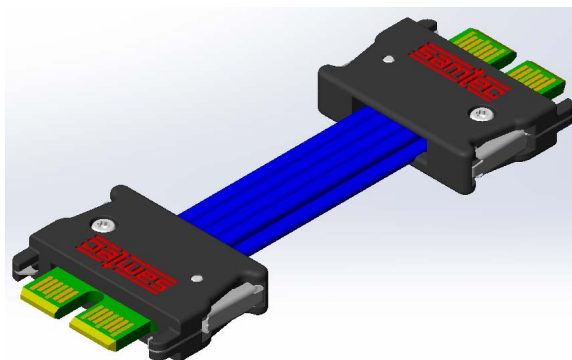




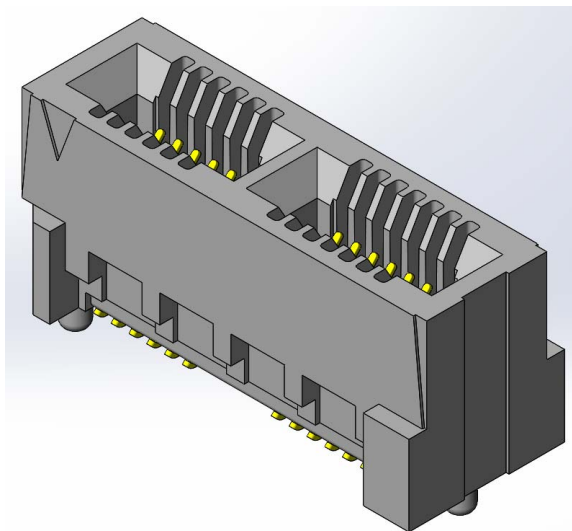
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## High Speed Characterization Report

ECDP-08-XX.XX-L1-L1-3-3



Mated with:  
HSEC8-113-XX-XX-DV-X-XX



### Description:

**High-Speed, 100 $\Omega$  differential signal routing, Edge Card Cable  
Assembly, 30 AWG Eye Speed® Twinax Cable**

**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed®  
Twinax Cable

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**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

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**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Cable Assembly Overview

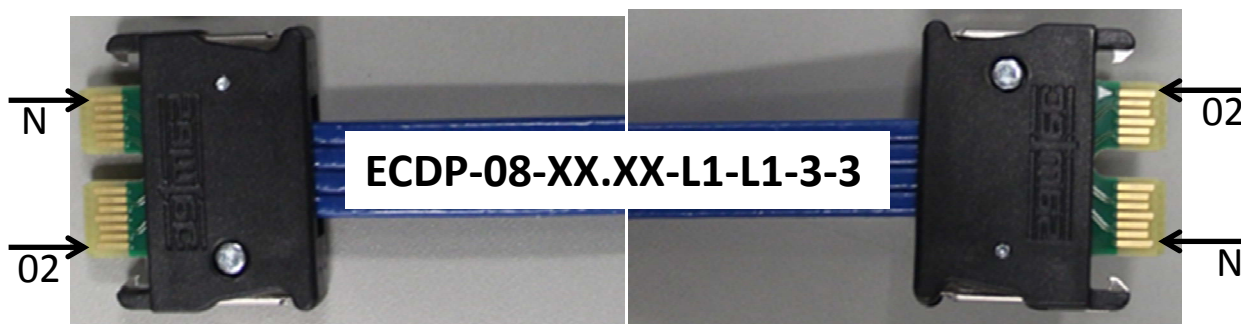
The 0.80 mm (.0315") ECDP Cable Assembly is constructed using Samtec 30 AWG, 100  $\Omega$ , and Eye Speed® twinax cable. The cable is terminated at each end with a 4 layer double vertical PCB edge card connector. Each edge card is double row structures with up to 16 differential pairs. The ECDP-08-XX.XX-L1-L1-3-3 cable assembly is wired to facilitate a Pin 1 to Pin N-1 mapping between the cable ends. The data in this report is applicable to 9.80 and 39.37 inch long cable assemblies.

Each ECDP assembly was tested by mating it to a HSEC8-113-01-L-DV-L1 double row 0.8mm High Speed Edge Card Assembly 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 picture is shown in Figure 1.

Two differential pairs, the longest physical signal path (Long Path) and the shortest physical signal path (Short Path), of each assembly type were tested. The Long Path and Short Path are identified as, the J1\_15,17 to J2\_11,9 and the J1\_16,18 to J2\_12,10, respectively.

| Length       | Part Number             | End 1 | End 2 |
|--------------|-------------------------|-------|-------|
| 9.80 inches  | ECDP-08-09.80-L1-L1-3-3 | HSEC8 | HSEC8 |
| 39.37 inches | ECDP-08-39.37-L1-L1-3-3 | HSEC8 | HSEC8 |

**Table 1: Sample Description**



**Figure 1: Test Sample**

**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## 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 ECDP cable assemblies tested.

| Assembly                |            | -7 dB Frequency |
|-------------------------|------------|-----------------|
| ECDP-08-09.80-L1-L1-3-3 | Long Path  | 12.0 GHz        |
|                         | Short Path | 12.0 GHz        |
| ECDP-08-39.37-L1-L1-3-3 | Long Path  | 7.5 GHz         |
|                         | Short Path | 7.5 GHz         |

**Table 2: Cable Assembly Speed Rating**

**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

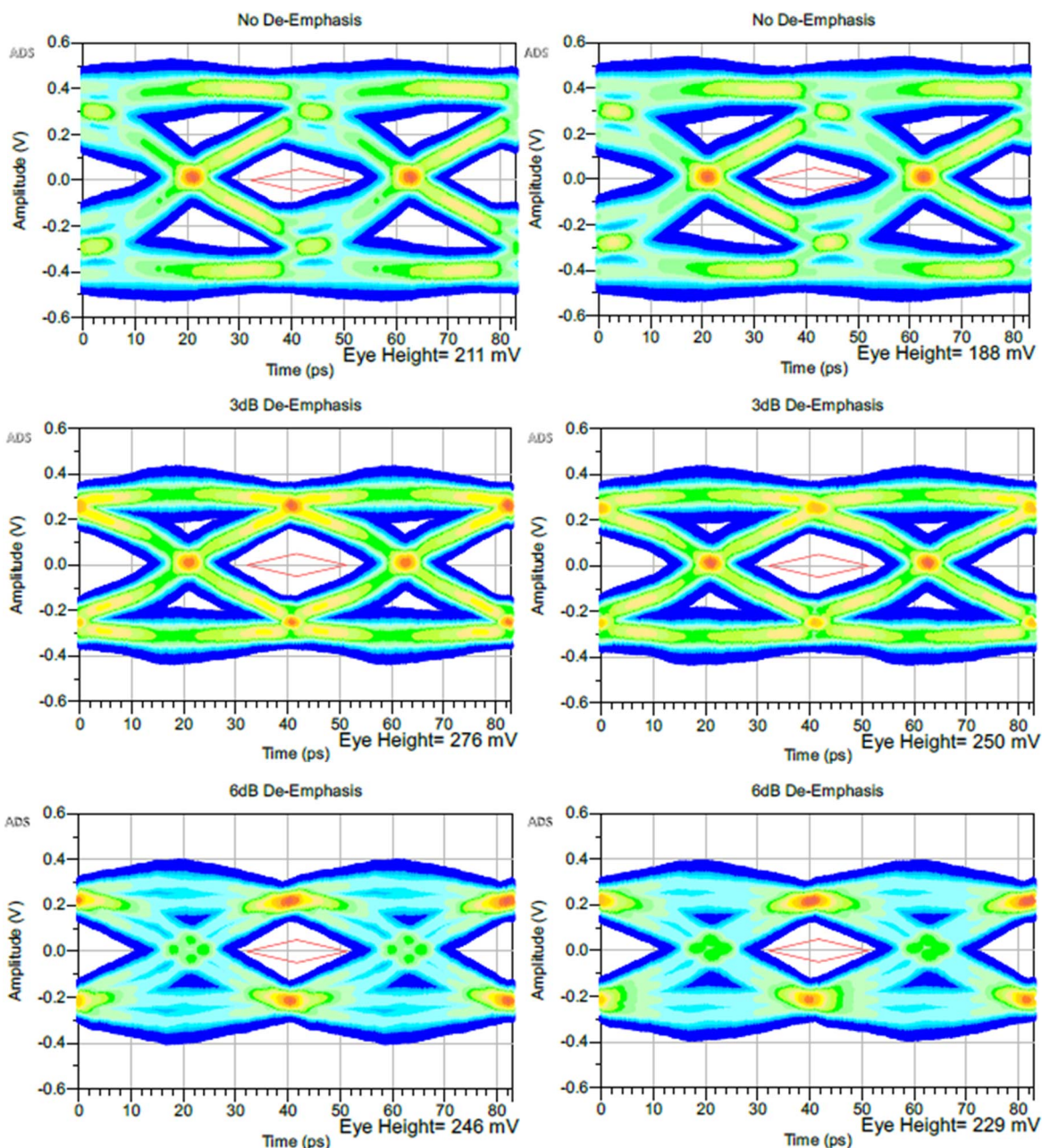
## Eye Pattern Summary

ECDP-08-09.80-L1-L1-3-3

Differential

Long Path Output Eye: 24 Gbps

Short Path Output Eye: 24 Gbps





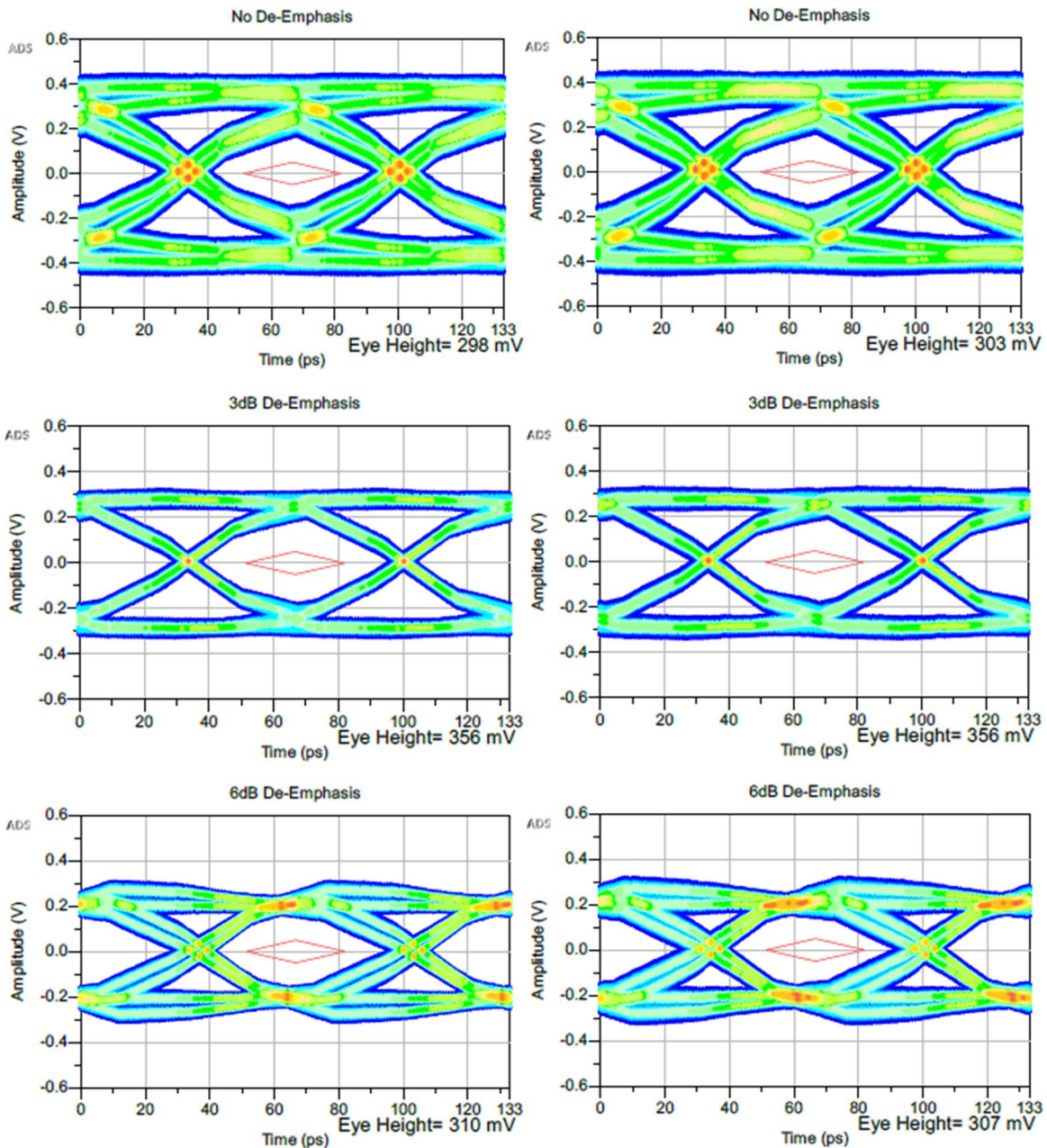
**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

ECDP-08-39.37-L1-L1-3-3  
Differential

Long Path Output Eye: 15 Gbps

Short Path Output Eye: 15 Gbps



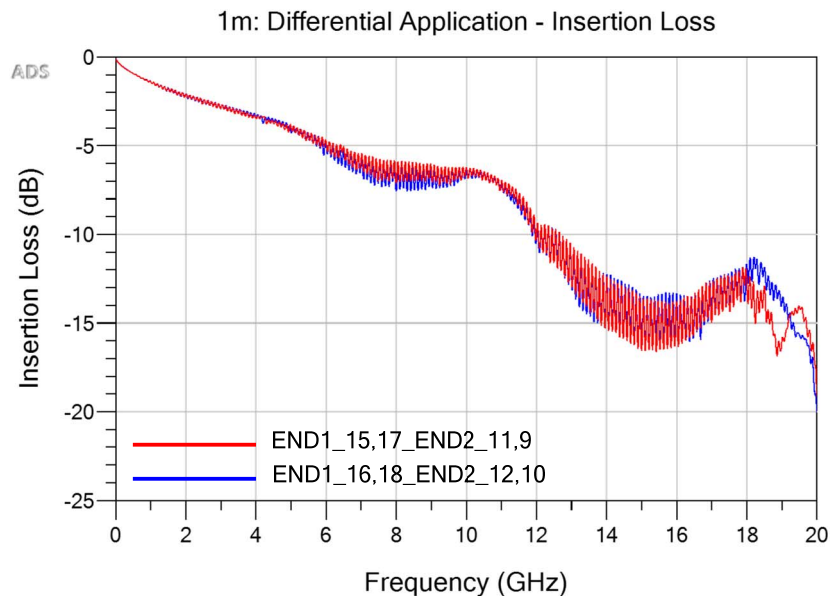
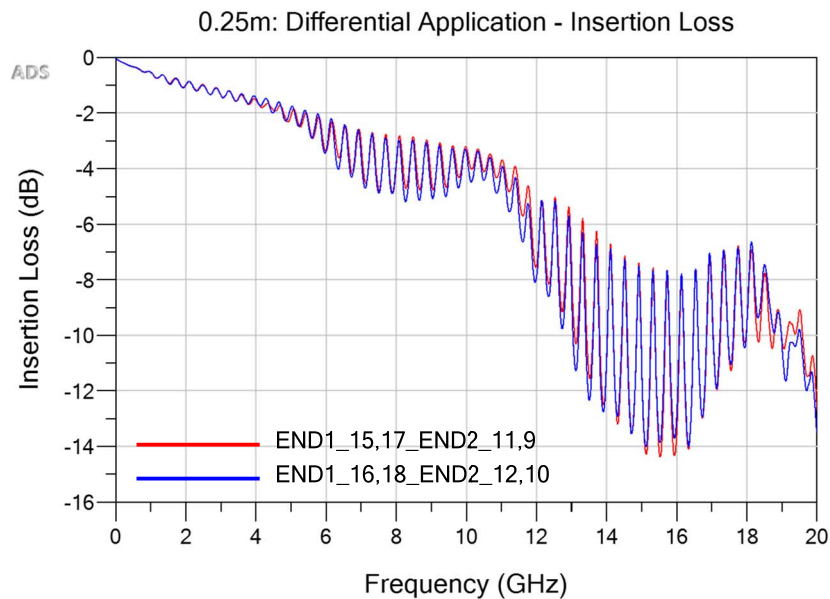
**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Frequency Domain Data Summary

| Table 3 - Differential Connector System Performance |                   |            |            |                     |                     |
|-----------------------------------------------------|-------------------|------------|------------|---------------------|---------------------|
| Test Parameter                                      | Configuration     | Driver     | Receiver   | 0.25m               | 1m                  |
| Insertion Loss                                      | Long Path         | END1_15,17 | END2_11,9  | 7dB@ 11.91 GHz      | 7dB@ 7.48 GHz       |
|                                                     | Short Path        | END1_16,18 | END2_12,10 | 7dB@ 11.87 GHz      | 7dB@ 7.27 GHz       |
| Return Loss                                         | Long Path         | END1_15,17 | END1_15,17 | >10dB to 4.53 GHz   | >10dB to 4.30 GHz   |
|                                                     | Short Path        | END1_16,18 | END1_16,18 | >10dB to 4.80 GHz   | >10dB to 4.20 GHz   |
| Near-End Crosstalk                                  | In Row: Long Path | END1_15,17 | END1_21,23 | <-20dB to 18.17 GHz | <-20dB to 17.71 GHz |
|                                                     | Across Row        | END1_15,17 | END1_16,18 | <-20dB to 20 GHz    | <-20dB to 20 GHz    |
| Far-End Crosstalk                                   | In Row: Long Path | END1_15,17 | END2_21,23 | <-20dB to 20 GHz    | <-20dB to 20 GHz    |
|                                                     | Across Row        | END1_15,17 | END2_16,18 | <-20dB to 20 GHz    | <-20dB to 20 GHz    |



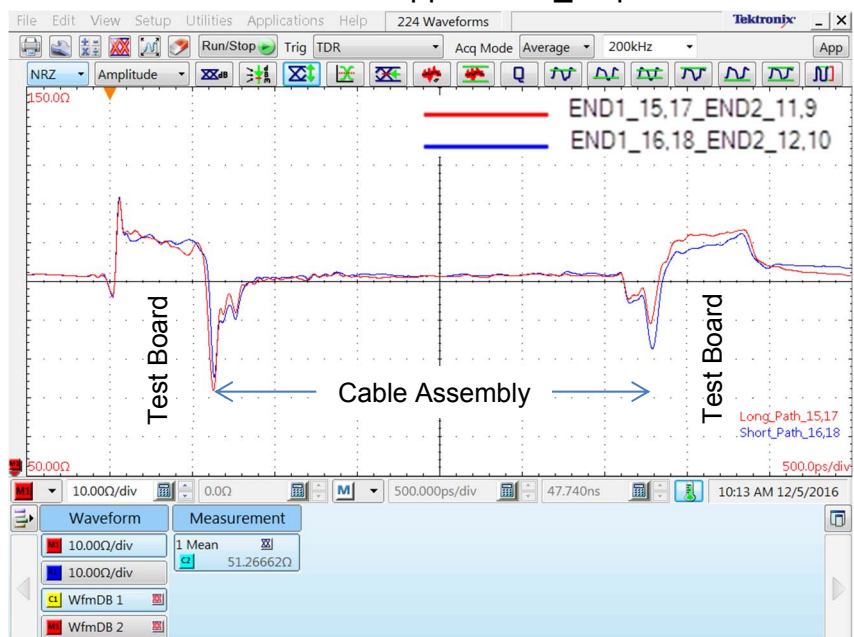
**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable**Bandwidth Chart – Differential Insertion Loss**

**Series:** ECDP

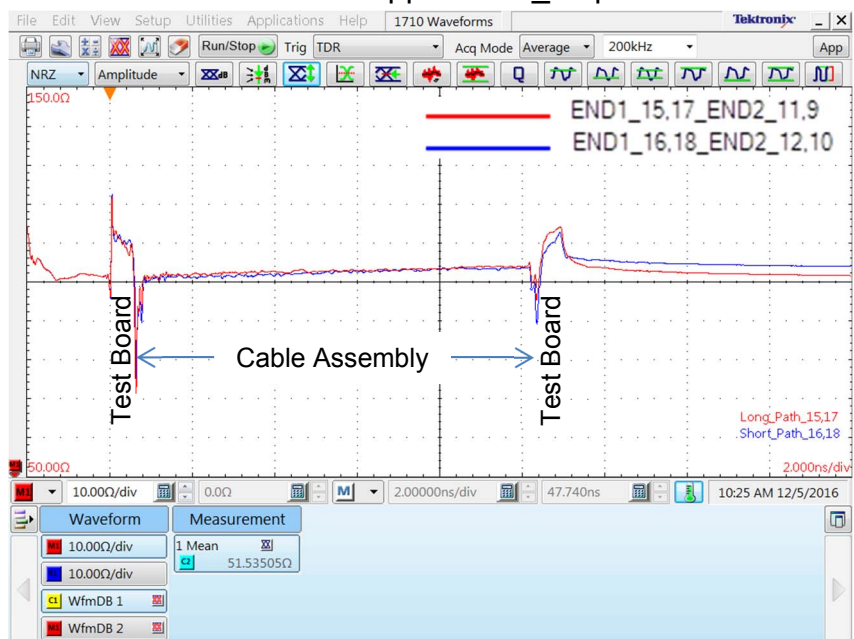
**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Time Domain Data Summary

0.25m: Differential Application \_ Impedance



1m: Differential Application \_ Impedance



**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable**Table 4 - Propagation Delay (Cable Assembly)**

| <b>Cable length</b> | <b>Driver/ Receiver</b>  | <b>Driver/ Receiver</b>   |
|---------------------|--------------------------|---------------------------|
|                     | END1_15,17/<br>END2_11,9 | END1_16,18/<br>END2_12,10 |
| <b>0.25m</b>        | 1.337ns                  | 1.336ns                   |
| <b>1m</b>           | 4.893ns                  | 4.893ns                   |

**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

### 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 mating connectors, 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:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

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

Differential Impedance:

- Long Path (furthest from test fixture)
- Short Path (closest to test fixture)

Differential Crosstalk:

- In Row: Long Path (adjacent terminals in the long row)
- In Row: Short Path (adjacent terminals in the short row)
- Across Row: “Xrow”: (from one row of terminals to the other row)

See Appendix D – Product and Test System Descriptions for details

Two differential pairs were driven for crosstalk measurements.

Other configurations can be evaluated upon request. Please contact [sig@samtec.com](mailto: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:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

### **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](mailto: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](mailto: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.

Impedance mismatch versus length is measured by DSA8200 Digital Serial Analyzer. Board related effects, such as pad-to-ground capacitance and trace loss, are included in the data presented in this report. The impedance data is provided in [Appendix C](#) of this report.

**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

The measured S-Parameters from the network analyzer are post-processed using Agilent ADS to obtain the time domain response for signal propagation time. The 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](mailto: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 6.5 mils of PCB trace on each connector 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](mailto: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](mailto:sig@samtec.com).

**Series:** ECDP

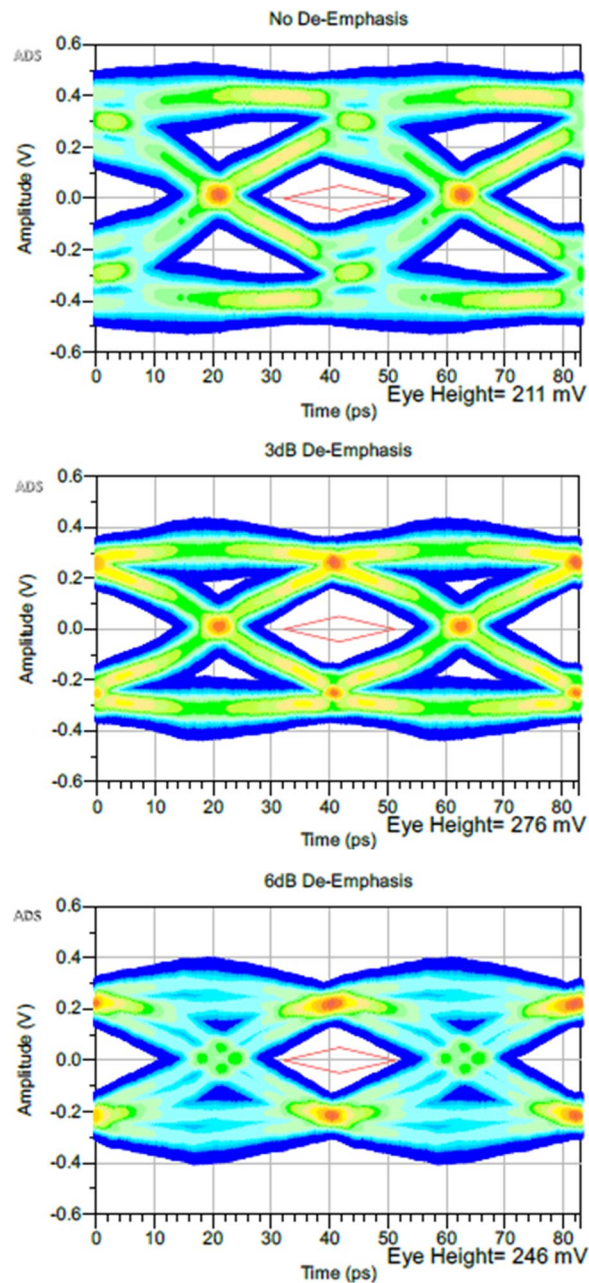
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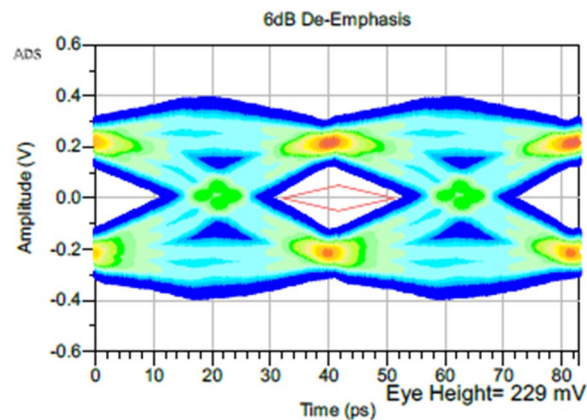
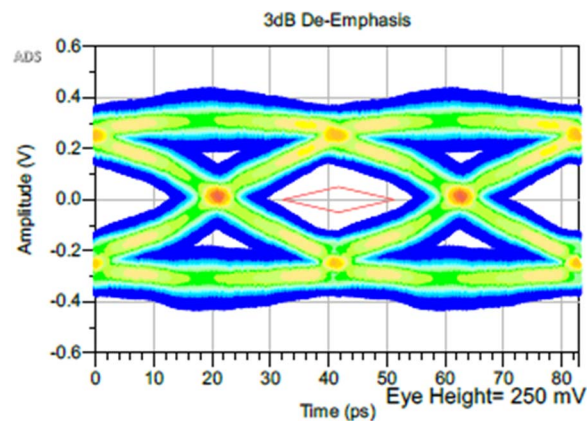
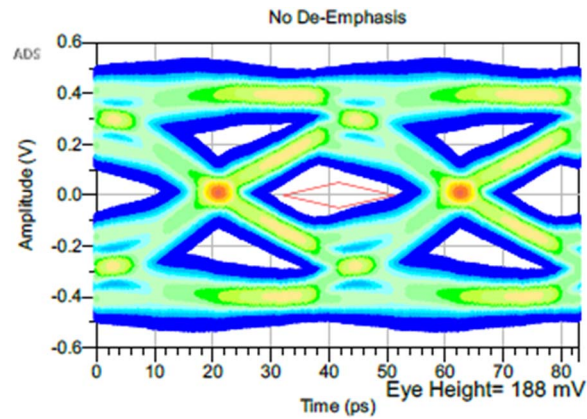
## Appendix A – Eye Diagrams

ECDP-08-09.80-L1-L1-3-3

Differential

24Gbps: Long Path



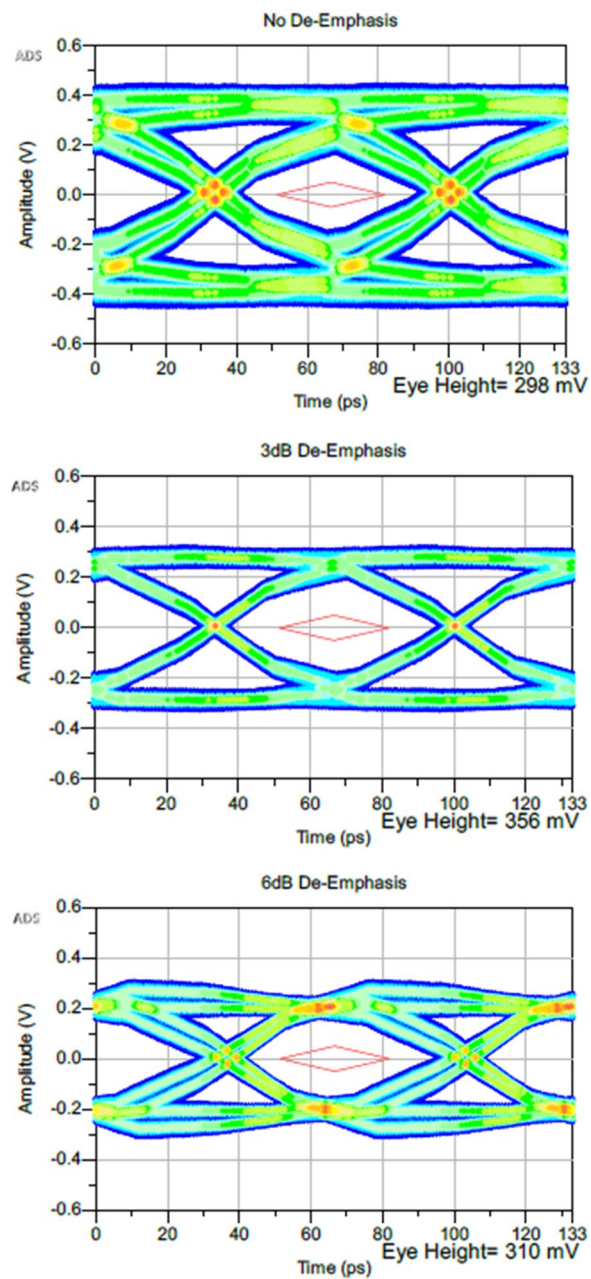
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**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

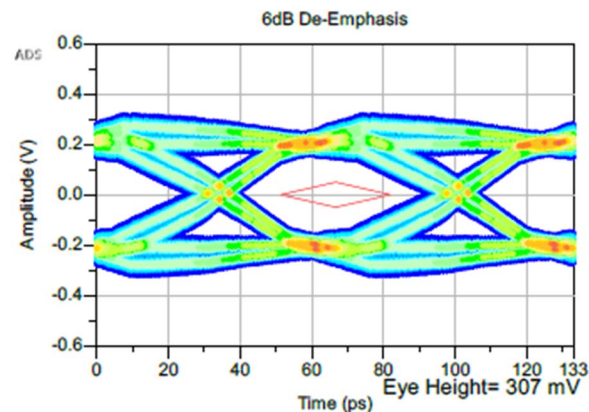
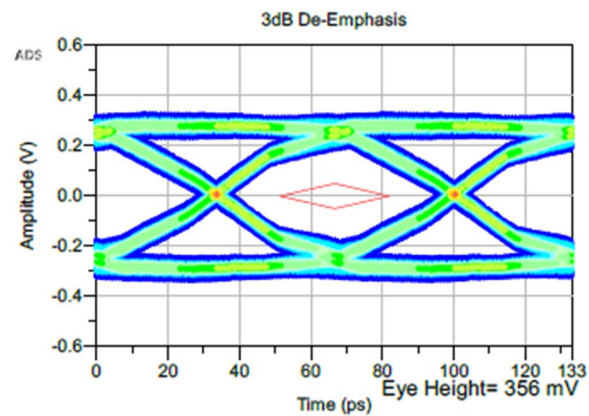
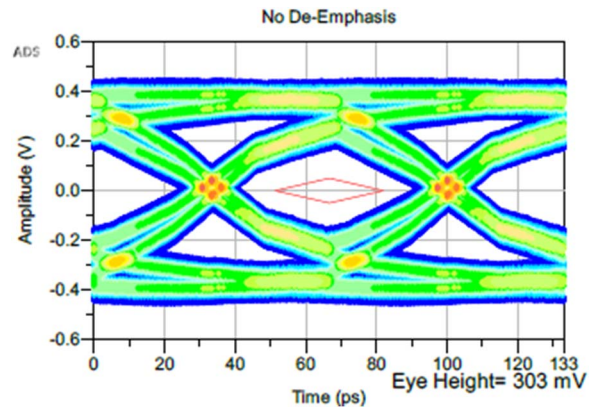
ECDP-08-39.37-L1-L1-3-3

Differential

15Gbps: Long Path





**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable**15Gbps: Short Path**

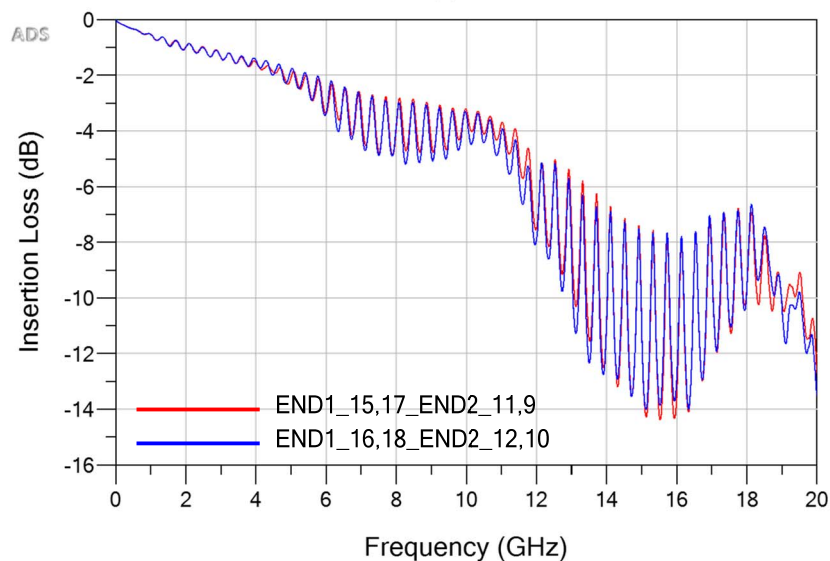


**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

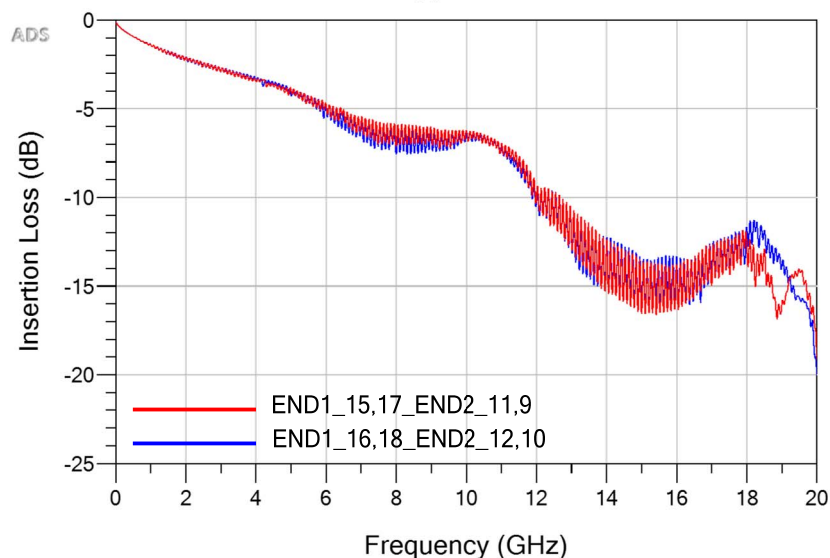
## Appendix B – Frequency Domain Response Graphs

### Differential Application – Insertion Loss

0.25m: Differential Application - Insertion Loss

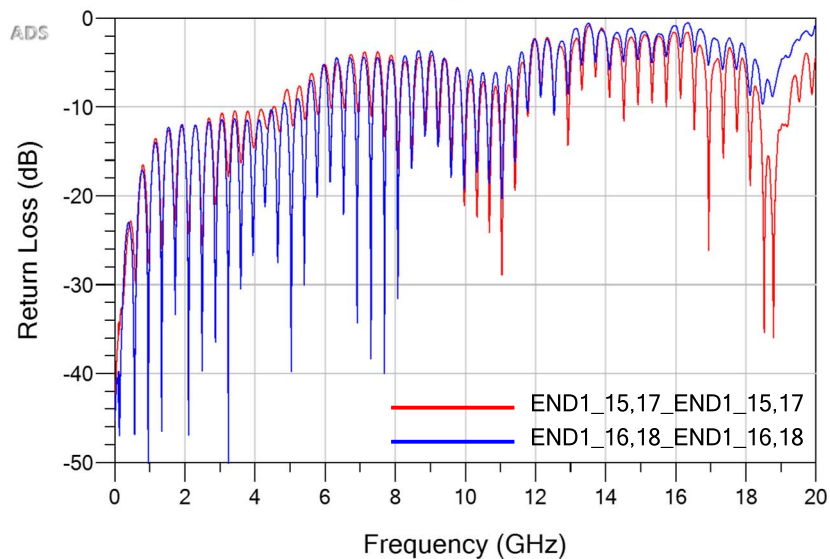


1m: Differential Application - Insertion Loss

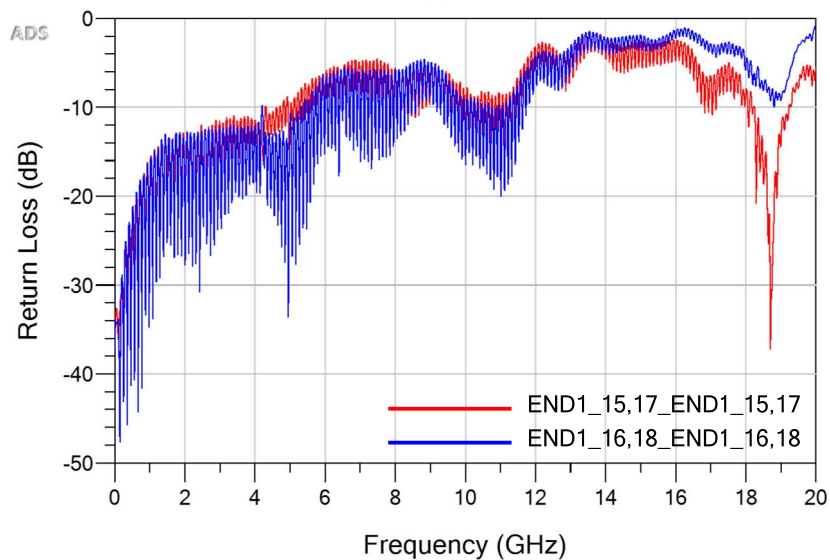


**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable**Differential Application – Return Loss**

0.25m: Differential Application - Return Loss

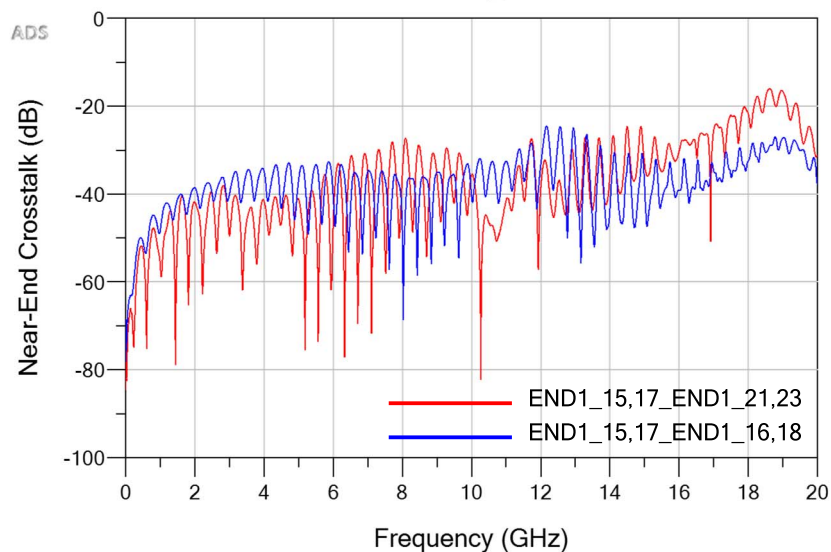


1m: Differential Application - Return Loss

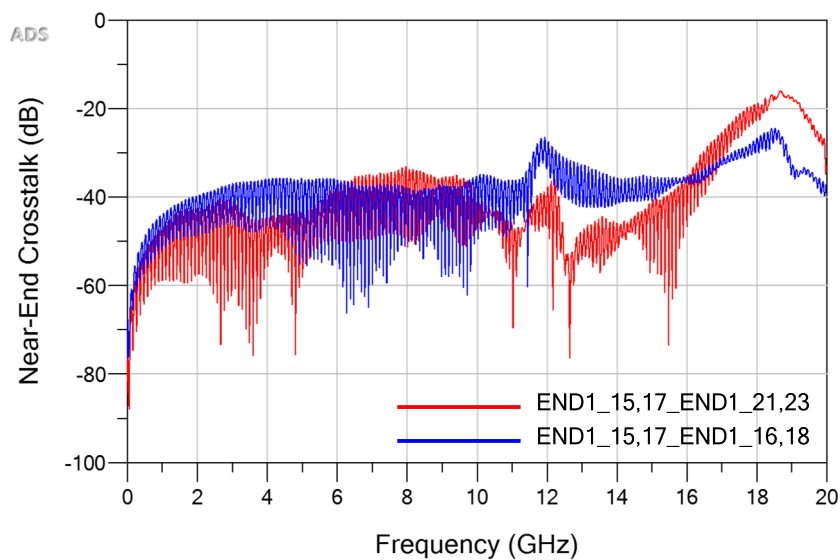


**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable**Differential Application – NEXT Configurations**

0.25m: Differential Application - NEXT

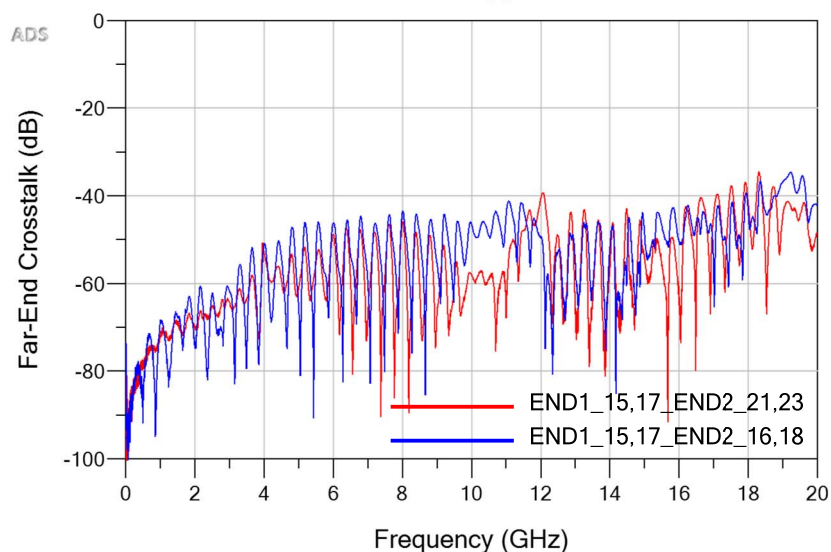


1m: Differential Application - NEXT

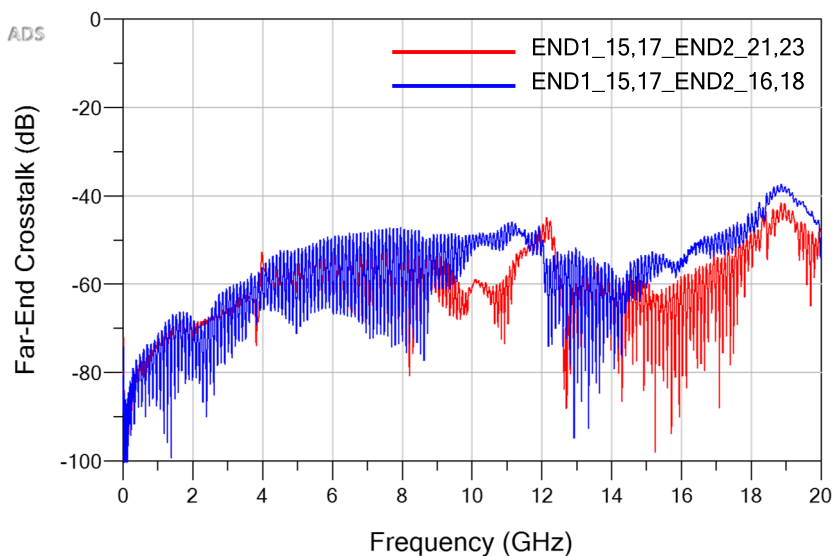


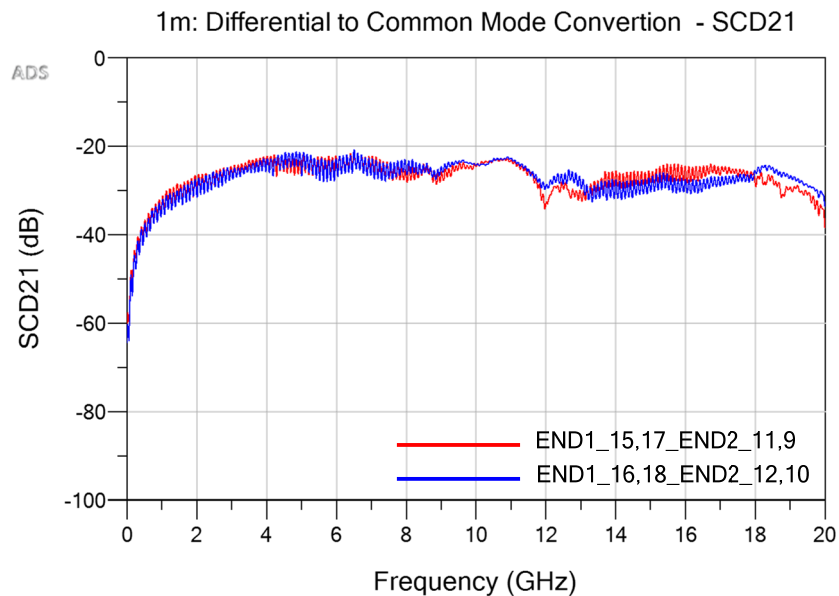
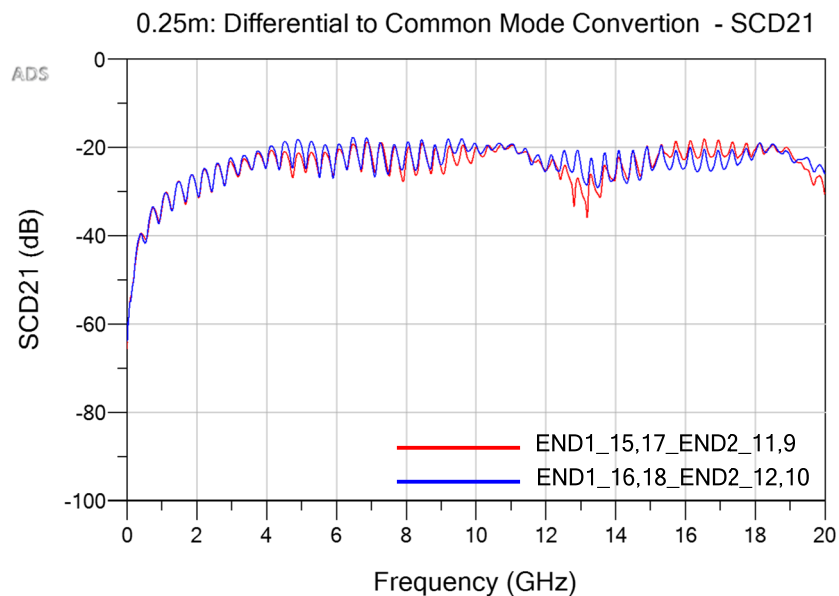
**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable**Differential Application – FEXT Configurations**

0.25m: Differential Application - FEXT



1m: Differential Application - FEXT



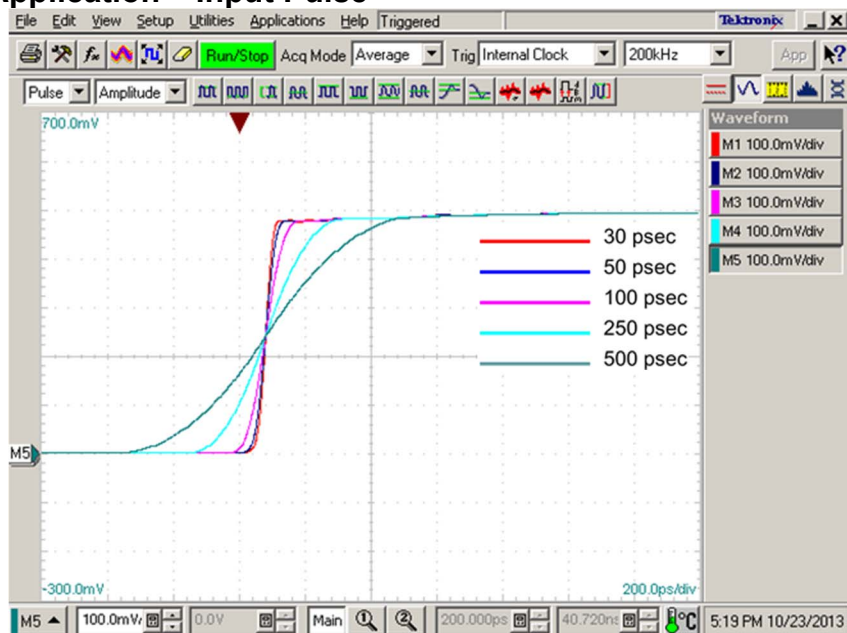
**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable**Differential Application – Differential to Common Mode Conversion**

**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Appendix C – Time Domain Response Graphs

### Differential Application – Input Pulse



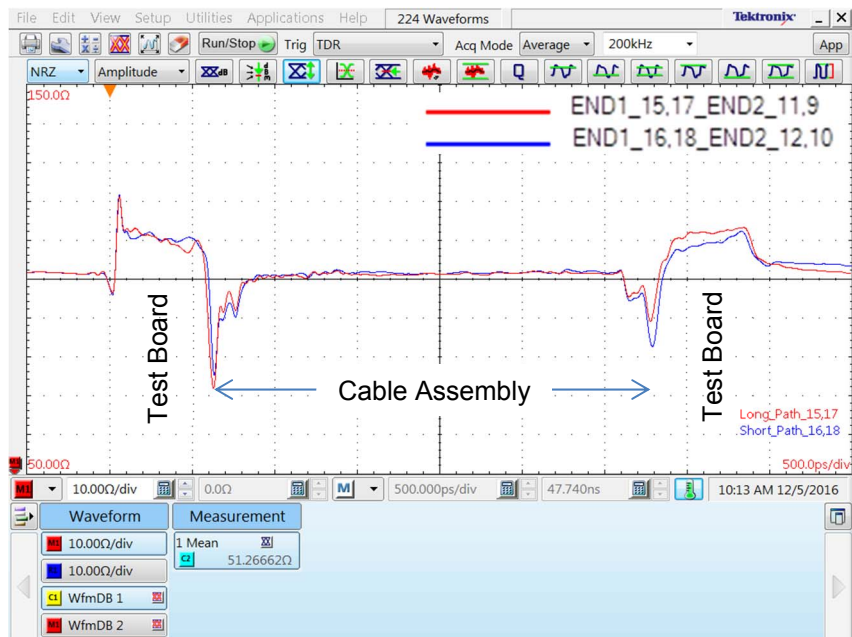


**Series:** ECDP

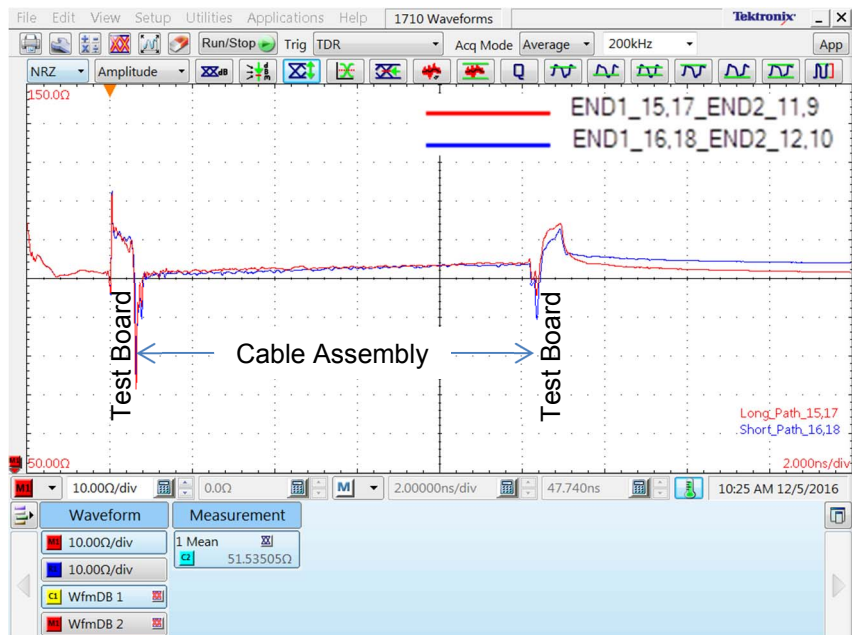
**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Differential Application – Cable Assembly Impedance

### 0.25m: Differential Application \_ Impedance



### 1m: Differential Application \_ Impedance

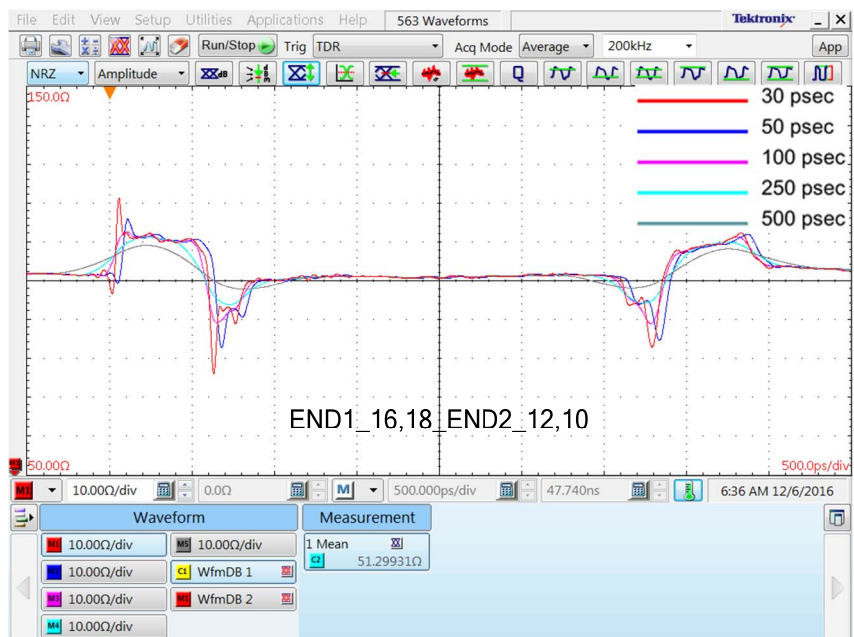
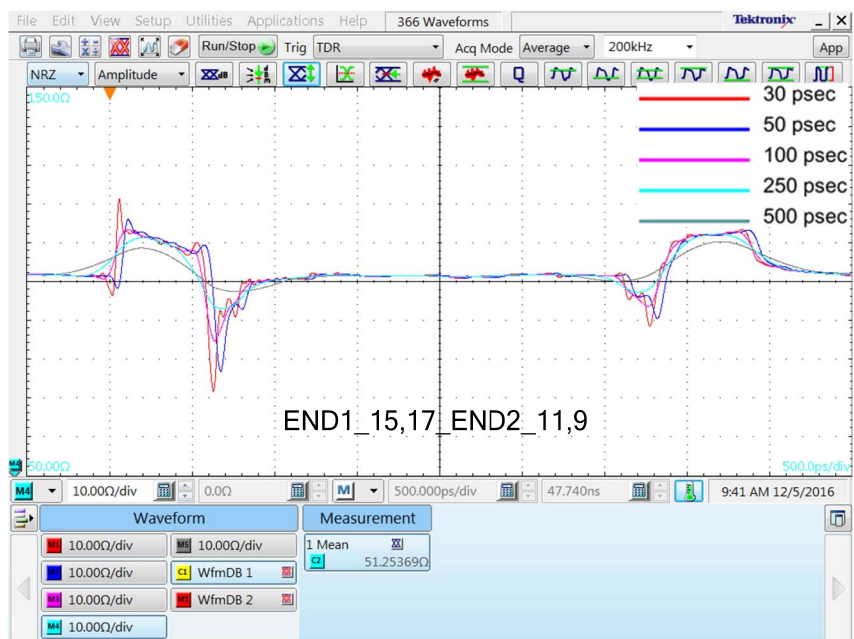


**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Differential Application – Cable assembly Impedance

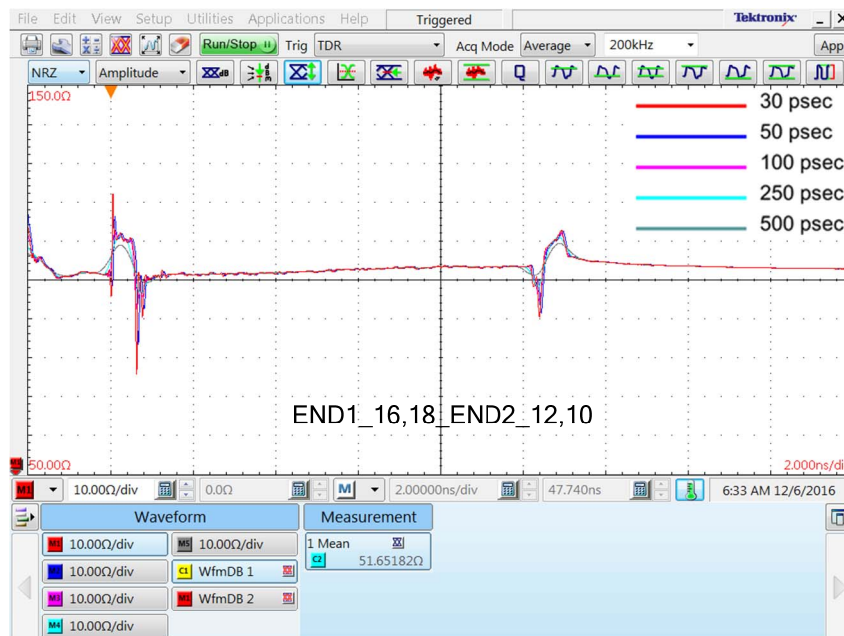
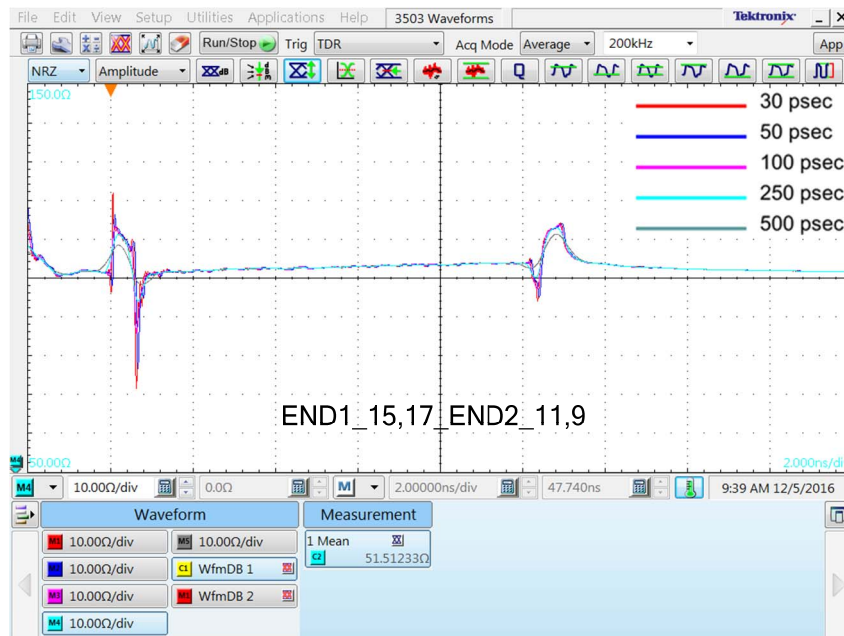
ECDP-08-09.80-L1-L1-3-3



**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

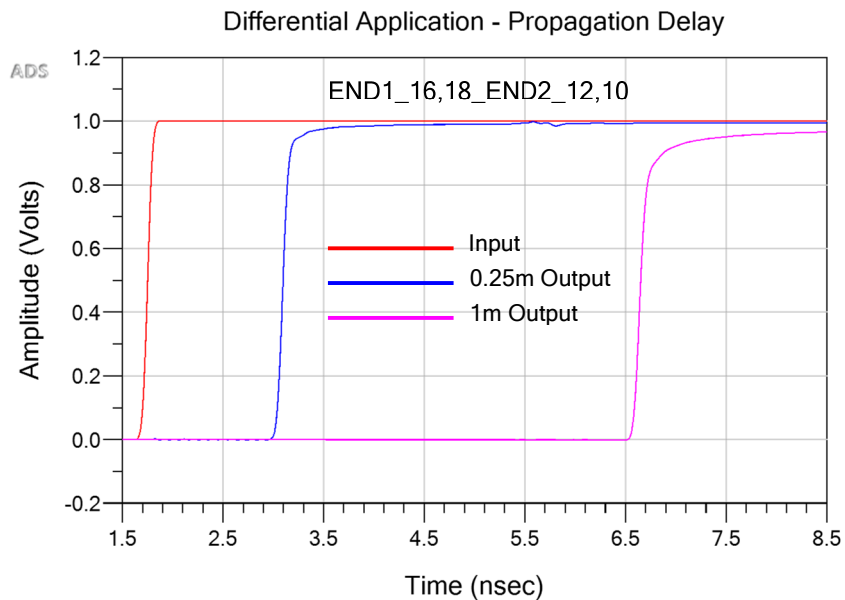
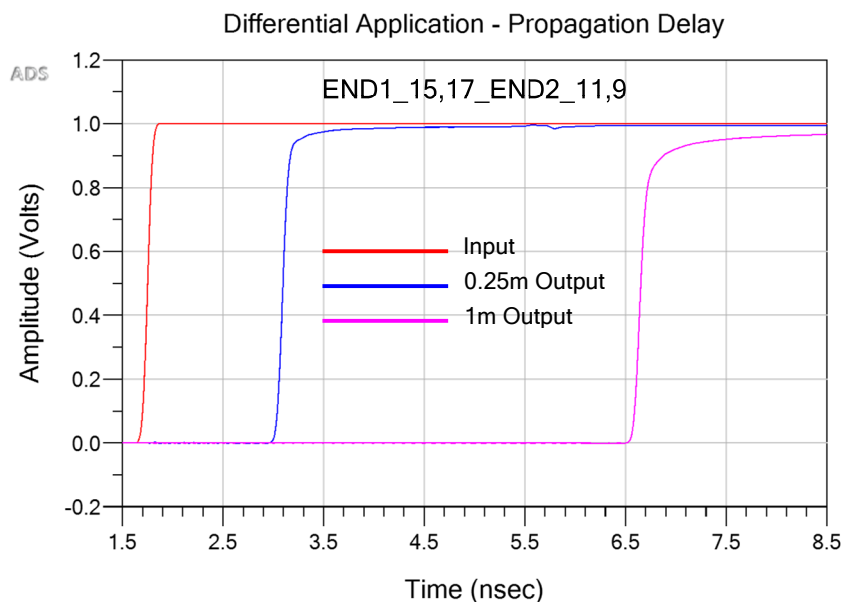
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**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Differential Application – Propagation Delay



**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Appendix D – Product and Test System Descriptions

### Product Description

Product test samples are 0.8mm Edge Rate eye-speed cable assemblies. The part numbers are ECDP-08-09.80-L1-L1-3-3 and ECDP-08-39.37-L1-L1-3-3, they mate with HSEC8-113-XX-XX-DV-X-XX. The cable assembly has two rows of 4 signal pairs evenly spaced on a 0.8 mm (0.0315”) pitch. A photo of the mated test article mounted to SI test boards is shown below.

The eye-speed cable assembly terminations had a particular signal line configuration. The respective signal line numbers are shown in table below. There are a total of 8 pairs. SMA jack numbers on the test boards correspond to the assembly line numbers. All adjacent lines are terminated where applicable.

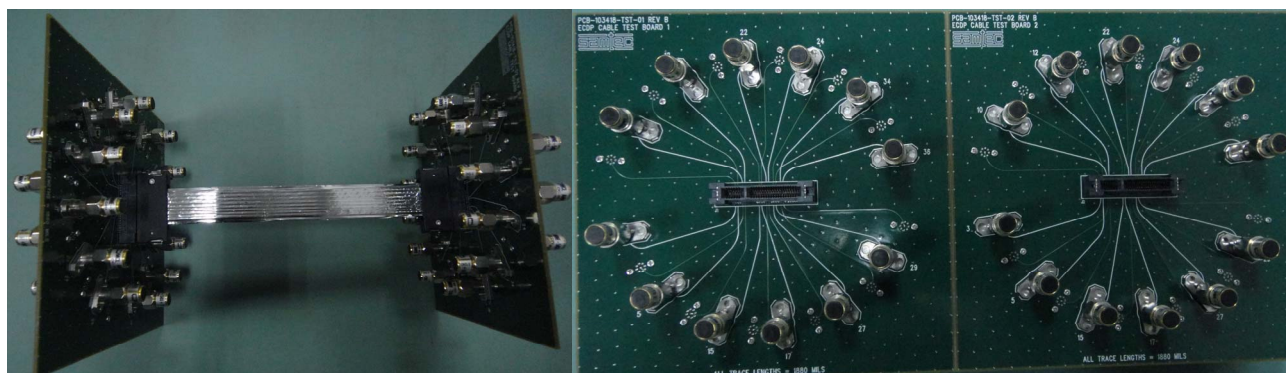
|   |   |   |   |    |    |     |   |    |    |   |    |    |   |
|---|---|---|---|----|----|-----|---|----|----|---|----|----|---|
| G | 3 | 5 | G | 9  | 11 | KEY | G | 15 | 17 | G | 21 | 23 | G |
| G | 4 | 6 | G | 10 | 12 |     | G | 16 | 18 | G | 22 | 24 | G |

Table 5: Respective signal line numbers as viewed from End 1

### Test System Description

The test fixtures are 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 fixtures. Optimization of the SMA launch was performed using full wave simulation tools to minimize reflections. Two test fixture specific to the ECDP series cable assembly identified by part PCB-103418-TST-01 and PCB-103418-TST-02. The Auto Fixture Removal (AFR) calibration structures designed specifically for the ECDP series are on PCB-103418-TST-99. Displayed on the following pages is information for the ECDP/AFR calibration structure and directives for mating ECDP fixtures.

### PCB-103418-TST-XX Test Fixtures

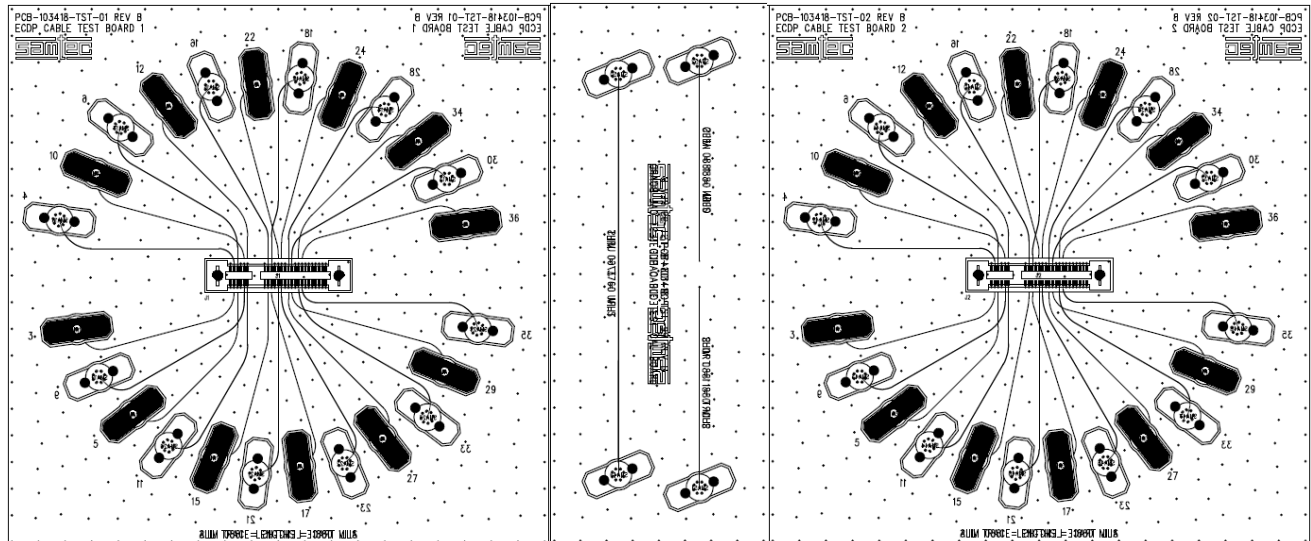




**Series:** ECDP

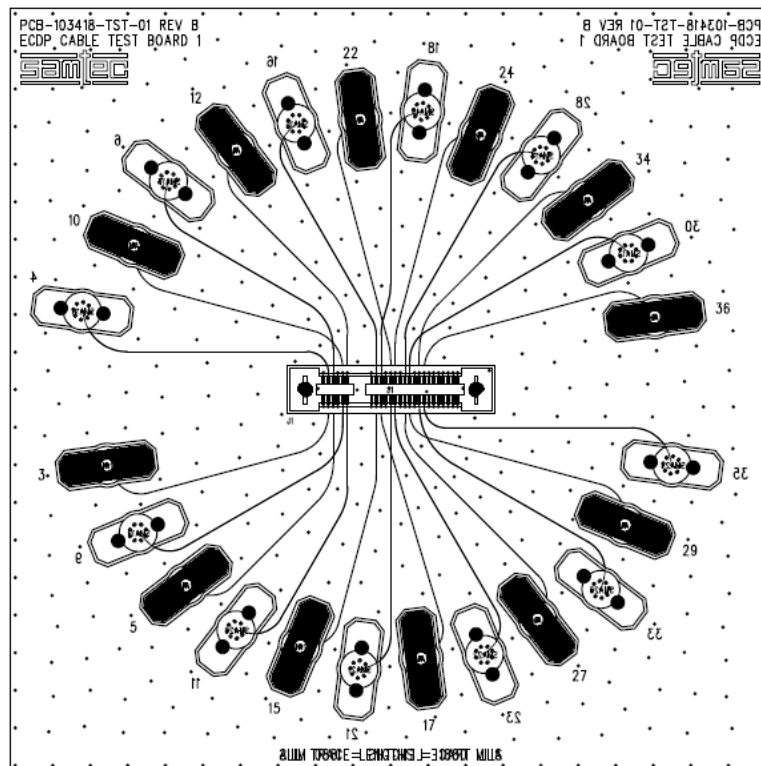
**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

Artwork of the PCB design is shown below.



### PCB Fixtures

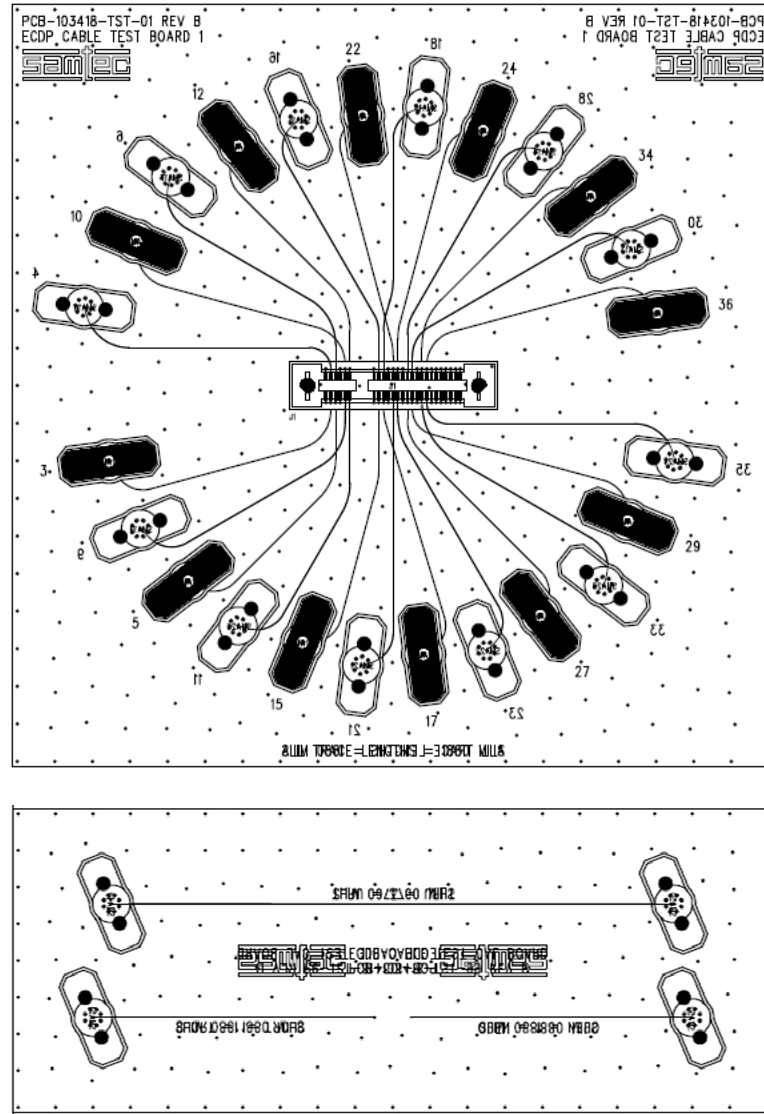
The test fixtures used are as follows:





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PCB-103418-TST-01 – ECDP Cable Test Board 1

PCB-103418-TST-02 – ECDP Cable Test Board 2

PCB-103418-TST-99 – Through

**Series:** ECDP**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## Appendix E – Test and Measurement Setup

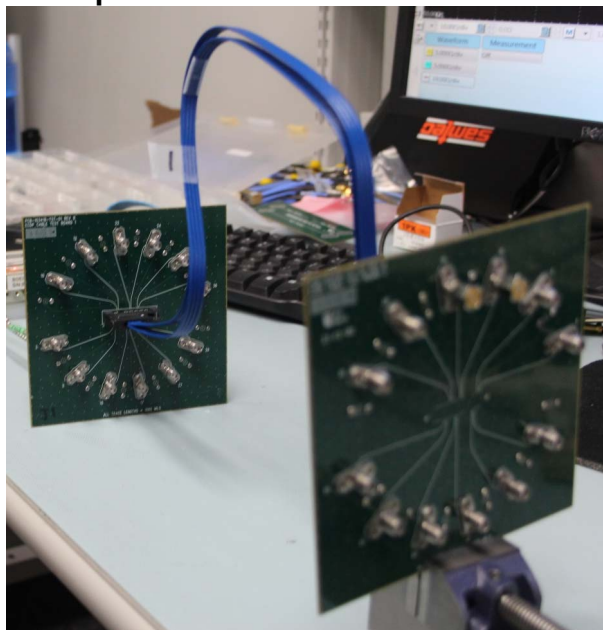
For frequency domain measurements, the test instrument is the Agilent N5230C PNA-L network analyzer. Frequency domain data and graphs are extracted from the instrument by AFR application. Post-processed time domain data and graphs are generated using convolution algorithms within Agilent ADS. The network analyzer is configured as follows:

Start Frequency – 5 MHz  
Stop Frequency – 20 GHz

Number of points – 4000  
IFBW – 1 KHz

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

### N5230C Measurement Setup



### Test Instruments

| <u>QTY</u> | <u>Description</u>                                        |
|------------|-----------------------------------------------------------|
| 1          | Agilent N5230C PNA-L Network Analyzer (300 KHz to 20 GHz) |
| 1          | Agilent N4433A ecal module (300 KHz to 20 GHz)            |

### Test Cables & Adapters

| <u>QTY</u> | <u>Description</u>               |
|------------|----------------------------------|
| 4          | Gore OWD01D02039-4 (DC-26.5 GHz) |

**Series:** ECDP

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For impedance measurements, the test instrument is the Tektronix DSA8200 Digital Serial Analyzer mainframe and 80E04 sampling module. The impedance data and profiles are obtained directly from the instrument. The Digital Analyzer is configured as follows:

Vertical Scale: 10 ohm / Div:  
Offset: Default / Scroll  
Horizontal Scale: 500ps / Div or 2ns / Div  
Record Length: 4000  
Averages:  $\geq 16$

### **DSA8200 Measurement Setup**



### **Test Instruments**

| <u>QTY</u> | <u>Description</u>                                      |
|------------|---------------------------------------------------------|
| 1          | Tektronix DSA8200 Digital Serial Analyzer               |
| 2          | Tektronix 80E04 Dual Channel 20 GHz TDR Sampling Module |

### **Test Cables & Adapters**

| <u>QTY</u> | <u>Description</u>                        |
|------------|-------------------------------------------|
| 2          | Samtec RF405-01SP1-01SP1-0305 (DC-20 GHz) |

**Series:** ECDP

**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## 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:

Agilent'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 1.0 inch length of Tx interconnect trace segment at the transmitter.
- SUT Cable Assembly S-Parameter measurements
  - o 6.5 mils of 7.5 mil wide differential stripline signal trace
  - o Test board vias, pads (footprint effects) for the HSEC8 connector
  - o The HSEC8 series connector J1
  - o The ECDP cable assembly
  - o The HSEC8 series connector J2
  - o Test board vias, pads (footprint effects) for the HSEC8 connector
  - o 6.5 mils of 7.5 mil wide differential stripline signal trace
- A 1.0 inch 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

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- Traces are microstrip with the following geometry:
  - o 7.5 mil trace width
  - o 2 mil trace copper thickness
  - o 4.4 mil FR4 dielectric thickness

#### 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:

$$\text{Rise time} = 0.35/\text{Bandwidth}$$

**Series:** ECDP

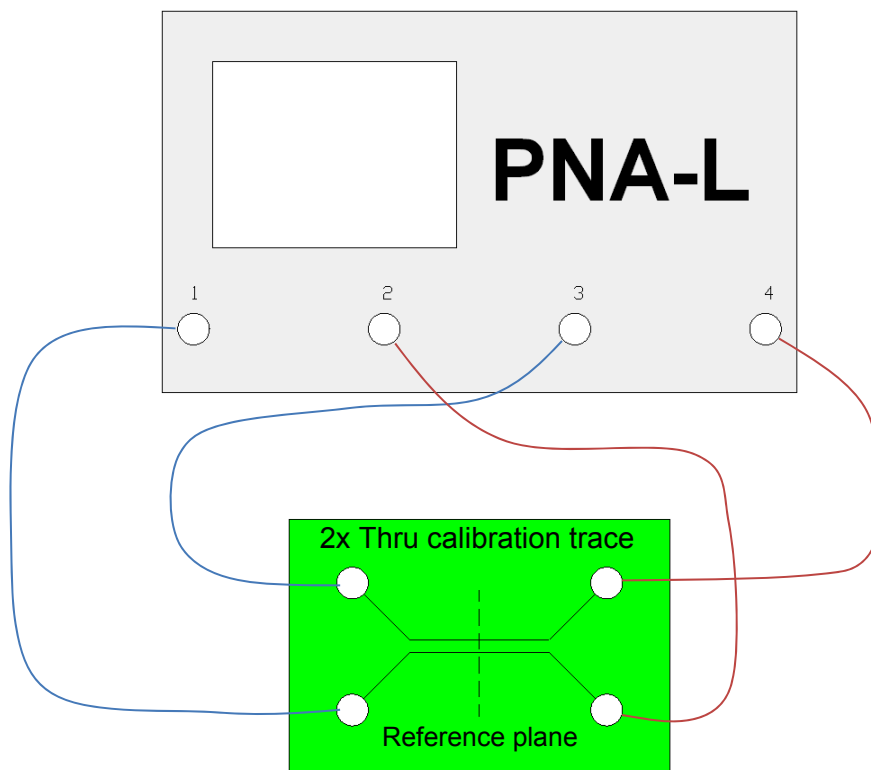
**Description:** 0.80 mm Edge Rate® Edge Card Twinax Cable Assembly, 30 AWG Eye Speed® Twinax Cable

## 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 N4433A 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 ECDP test boards, this is greater than 20 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.





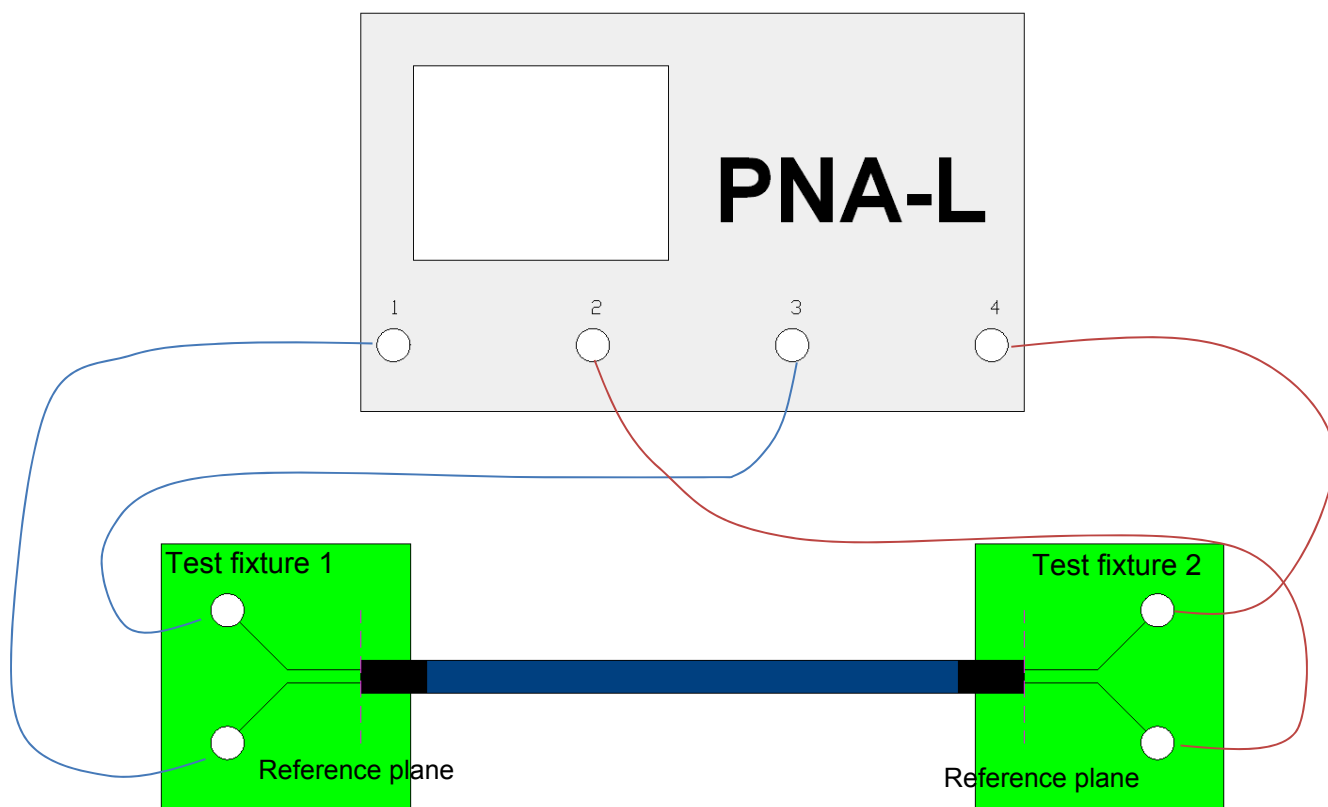
**Series:** ECDP

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Measurements are then performed using the test boards as shown below. The test board effects are removed in post-processing via AFR in Agilent PLTS. The calibrated reference plane is located 6.5 mils from the connector footprint on each side. The S-Parameter measurements include:

- A. 6.5 mils of 7.5 mil wide differential stripline signal trace
- B. Test board vias, pads (footprint effects) for the HSEC8 connector
- C. The HSEC8 series connector J1
- D. The ECDP test cable
- E. The HSEC8 series connector J2
- F. Test board vias, pads (footprint effects) for the HSEC8 connector
- G. 6.5 mils of 7.5 mil wide differential stripline signal trace

The test boards used for this characterization had a differential trace impedance of 112 ohms. Unfortunately, this impedance offset cascades through the AFR process and distorting the impedance measurements. For this reason, AFR was not applied to the impedance data in this report. The figure below shows the location of the measurement reference plane.



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### 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 Agilent 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](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)

Measurements involving digital pulses are performed using either Time Domain Reflectometer (TDR) or Time Domain Transmission (TDT) methods. The TDR method is used for the impedance measurements in this report.

The signal line(s) of the SUT's is energized with a TDR pulse and the far-end of the energized signal line is terminated in the test systems characteristic impedance (e.g.; 50Ω or 100Ω terminations). By terminating the adjacent signal lines in the test systems characteristic impedance, the effects on the resultant impedance shape of the waveform is limited. The "best case" signal mapping was tested and is presented in this report.

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### 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)