential Application – FEXT, HDTM_A4B4_HDTF-RA _C4D4

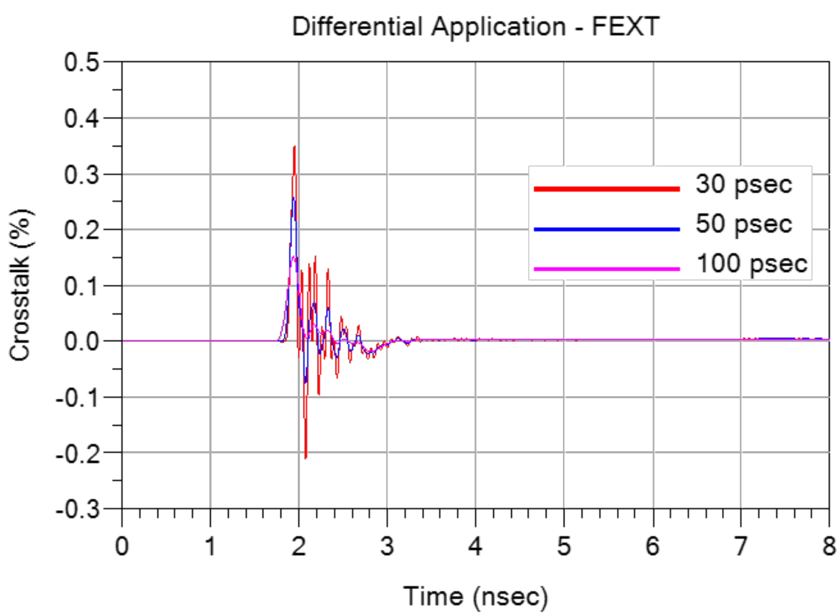

Figure 25

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – FEXT, HDTM_C4D4_HDTF-RA _E4F4

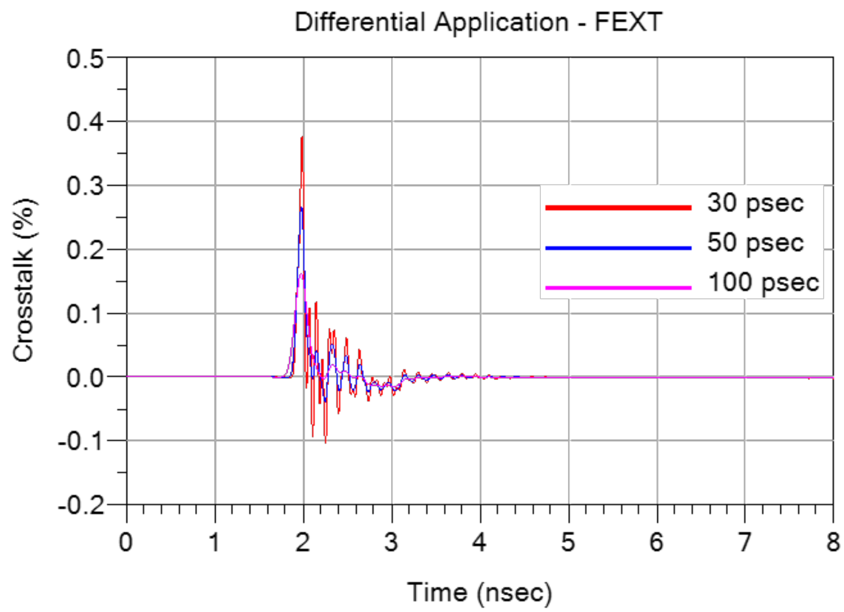

Figure 26

Differential Application – FEXT, HDTM_E3F3_HDTF-RA _G3H3

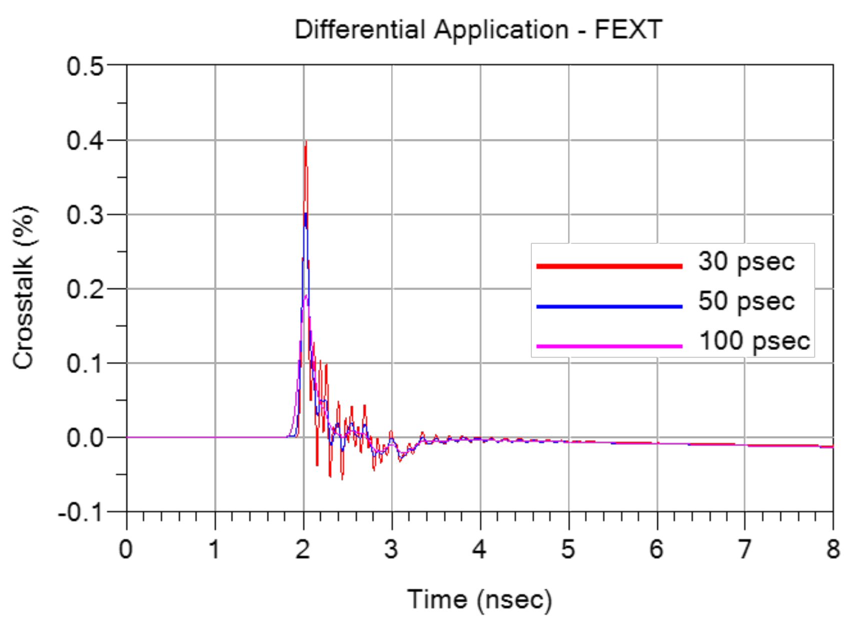

Figure 27

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – FEXT, HDTM_G4H4_HDTF-RA _J4K4

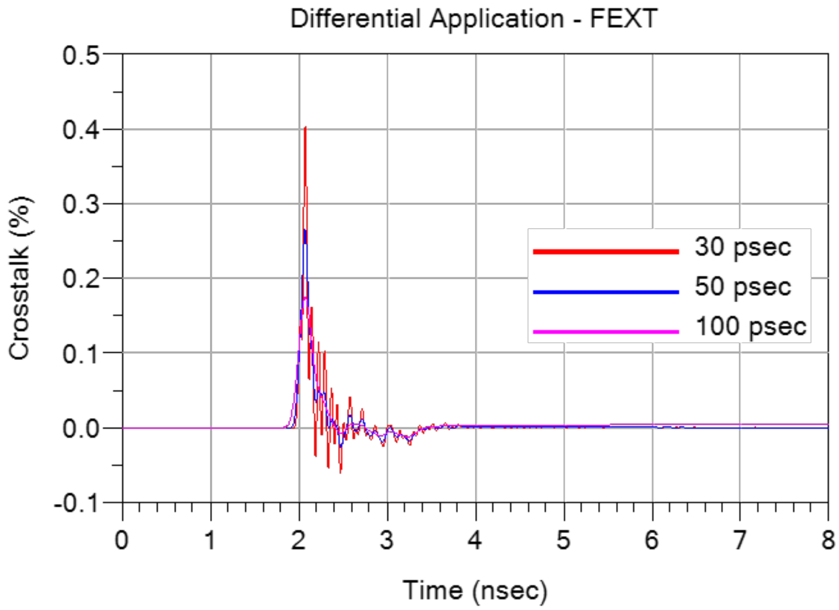

Figure 28

Differential Application – FEXT, HDTM_J4K4_HDTF-RA _L4M4

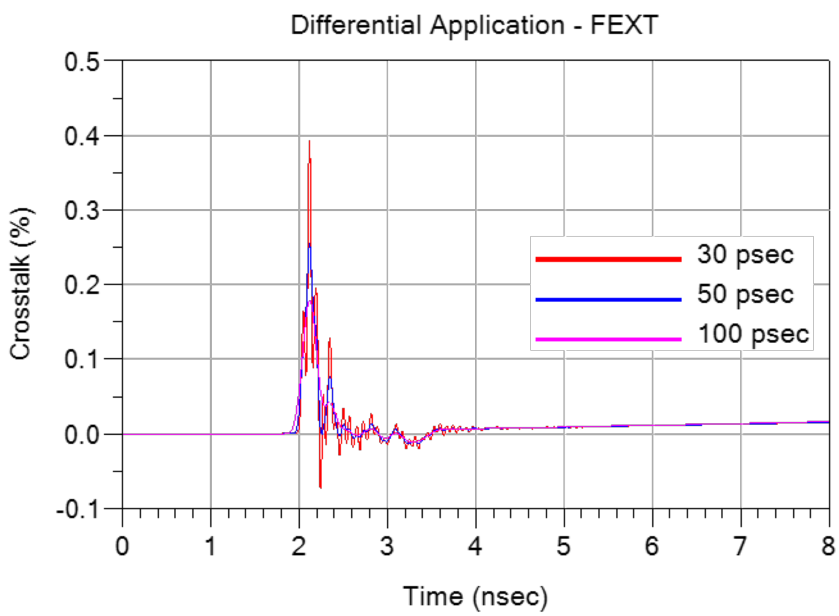

Figure 29

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Differential Application – FEXT, HDTM_E3F3_HDTF-RA _G4H4

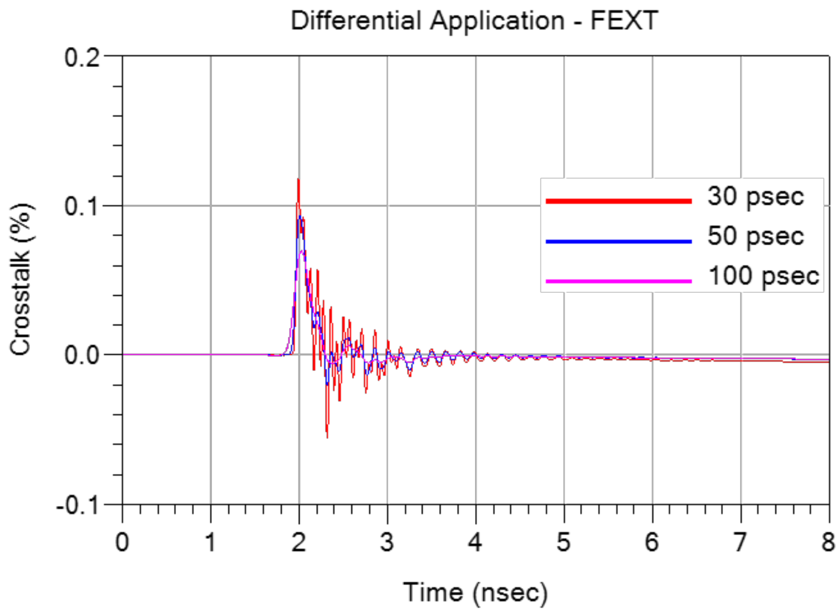

Figure 30

Differential Application – FEXT, HDTM_G3H3_HDTF-RA _J3K3

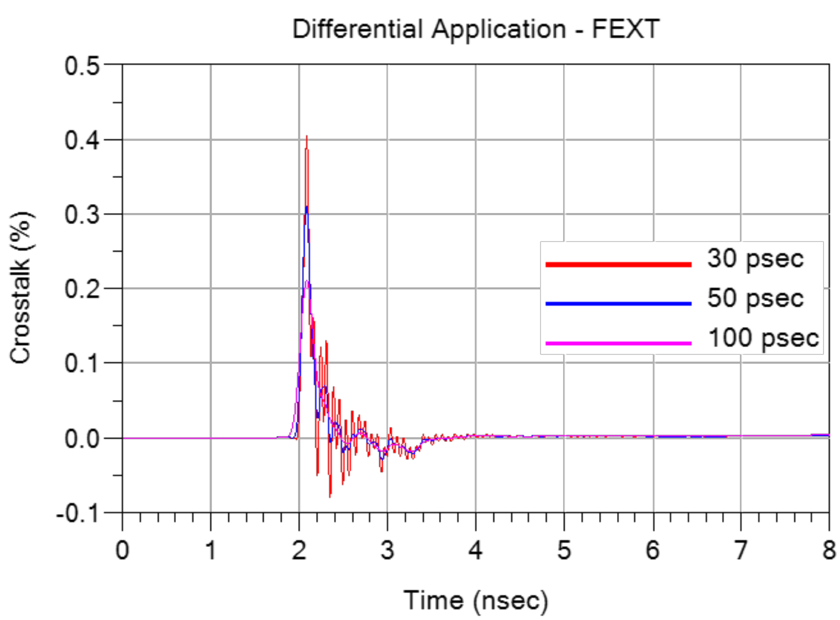

Figure 31

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Appendix C – Product and Test System Descriptions

Product Description

Product test samples are press-fit HDTx Series connectors. The part number is HDTF-6-06-S-RA-HS-085 and HDTM-6-06-1-S-VT-0-2. The HDTx Series connectors are available for standard or high-speed wafers. The modular design provides flexibility in applications. A photo of the test articles mounted to SI test boards is shown below.

Test System Description

The test fixtures are composed of eight-layer FR-4 material with 42.5Ω signal trace and pad configurations designed for the electrical characterization of Samtec high speed connector products. A PCB mount 2.4mm connector is used to interface the PNA test cables to the test fixtures. Optimization of the 2.4mm launch was performed using full wave simulation tools to minimize reflections. The test fixtures and calibration kit are specific to the HDTx series connector set and identified by part number PCB-109192-SIG.

PCB-109192-SIG-XX Test Fixtures

Shown below is a photograph of the one of the three test board sets.

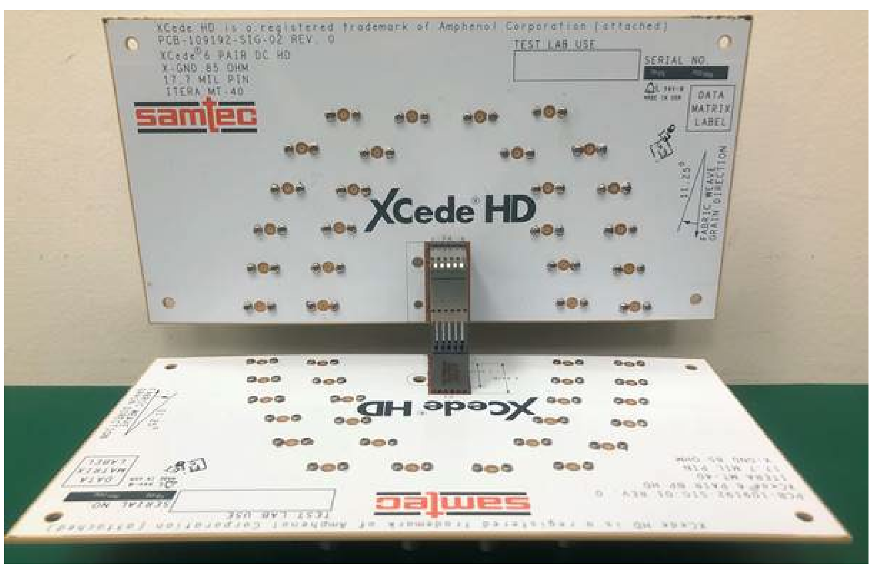

Figure 32

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

PCB Fixtures

The test fixtures used are as follows:

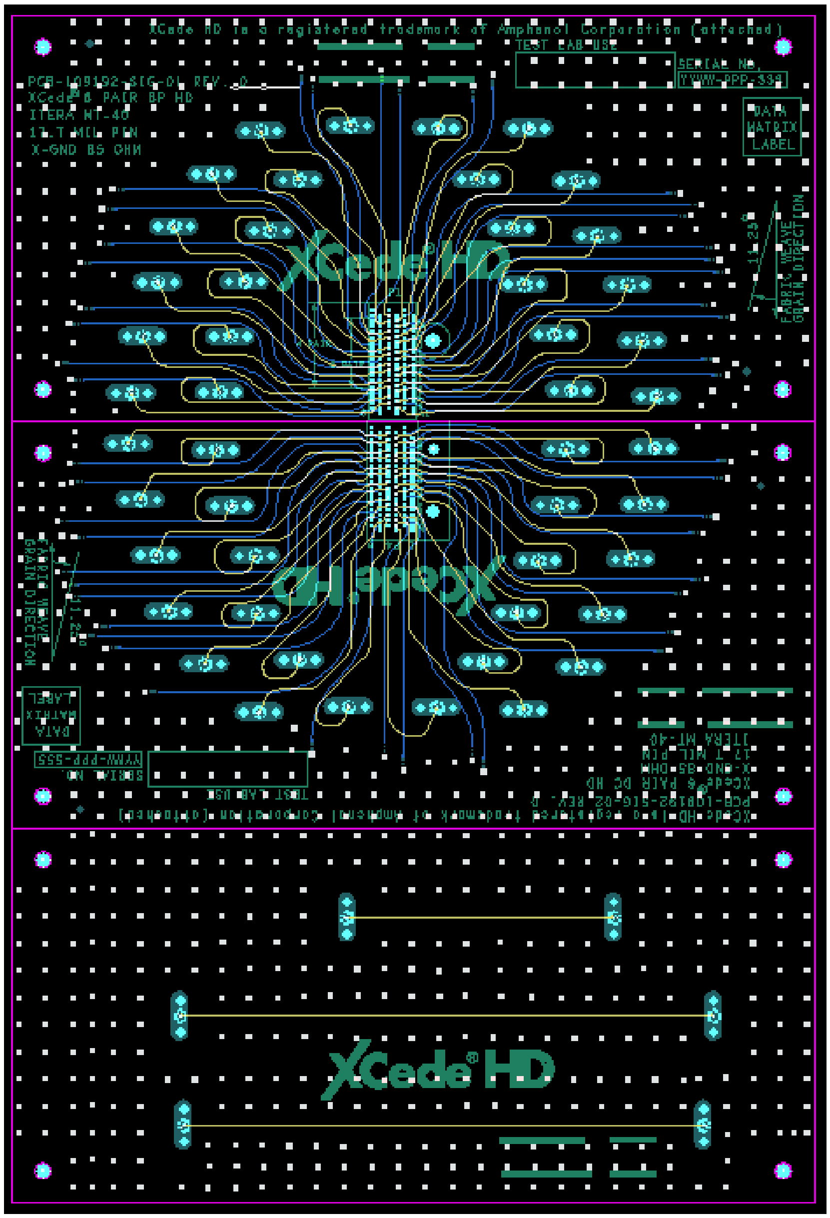

Figure 33

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

All traces on the test boards are length matched to 59.56 mm measured from the edge of the pad to the 2.4mm connector. The AFR calibration effectively removes 59 mm of test board trace effects. This means that 0.56 mm of test board trace length effects are included in the both sides of test boards in the measurement. The S-Parameter measurement includes:

A- The HDTx Series connector set
B- Test board vias, pads (footprint effects) for the HDTM connector side.
C- 0.56 mm of 0.173 mm wide microstrip trace.
D- Test board vias, pads (footprint effects) for the HDTF-RA side.
E- 0.56 mm of 0.173 mm wide microstrip trace.

The figure below shows the location of the measurement reference plane.

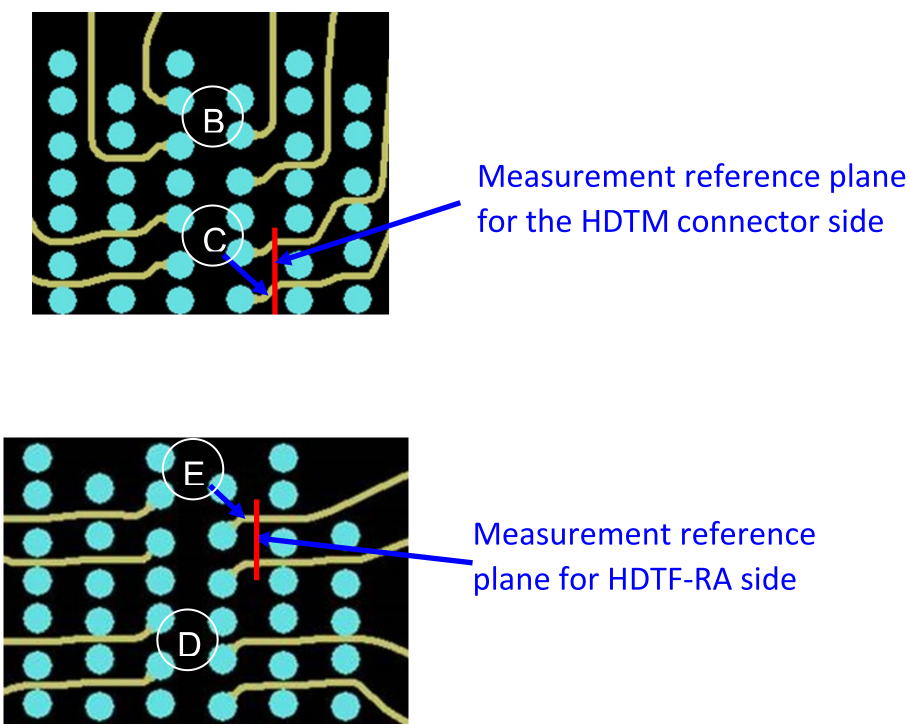

Figure 34

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Appendix D – Test and Measurement Setup

For frequency domain measurements, the test instrument is the Keysight N5227B PNA-L network analyzer. Frequency domain data are obtained directly from the instrument and figures are generated by Keysight ADS. The network analyzer is configured as follows:

Start Frequency – 10 MHz
Stop Frequency – 50 GHz
Number of points – 5000
IFBW – 700 Hz

N5227B Measurement Setup

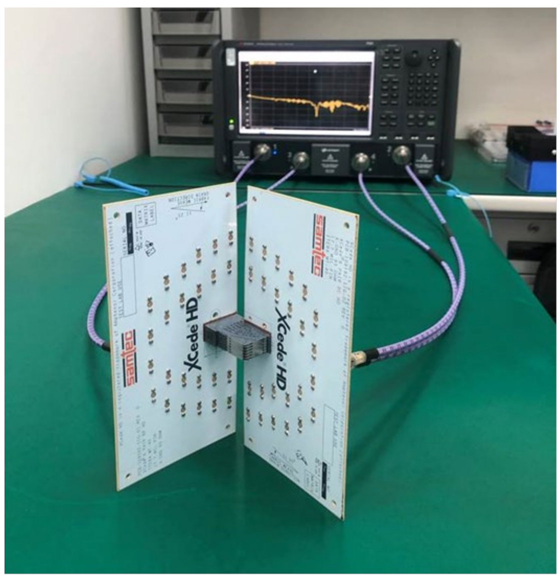

Figure 35

Test Instruments

<u>QTY</u> <u>Description</u>
1 Keysight N5227B PNA-L Network Analyzer (10 MHz to 67 GHz)
1 Keysight N4694-60003 ECAL Module (10 MHz to 67 GHz)

Test Cables & Adapters

<u>QTY</u> <u>Description</u>
4 Gore 0F0CACB036.0-LF (DC to 67 GHz)

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Appendix E - Frequency and Time Domain Measurements

Frequency (S-Parameter) Domain Procedures

The quality of any data taken with a network analyzer is directly related to the quality of the calibration standards and the use of proper test procedures. For this reason, extreme care is taken in the design of the through calibration standards, the SI test boards, and the selection of the PCB vendor.

A coaxial SOLT calibration is performed using a N4694-60003 ECAL module. Then DUT measurements are performed under SOLT calibration. The measurements include the effect of test fixture. The measurements of the 2X THRU line standards are required to remove the test fixture effect.

Time Domain Procedures

Mathematically, Frequency Domain data can be transformed to obtain a Time Domain response. Perfect transformation requires Frequency Domain data from DC to infinity Hz. Fortunately, a very accurate Time Domain response can be obtained with bandwidth-limited data, such as measured with modern network analyzer.

The Time Domain responses were generated using Keysight ADS 2017. This tool has a transient convolution simulator, which can generate a Time Domain response directly from measured S-Parameters. An example of a similar methodology is provided in the Samtec Technical Note on domain transformation.
http://www.samtec.com/Technical_Library/reference/articles/pdfs/tech-note_using-PLTS-for-time-domain-data_web.pdf

Impedance (TDR)
A step pulse is applied to the touchstone model of the connector and the reflected voltage is monitored. The reflected voltage is converted to a reflection coefficient and then transformed into an impedance profile. All ports of the Touchstone model are terminated in 42.5 ohms.

Propagation Delay (TDT)
The Propagation Delay is a measure of the Time Domain delay through the connector and footprint. A step pulse is applied to the touchstone model of the connector and the transmitted voltage is monitored. The same pulse is also applied to a reference channel with zero loss, and the Time Domain pulses are plotted on the same graph. The difference in time, measured at the 50% point of the step voltage is the propagation delay.

Series: HDTF-RA / HDTM
Description: XCede® HD 1.80 mm Backplane Connector, 6-Pair, 85-ohm HS Wafer

Appendix F – Glossary of Terms

ADS – Advanced Design Systems
FD – Frequency domain
FEXT – Far-End Crosstalk
GSG – Ground–Signal-Ground; geometric configuration
GSSG - Ground–Signal-Signal-Ground; geometric configuration
NEXT – Near-End Crosstalk
PCB – Printed Circuit Board
SE – Single-Ended
SI – Signal Integrity
SOLT – acronym used to define Short, Open, Load & Thru Calibration Standards
TD – Time Domain
TDA – Time Domain Analysis
TDR – Time Domain Reflectometry
TDT – Time Domain Transmission
Z – Impedance (expressed in ohms)

Samtec Inc.
520 Park East Blvd.
New Albany IN 47151-1147 USA

WWW.SAMTEC.COM
1-800-SAMTEC-9 (US & Canada)
SIG@samtec.com

Phone: 812-944-6733
Fax: 812-948-5047
Report Revision: 11/20/2020