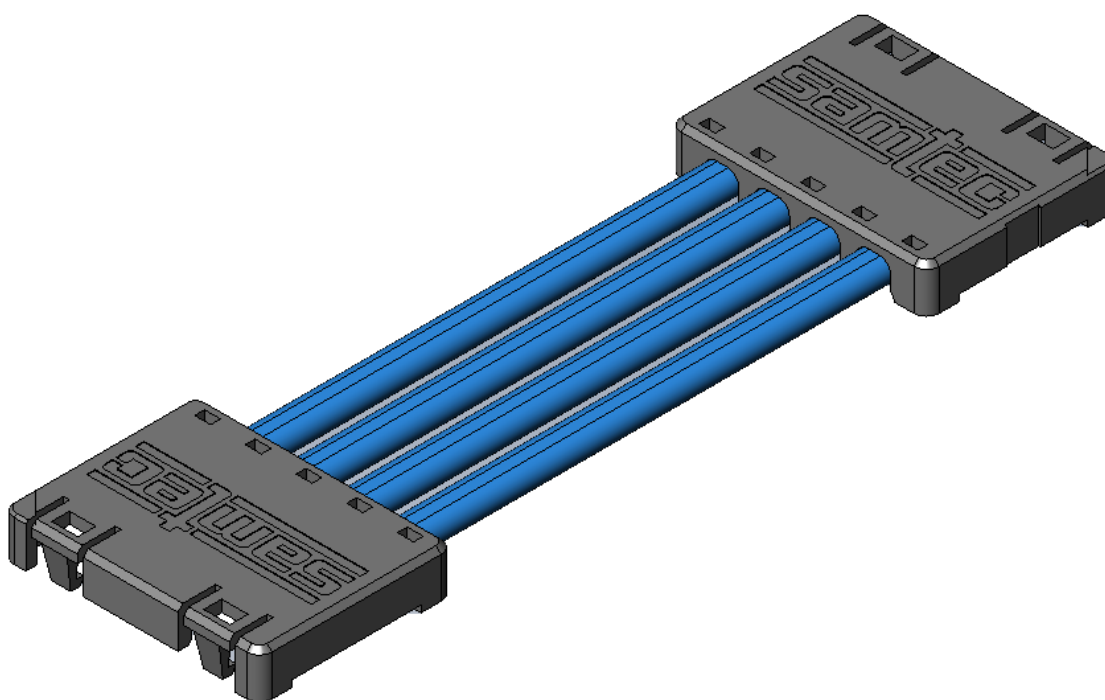




High Speed Characterization Report

DCH-04-XX.X-T-PF-1-4



Description:

**High-Speed Press-Fit Cable Assembly,
2.00 mm Pitch, 30 AWG Twinax Cable**

Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

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Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Cable Assembly Overview

The 2.00 mm (.0787") DCH Cable Assembly is constructed using Samtec 30 AWG, 100 Ω twinax ribbon cable. There is a small transition board with high retention press-fit termination mounted at each end. The DCH is available in 4 differential pair and 8 differential pair versions. The DCH-04-XX.X-T-PF-1-4 cable assembly is wired to facilitate a Pin 1 to Pin N mapping between the cable ends. The data in this report is applicable to 9.80 inch, 19.7 inch and 39.4 inch long cable assemblies.

Each DCH assembly was tested by pressing it into a test board at each end. One sample of each assembly was tested. The actual part numbers that were tested are shown in Table 1, which also identifies End 1 and End 2 of each assembly. A relative sample figure is shown in Figure1. Four pairs, called TX1-to-RX1, TX2-to-RX2, TX3-to-RX3 and TX4-to-RX4, of each assembly type were tested.

Length	Part Number	End 1	End 2
9.8 inches	DCH-04-09.8-T-PF-1-4	TX	RX
19.7 inches	DCH-04-19.7-T-PF-1-4	TX	RX
39.4 inches	DCH-04-39.4-T-PF-1-4	TX	RX

Table 1: Sample Description

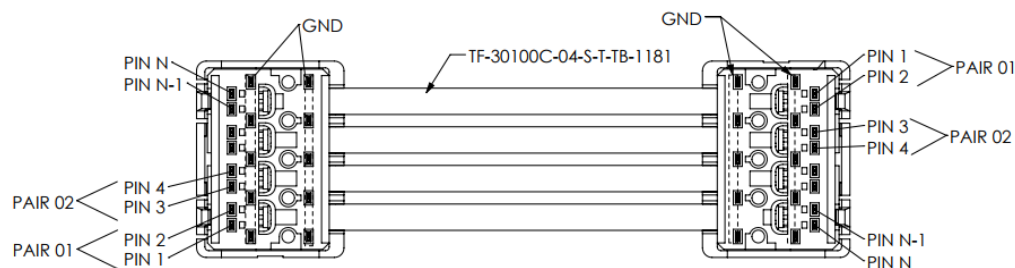


Figure 1: Test Sample

Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Cable Assembly Bandwidth

The cable assembly bandwidth is based on the -7 dB insertion loss point of the mated cable assembly. The -7 dB point can be used to estimate usable system bandwidth in a typical two-level signaling environment. Modern high-speed digital transceivers can accommodate roughly 9 dB of loss and still operate reliably. The -7 dB rating is a conservative number that allocates 2 dB of system budget for other channel components such as short PCB traces and IC packaging effects.

To calculate the Speed Rating, the measured -7 dB point is rounded up to the nearest half-GHz level. The up-rounding corrects for any loss from the test board traces. The following table summarizes the Cable Assembly Bandwidth for the DCH cable assemblies tested.

Assembly		-7 dB Frequency
DCH-04-09.8-T-PF-1-4	TX1-RX1	27.5 GHz
	TX2-RX2	26.5 GHz
	TX3-RX3	26.5 GHz
	TX4-RX4	27.0 GHz
DCH-04-19.7-T-PF-1-4	TX1-RX1	26.0 GHz
	TX2-RX2	25.5 GHz
	TX3-RX3	25.5 GHz
	TX4-RX4	26.0 GHz
DCH-04-39.4-T-PF-1-4	TX1-RX1	20.0 GHz
	TX2-RX2	20.0 GHz
	TX3-RX3	20.0 GHz
	TX4-RX4	20.0 GHz

Table 2: Cable Assembly Bandwidth

Series: DCH

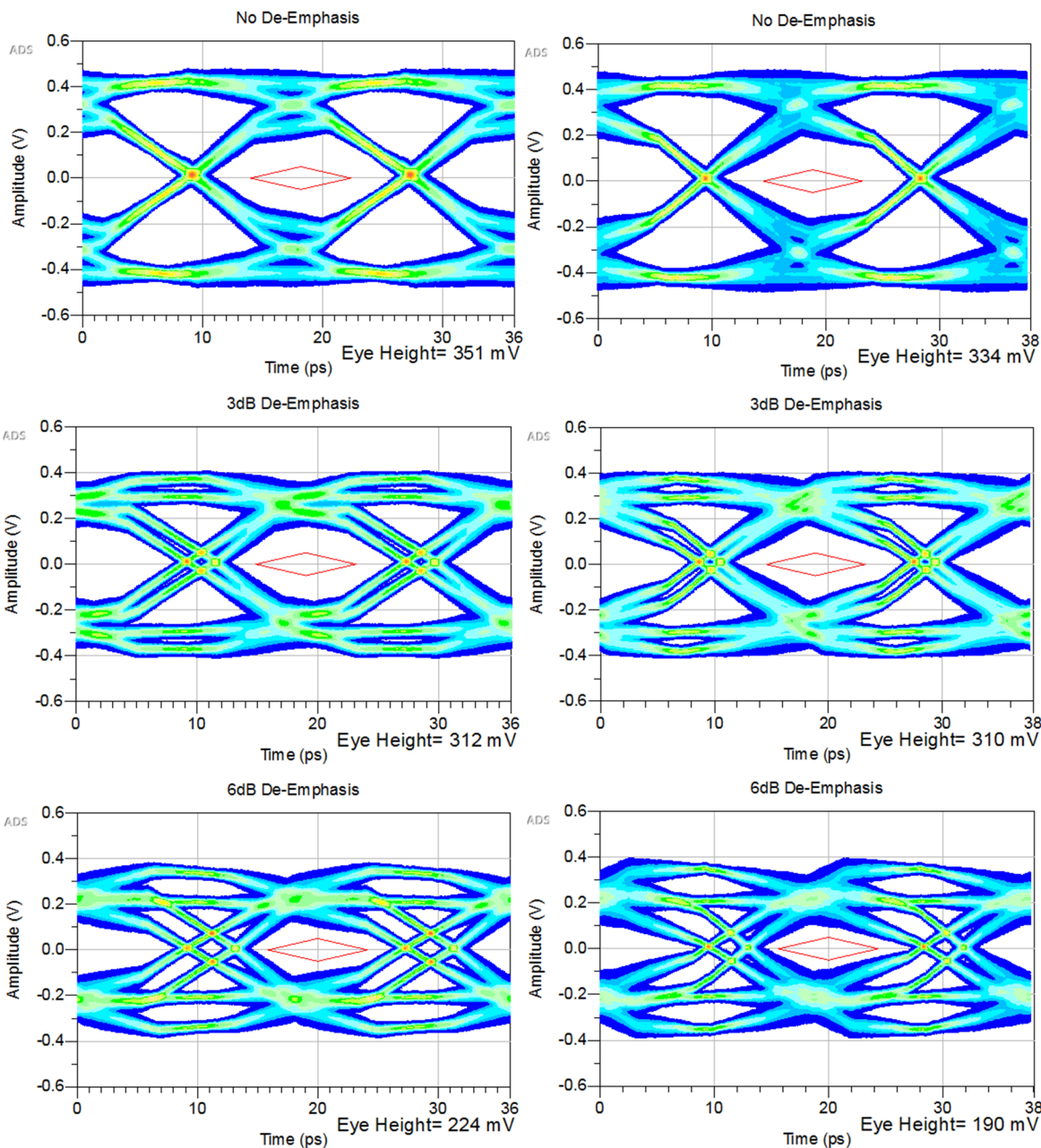
Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Eye Pattern Summary

DCH-04-09.8-T-PF-1-4
Differential

TX1/RX1 Output Eye: 55 Gbps

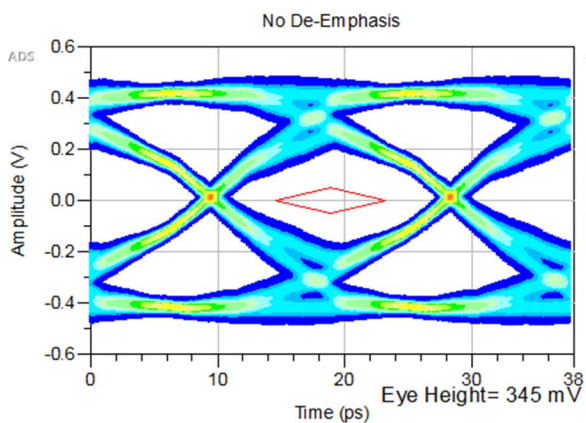
TX2/RX2 Output Eye: 53 Gbps



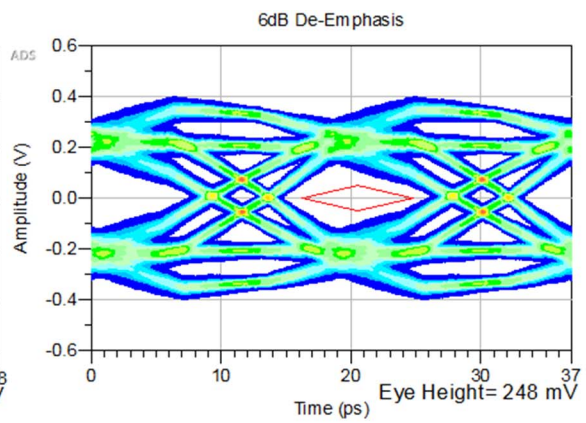
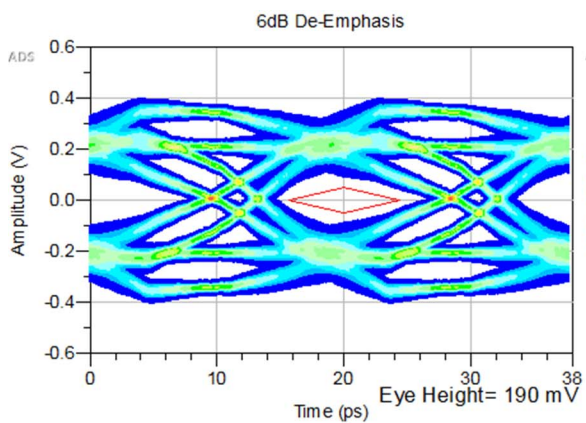
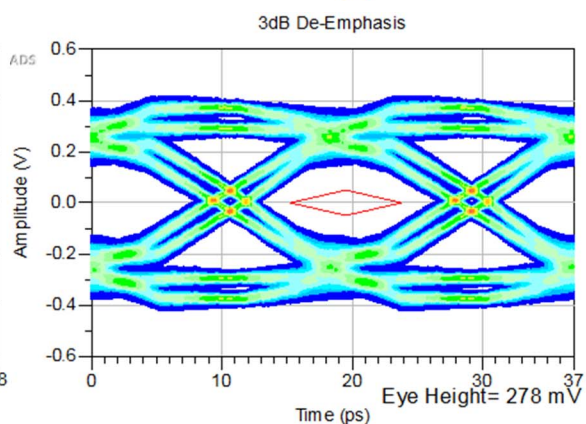
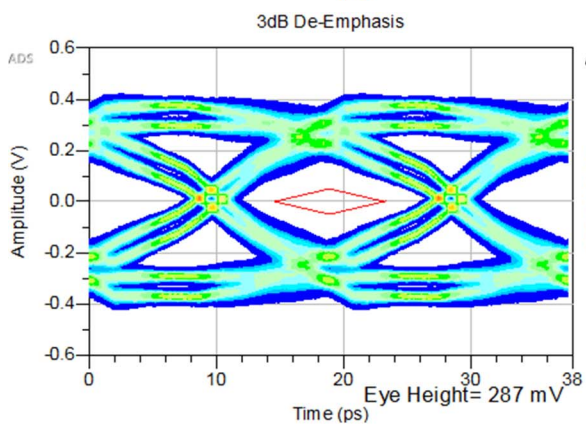
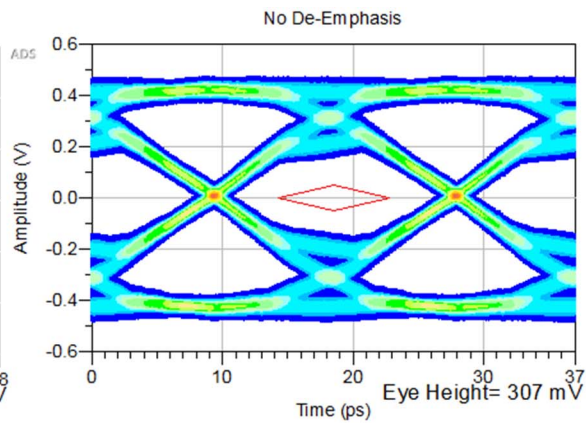
Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

TX3/RX3 Output Eye: 53 Gbps



TX4/RX4 Output Eye: 54 Gbps



Series: DCH

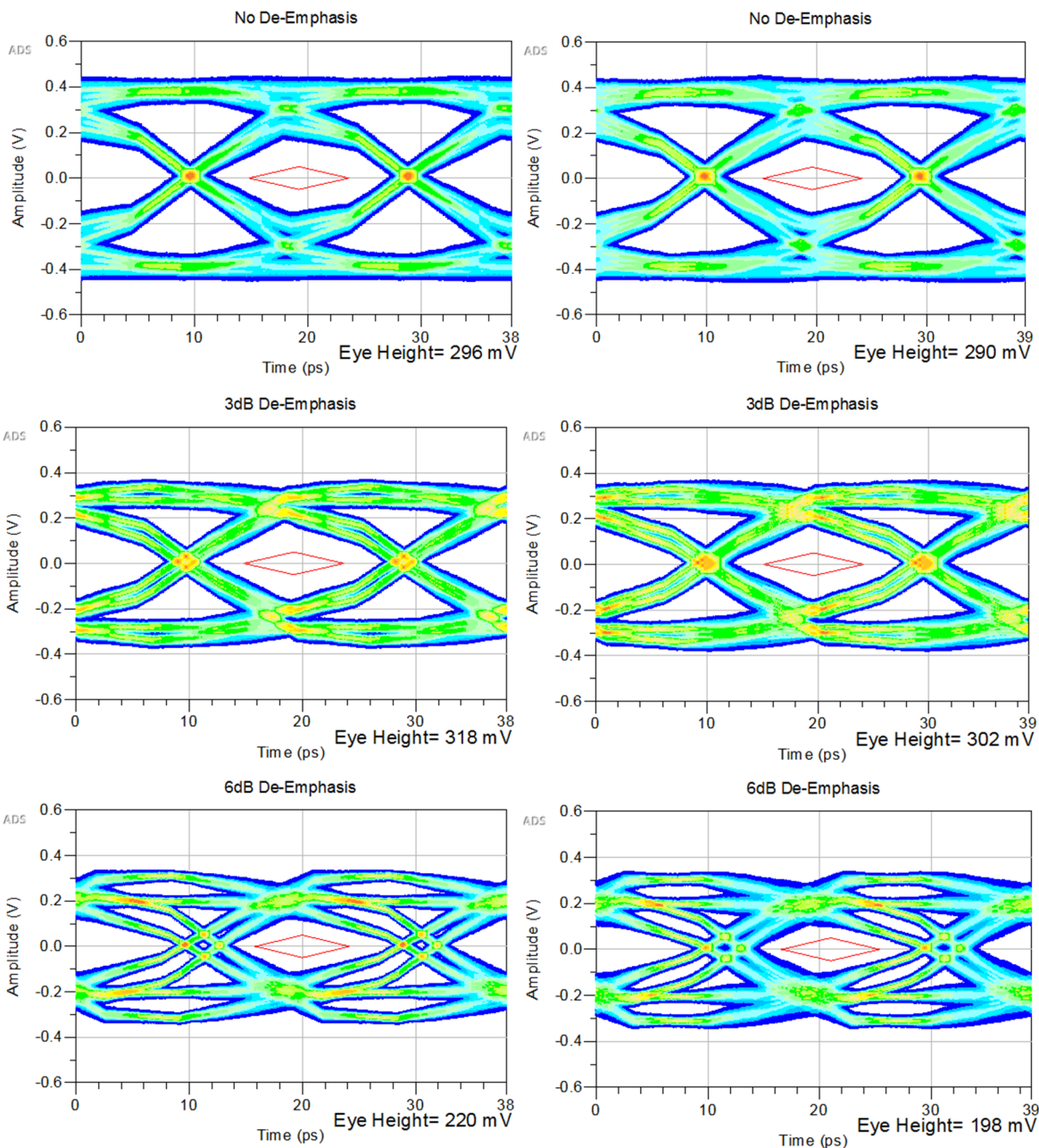
Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

DCH-04-19.7-T-PF-1-4

Differential

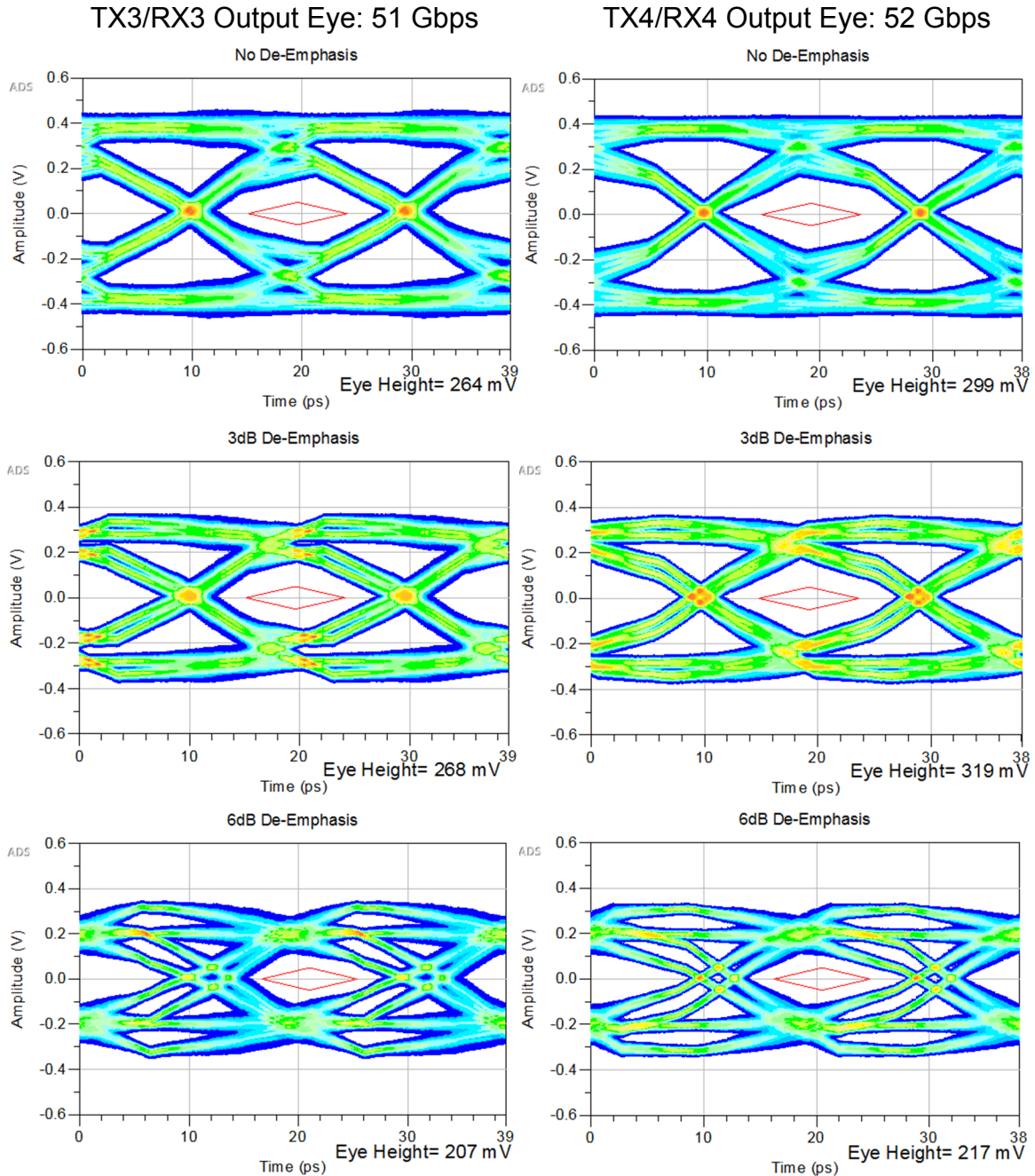
TX1/RX1 Output Eye: 52 Gbps

TX2/RX2 Output Eye: 51 Gbps



Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly



Series: DCH

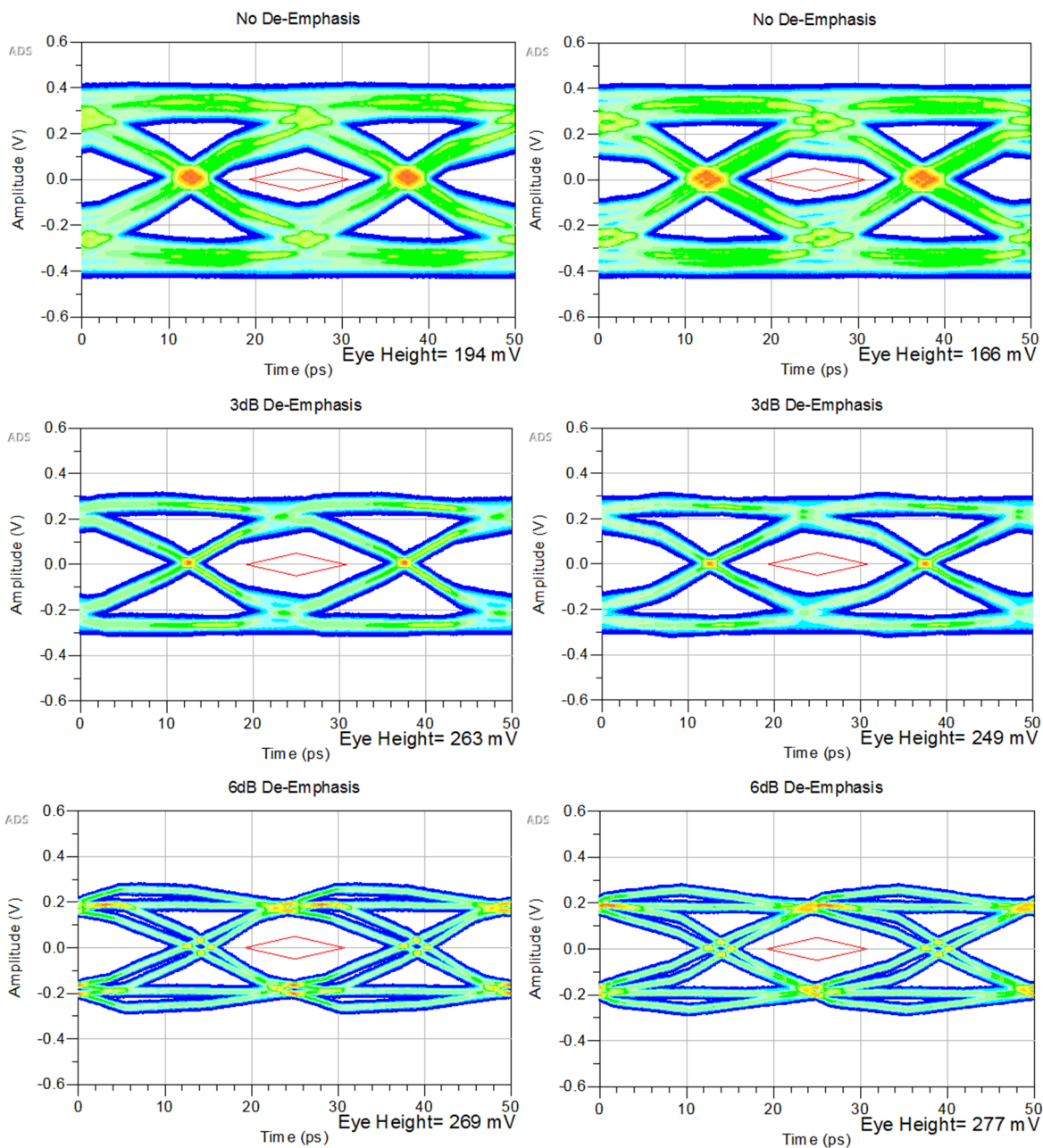
Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

DCH-04-39.4-T-PF-1-4

Differential

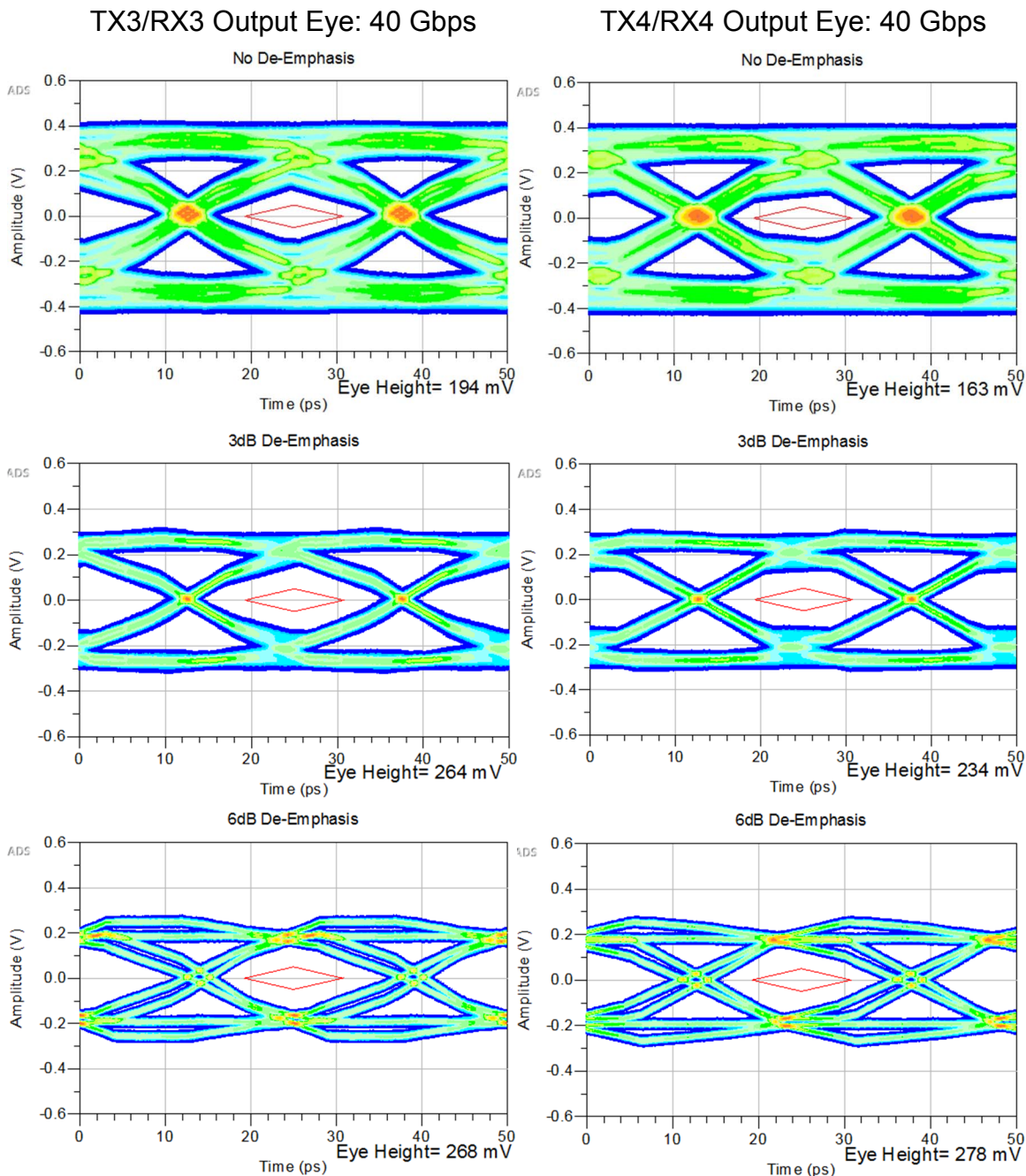
TX1/RX1 Output Eye: 40 Gbps

TX2/RX2 Output Eye: 40 Gbps



Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly



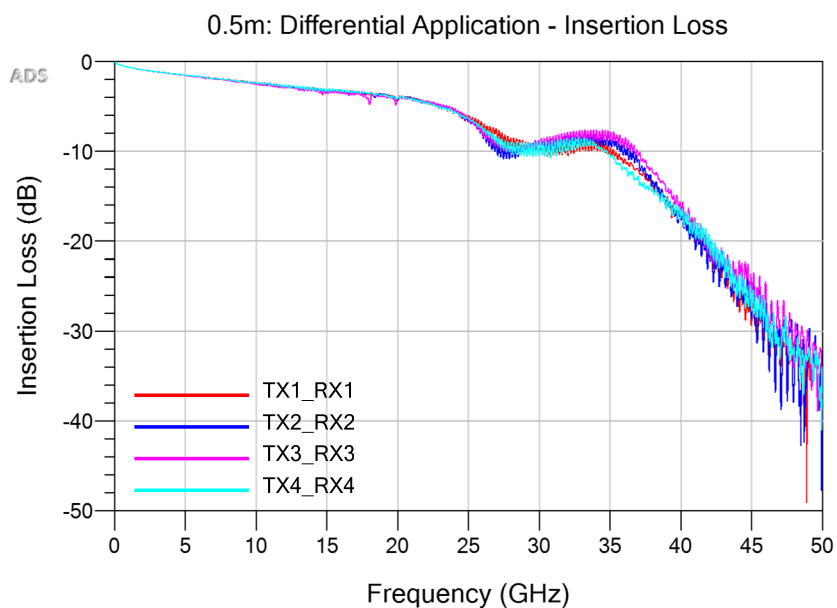
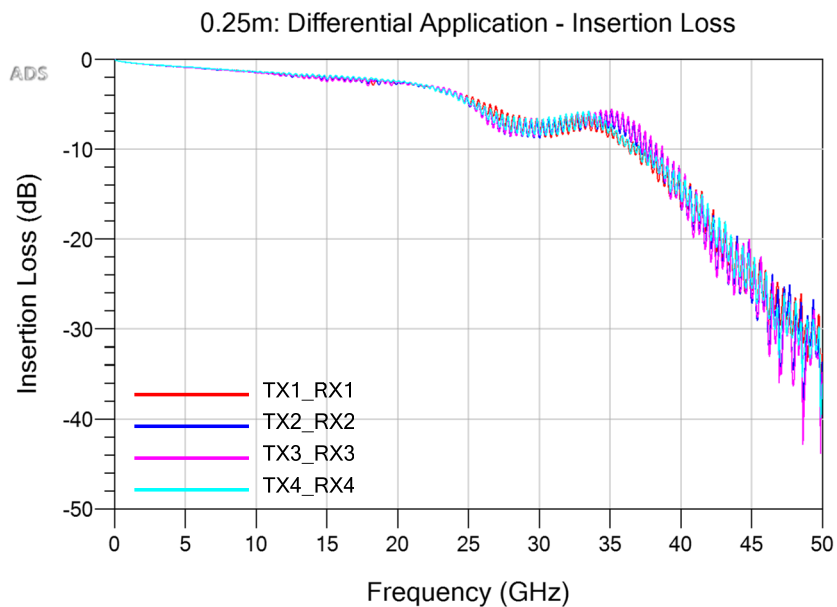
Series: DCH

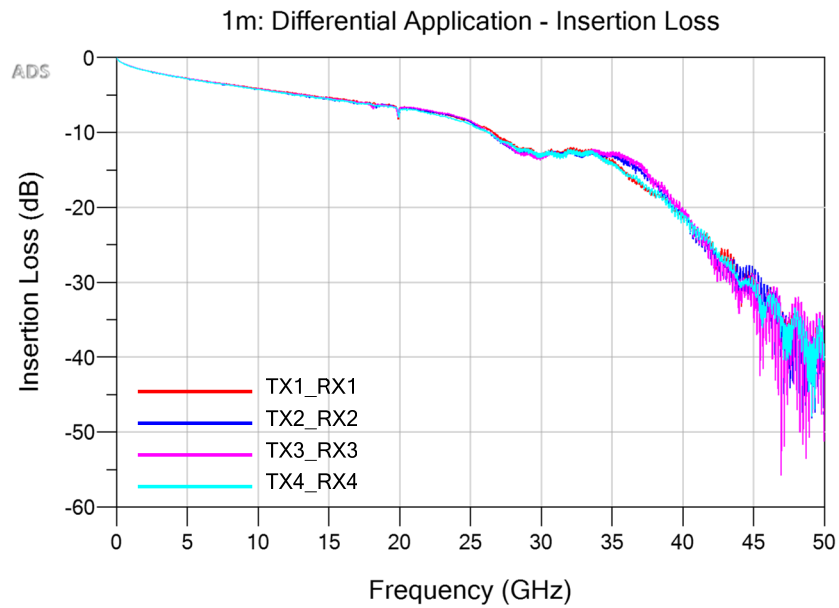
Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Frequency Domain Data Summary

Table 3 - Differential Connector System Performance

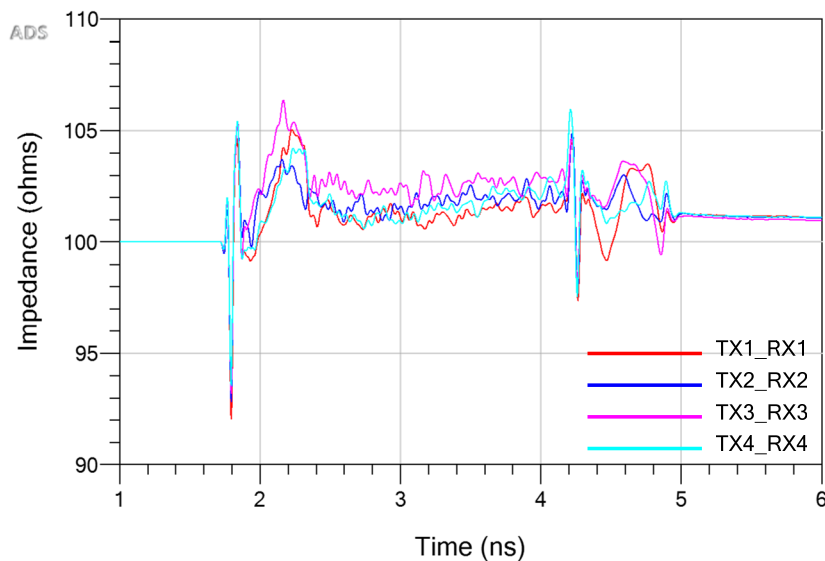
Test Parameter	Configuration	Driver	Receiver	0.25m	0.5m	1m
Insertion Loss	Channel 1	TX1	RX1	7dB@ 27.5 GHz	7dB@ 25.7 GHz	7dB@ 19.8 GHz
	Channel 2	TX2	RX2	7dB@ 26.3 GHz	7dB@ 25.4 GHz	7dB@ 19.8 GHz
	Channel 3	TX3	RX3	7dB@ 26.3 GHz	7dB@ 25.4 GHz	7dB@ 19.8 GHz
	Channel 4	TX4	RX4	7dB@ 26.8 GHz	7dB@ 25.6 GHz	7dB@ 19.8 GHz
Return Loss	Channel 1	TX1	TX1	>10dB to 14.6 GHz	>10dB to 14.6 GHz	>10dB to 24.0 GHz
	Channel 2	TX2	TX2	>10dB to 18.6 GHz	>10dB to 23.5 GHz	>10dB to 25.5 GHz
	Channel 3	TX3	TX3	>10dB to 14.6 GHz	>10dB to 14.5 GHz	>10dB to 25.5 GHz
	Channel 4	TX4	TX4	>10dB to 22.6 GHz	>10dB to 23.1 GHz	>10dB to 25.4 GHz
Near-End Crosstalk	Channel 1-2	TX1	TX2	<-20dB to 27.3 GHz	<-20dB to 27.5 GHz	<-20dB to 50 GHz
	Channel 1-3	TX1	TX3	<-20dB to 50 GHz	<-20dB to 50 GHz	<-20dB to 50 GHz
	Channel 1-4	TX1	TX4	<-20dB to 50 GHz	<-20dB to 50 GHz	<-20dB to 50 GHz
	Channel 2-3	TX2	TX3	<-20dB to 27.3 GHz	<-20dB to 27.1 GHz	<-20dB to 27.8 GHz
	Channel 2-4	TX2	TX4	<-20dB to 26.5 GHz	<-20dB to 50 GHz	<-20dB to 50 GHz
	Channel 3-4	TX3	TX4	<-20dB to 27.3 GHz	<-20dB to 27.1 GHz	<-20dB to 50 GHz
Far-End Crosstalk	Channel 1-2	TX1	RX2	<-20dB to 25.1 GHz	<-20dB to 25.4 GHz	<-20dB to 50 GHz
	Channel 1-3	TX1	RX3	<-20dB to 50 GHz	<-20dB to 50 GHz	<-20dB to 50 GHz
	Channel 1-4	TX1	RX4	<-20dB to 50 GHz	<-20dB to 50 GHz	<-20dB to 50 GHz
	Channel 2-3	TX2	RX3	<-20dB to 24.8 GHz	<-20dB to 25.0 GHz	<-20dB to 50 GHz
	Channel 2-4	TX2	RX4	<-20dB to 50 GHz	<-20dB to 50 GHz	<-20dB to 50 GHz
	Channel 3-4	TX3	RX4	<-20dB to 24.8 GHz	<-20dB to 25.0 GHz	<-20dB to 50 GHz

Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**Bandwidth Chart – Differential Insertion Loss**

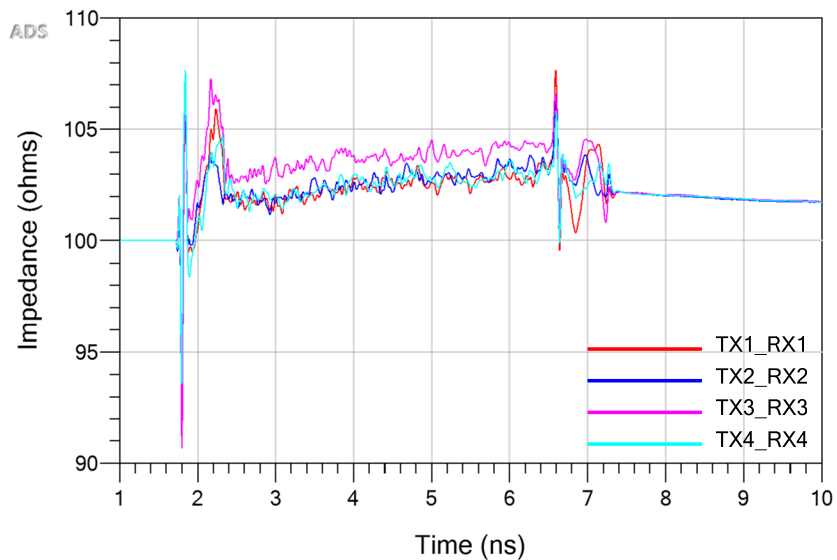
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**Time Domain Data Summary**

0.25m: Differential Application _ Impedance
0.25m: Differential Application - Impedance



0.5m: Differential Application _ Impedance
0.5m: Differential Application - Impedance



Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

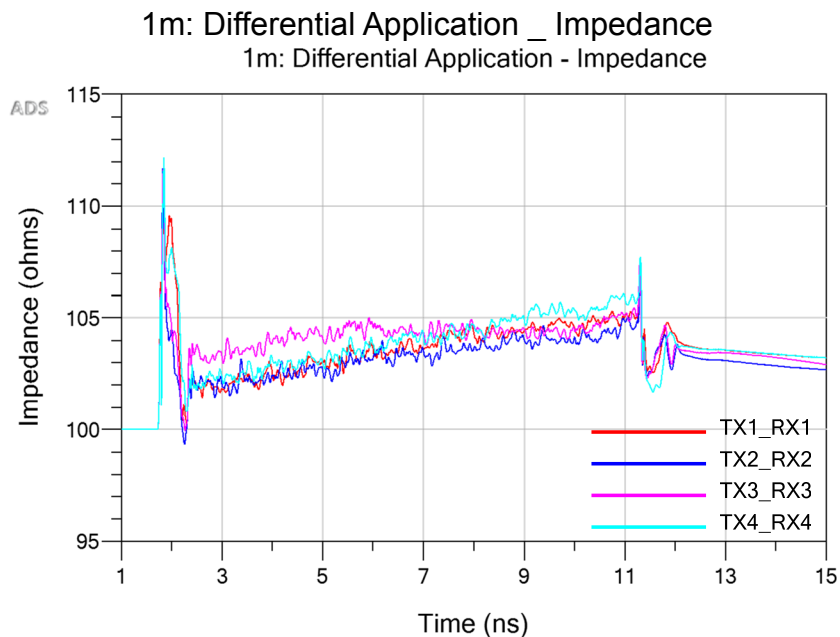


Table 4 - Propagation Delay (Cable Assembly)

Cable length	Driver/ Receiver	Driver/ Receiver	Driver/ Receiver	Driver/ Receiver
	TX1/ RX2	TX2/ RX2	TX3/ RX3	TX4/ RX4
0.25m	1.283ns	1.282ns	1.280ns	1.280ns
0.5m	2.474ns	2.474ns	2.471ns	2.474ns
1m	4.840ns	4.836ns	4.833ns	4.837ns

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Characterization Details

This report presents data that characterizes the signal integrity response of a cable assembly 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 cable assembly 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 cable assembly'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 cable assemblies 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 "GSSG" differential drive configuration only.

Cable assembly Signal to Ground Ratio

Samtec cable assemblies 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 cable assemblies, a ground plane or blade, or an outer shield, is used as the signal return, while in others, cable assembly 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 cable assembly. Therefore, care must be taken when choosing signal/ground ratios in cost or density-sensitive applications.

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

For this cable assembly, the following array configurations are evaluated:

Differential Impedance:

- TX1/RX1
- TX2/RX2
- TX3/RX3
- TX4/RX4

Differential Crosstalk:

- TX1 to TX2, TX1 to TX3, TX1 to TX4, TX2 to TX3, TX2 to TX4, TX3 to TX4
- TX1 to RX2, TX1 to RX3, TX1 to RX4, TX2 to RX3, TX2 to RX4, TX3 to RX4

See Appendix D – Product and Test System Descriptions for details

Just one differential pair were driven for crosstalk measurements.

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 cable assembly than at the driver launch point. To estimate interconnect performance at other edge rates, data is provided for several rise times between 30ps and 500ps.

Unless otherwise stated, measured rise times were at 10%-90% signal levels.

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Eye Diagram Data

Eye patterns are a time domain characterization of system level performance. Eye patterns are generated by sending continuous streams of data from a transmitter to a receiver, and overlaying the received signals upon one another. Over time, the received data builds to resemble an eye. Negative SI effects in the transmission path can cause the signal to distort, which over time, will cause the eye to “close”. Specifications, such as an eye mask template, can be placed on the amount of open area required in the eye to ensure a functional system.

An eye mask template is a representation of the receiver’s sensitivity and is often used as a metric of performance. While there are lot-to-lot and vendor-to-vendor variations in receiver sensitivity, some general guidelines can be developed. After reviewing several major industry standards (PCIe, Gigabit Ethernet) we find similar eye mask requirements and we will use these as the basis for a generic template in this report. For this report, we will assume a receiver amplitude sensitivity of 50 mVpp and a jitter margin of 0.5 UI. This results in a diamond shape eye mask template that is 50 mV high and 0.5 UI wide.

Please contact our Signal Integrity Group at sig@samtec.com for more information.

Frequency Domain Data

Frequency Domain parameters are helpful in evaluating the cable assembly 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, Near-End and Far-End Crosstalk, and Mode Conversion. 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 and signal propagation time 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 F](#) 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 cable assembly, mating connectors, and connector footprint. It also includes 3mm of

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

PCB trace on each side. Delay is measured at 100 picoseconds signal rise-time. Delay is calculated as the difference in time measured between the 50% amplitude levels of the input and output pulses.

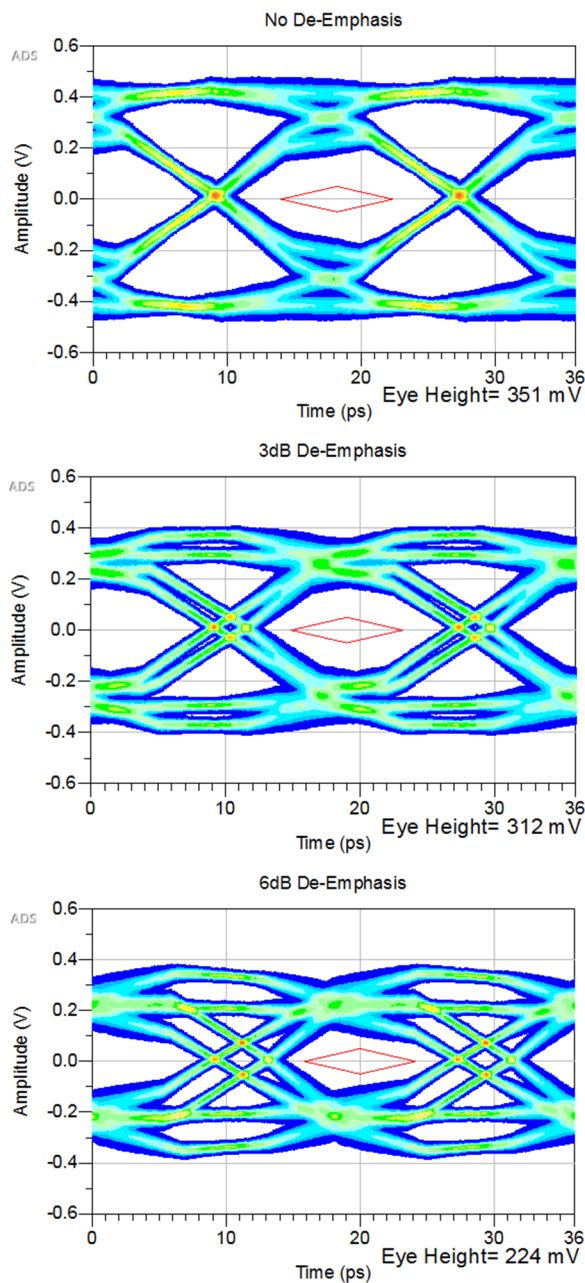
Data for other configurations may be available. Please contact our Signal Integrity Group at sig@samtec.com for further information.

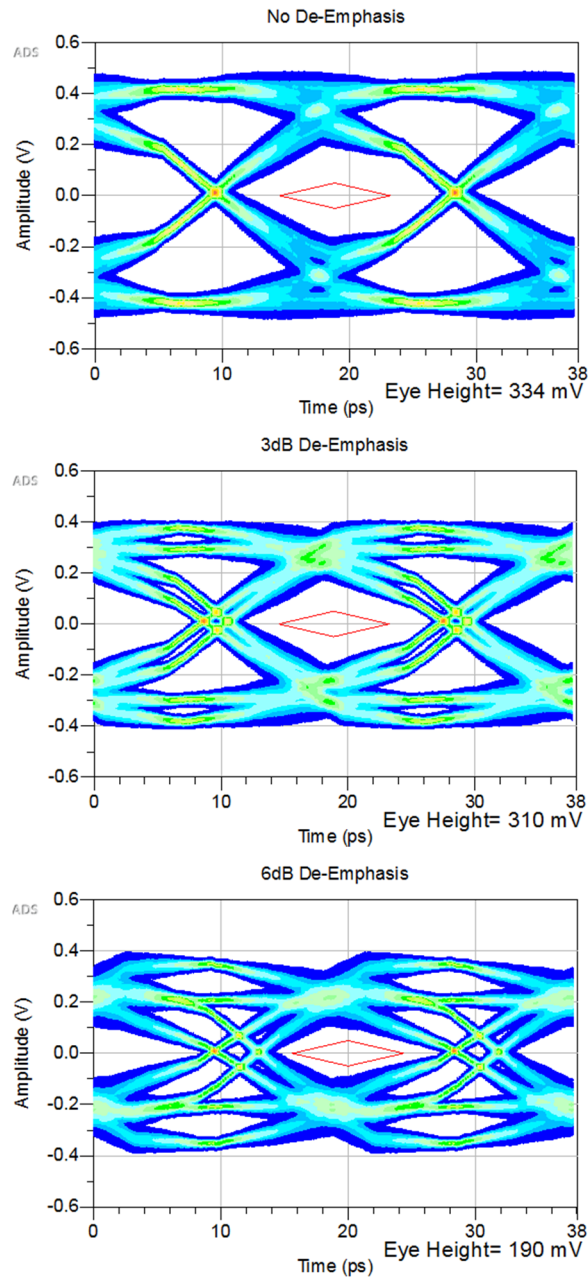
Additional information concerning test conditions and procedures is located in the appendices of this report. Further information may be obtained by contacting our Signal Integrity Group at sig@samtec.com.

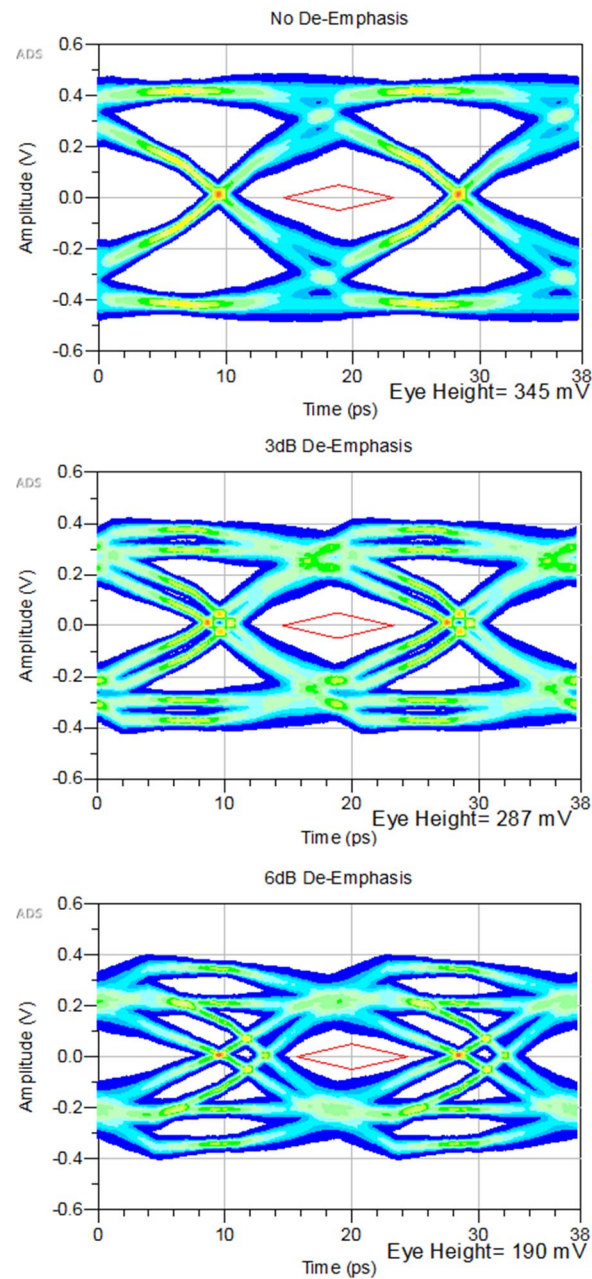
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**Appendix A – Eye Diagrams**

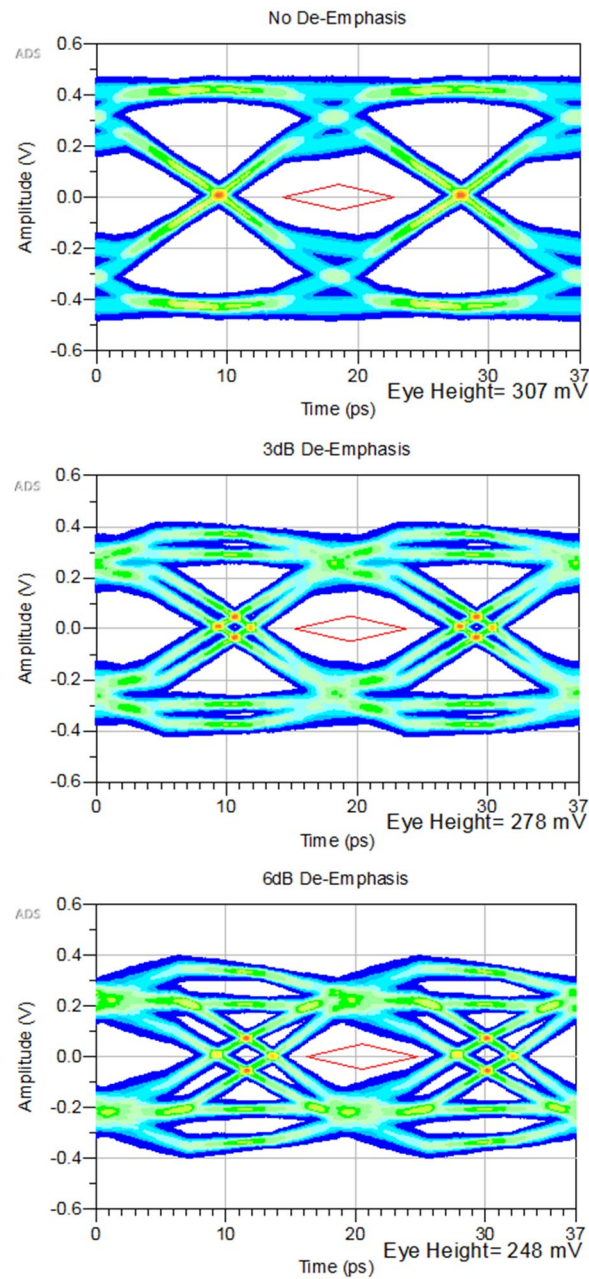
DCH-04-09.8-T-PF-1-4
Differential

55Gbps: TX1/RX1



Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**53Gbps: TX2/RX2**

Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**53Gbps: TX3/RX3**

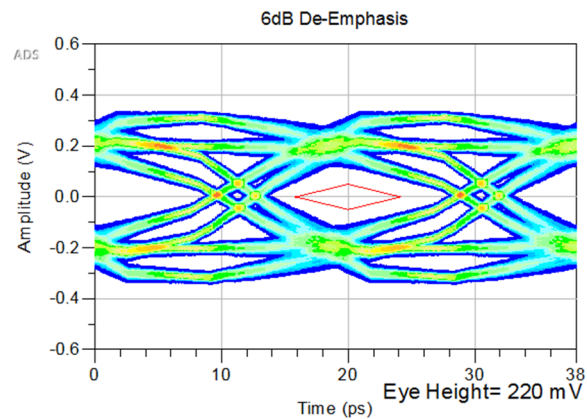
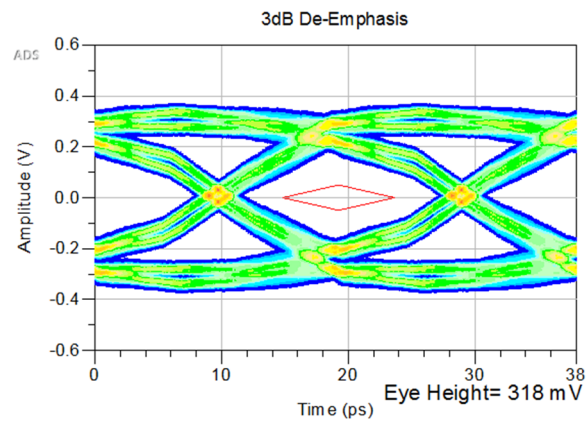
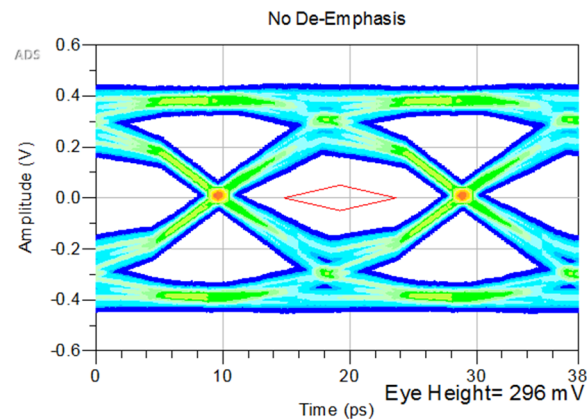
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**54Gbps: TX4/RX4**

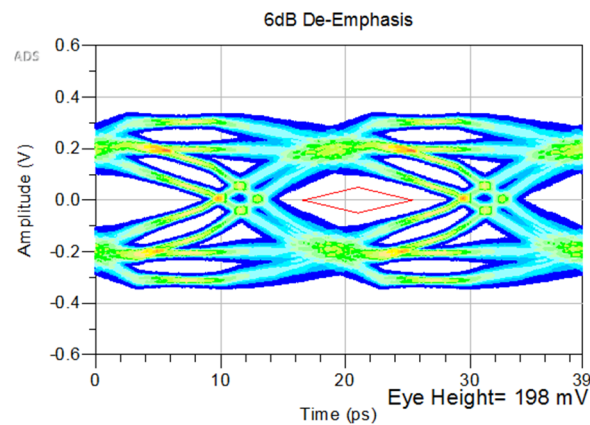
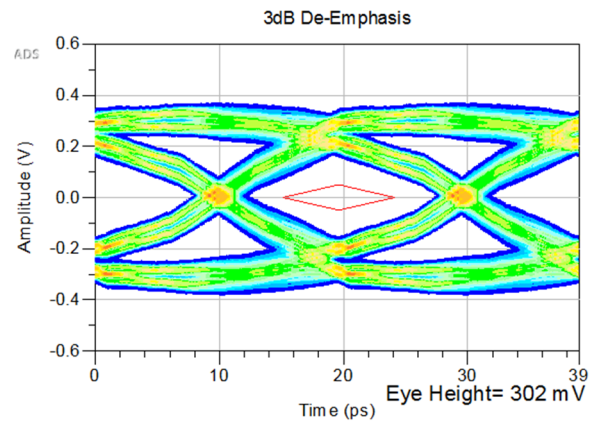
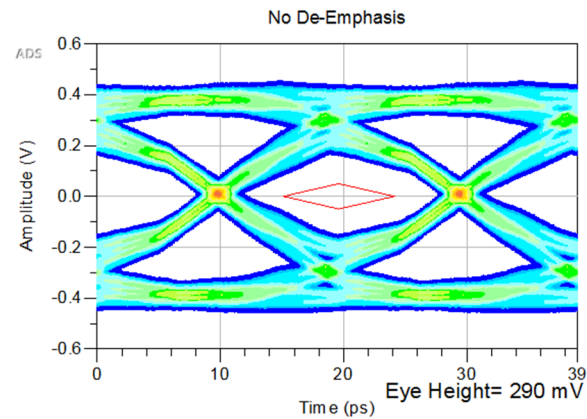
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

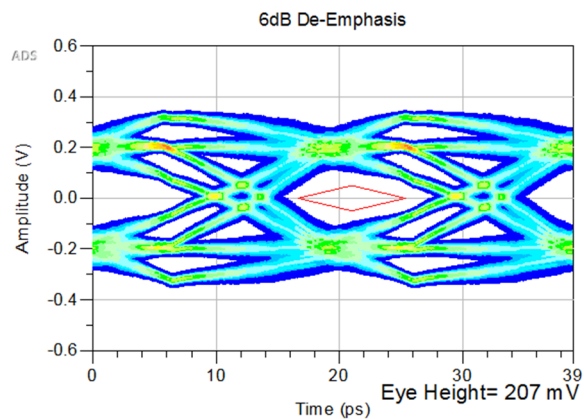
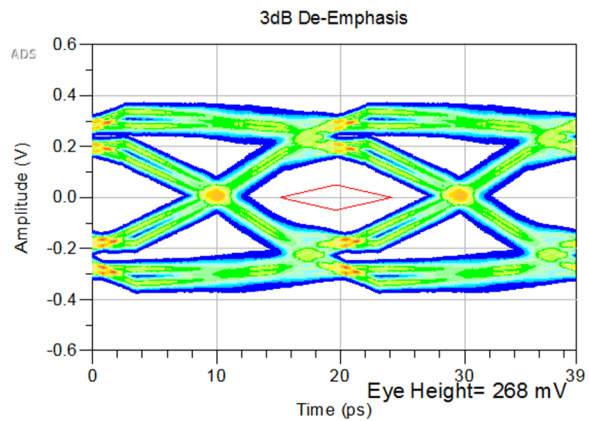
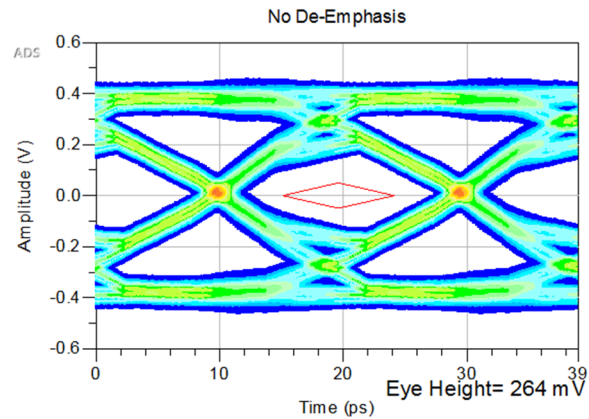
DCH-04-19.7-T-PF-1-4

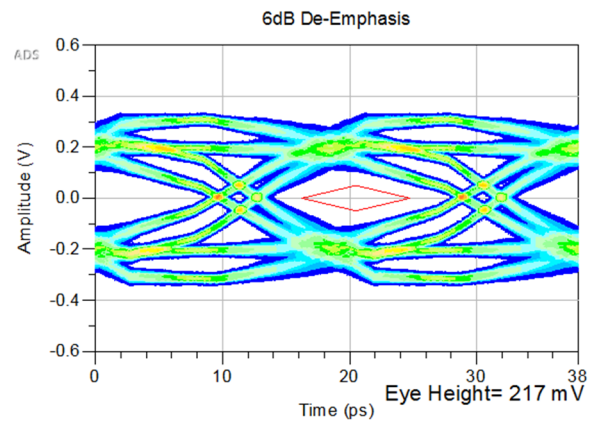
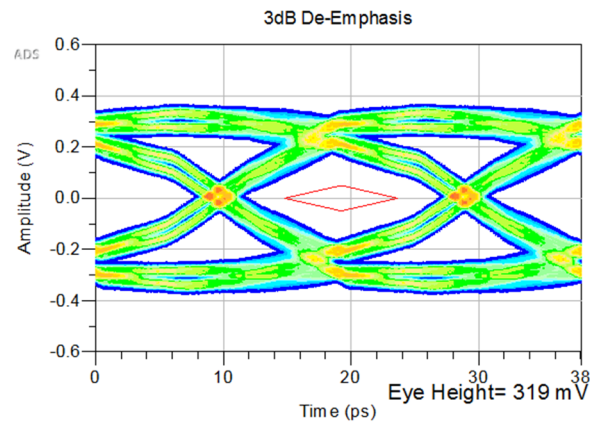
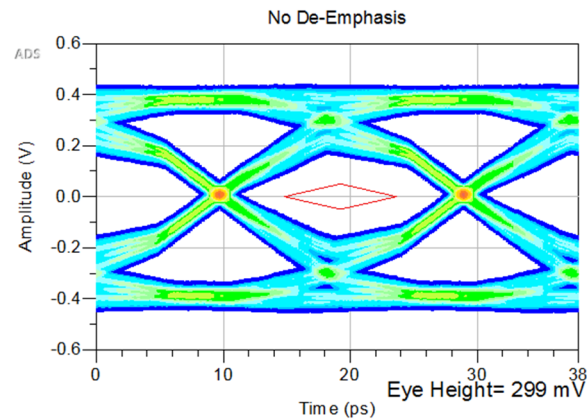
Differential

52Gbps: TX1/RX1



Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**51Gbps: TX2/RX2**

Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**51Gbps: TX3/RX3**

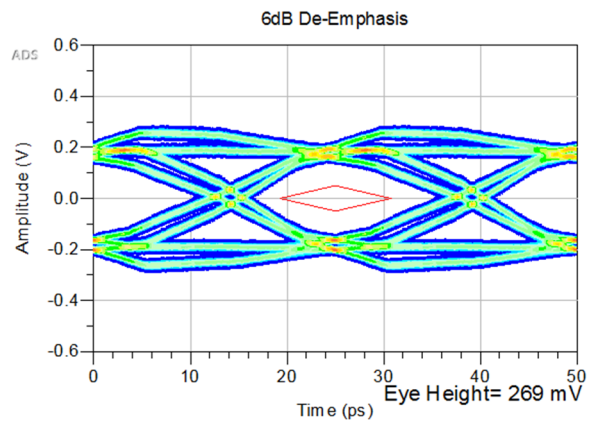
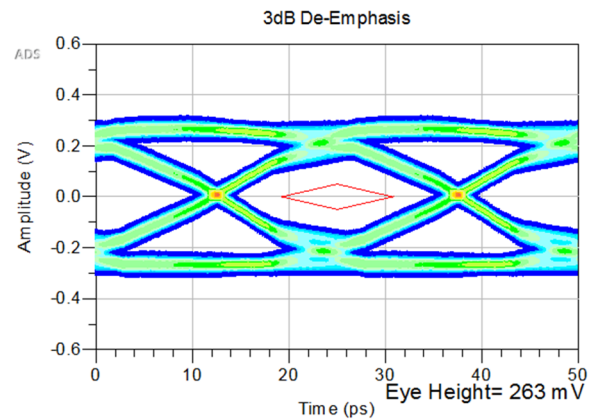
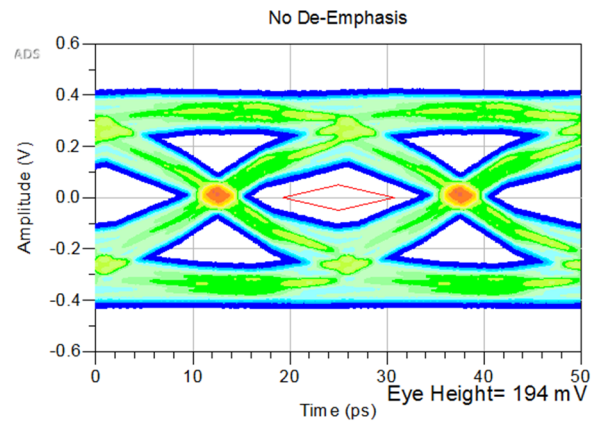
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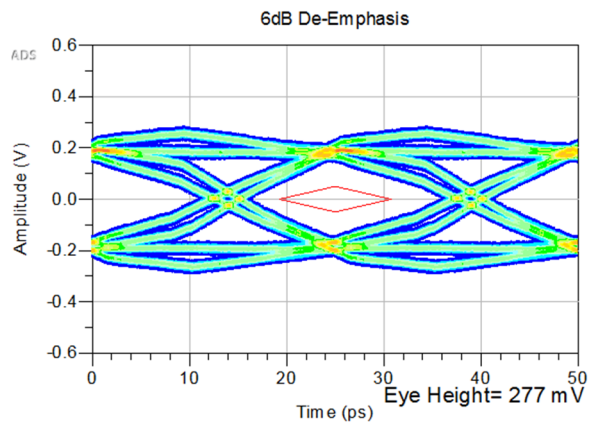
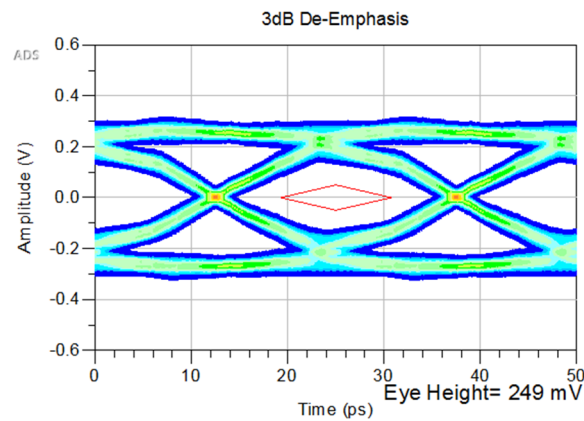
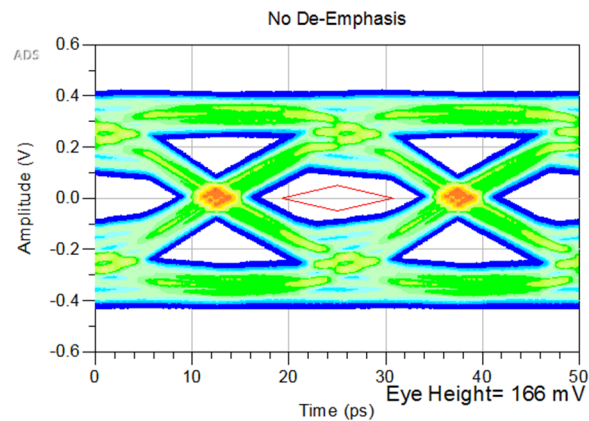
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

DCH-04-39.4-T-PF-1-4

Differential

40Gbps: TX1/RX1

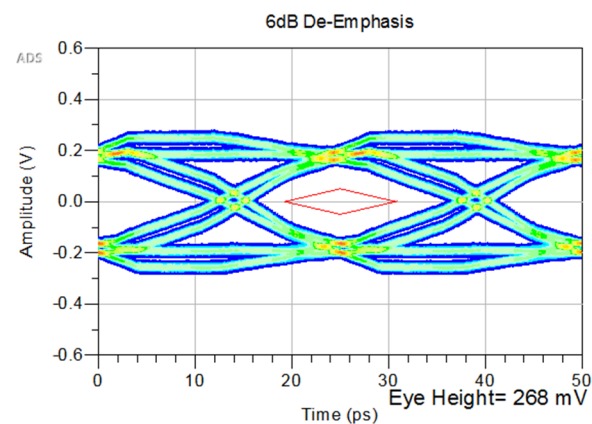
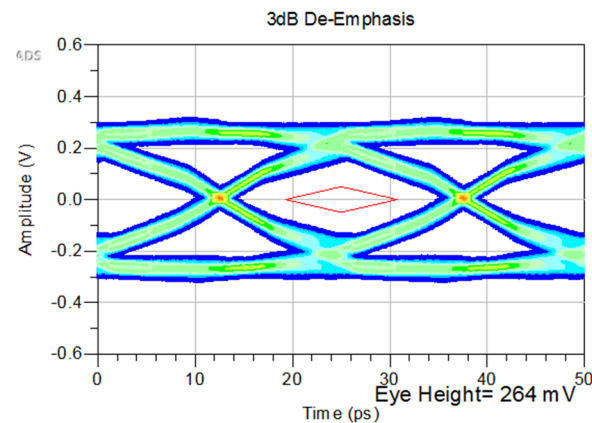
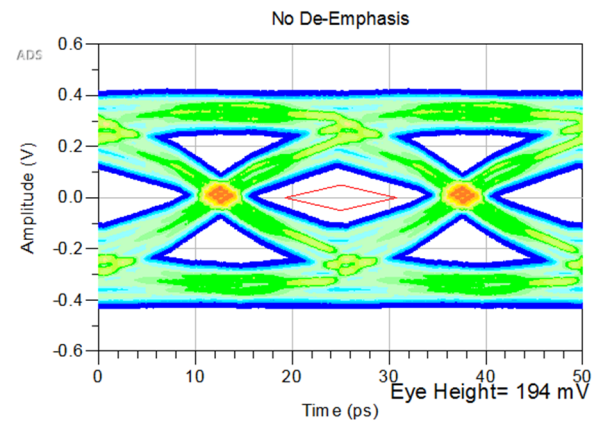


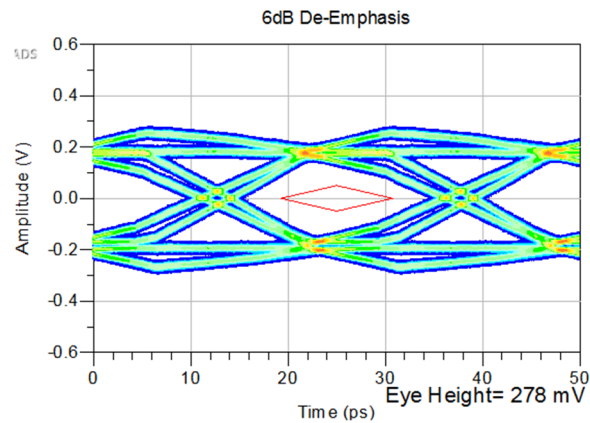
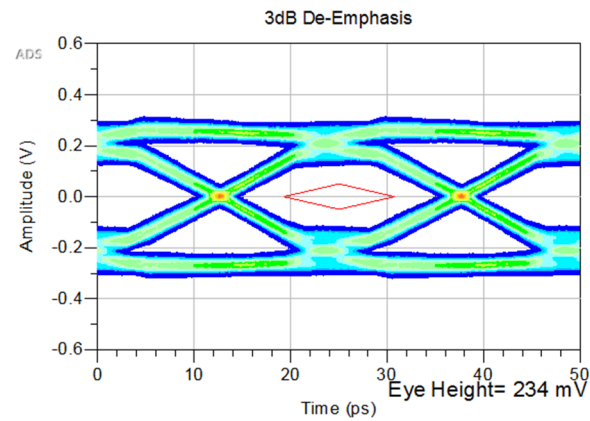
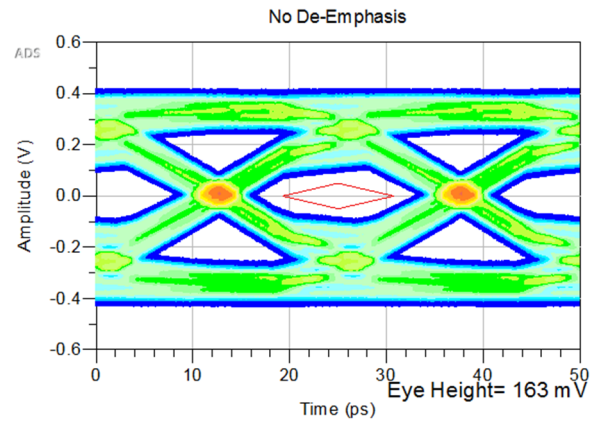
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**40Gbps: TX2/RX2**

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

40Gbps: TX3/RX3



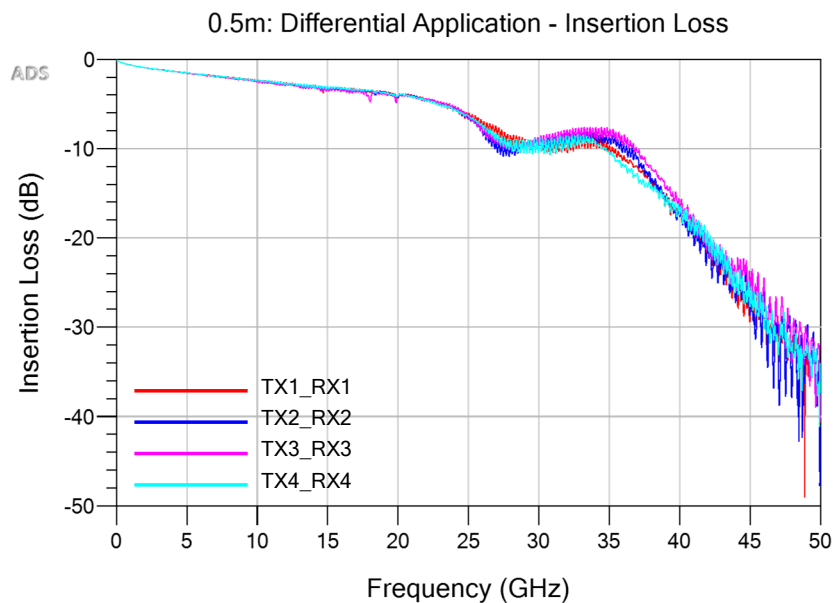
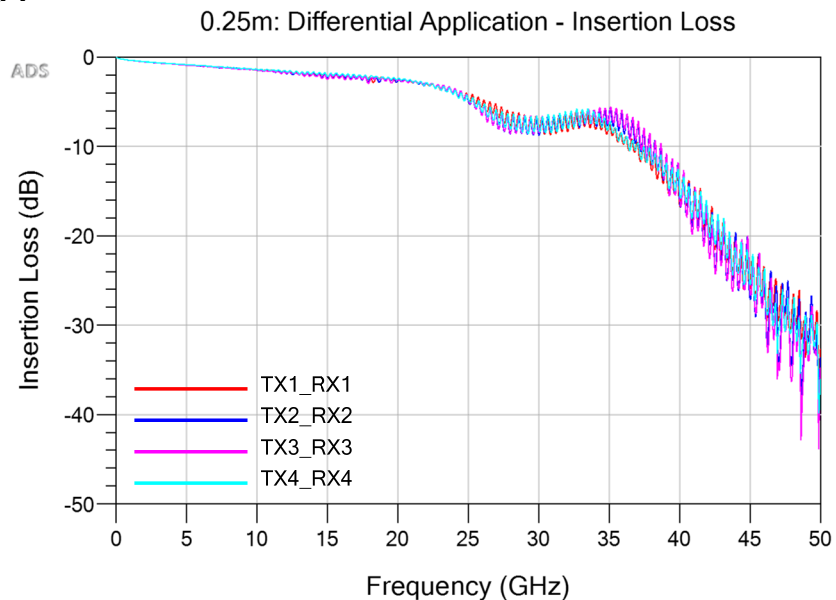
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**40Gbps: TX4/RX4**

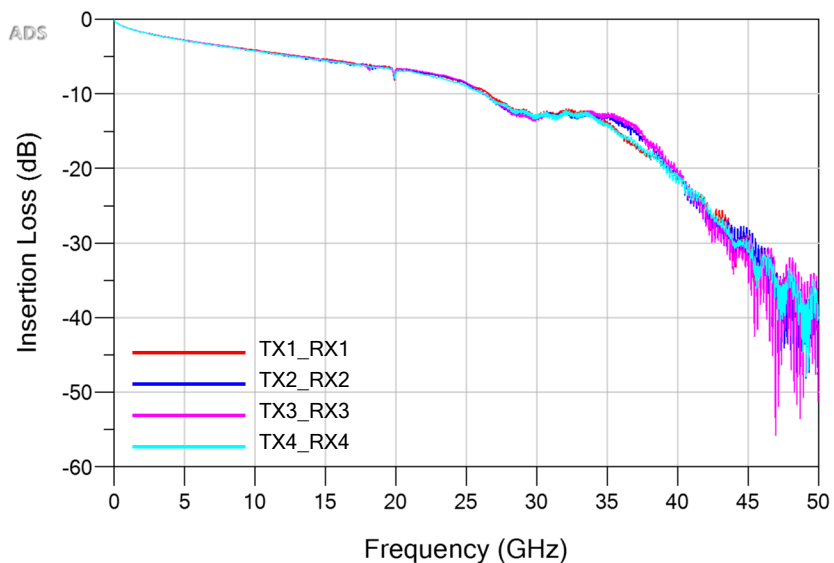
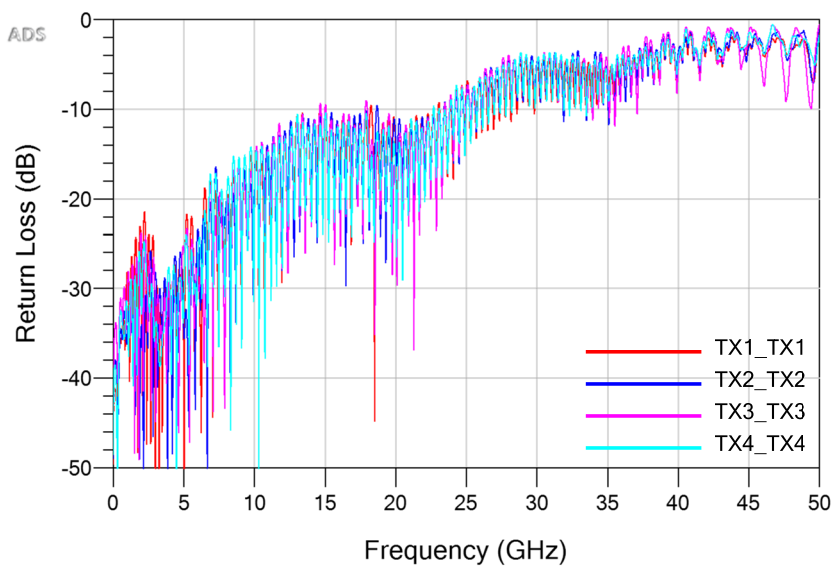
Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Appendix B – Frequency Domain Response Graphs

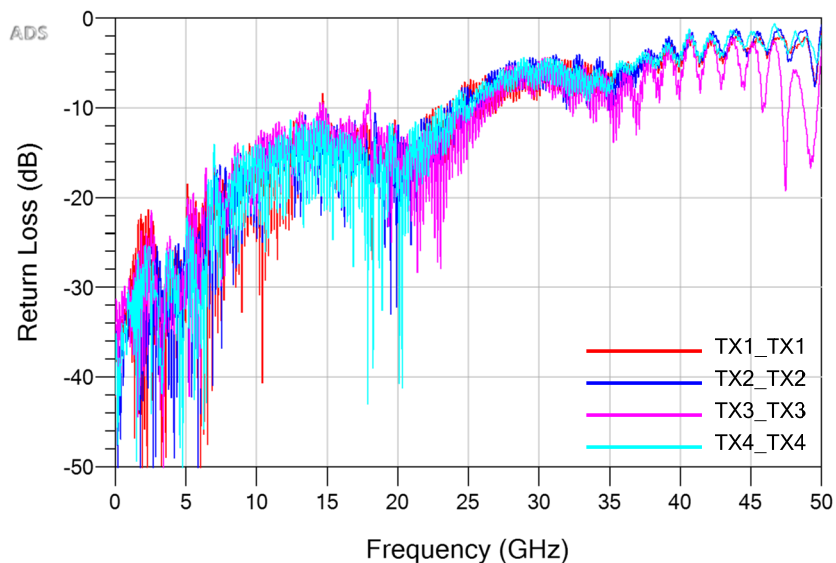
Differential Application – Insertion Loss



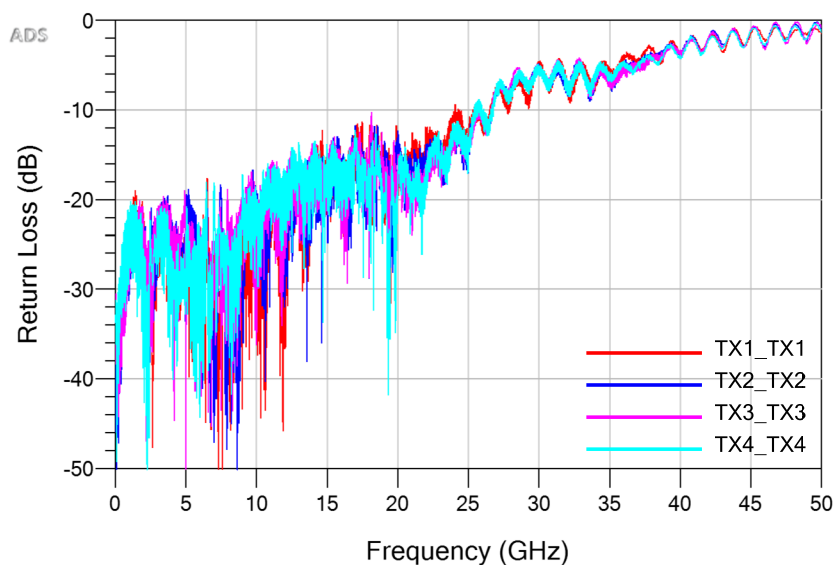
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**1m: Differential Application - Insertion Loss****Differential Application – Return Loss****0.25m: Differential Application - Return Loss**

Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

0.5m: Differential Application - Return Loss

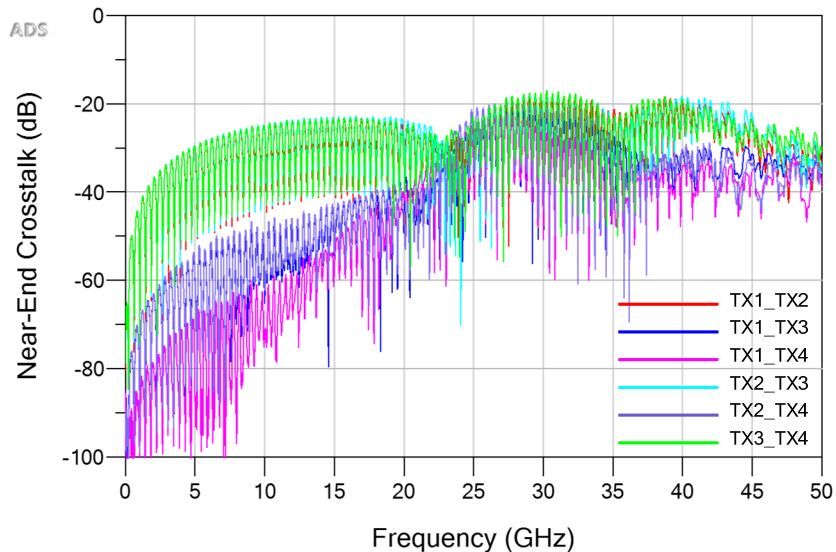


1m: Differential Application - Return Loss

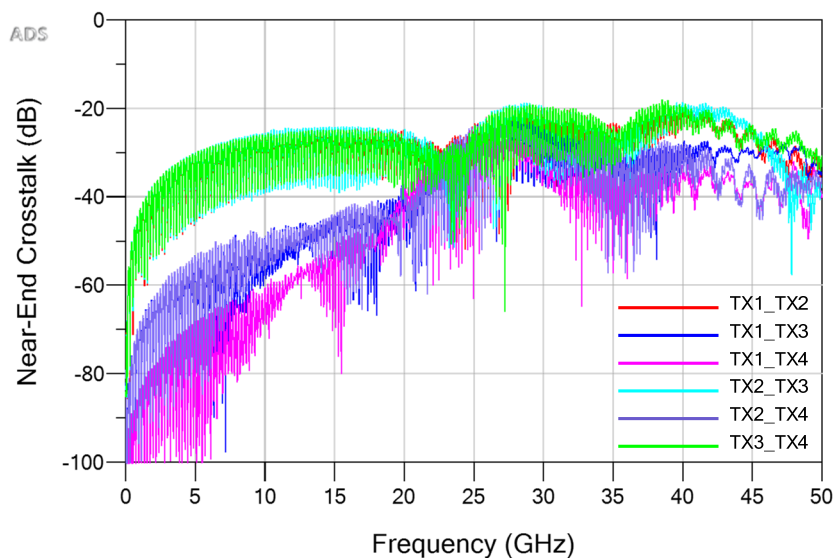


Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**Differential Application – NEXT Configurations**

0.25m: Differential Application - NEXT

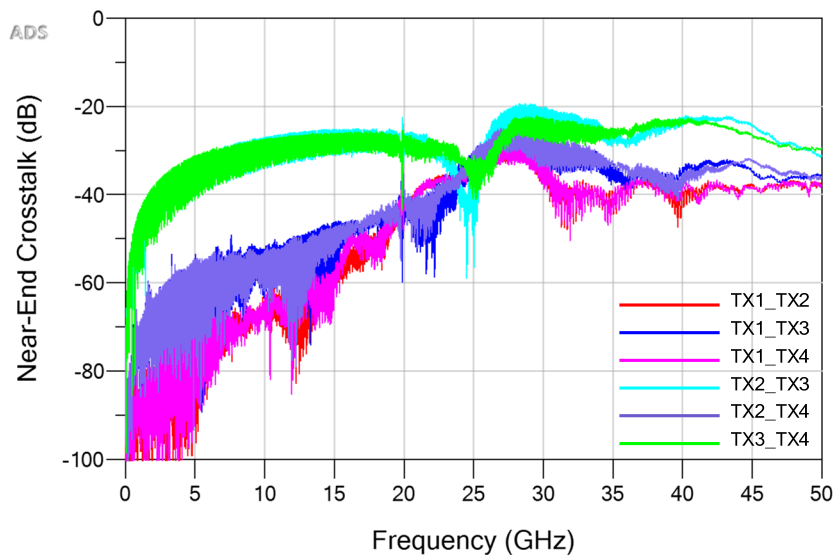


0.5m: Differential Application - NEXT

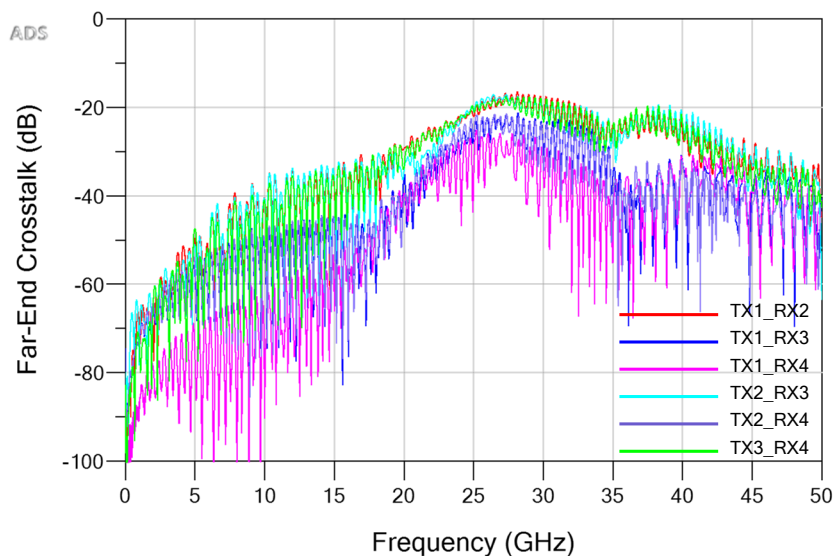


Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

1m: Differential Application - NEXT

**Differential Application – FEXT Configurations**

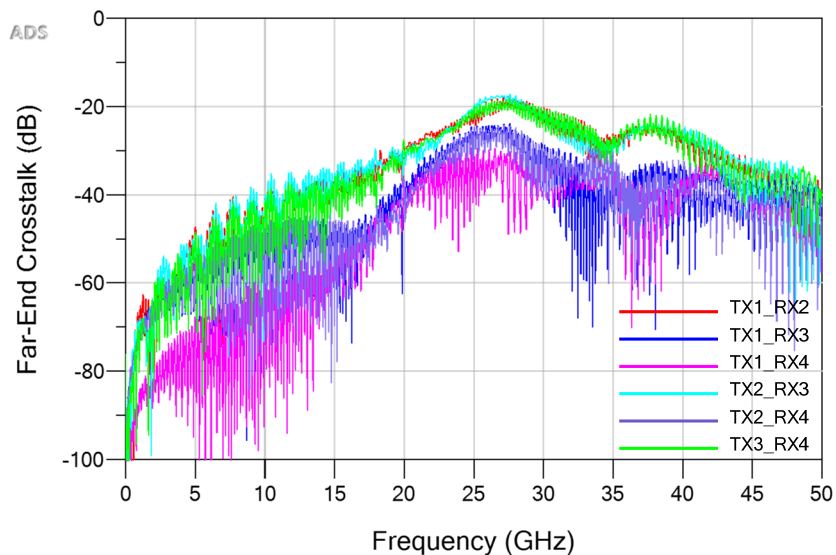
0.25m: Differential Application - FEXT



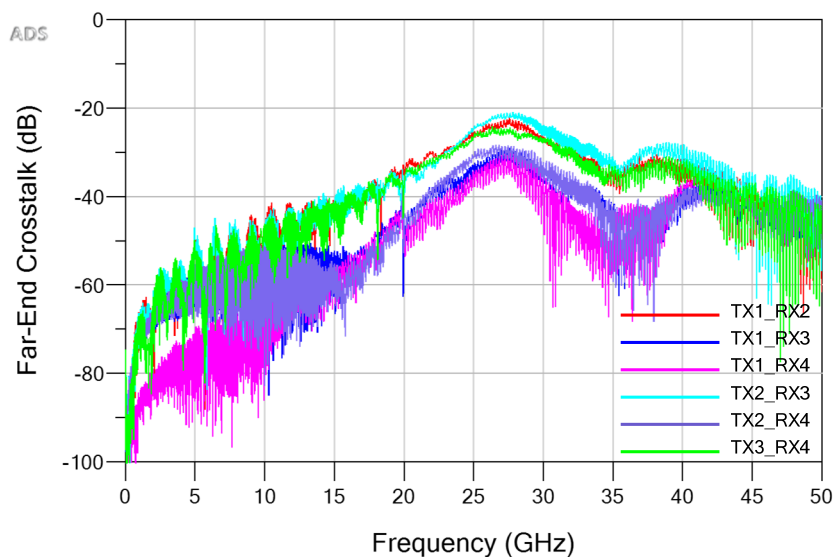
Series: DCH

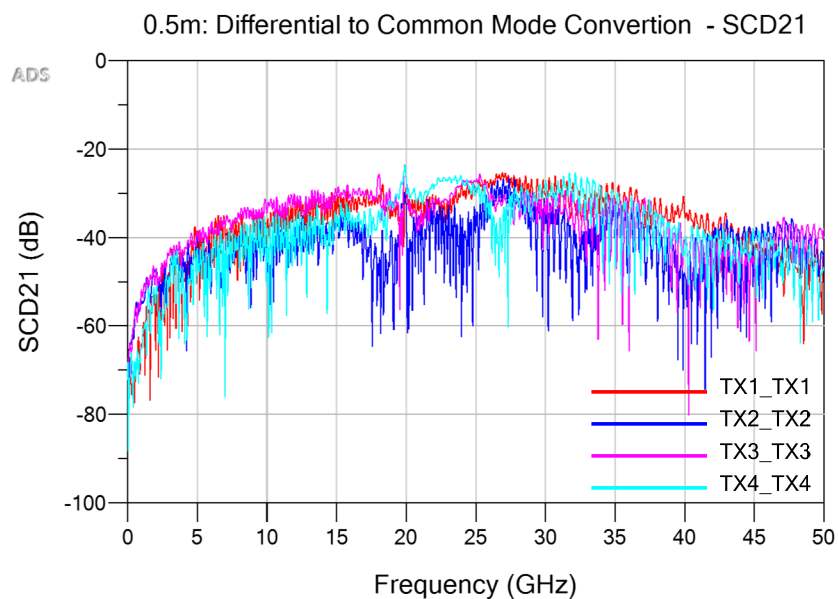
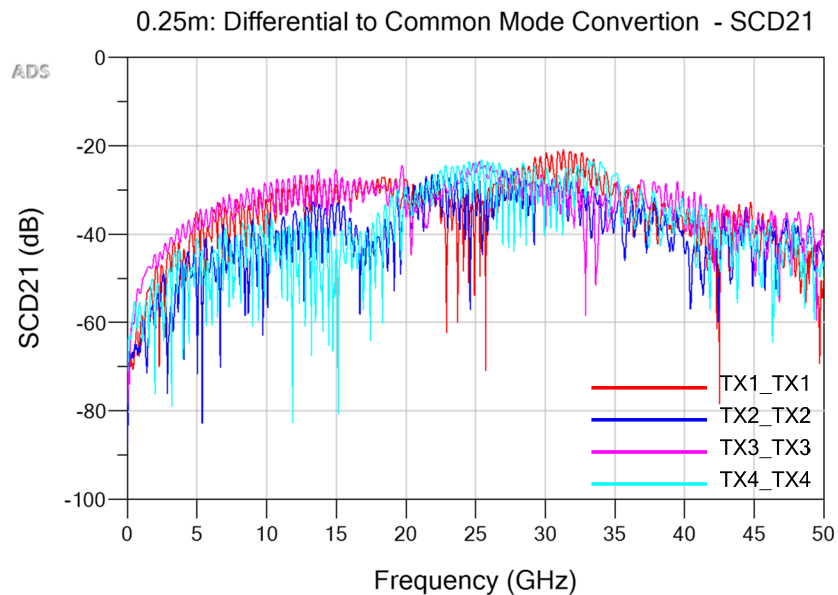
Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

0.5m: Differential Application - FEXT



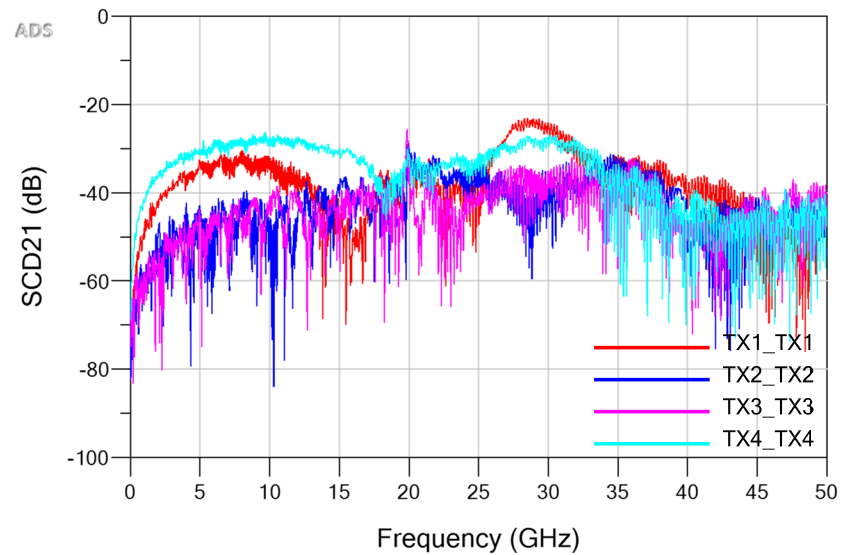
1m: Differential Application - FEXT



Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**Differential Application – Differential to Common Mode Conversion**

Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

1m: Differential to Common Mode Conversion - SCD21

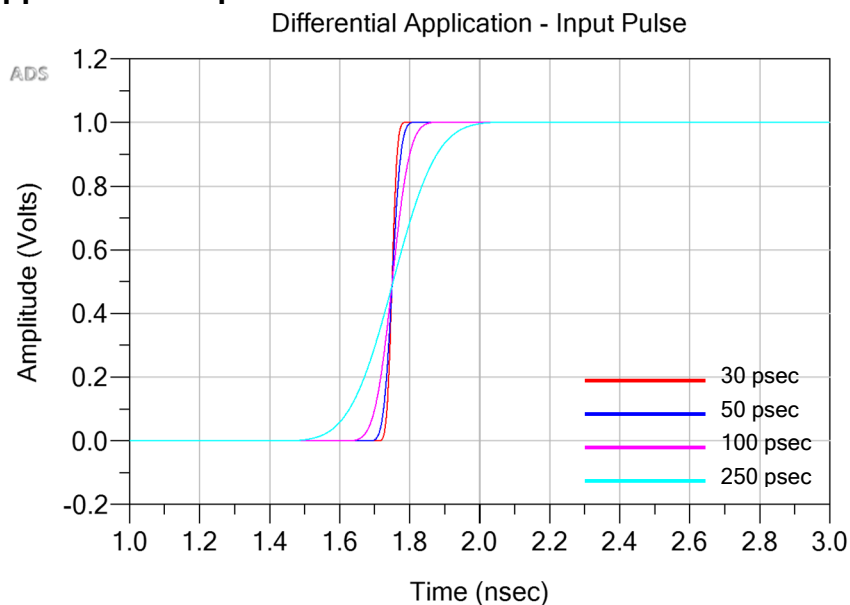


Series: DCH

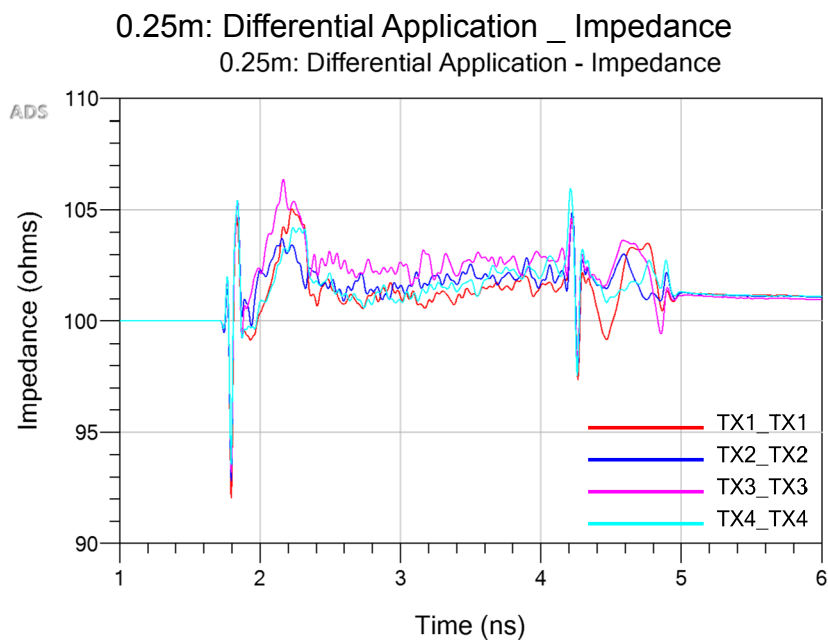
Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Appendix C – Time Domain Response Graphs

Differential Application – Input Pulse



Differential Application – Cable Assembly Impedance

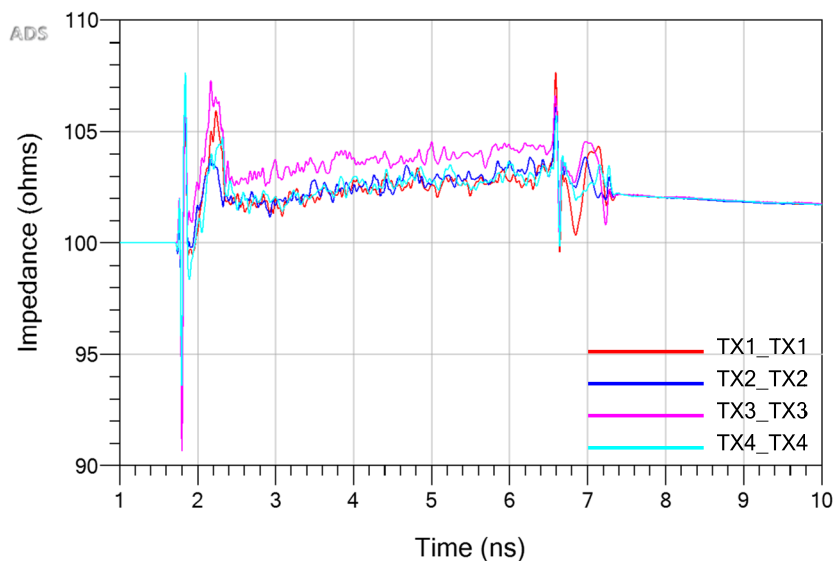


0.5m: Differential Application _ Impedance

Series: DCH

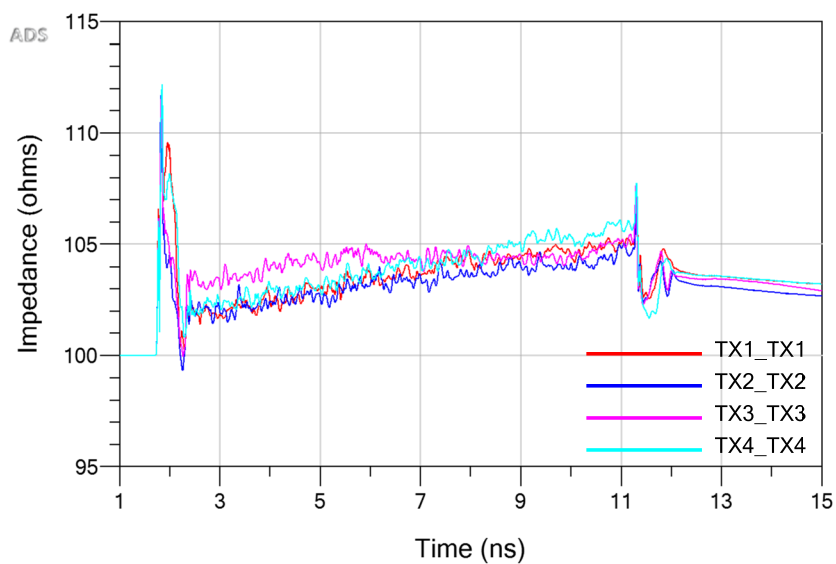
Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

0.5m: Differential Application - Impedance



1m: Differential Application _ Impedance

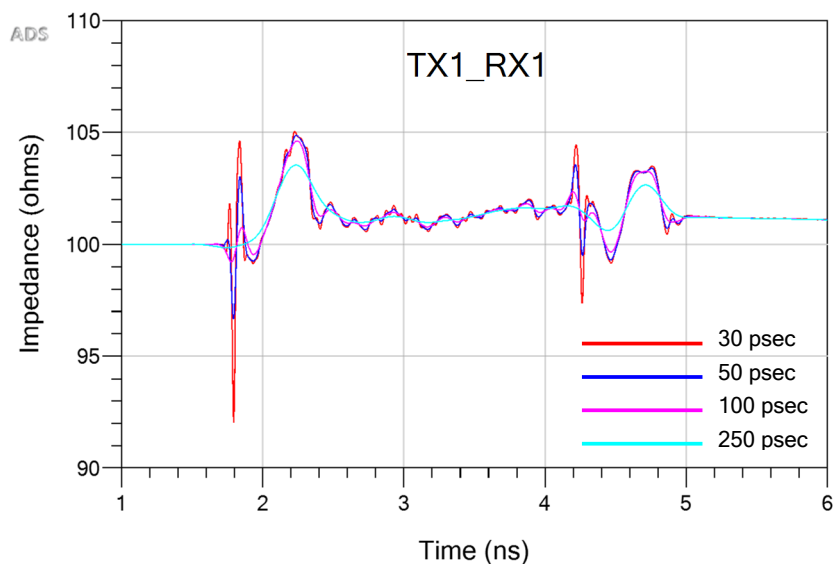
1m: Differential Application - Impedance



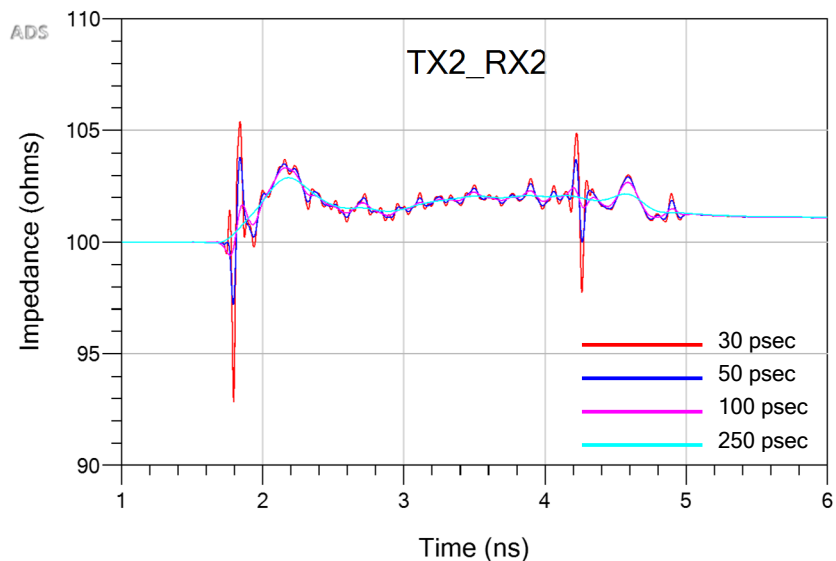
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**Differential Application – Cable assembly Impedance**

DCH-04-09.8-T-PF-1-4

0.25m: Differential Application - Impedance

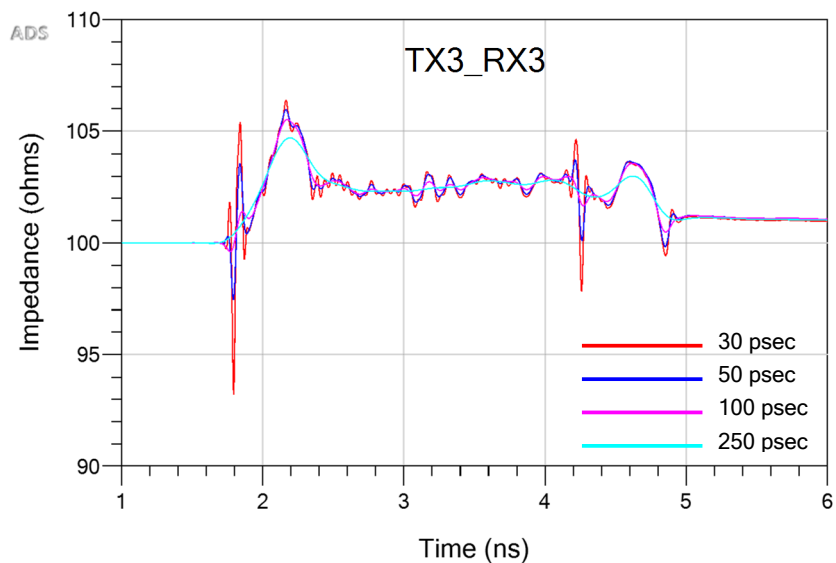


0.25m: Differential Application - Impedance

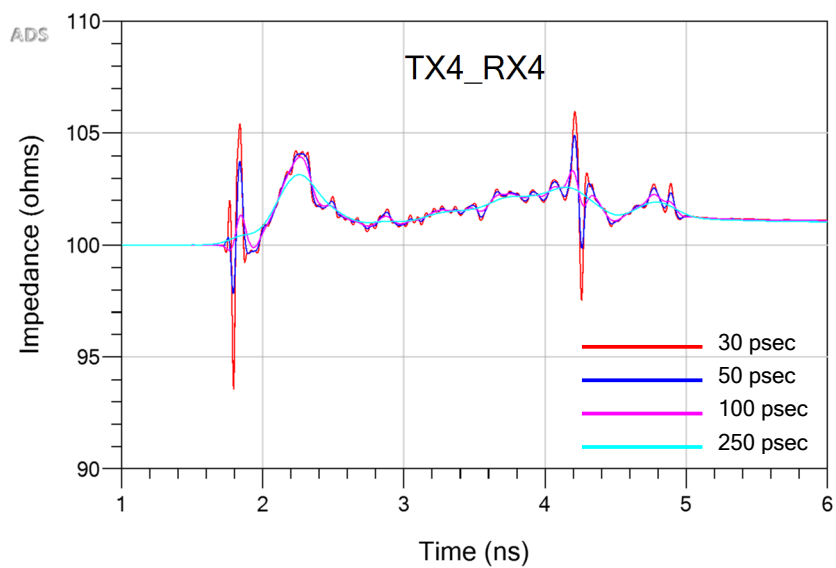


Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

0.25m: Differential Application - Impedance



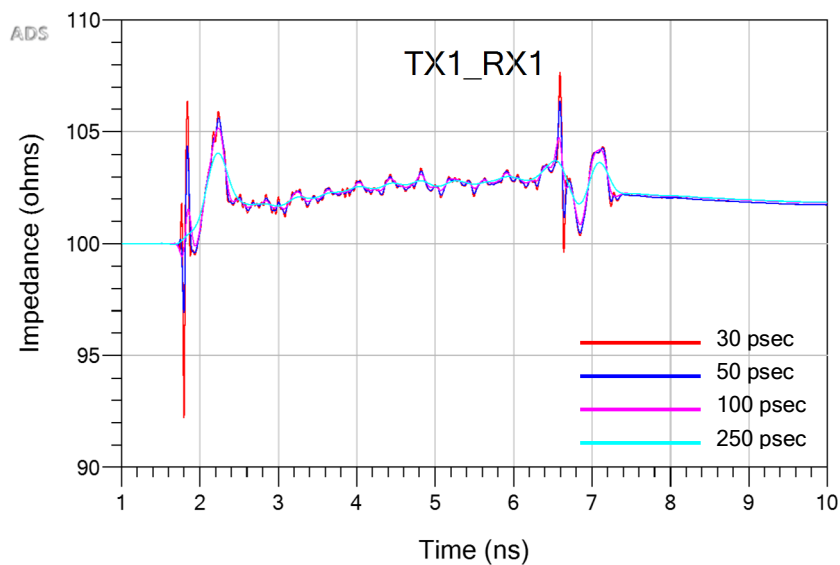
0.25m: Differential Application - Impedance



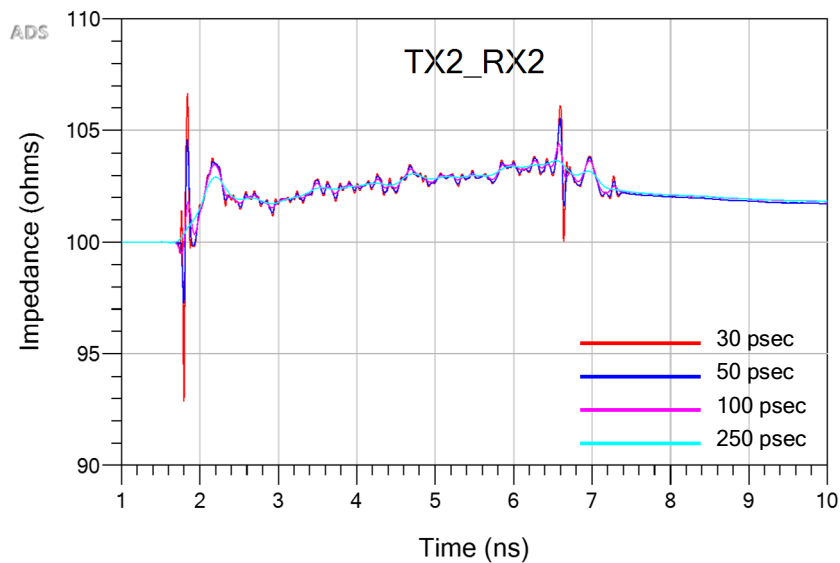
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

DCH-04-19.7-T-PF-1-4

0.5m: Differential Application - Impedance

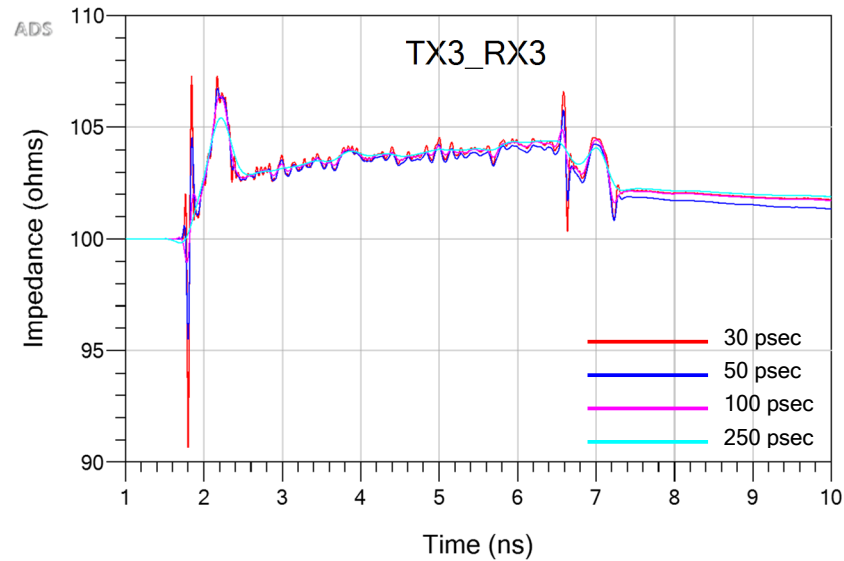


0.5m: Differential Application - Impedance

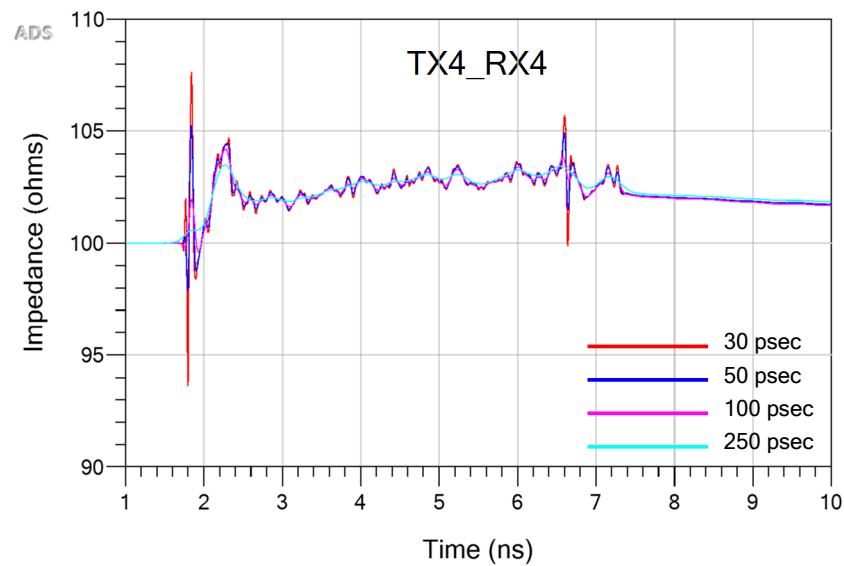


Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

0.5m: Differential Application - Impedance



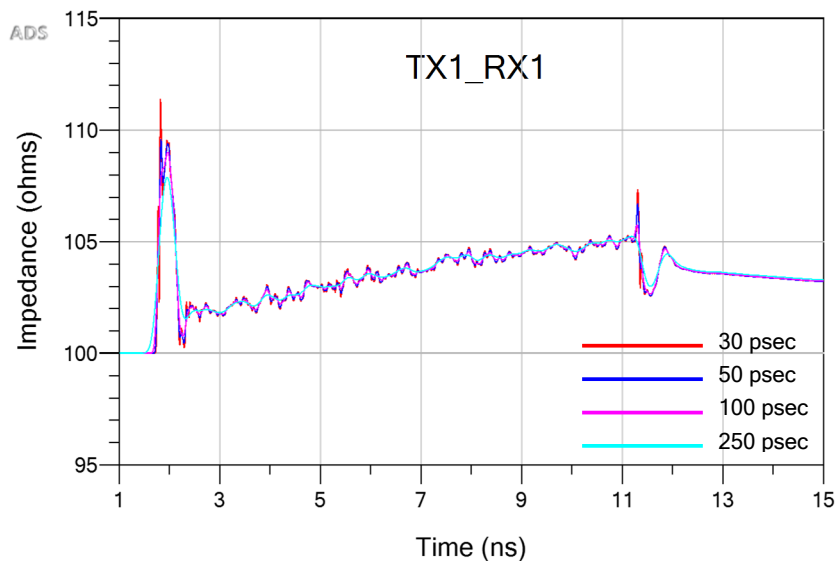
0.5m: Differential Application - Impedance



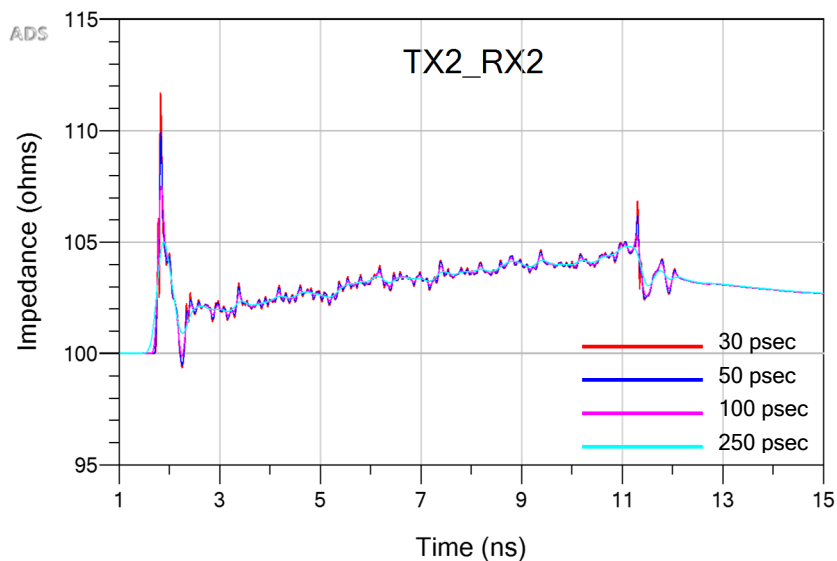
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

DCH-04-39.4-T-PF-1-4

1m: Differential Application - Impedance

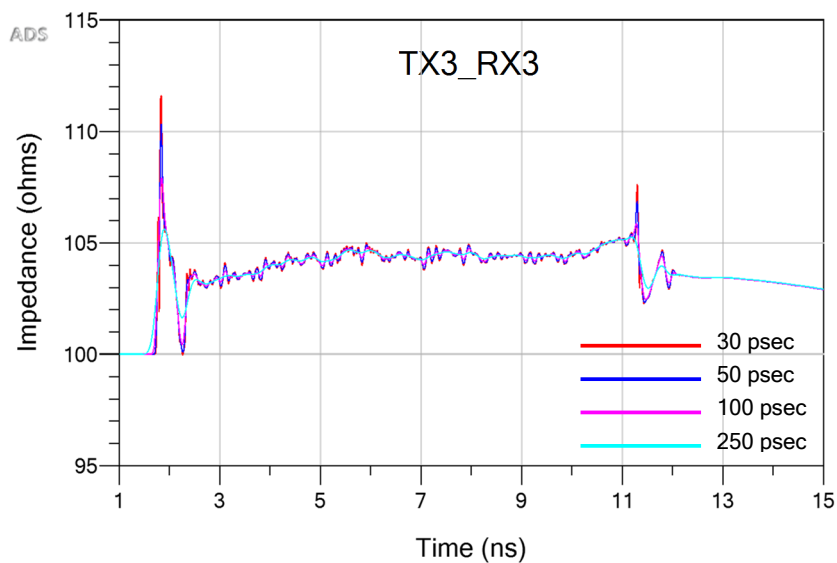


1m: Differential Application - Impedance

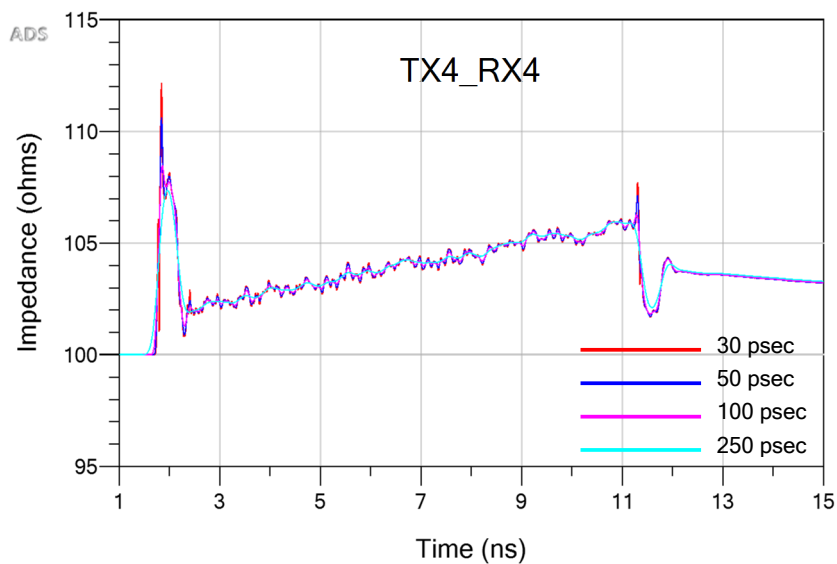


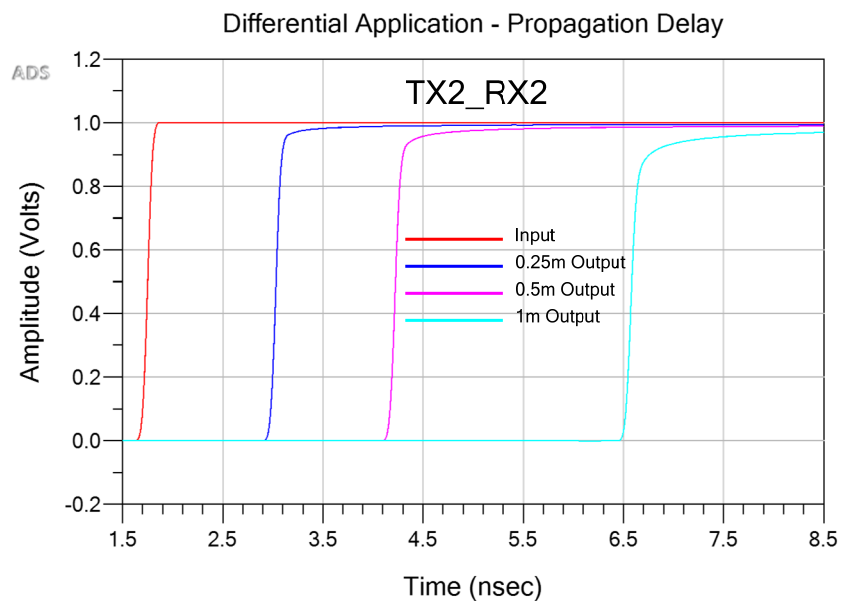
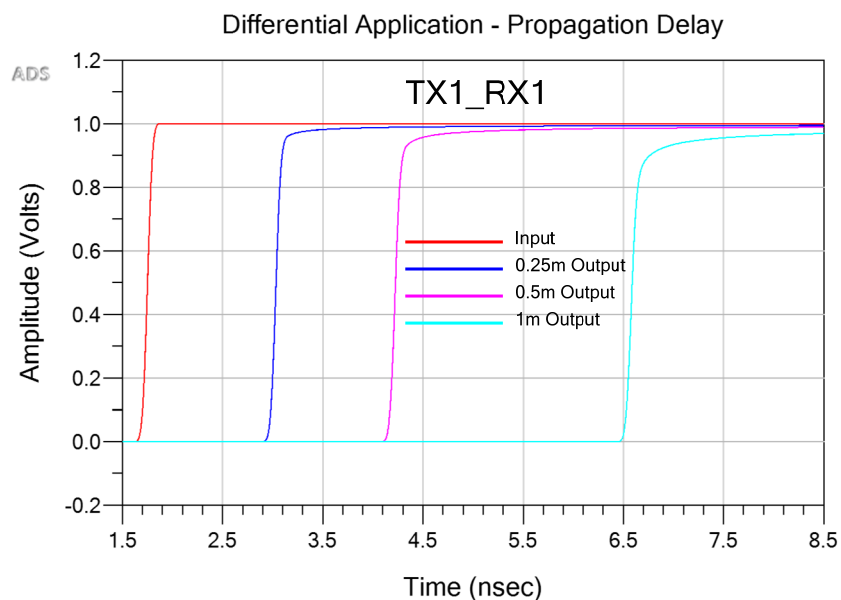
Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

1m: Differential Application - Impedance



1m: Differential Application - Impedance

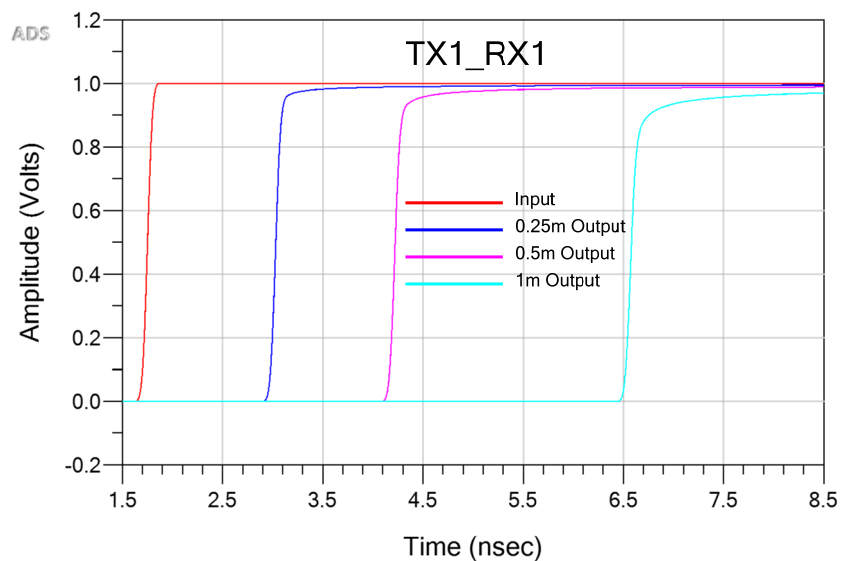


Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly**Differential Application – Propagation Delay**

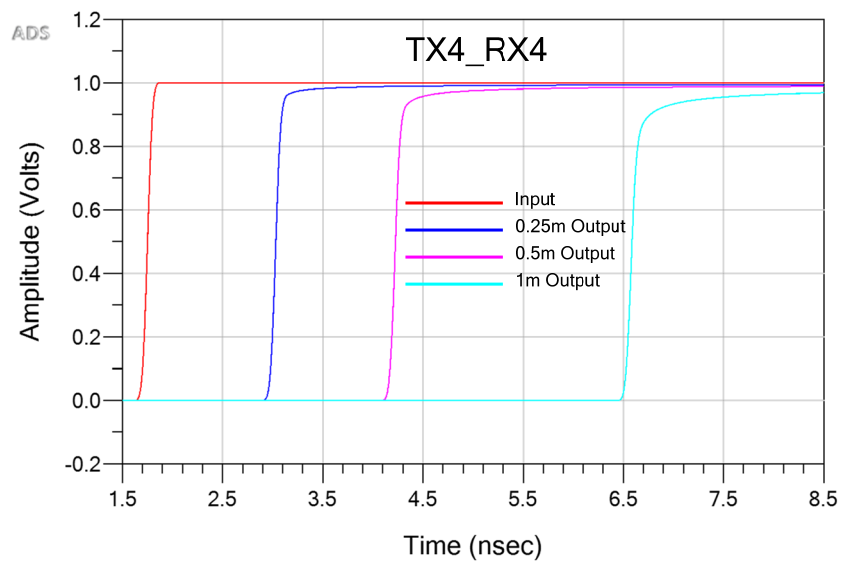
Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Differential Application - Propagation Delay



Differential Application - Propagation Delay



Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Appendix D – Product and Test System Descriptions

Product Description

Product test samples are 2mm high-speed press-fit cable assemblies. The part number are DCH-04-09.8-T-PF-1-4, DCH-04-19.7-T-PF-1-4 and DCH-04-39.4-T-PF-1-4. A photo of the mated test article pressed into SI test boards is shown below.

The high-speed cable assembly terminations had a particular signal line configuration. The respective signal line numbers are shown in table below. There is a total of 4 pairs. SMA jack numbers on the test boards correspond to the assembly line numbers. All adjacent lines are terminated where applicable.

-04	FIRST END	1	2	3	4	5	6	7	8	NUMBER OF GND PINS: 10
		PAIR		PAIR		PAIR		PAIR		
	SECOND END	8	7	6	5	4	3	2	1	

Table 5: Respective signal line numbers

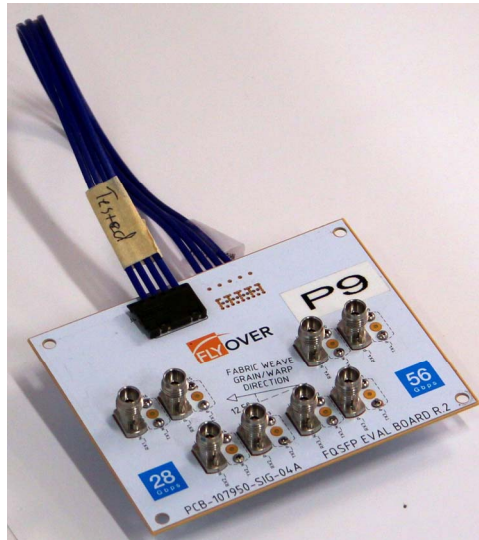
Test System Description

The test fixture is composed of six-layer FR-406 material with 50Ω signal trace and pad configurations designed for the electrical characterization of Samtec high speed cable assembly products. A PCB mount SMA connector is used to interface the VNA test cables to the test fixture. Optimization of the SMA launch was performed using full wave simulation tools to minimize reflections. The test fixture specific to the DCH series cable assembly is identified by part PCB-107950-SIG-04A. The Auto Fixture Removal (AFR) calibration structures designed specifically for the DCH series are on PCB-107950-SIG-03.

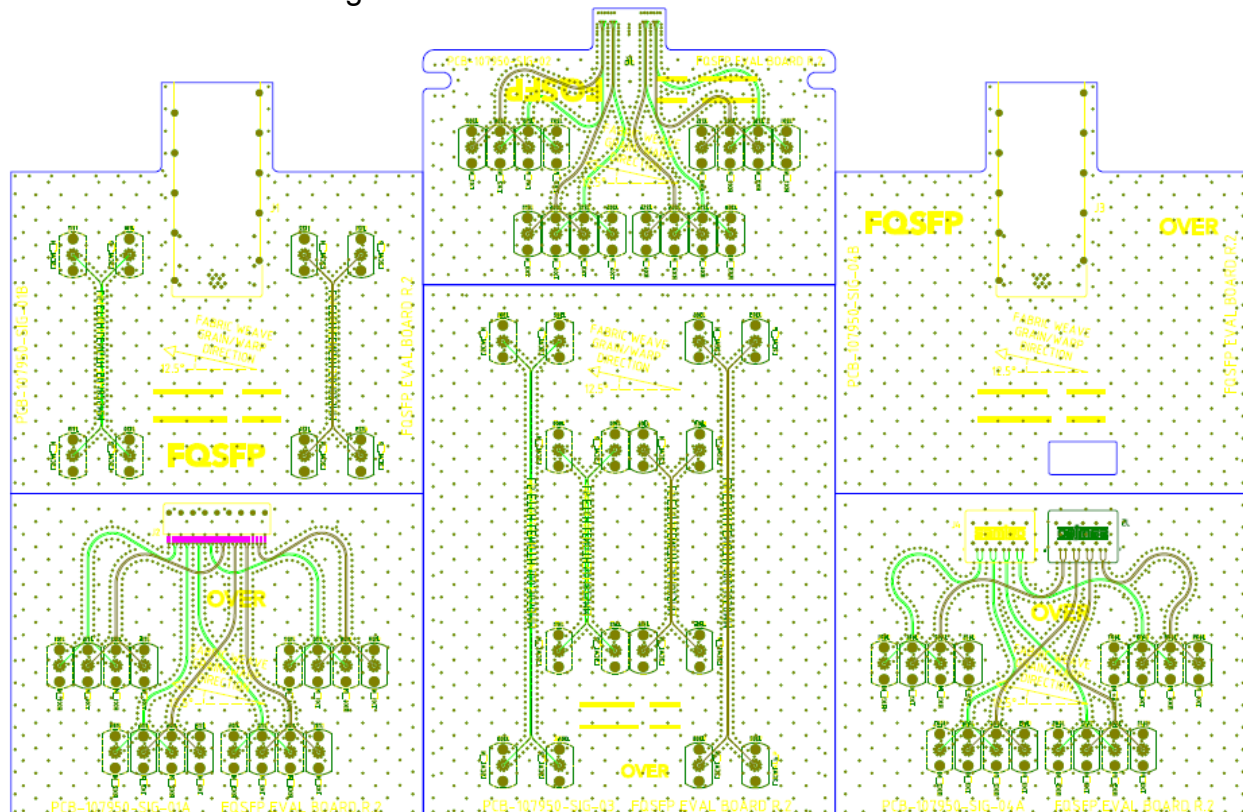
Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

PCB-107950-SIG-XX Test Fixtures



Artwork of the PCB design is shown below.

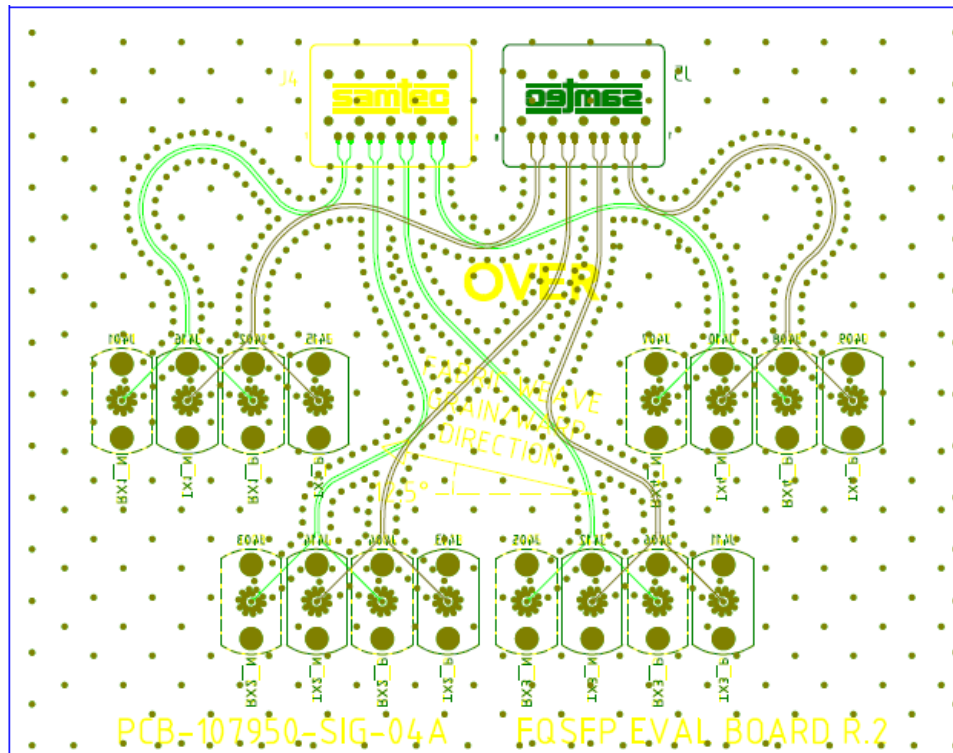


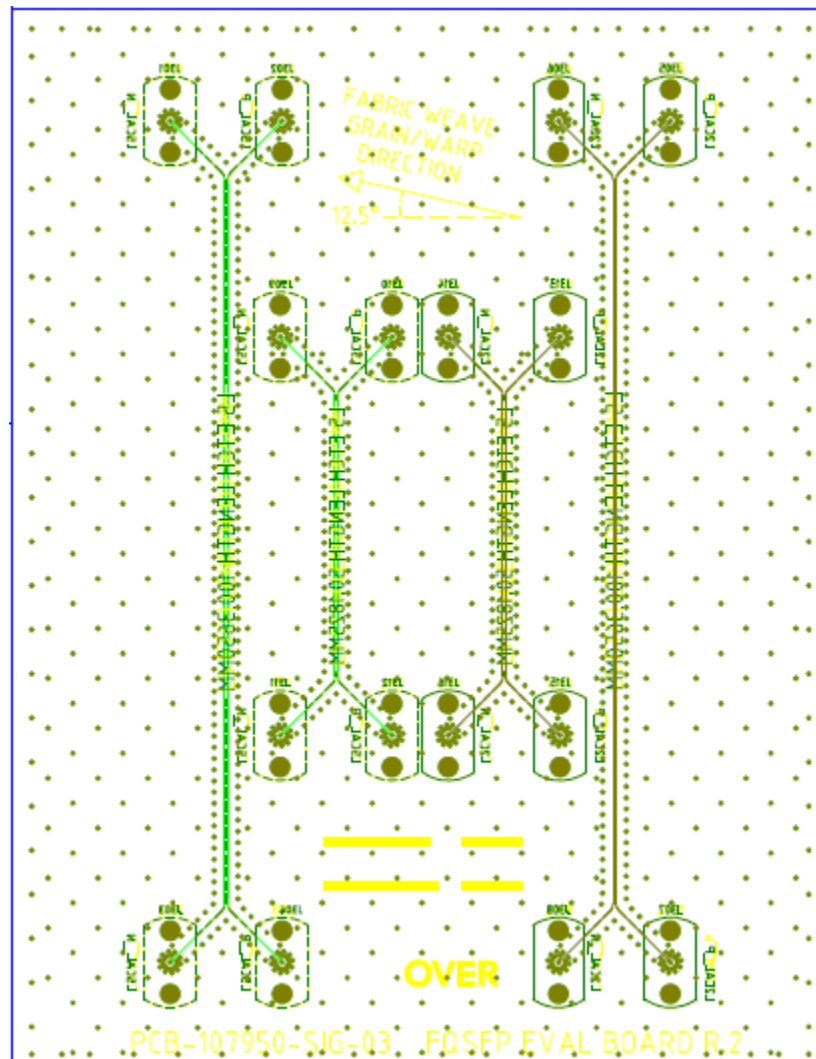
Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

PCB Fixtures

The test fixtures used are as follows; -04A was used for the measurements:



Series: DCH**Description:** 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

PCB-107950-SIG-04A – DCH Cable Test Board

PCB-107950-SIG-03 – DCH Calibration Board

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Appendix E – Test and Measurement Setup

The test instrument is the Agilent N5227A PNA network analyzer. Frequency domain data and graphs are extracted from the instrument by AFR application. Post-processed time domain data and graphs are generated using convolution algorithms within Keysight ADS. The network analyzer is configured as follows:

Start Frequency – 10 MHz

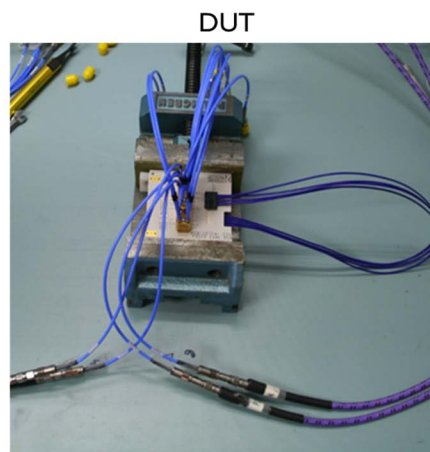
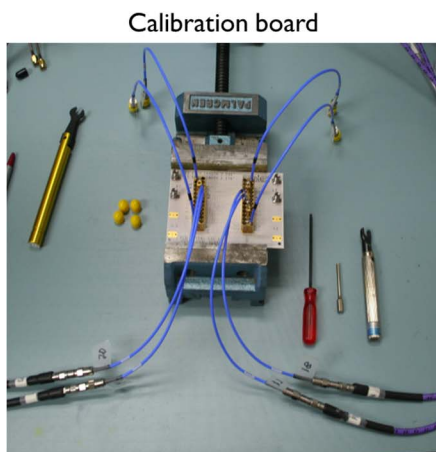
Number of points – 4200

Stop Frequency – 50 GHz

IFBW – 700 Hz

With these settings, the measurement time is approximately 20 seconds.

N5227A Measurement Setup



Test Instruments

<u>QTY</u>	<u>Description</u>
1	Keysight N5227A PNA 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-67 GHz)

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Appendix F - Frequency and Time Domain Measurements

Eye Diagram Procedures

Eye Diagrams and statistical eye diagram metrics such as eye height can be generated by post-processing Frequency Domain measurements using Agilent ADS. Simulated data is sent over a touchstone model and the bits are overlain into an eye pattern.

Currently, no CEI specification is available for 7Gbps, so *CEI-28-VSR Working Clause Proposal, CEI Implementation agreement Draft 7.0*, dated May 14, 2012 was used for this report.

The simulation circuit is modeled as:

Keysight's Advanced Design System Tx and Rx modules that are configured to the *CEI-28-VSR Working Clause Proposal, CEI Implementation Agreement Draft 7.0*, dated May 14, 2012.

- Tx parameters are specified in Section 1.3.3, *Module-to-Host Specifications*, Table 1-4, Page 7.
- Rx parameters defined in Section 1.3.2 *Host-to-Module Electrical Specifications*, Table 1-1, Page 5.
- A 50.1825 mm length of Tx interconnect trace segment at the transmitter.
- SUT Cable Assembly S-Parameter measurements
 - o 3 mm of 0.1448 mm wide differential stripline signal trace
 - o Test board vias, pads (footprint effects) for the TX end
 - o The DCH cable assembly
 - o Test board vias, pads (footprint effects) for the RX end
 - o 3 mm of 0.1448 mm wide differential stripline signal trace
- A 50.1825 mm length of Rx interconnect trace segment at the receiver.

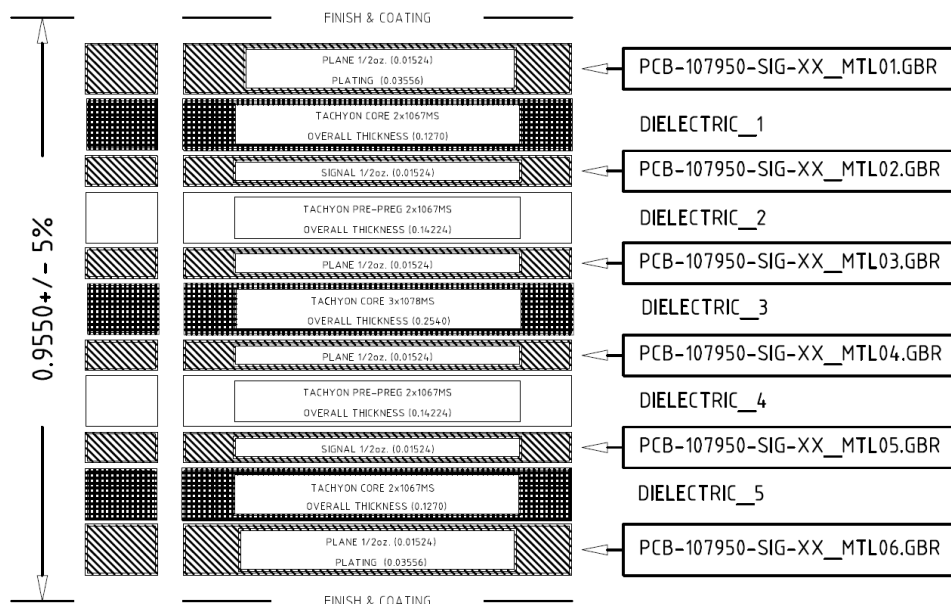
All traces were modeled as microstrip on FR4 with the following parameters:

- The FR4 parameters are modeled using:
 - o $\epsilon_r = 4.2 @ 1 \text{ GHz}$
 - o Loss Tangent = $0.02 @ 1 \text{ GHz}$
- Copper is modeled as:
 - o Conductivity = $4.5E+7 \text{ S-m}$
 - o Surface roughness = 0.6 micron

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

- Signal traces are stripline with the following geometry:
 - Trace width: 0.1448 mm



Eye Mask

The eye mask is set for 50mVpp, with a jitter margin of 0.5 UI.

Rise Time

The 10-90 rise time of the 18Gbps signal was determined to be 19 psec, using the following formula:

$$\text{Risetime} = 0.35/\text{Bandwidth}$$

Series: DCH

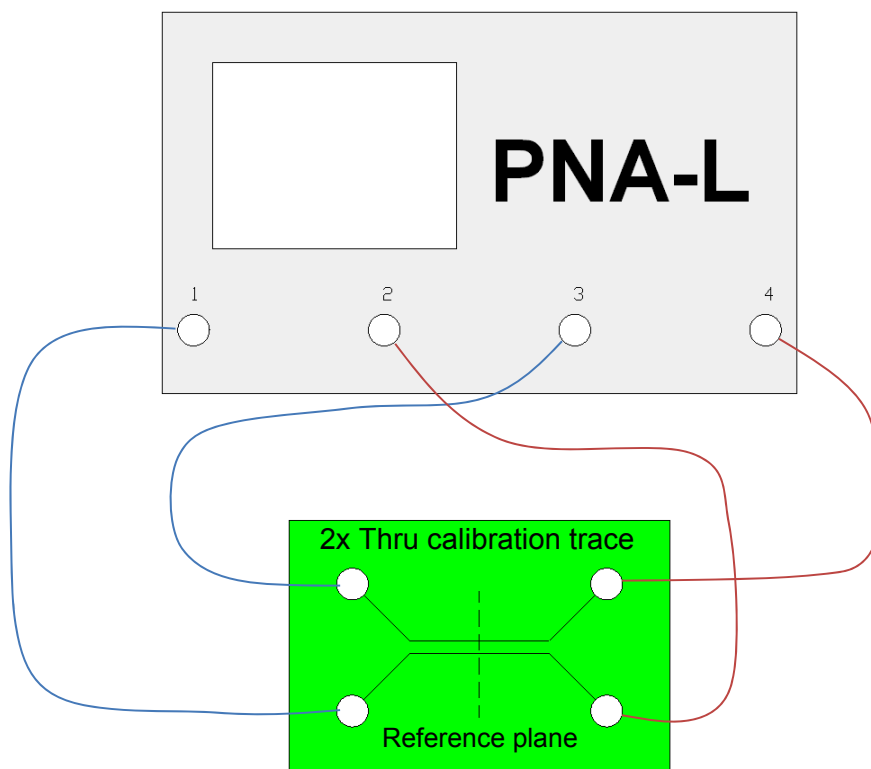
Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

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 AFR calibration standards, the SI test boards, and the selection of the PCB vendor.

The measurement process begins with a measurement of the AFR calibration standards. A coaxial SOLT calibration is performed using an N4694-60003 E-Cal module. This measurement is required in order to obtain precise values of the line standard offset delay and frequency bandwidths. Measurements of the 2x through line standard can be used to determine the maximum frequency for which the calibration standards are valid. For the DCH test boards, this is greater than 50 GHz.

The figure below shows how the THRU reference traces is utilized to compensate for the losses due to the coaxial test cables and the test fixture during testing. The calibration board is characterized to obtain parameters required to define the 2x Thru.



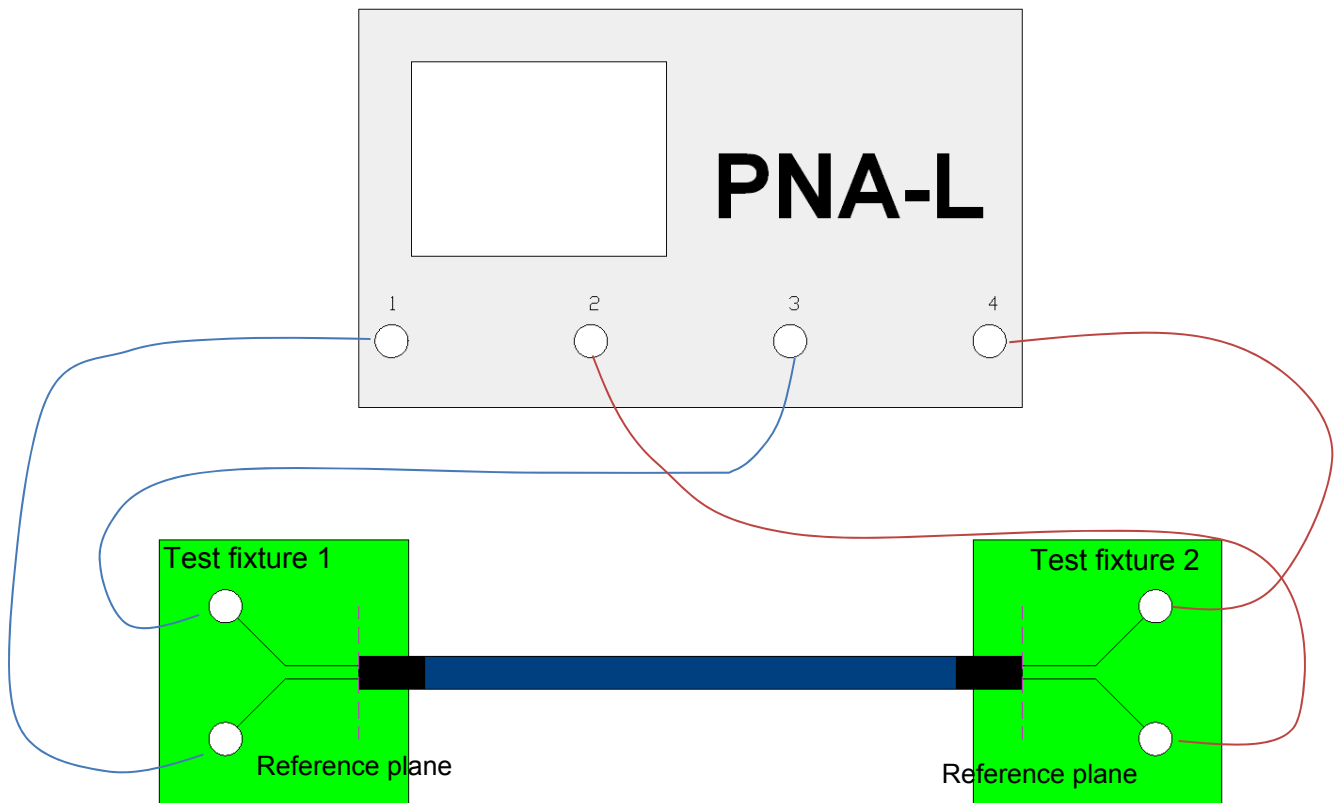
Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Measurements are then performed using the test boards as shown below. The test board effects are removed in post-processing via AFR in Keysight PLTS. The calibrated reference plane is located 3mm from the footprint on each side. The S-Parameter measurements include:

- A. 3 mm of 0.1448 mm wide differential stripline signal trace
- B. Test board vias, pads (footprint effects) for the TX end
- C. The DCH test cable
- D. Test board vias, pads (footprint effects) for the RX end
- E. 3 mm of 0.1448 mm wide differential stripline signal trace

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



Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

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 2016 update 1. 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/Documents/WebFiles/Technical_Library/Reference/Articles/tech_note_using-PLTS-for-time-domain-data_web.pdf

Propagation Delay (TDT)

The Propagation Delay is a measure of the Time Domain delay through the cable assembly and footprint. A step pulse is applied to the touchstone model of the cable assembly 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.

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 50 ohms.

Series: DCH

Description: 2.00 mm High-Speed Press-Fit Twinax Cable Assembly

Appendix G – Glossary of Terms

ADS – Agilent Advanced Design System

AFR – Automatic Fixture Removal

CTLE – Continuous Time Linear Analyzer

CuFireFly™ - Copper FireFly™ assembly

DUT – Device under test

FD – Frequency domain

FEXT – Far-End Crosstalk

HDV – High Density Vertical

NEXT – Near-End Crosstalk

OV – Optimal Vertical

OH – Optimal Horizontal

PCB – Printed Circuit Board

PLTS – Agilent Physical Layer Design System

PPO – Pin Population Option

SE – Single-Ended

SI – Signal Integrity

SUT – System Under Test

S – Static (independent of PCB ground)

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

UI – Unit Interval

XROW – Across Row

Z – Impedance (expressed in ohms)