

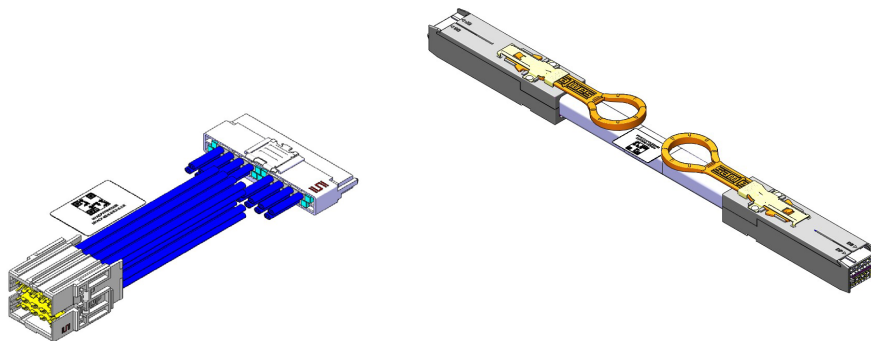


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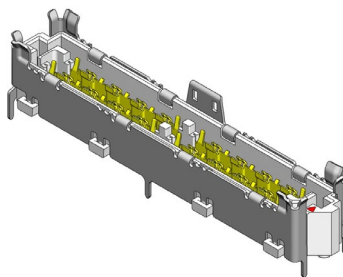
## High Speed Characterization Report

**NVACP-DP-3-4-06.0-B-1-2**  
(Twinax Pairs Only, 34AWG 92ohm, 4-row, NVAC End 2, 112G PAM4 Speed)

**NVACE-DP-5-4-X.X-A-1-2**  
(Twinax Pairs Only, 28AWG 100ohm, 4-row, NVACE End 2, 112G PAM4 Speed)



**Mated with:**  
**NVAM-DP-02-2-02.0-S-2-C**



**Description:**  
**NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP), and**  
**NovaRay® I/O Extreme Performance Cable Assembly (NVACE)**

**Series:** NVACE, NVACP**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

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**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

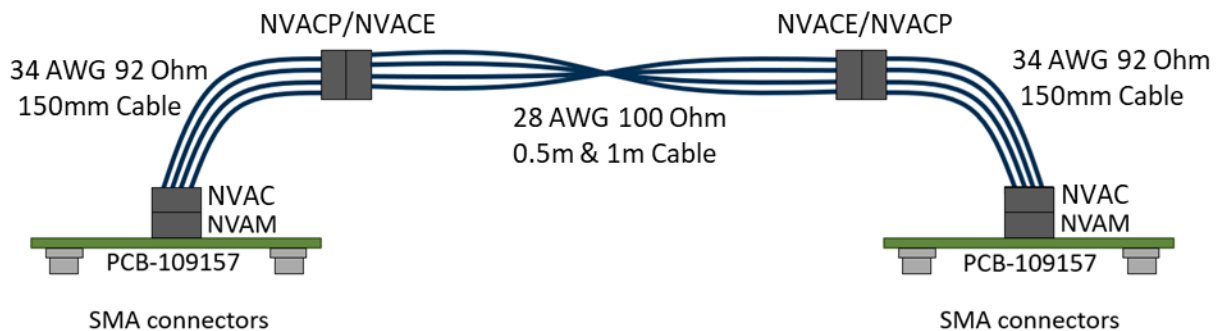
## Cable Assembly Overview

The NovaRay® Extreme Performance Panel Mount Cable Assembly (NVACP) is constructed using 28, 30 or 34 AWG twinax cable for differential signaling or 34 AWG coax for single-ended signaling. It is an internal, inside the box cable, which adopts cable-to-cable bulkhead panel connection using Flyover® cable technology.

The NovaRay® Extreme Performance Cable Assembly (NVACE) is constructed using 28, 30 or 34 AWG twinax cable for differential signaling or 34 AWG coax for single-ended signaling. It is an external, outside the box cable, which adopts cable-to-cable bulkhead panel connection using Flyover® cable technology. This report is only available for the NVACP with 6 inch long 34 AWG 92 Ohm twinax cable, NVAC End 2 mated to NVACE with 28 AWG 100 Ohm twinax cable (0.5 meter and 1 meter lengths).



**Figure 1: Test Sample**



**Figure 2: Diagram of the DUT**

Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Frequency Domain Data Summary

### Bandwidth Figures – Differential Insertion Loss

NVACP-150mm + NVACE-0.5m + NVACP-150mm  
Differential Application - Insertion Loss

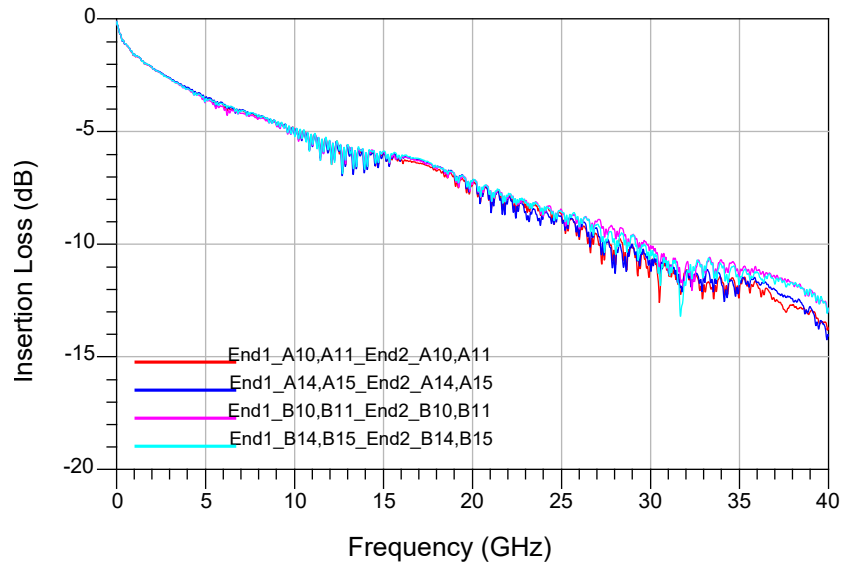


Figure 3

NVACP-150mm + NVACE-1m + NVACP-150mm  
Differential Application - Insertion Loss

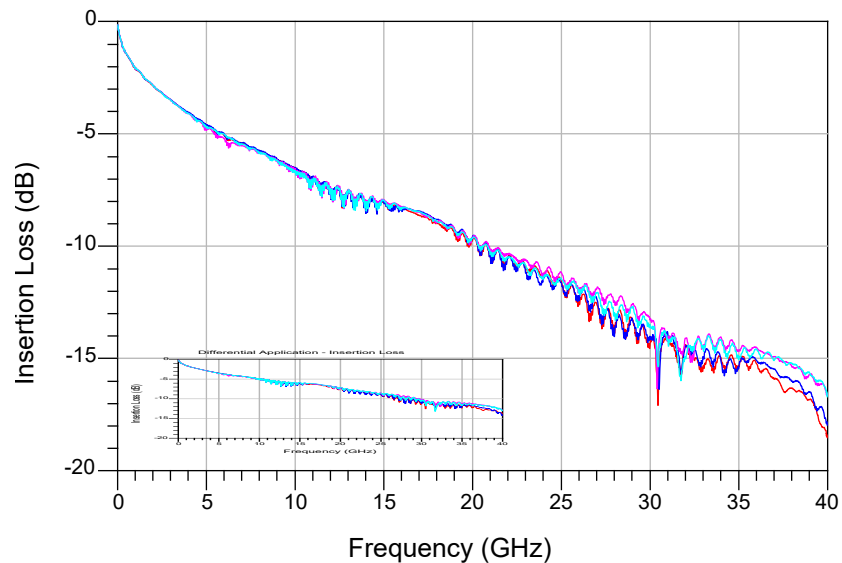


Figure 4

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Time Domain Data Summary

NVACP-150mm + NVACE-0.5m + NVACP-150mm

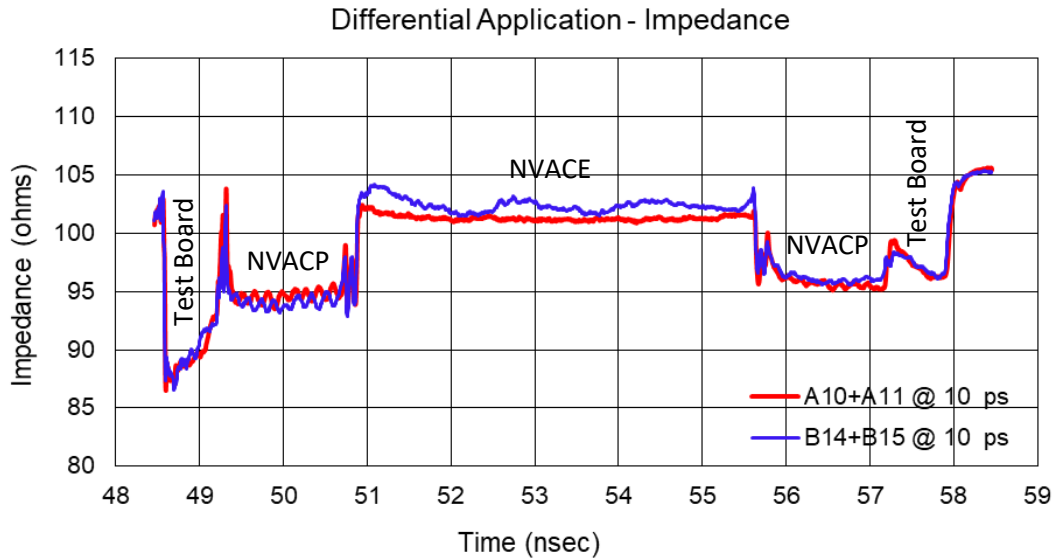


Figure 5

NVACP-150mm + NVACE-1m + NVACP-150mm

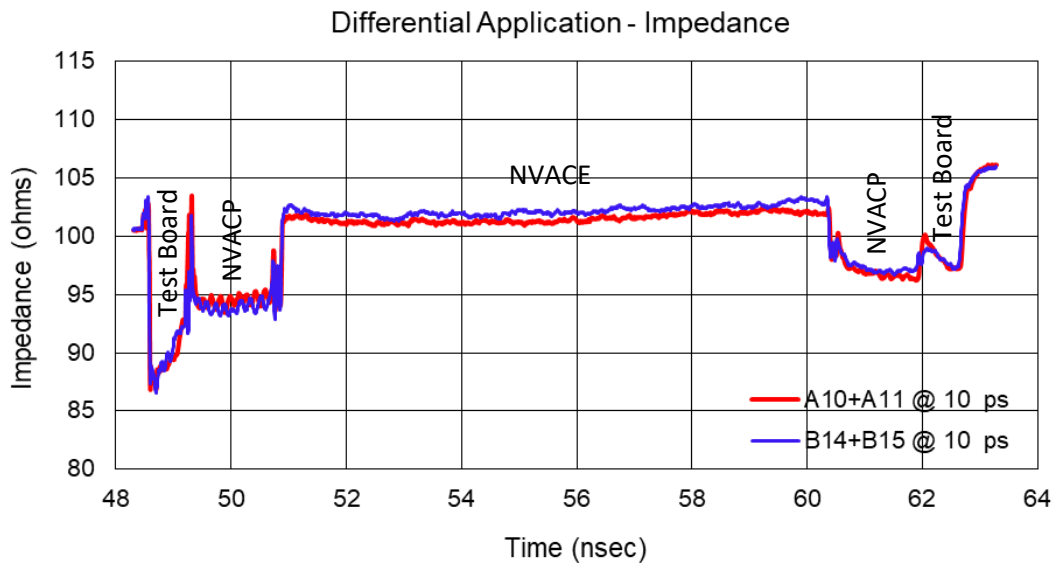


Figure 6

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

<b>Table 1 - Propagation Delay (Cable Assembly)</b>			
<b>Driver</b>	<b>Receiver</b>	<b>NVACP-150mm + NVACE- 0.5m + NVACP-150mm</b>	<b>NVACP-150mm + NVACE- 1m + NVACP-150mm</b>
End 1_A10, A11	End 2_A10, A11	4.096 ns	6.484 ns
End 1_A14, A15	End 2_A14, A15	4.097 ns	6.487 ns
End 1_B10, B11	End 2_B10, B11	4.091 ns	6.477 ns
End 1_B14, B15	End 2_B14, B15	4.092 ns	6.473 ns

## 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 assemblies, 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.

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Cable Assembly Pin Map

The NVACP-NVACE-NVACP flyover cable assembly pin mapping is pre-defined and shown below:

NVAx		NVAC to NVACP Cable Mapping		NVACE to NVACE Cable Mapping		NVACx			
	B01	A02	A02	A02	A02	A01	B01	C01	D01
A01	B02	A03	A03	A03	A03	A02	B02	C02	D02
A02	B03	A06	A05	A05	A05	A03	B03	C03	D03
A03	B04	A07	A06	A06	A06	A04	B04	C04	D04
A04	B05	A10	A08	A08	A08	A05	B05	C05	D05
A05	B06	A11	A09	A09	A09	A06	B06	C06	D06
A06	B07	A14	A11	A11	A11	A07	B07	C07	D07
A07	B08	A15	A12	A12	A12	A08	B08	C08	D08
A08	B09	B02	B02	B02	B02	A09	B09	C09	D09
A09	B10	B03	B03	B03	B03	A10	B10	C10	D10
A10	B11	B06	B05	B05	B05	A11	B11	C11	D11
A11	B12	B07	B06	B06	B06	A12	B12	C12	D12
A12	B13	B10	B08	B08	B08	A13	B13	C13	D13
A13	B14	B11	B09	B09	B09				
A14	B15	B14	B11	B11	B11				
A15	B16	B15	B12	B12	B12				
A16		A18	C02	C02	C02				
	B17	A19	C03	C03	C03				
A17	B18	A22	C05	C05	C05				
A18	B19	A23	C06	C06	C06				
A19	B20	A26	C08	C08	C08				
A20	B21	A27	C09	C09	C09				
A21	B22	A30	C11	C11	C11				
A22	B23	A31	C12	C12	C12				
A23	B24	B18	D02	D02	D02				
A24	B25	B19	D03	D03	D03				
A25	B26	B22	D05	D05	D05				
A26	B27	B23	D06	D06	D06				
A27	B28	B26	D08	D08	D08				
A28	B29	B27	D09	D09	D09				
A29	B30	B30	D11	D11	D11				
A30	B31	B31	D12	D12	D12				
A31	B32								
A32									

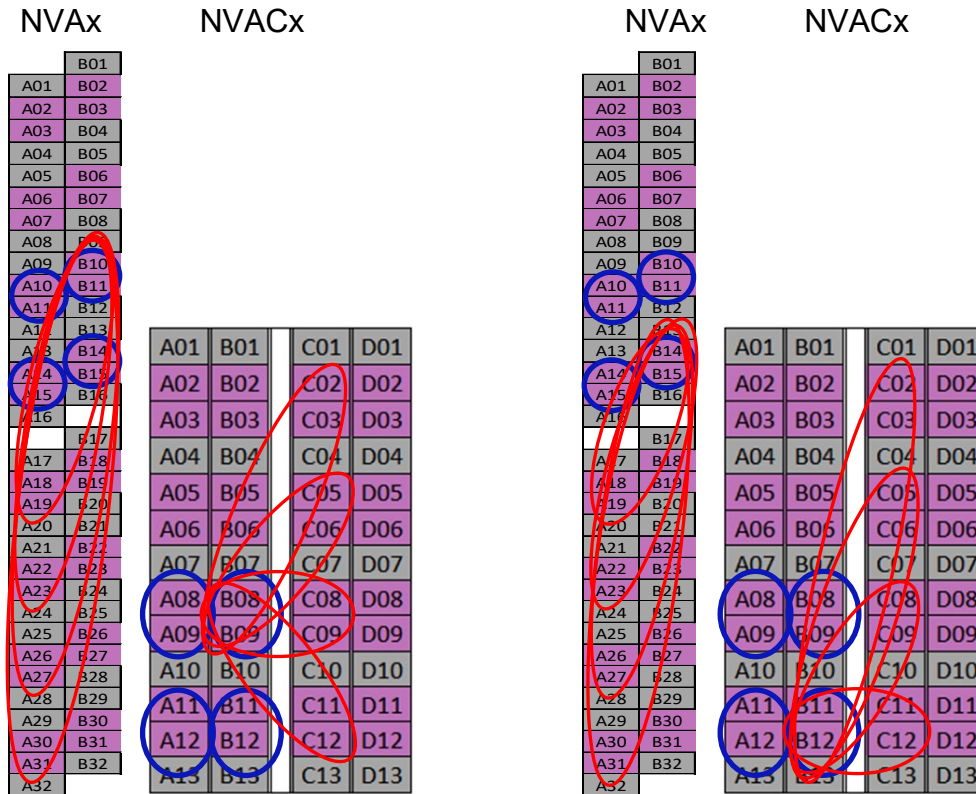
x Ground Pin  
x Routed Pair  
x

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

For this cable assembly, the following configurations are evaluated:

Potential NEXT aggressors, depending on pinout:

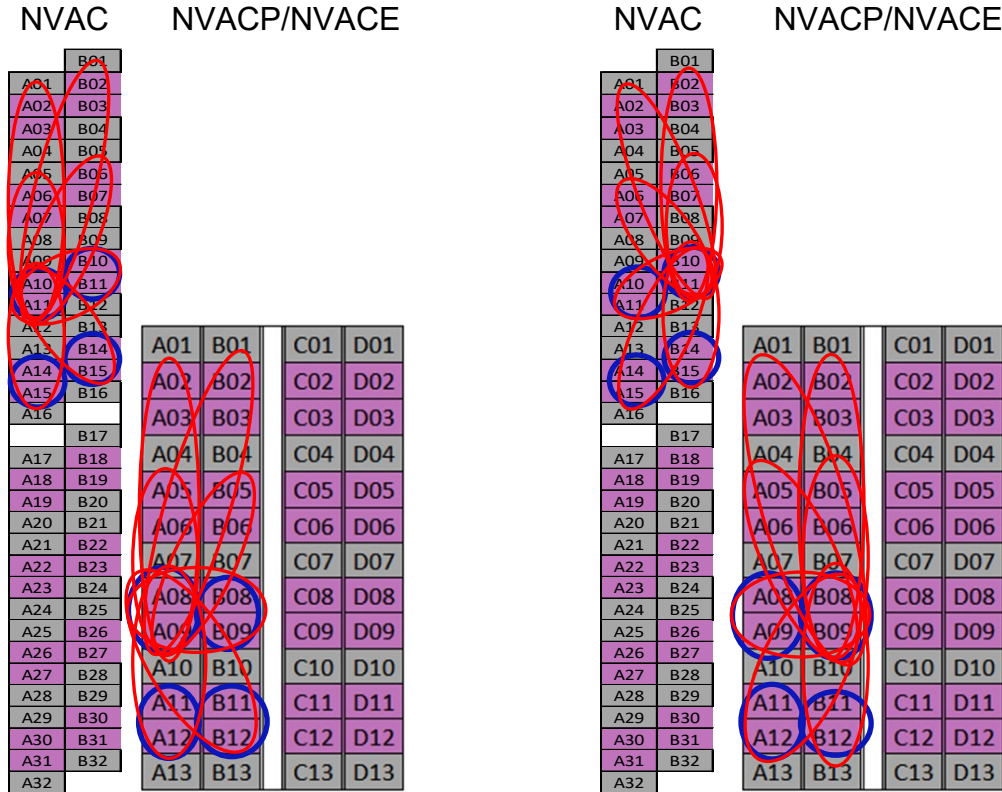




**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

Potential FEXT aggressors, depending on pinout:



Differential Impedance (denoted by blue 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.

See [Appendix C](#) – Product and Test System Descriptions for details

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

### 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 10 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 10 ps and 100 ps.

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

### **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 DSA8300 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 B](#) of this report.

The measured S-Parameters from the network analyzer are post-processed using Keysight ADS to obtain the time domain response for signal propagation time. The 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](mailto:sig@samtec.com) for more information.

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

In this report, propagation delay is defined as the signal propagation time through the cable assembly, mating connectors, and connector footprint. It also includes 2.937 mm 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.

Additional information concerning test conditions and procedures is 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: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Appendix A – Frequency Domain Responses

### Differential Application – Insertion Loss

NVACP-150mm + NVACE-0.5m + NVACP-150mm  
Differential Application - Insertion Loss

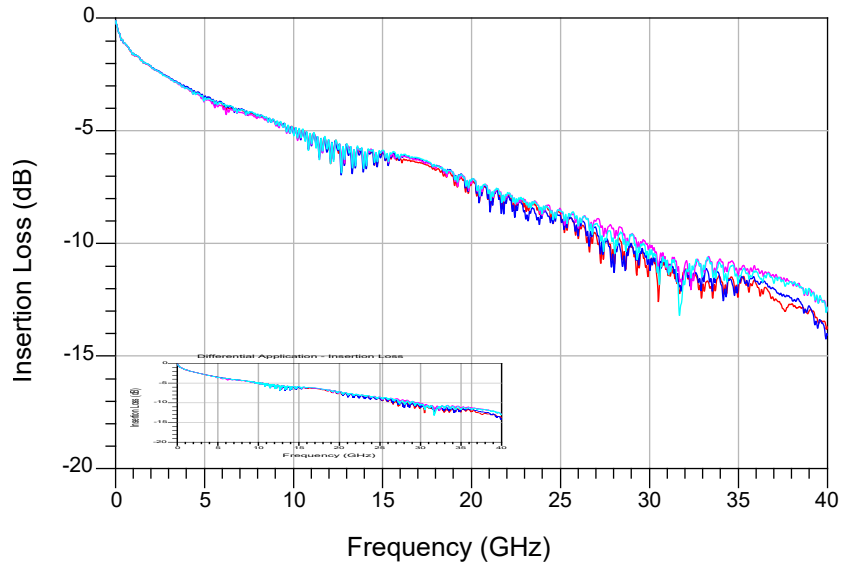


Figure 7

NVACP-150mm + NVACE-1m + NVACP-150mm  
Differential Application - Insertion Loss

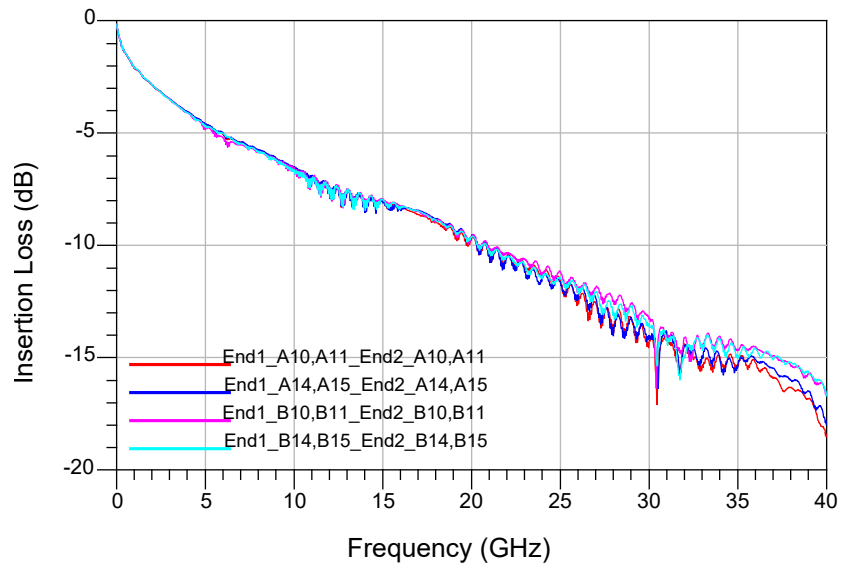


Figure 8

Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Differential Application – Return Loss

NVACP-150mm + NVACE-0.5m + NVACP-150mm  
Differential Application - Return Loss

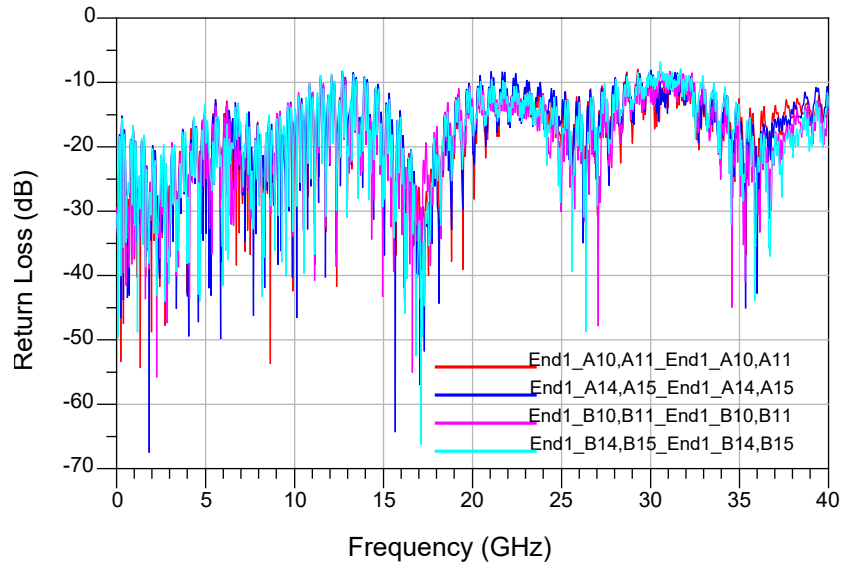


Figure 9

NVACP-150mm + NVACE-1m + NVACP-150mm  
Differential Application - Return Loss

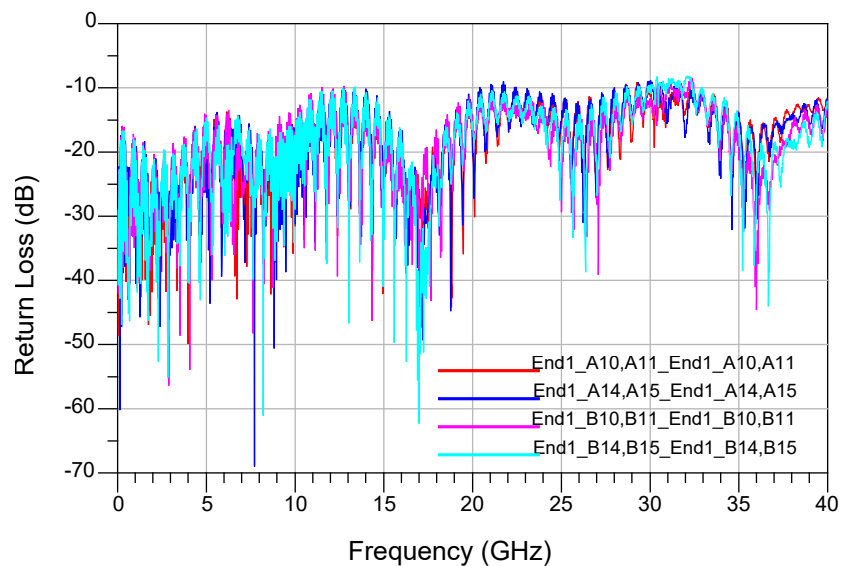


Figure 10

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Differential Application – NEXT Configurations

NVACP-150mm + NVACE-0.5m + NVACP-150mm  
Differential Application - NEXT

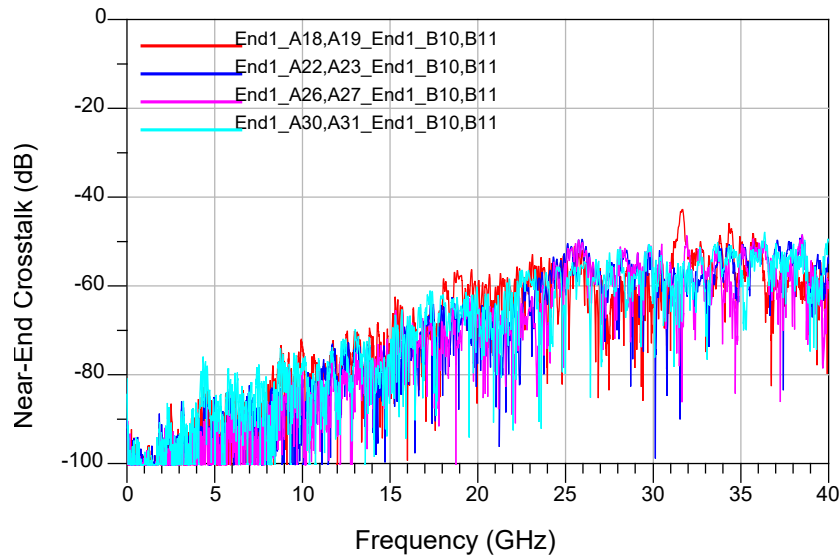


Figure 11

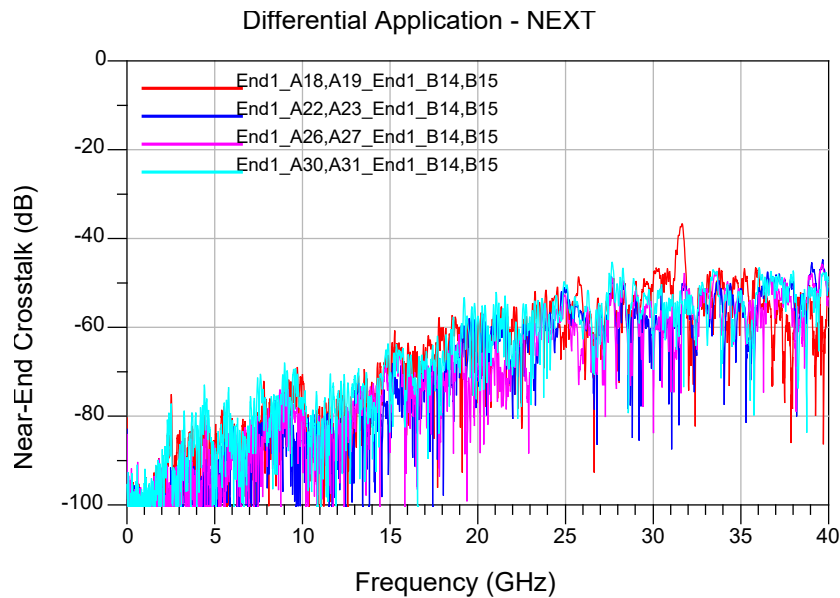


Figure 12

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

NVACP-150mm + NVACE-1m + NVACP-150mm  
Differential Application - NEXT

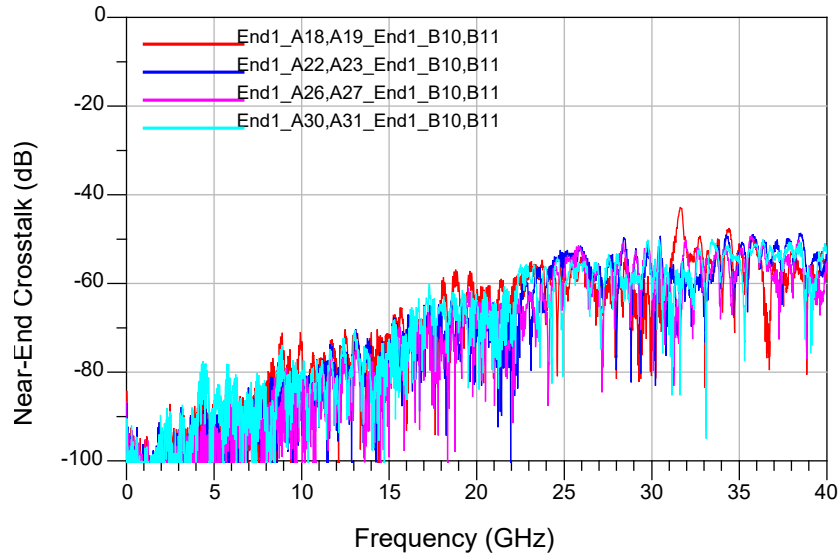


Figure 13

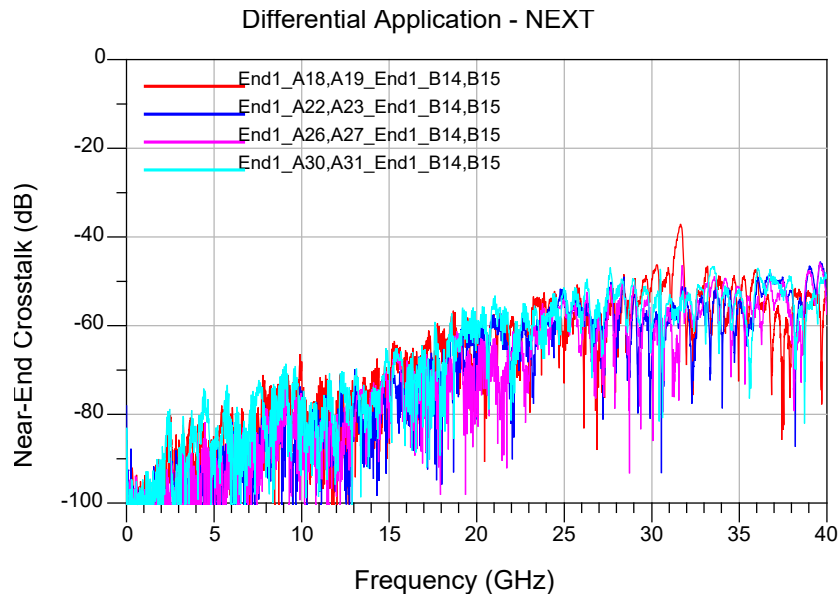


Figure 14

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Differential Application – FEXT Configurations

NVACP-150mm + NVACE-0.5m + NVACP-150mm  
Differential Application - FEXT

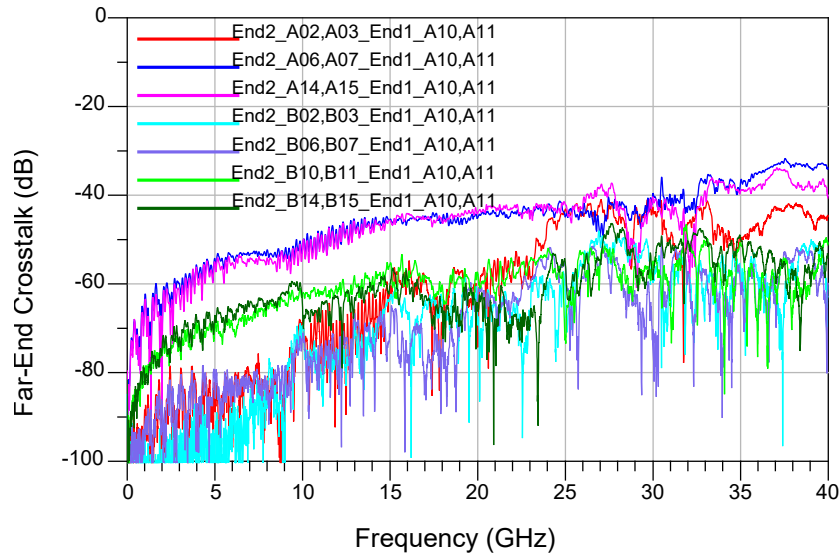


Figure 15

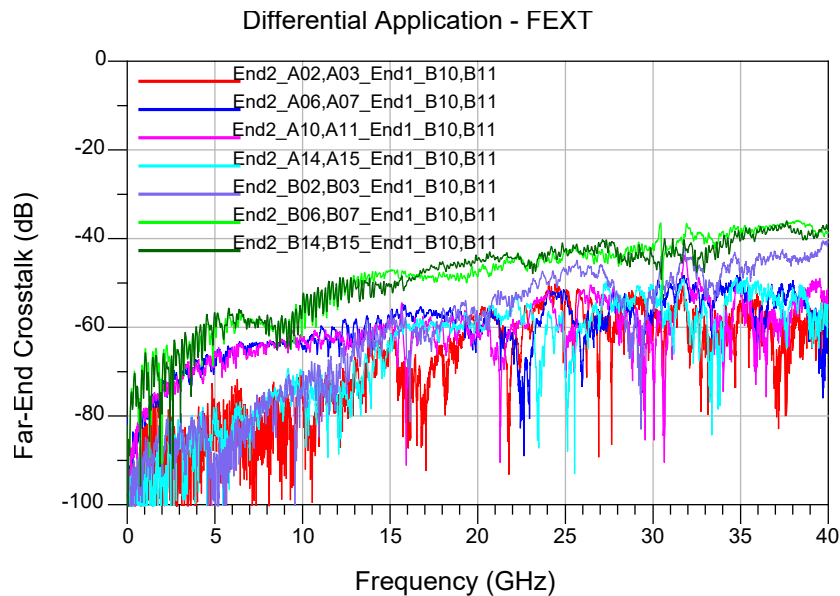


Figure 16



**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

NVACP-150mm + NVACE-1m + NVACP-150mm  
Differential Application - FEXT

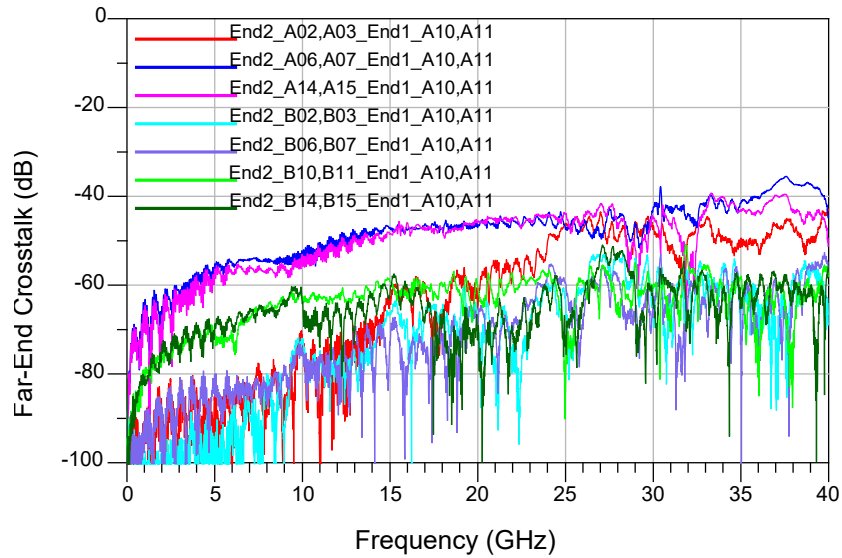


Figure 17

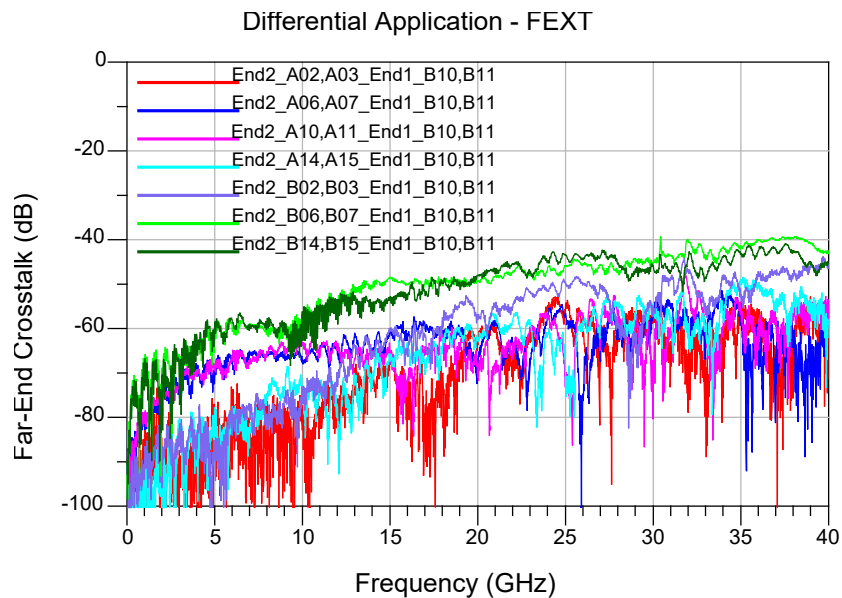


Figure 18

Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Differential Application – Differential to Common Mode Conversion

NVACP-150mm + NVACE-0.5m + NVACP-150mm

Differential to Common Mode Conversion - SCD21

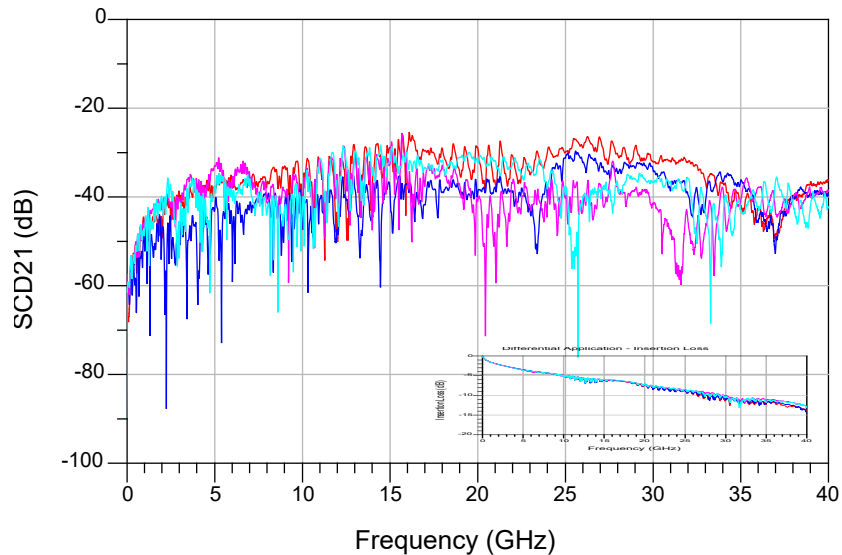


Figure 19

NVACP-150mm + NVACE-1m + NVACP-150mm

Differential to Common Mode Conversion - SCD21

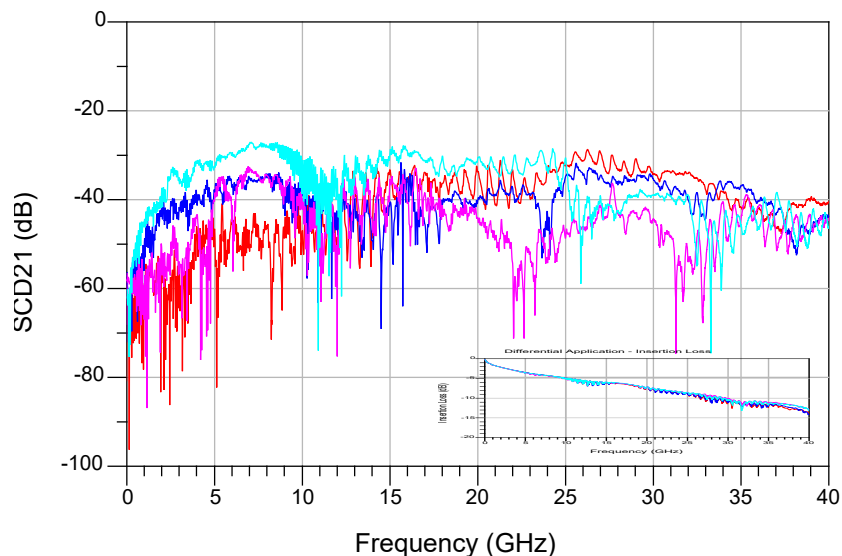


Figure 20

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Appendix B – Time Domain Responses

### Differential Application – Input Pulse

Differential Application - Input Pulse

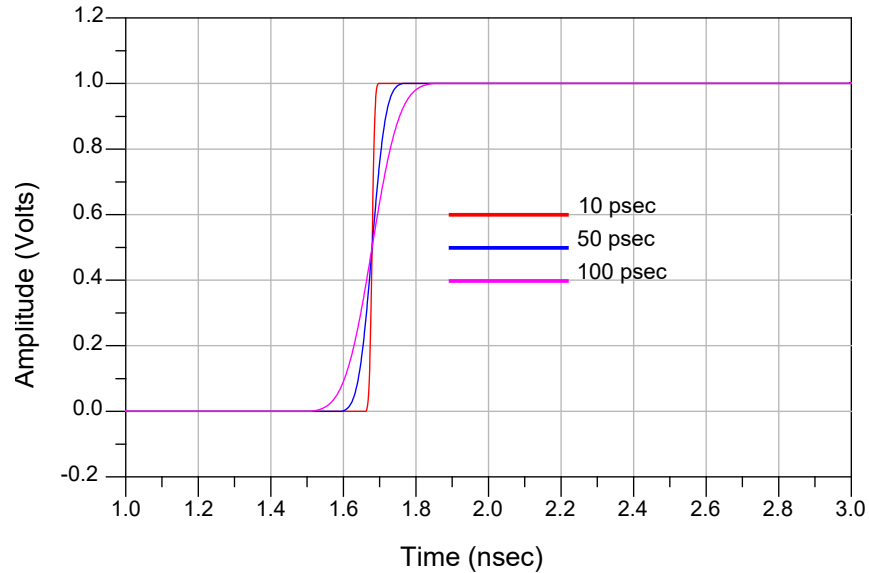


Figure 21

### Differential Application – Cable Assembly Impedance:

NVACP-150mm + NVACE-0.5m + NVACP-150mm

Differential Application - Impedance

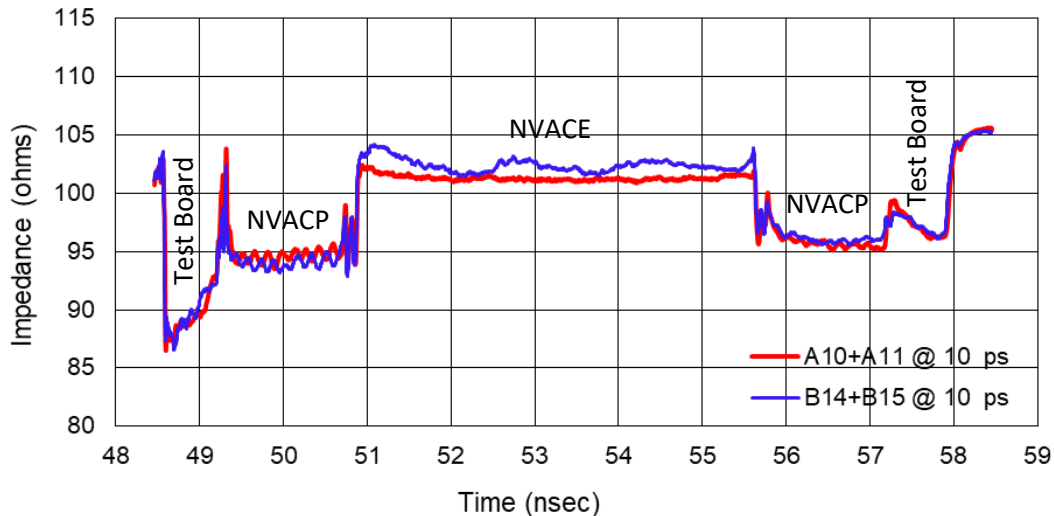


Figure 22

Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

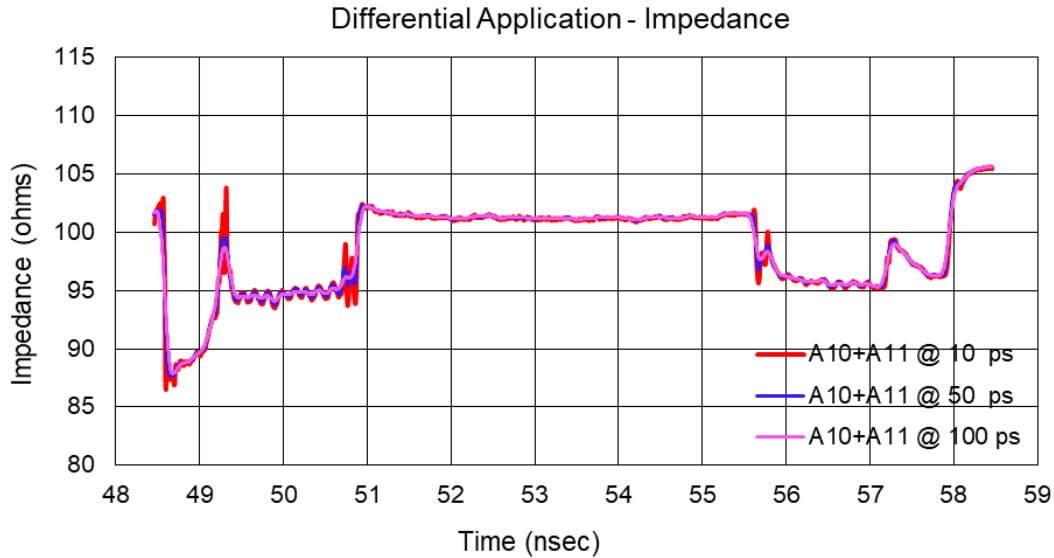


Figure 23

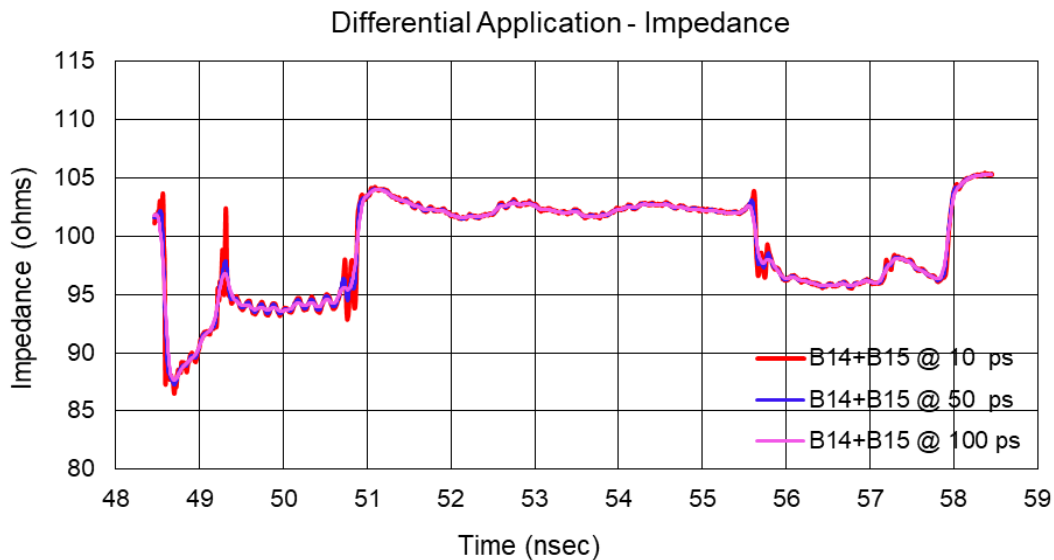


Figure 24

Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

### Differential Application – Cable Assembly Impedance: NVACP-150mm + NVACE-1m + NVACP-150mm

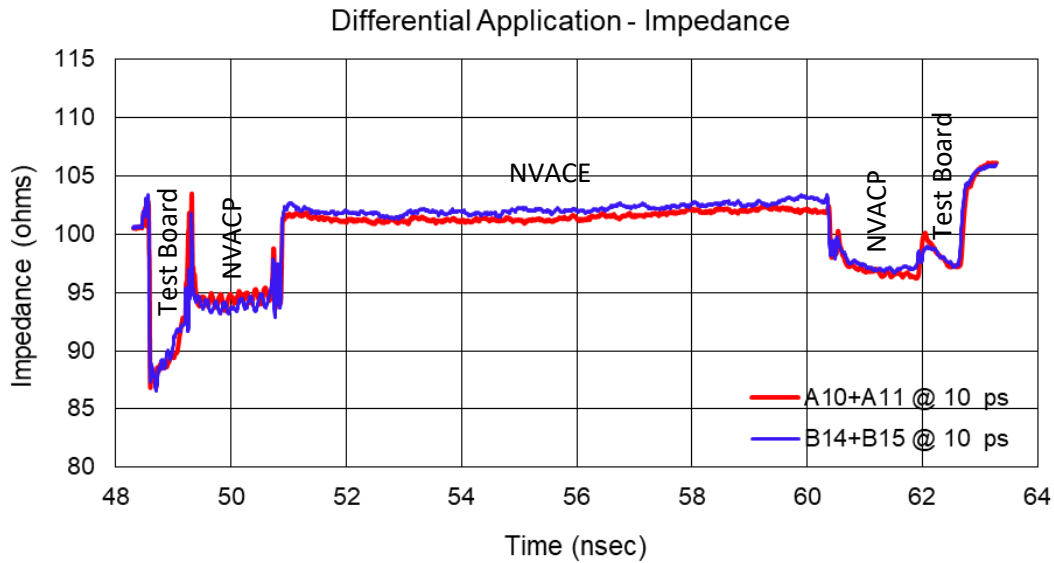


Figure 25

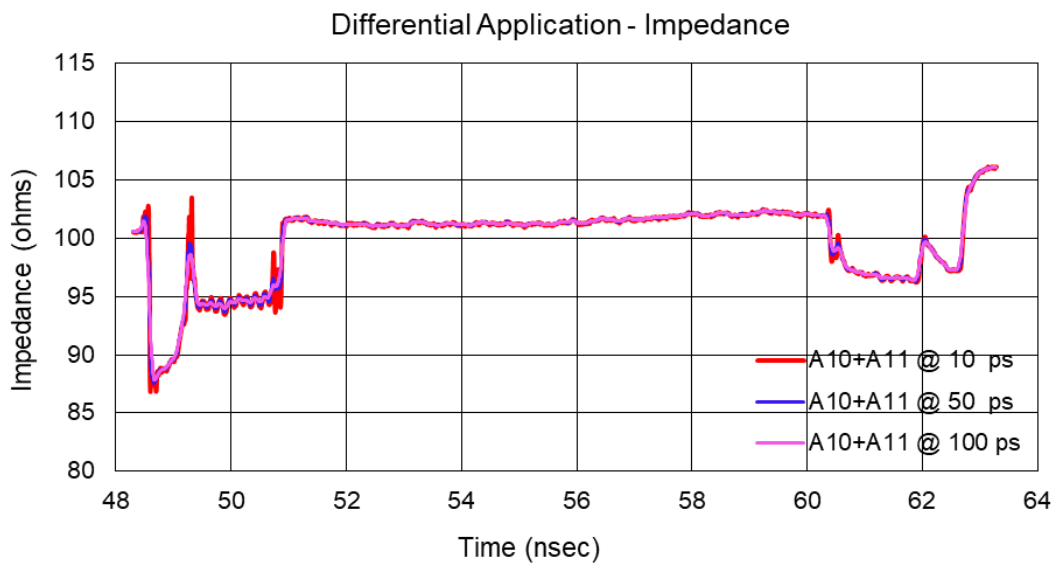


Figure 26

Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

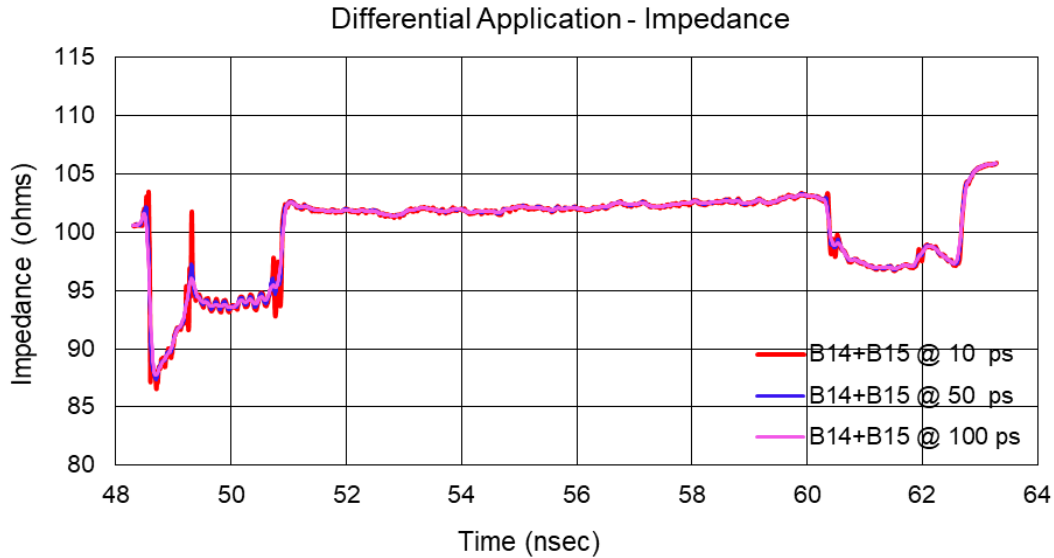


Figure 27

### Differential Application – Propagation Delay:

NVACP-150mm + NVACE-0.5m + NVACP-150mm

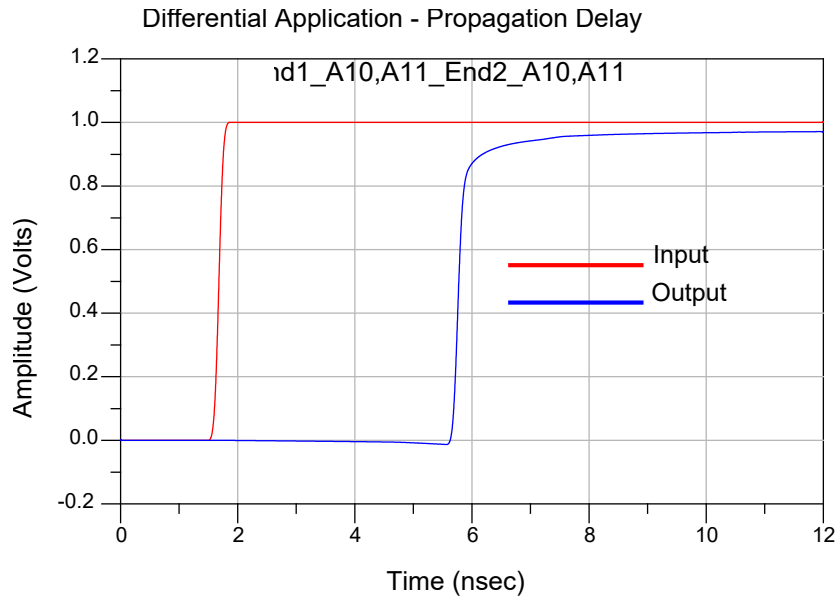


Figure 28

Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

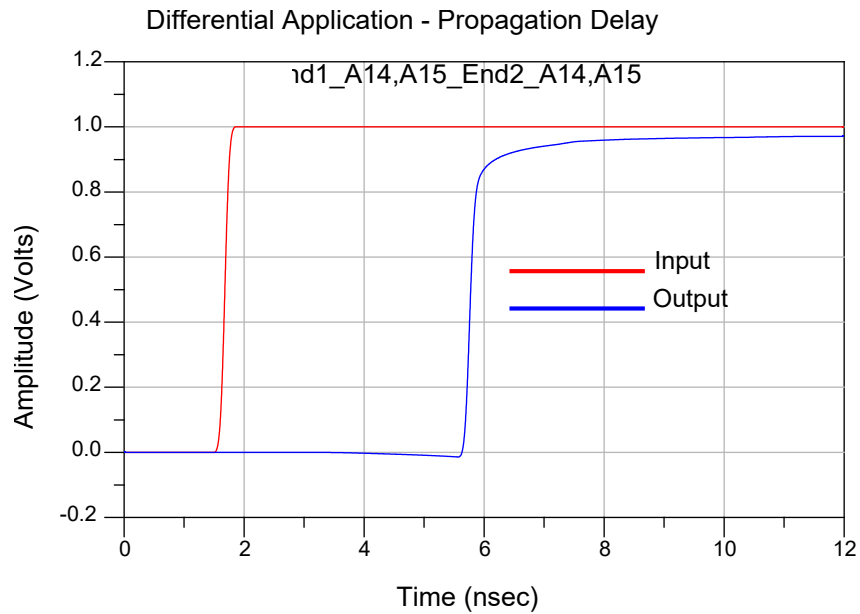


Figure 29

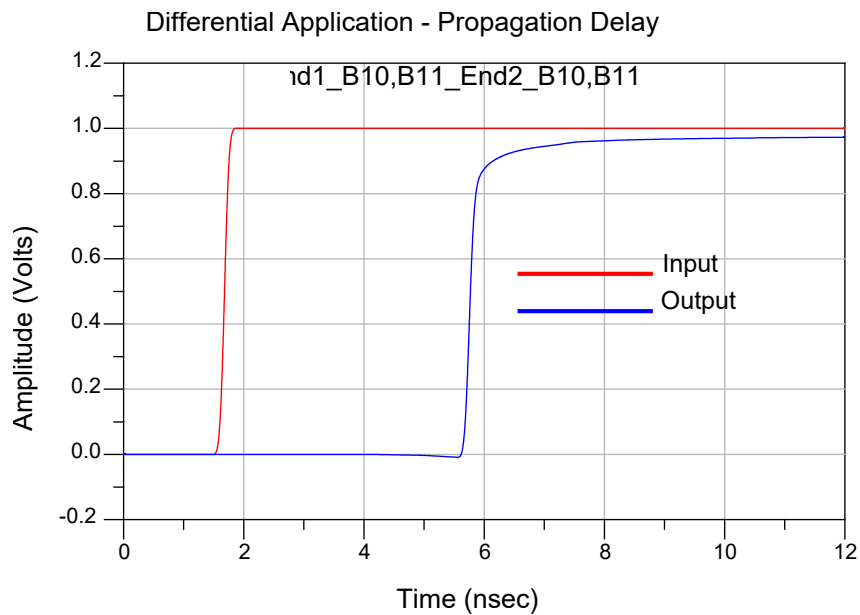


Figure 30

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

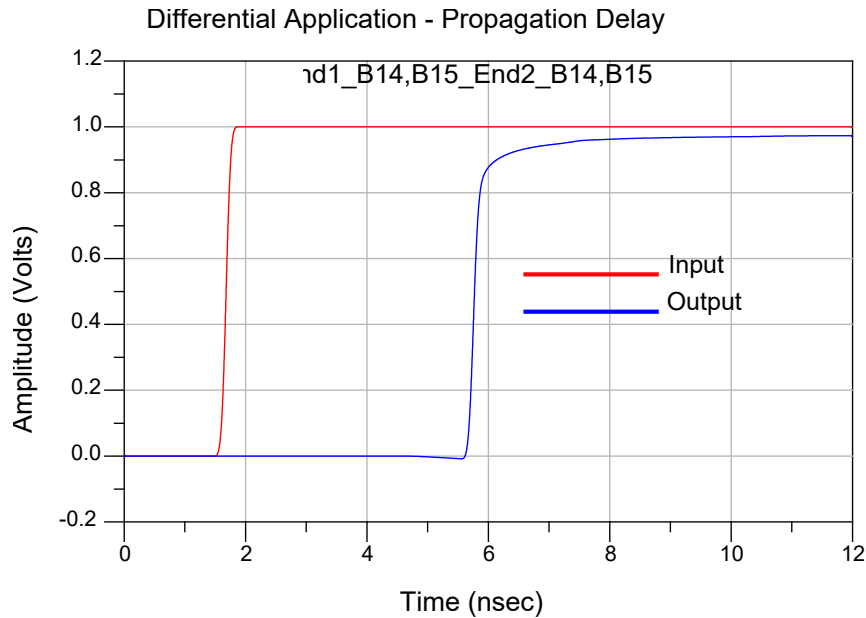


Figure 31

**Differential Application – Propagation Delay:**

NVACP-150mm + NVACE-1m + NVACP-150mm

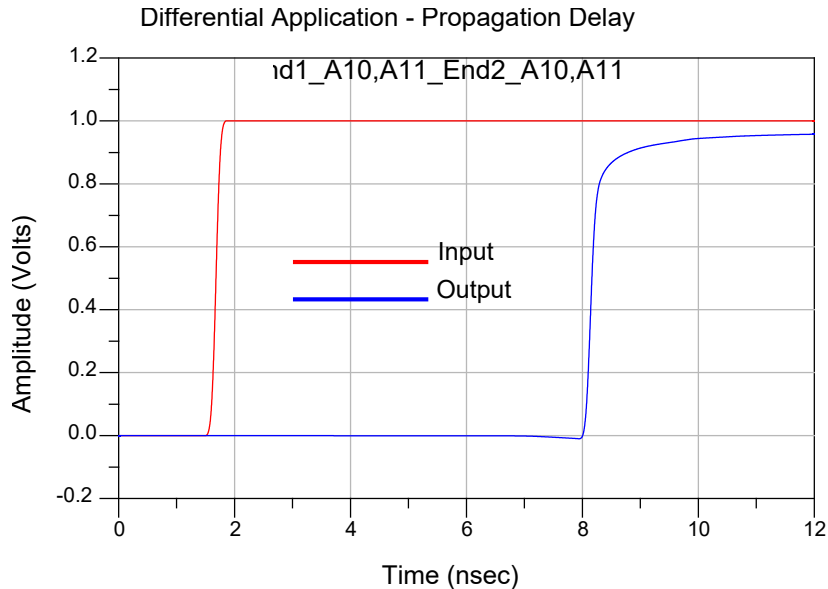


Figure 32



Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

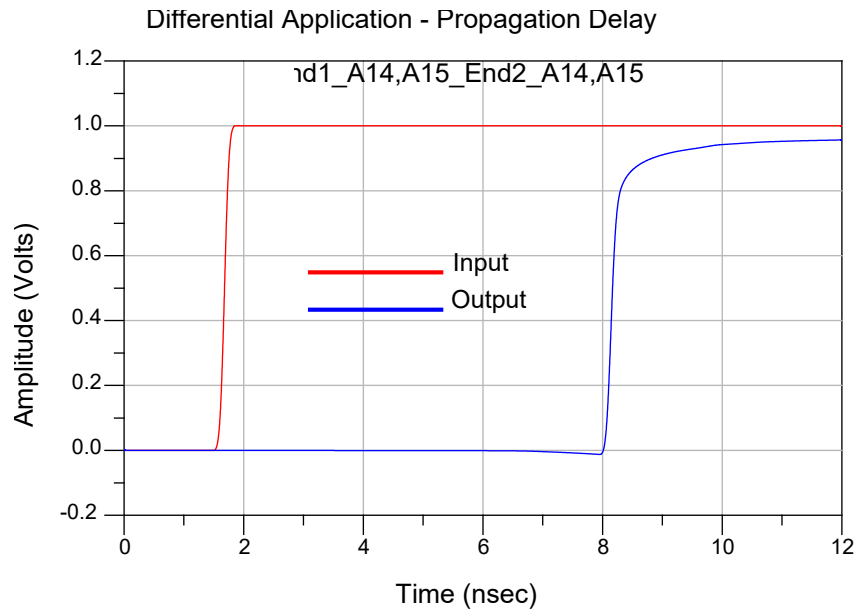


Figure 33

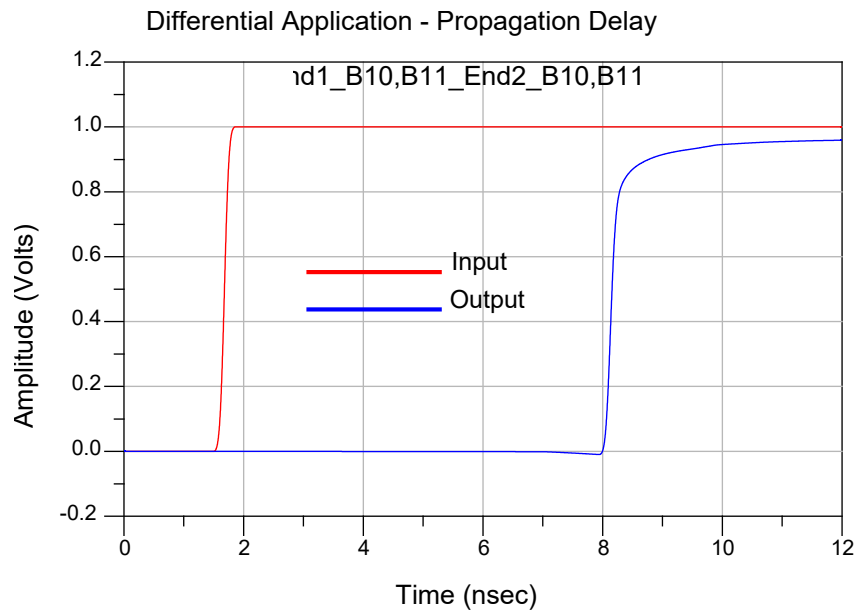


Figure 34

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

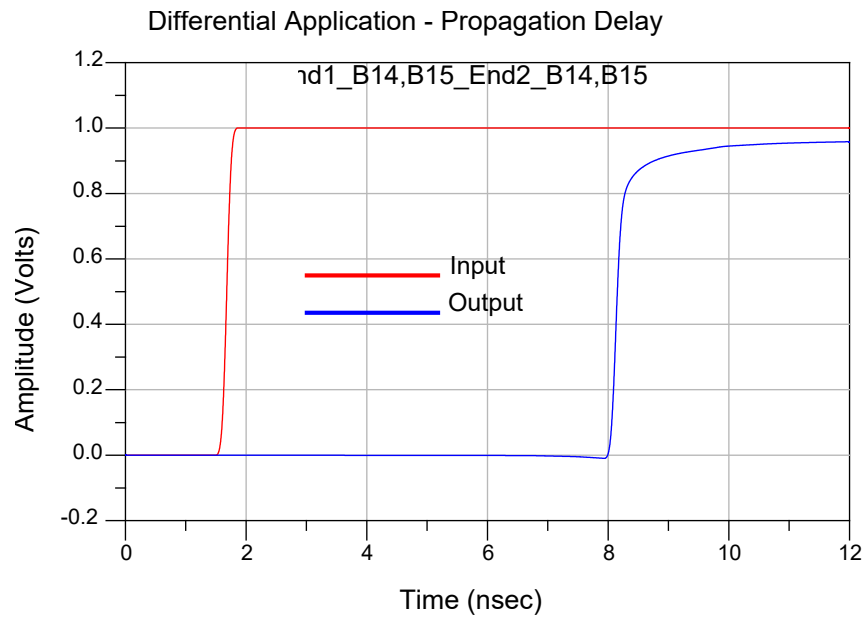


Figure 35

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Appendix C – Product and Test System Descriptions

### Product Description

Product test samples include two 0.80 mm NovaRay® Extreme Performance Panel Mount Cable Assembly (NVACP), part number NVACP-DP-3-4-06.0-B-1-2 and two NovaRay® Extreme Performance Cable Assembly (NVACE), part numbers NVACE-DP-5-4-0.5-A-1-2 and NVACE-DP-5-4-1.0-A-1-2. A photo of the mated test article mounted to SI test boards is shown in figure 38.

### Test System Description

The test fixtures are composed of six-layer Isola Tachyon 100G material with 50Ω 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 NVAX series connector set and identified by part number PCB-NVAM-109157-SIG-XX.

### PCB-NVAM-109157-SIG-0 Test Fixtures



Figure 36

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

### PCB Fixtures

The test fixtures used are as follows:

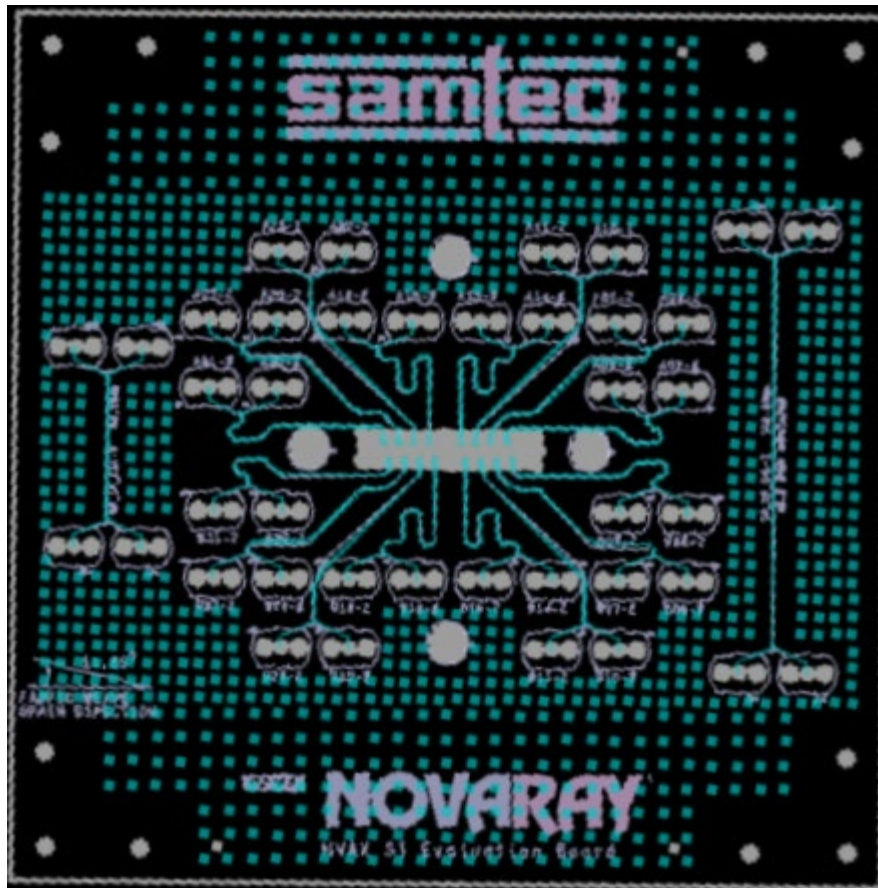


Figure 37

Series: NVACE, NVACP

Description: NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## Appendix D – Test and Measurement Setup

For frequency domain measurements, the test instrument is the Agilent N5225B PNA-L network analyzer. Frequency domain data and graphs are extracted from the instrument by AFR application. The network analyzer is configured as follows:

Start Frequency – 10 MHz

Stop Frequency – 40 GHz

IFBW – 1 KHz

### N5225B Measurement Setup

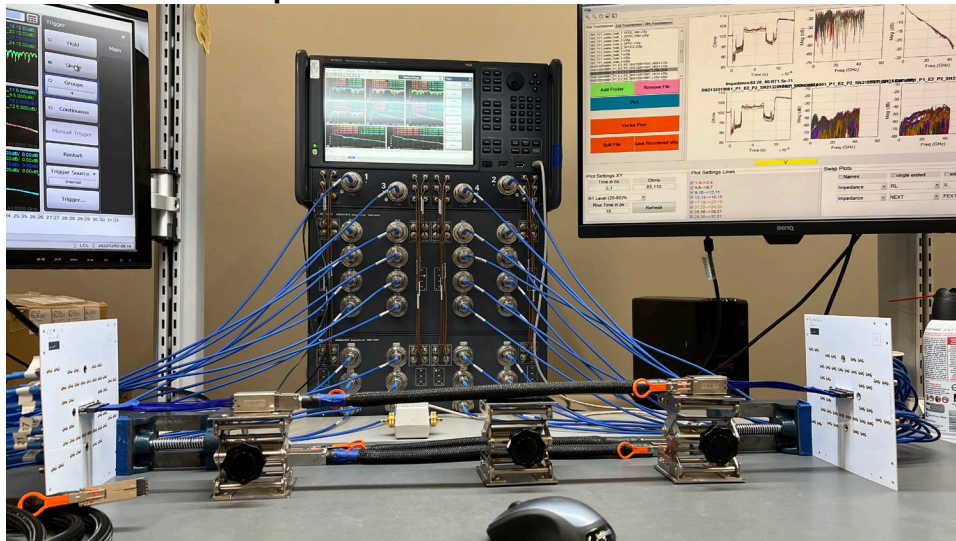


Figure 38

### Test Instruments

<u>QTY</u>	<u>Description</u>
1	Agilent N5225B PNA-L Network Analyzer (10 MHz to 67 GHz)
1	Agilent N4694-60003 ECAL Module (10 MHz to 67 GHz)

### Test Cables & Adapters

<u>QTY</u>	<u>Description</u>
4	1 m Junkosha 2.4mm male to female cables



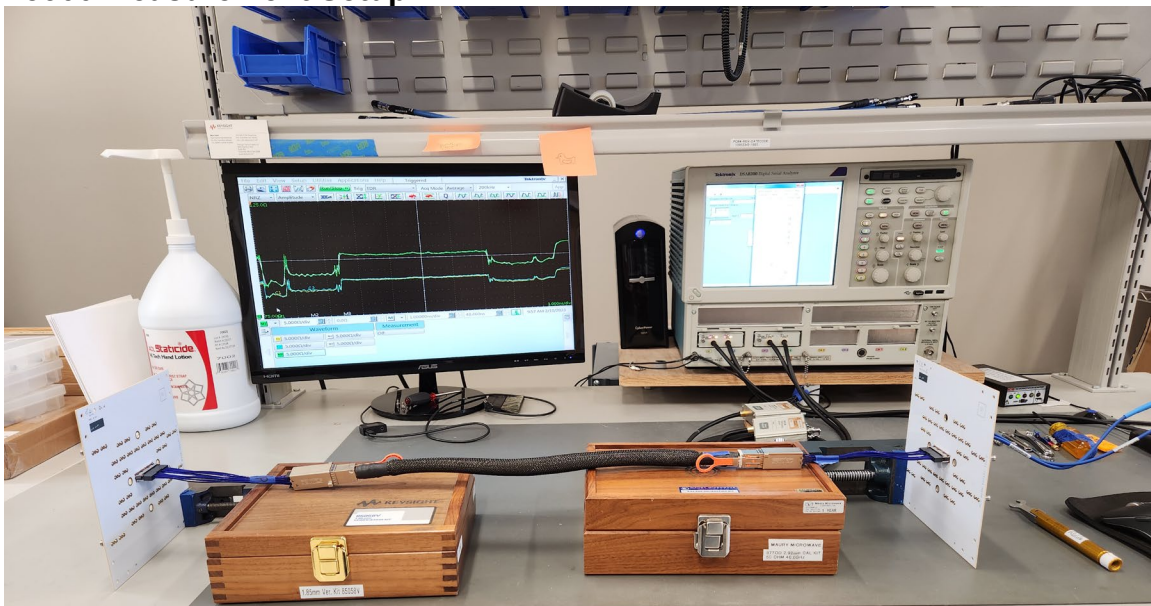
**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

For impedance measurements, the test instrument is the Tektronix DSA8300 Digital Serial Analyzer mainframe and 80E10B sampling module. The impedance data and profiles are obtained directly from the instrument. The Digital Analyzer is configured as follows:

	Single-Ended Signal	Differential Signal
Vertical Scale:	5 ohm / Div:	10 ohm / Div:
Offset:	Default / Scroll	Default / Scroll
Horizontal Scale:	200ps/ Div	200ps/ Div
Record Length:	4000	4000
Averages:	≥ 16	≥ 16

### DSA8300 Measurement Setup



### Test Instruments

<u>QTY</u>	<u>Description</u>
1	Tektronix DSA8300 Digital Serial Analyzer
2	Tektronix 80E10B TDR/Sampling Module

### Test Cables & Adapters

<u>QTY</u>	<u>Description</u>
4	Junkosha J12J10550

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

## **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 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 2020. 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://suddendocs.samtec.com/notesandwhitepapers/tech-note\\_using-plts-for-time-domain-data\\_web.pdf](http://suddendocs.samtec.com/notesandwhitepapers/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 figure.

The difference in time, measured at the 50% point of the step voltage is the propagation delay.

**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

### 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 are limited.



**Series:** NVACE, NVACP

**Description:** NovaRay® I/O Extreme Performance Panel Mount Cable Assembly (NVACP) and NovaRay® I/O Extreme Performance Cable Assembly (NVACE)

### Appendix F – Glossary of Terms

ADS – Keysight Advanced Design System

AFR – Automatic Fixture Removal

PCB – Printed Circuit Board

SUT – System Under Test

SOLT – acronym used to define Short, Open, Load & Thru Calibration Standards

TDR – Time Domain Reflectometry

TDT – Time Domain Transmission