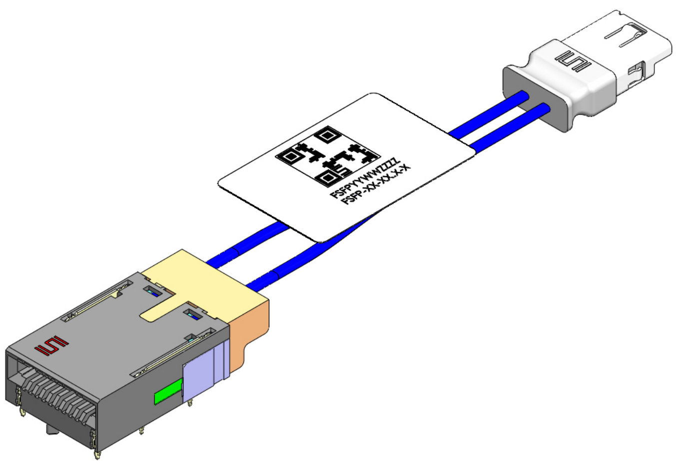
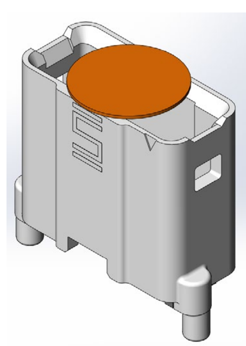
High Speed Characterization Report

FSFP-01-XX.X-1



Mated with:

AMF6-02-X-K-XR



Description:
Flyover® SFP Cable System,
34AWG, 92-ohm Twinax, ARM6 End 2 Option

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

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

Phone: 812-944-6733
Fax: 812-948-5047
Report Revision: 06/17/2024

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Table of Contents

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Cable Assembly Overview

The Flyover® SFP Cable System (FSFP Series) assembly is constructed using 34 AWG, 92-ohm twinax cable. The cable is terminated to the FSFP interface at end 1 and an ARM6 interface at end 2. The data in this report is only applicable to 6-inch,12-inch, and 20-inch cable lengths.

Each FSFP assembly was tested by mating it to FSFP edge card at end 1 and AMF6 at end 2. 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 Figure1.

Length	Part Number	End 1	End 2
6 inches	FSFP-01-06.0-1	FSFP	ARM6-02
12 inches	FSFP-01-12.0-1	FSFP	ARM6-02
20 inches	FSFP-01-20.0-1	FSFP	ARM6-02

Table 1: Sample Description

Figure 1: Test Sample

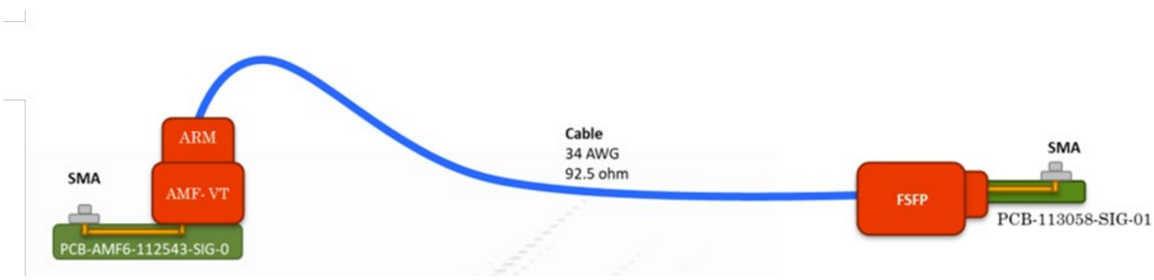


Figure 2: Diagram of the DUT

Samtec Inc.
520 Park East Blvd.
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Frequency Domain Data Summary

Bandwidth Figures – Differential Insertion Loss

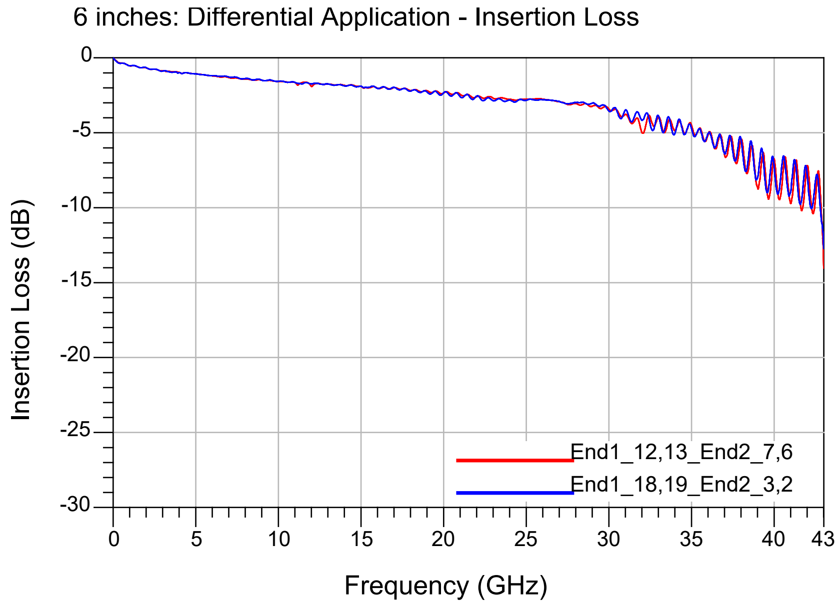

Figure 3

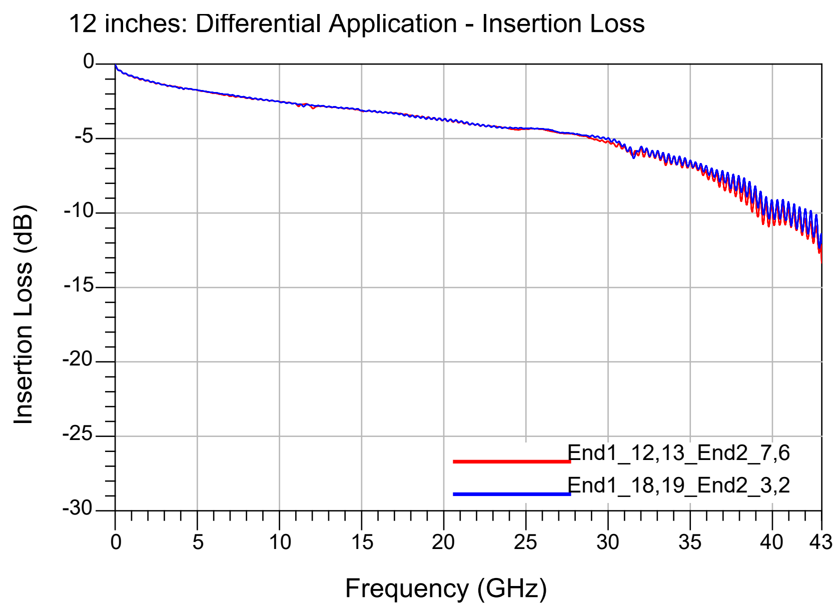

Figure 4

Samtec Inc.
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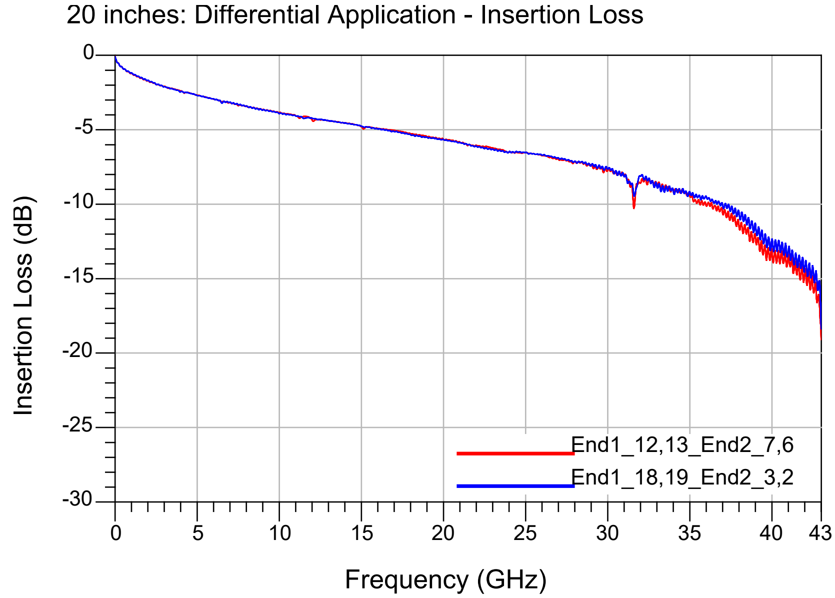

Figure 5

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Time Domain Data Summary

6 inches: Differential Application - Impedance

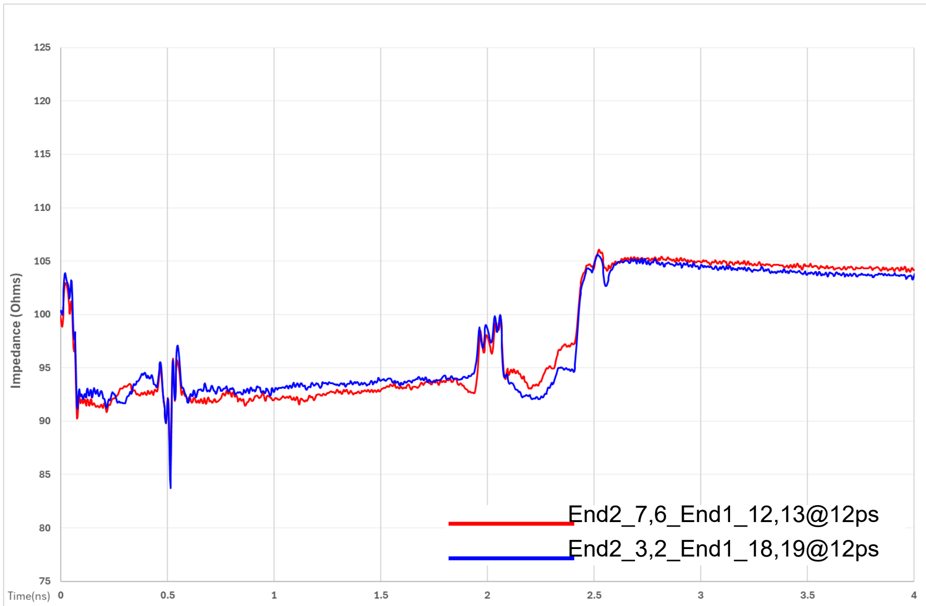

Figure 6

Because the same cable type is used in the cable assemblies with different lengths, only the impedance profile of 6 inches cable assembly is reported.

Table 2 - Propagation Delay (Cable Assembly)				
Driver	**Receiver**	**6 inches**	**12 inches**	**20 inches**
End 1_12,13	End 2_7,6	0.816 ns	1.549 ns	2.517 ns
End 1_18,19	End 2_3,2	0.818 ns	1.548 ns	2.515 ns

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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.

Pin Configuration

FSFP follows a fixed pin assignment. For this cable assembly, the following configurations are evaluated:

SIGNAL MAPPING TO ARM6-02 (END 2 OPTION -1)						
J1	NAME	J2		J1	NAME	J2
1	GND	NC		11	GND	
2	TxFault	NC		12	RD-	7
3	TxDisable	NC		13	RD+	6
4	SDA	NC		14	GND	
5	SCL	NC		15	VccR	NC
6	Mod_ABS	NC		16	VccT	NC
7	Speed1	NC		17	GND	
8	RxLOS	NC		18	TD+	3
9	Speed2	NC		19	TD-	2
10	GND	NC		20	GND	
1, 4, 5, 8 OF J2 ARE GND						
ALL GROUNDS ARE COMMON AND TIED TO CABLE SHIELD						
ALL NC NETS DO NOT TRANSMIT THROUGH CABLE, THEY WILL ROUTE THROUGH CUSTOMER PCB						
ON THE MATING BOARD ASSEMBLY, SAMTEC RECOMMENDS IMPLEMENTING A GND REFERENCE TYING ALL GND'S TOGETHER						

Series: FSFP
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Differential Impedance (denoted by purple circles):

- GSSG (Ground-positive signal-negative signal-Ground)

Differential Crosstalk (denoted by red circles):

- All configurations are in row: from the terminals to the other terminals on the same row

See Appendix C – Product and Test System Descriptions for details

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 12 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 12 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 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 DCA-X86100D 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.

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

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 D 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 1.51mm of PCB trace on end 1 and 1.27 mm of PCB trace on end 2. 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: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Appendix A – Frequency Domain Responses

Differential Application – Insertion Loss

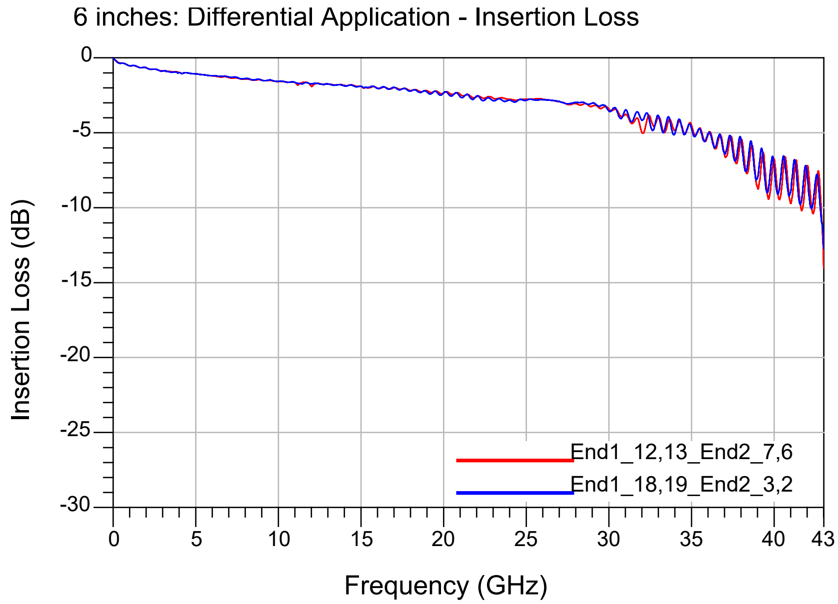

Figure 7

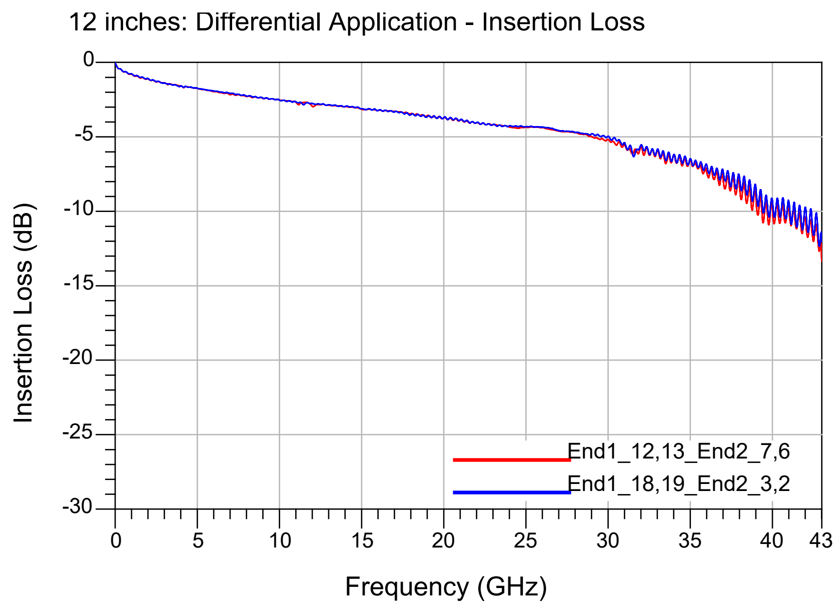

Figure 8

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

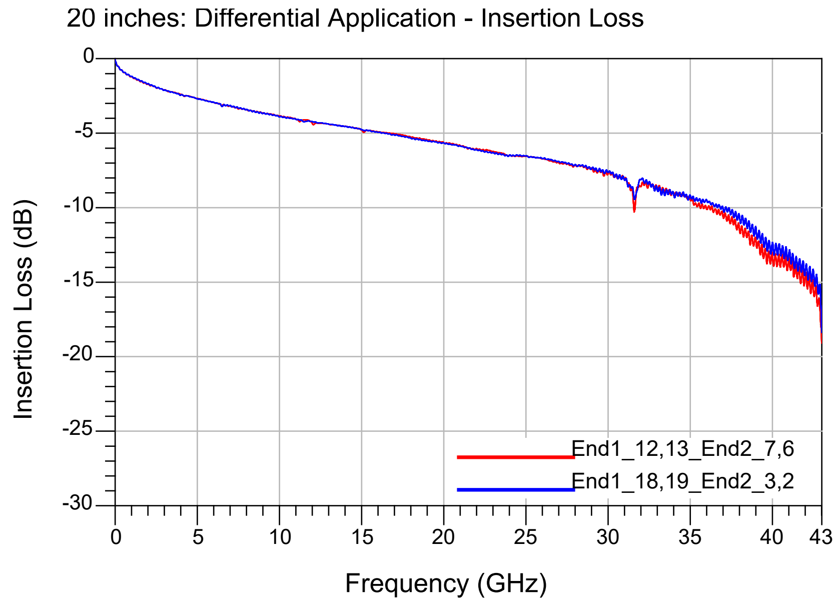

Figure 9

Differential Application – Return Loss

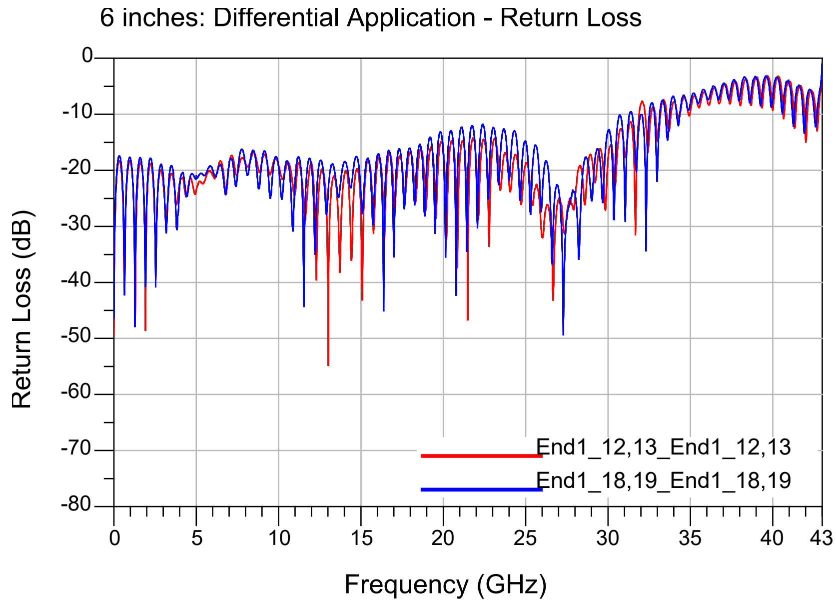

Figure 10

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

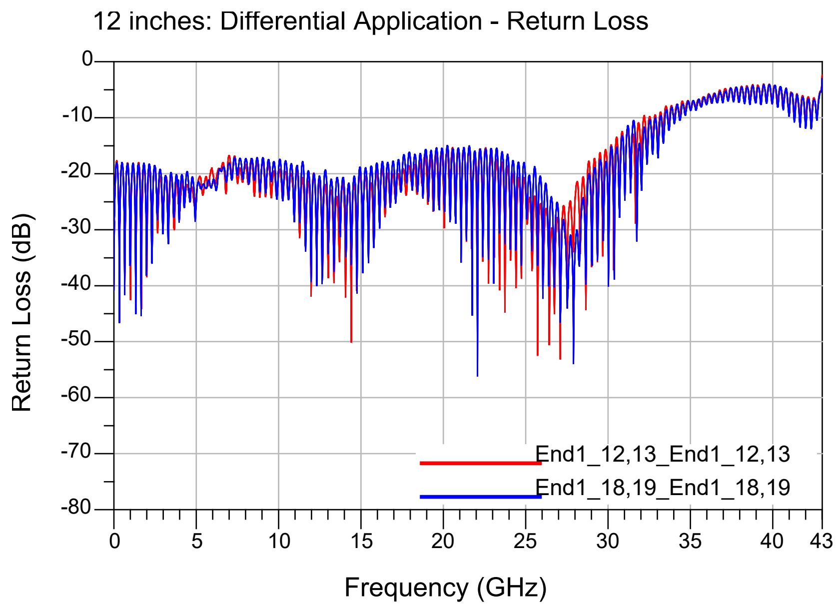

Figure 11

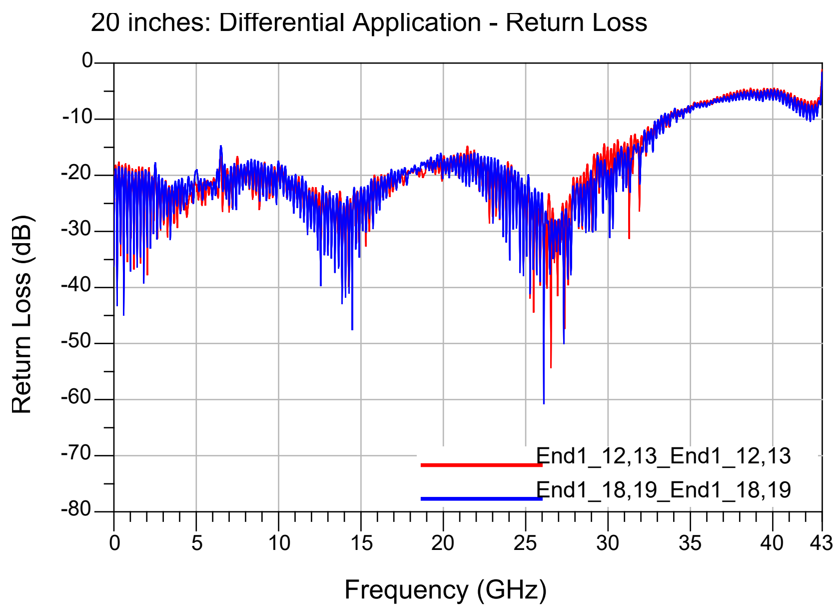

Figure 12

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Differential Application – NEXT Configurations

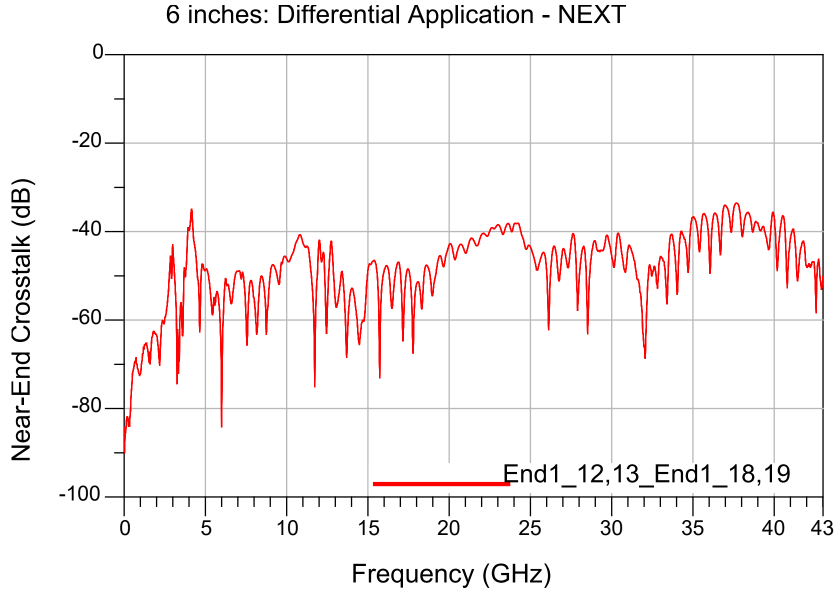

Figure 13

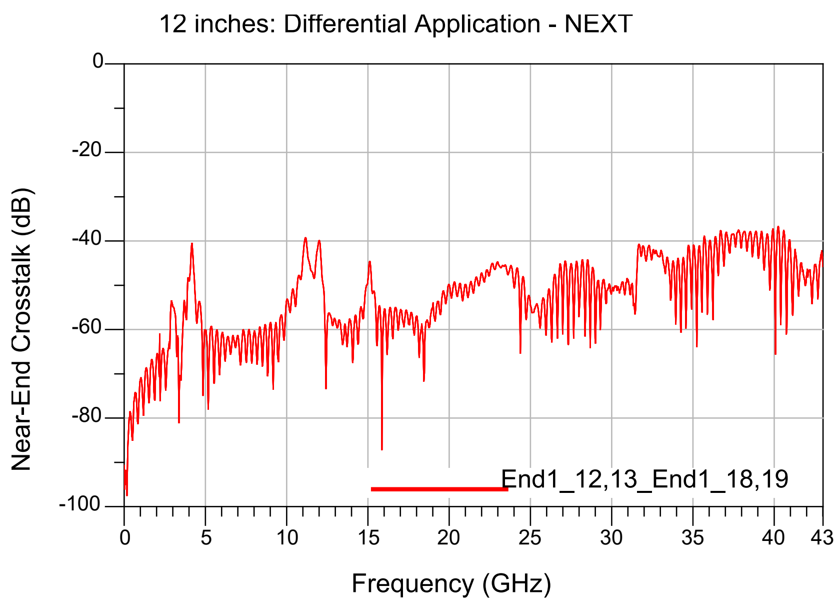

Figure 14

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

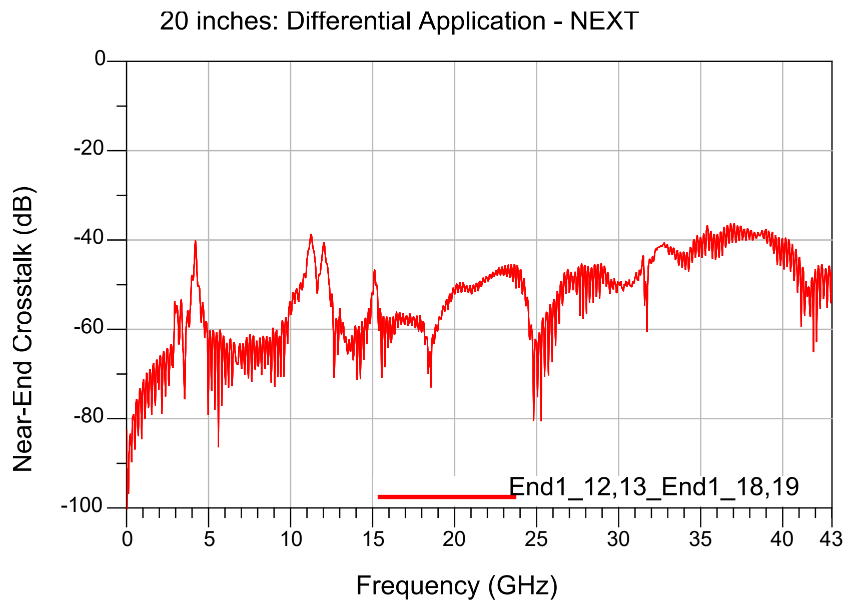

Figure 15

Differential Application – FEXT Configurations

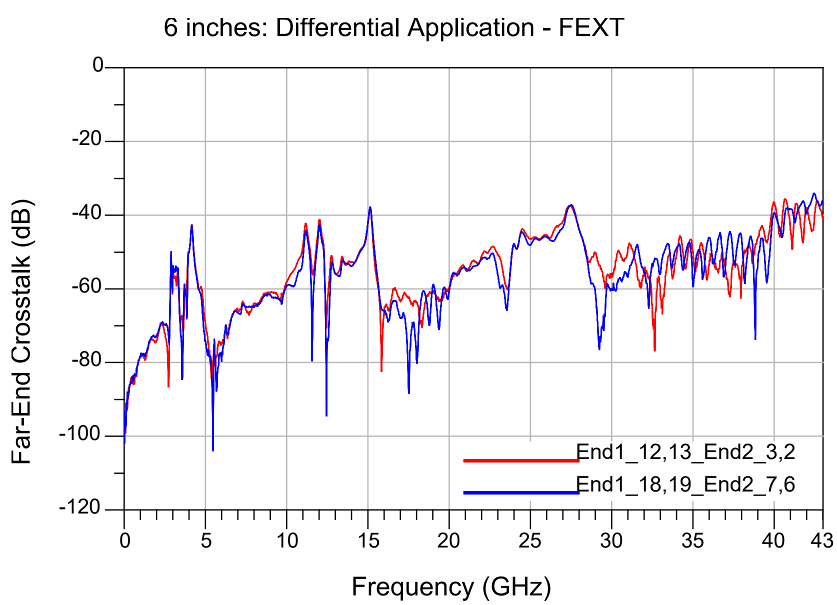

Figure 16

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

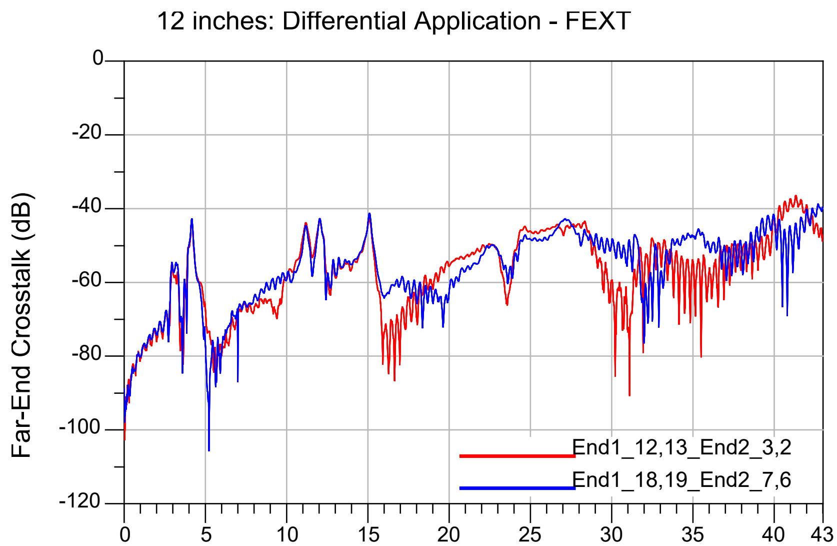

Figure 17

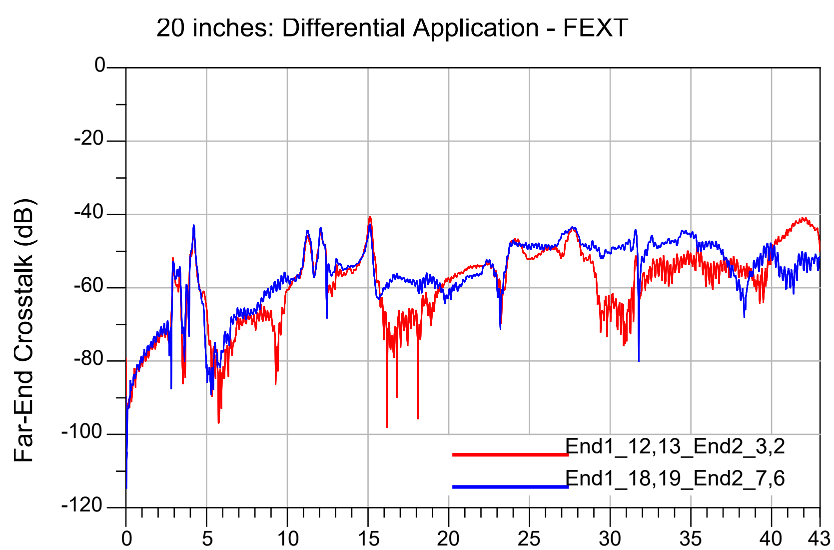

Figure 18

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Differential Application – Differential to Common Mode Conversion

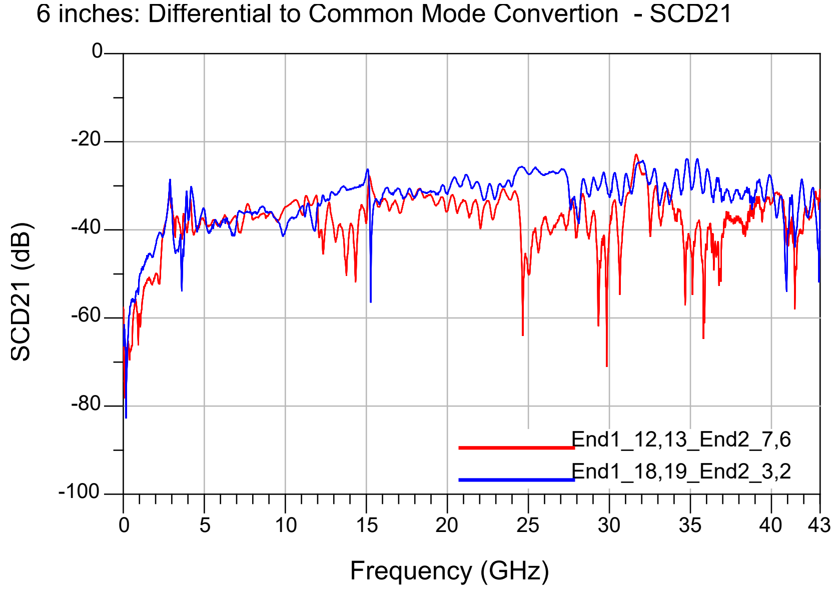

Figure 19

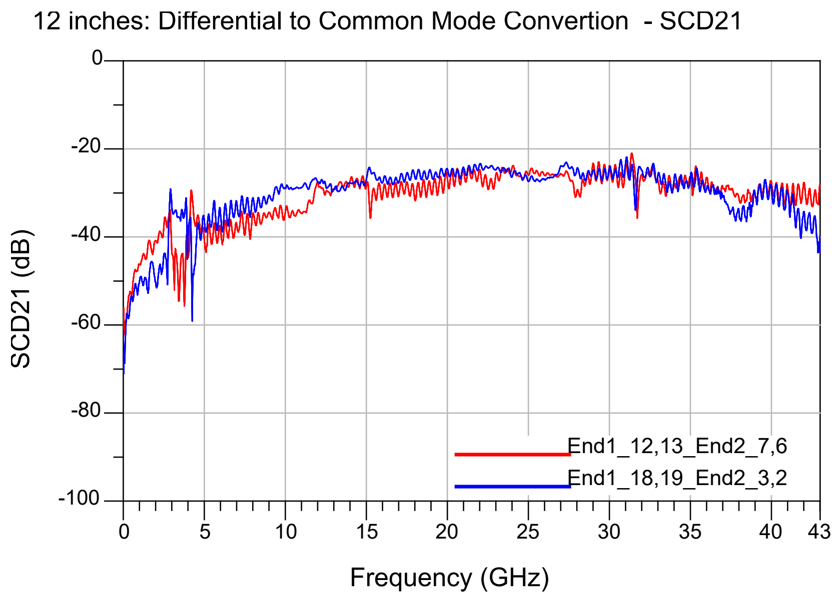

Figure 20

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

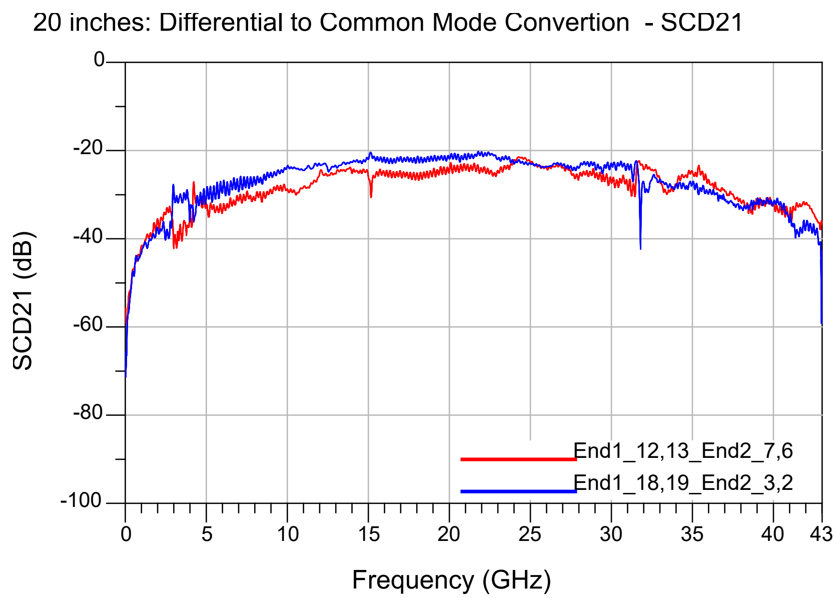

Figure 21

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Appendix B – Time Domain Responses

Differential Application – Input Pulse

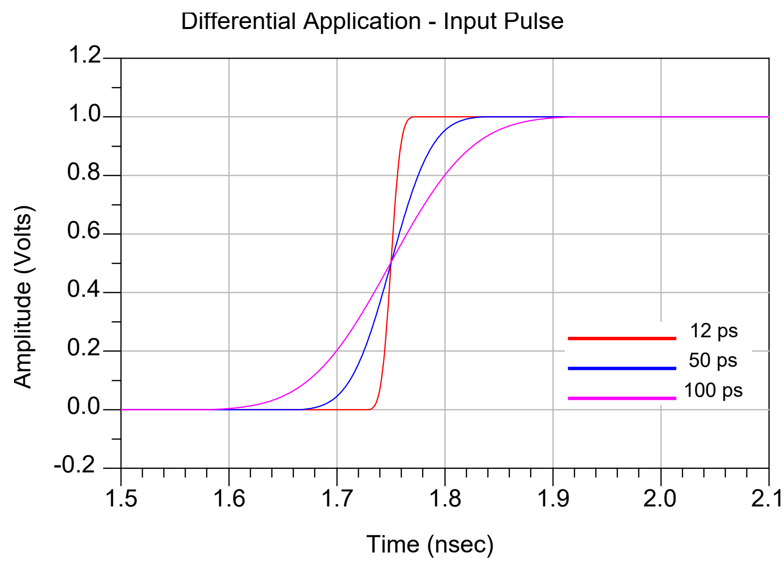

Figure 22

Differential Application – Cable assembly Impedance

FSFP-01-06.0-1

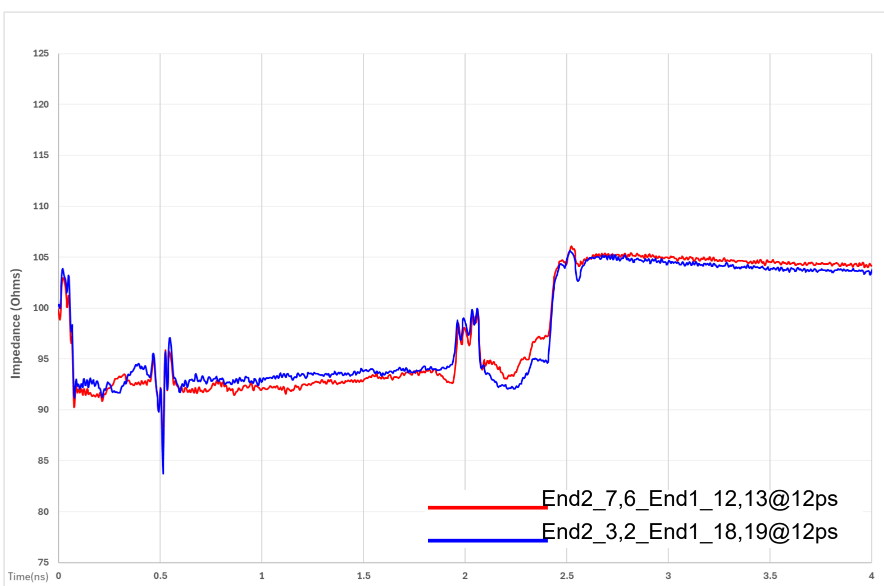

Figure 23

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Differential Application – Cable assembly Impedance

FSFP-01-06.0-1

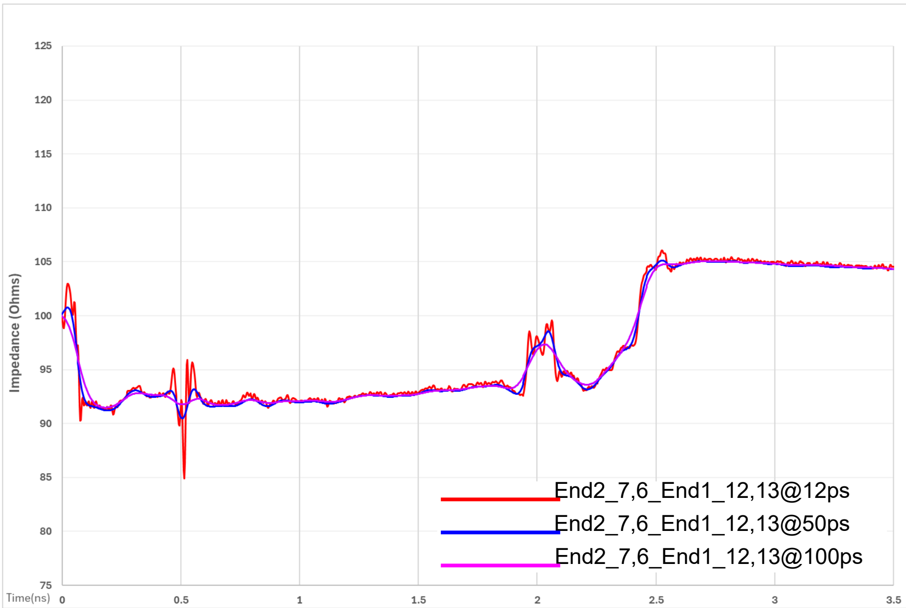

Figure 24

FSFP-01-06.0-1

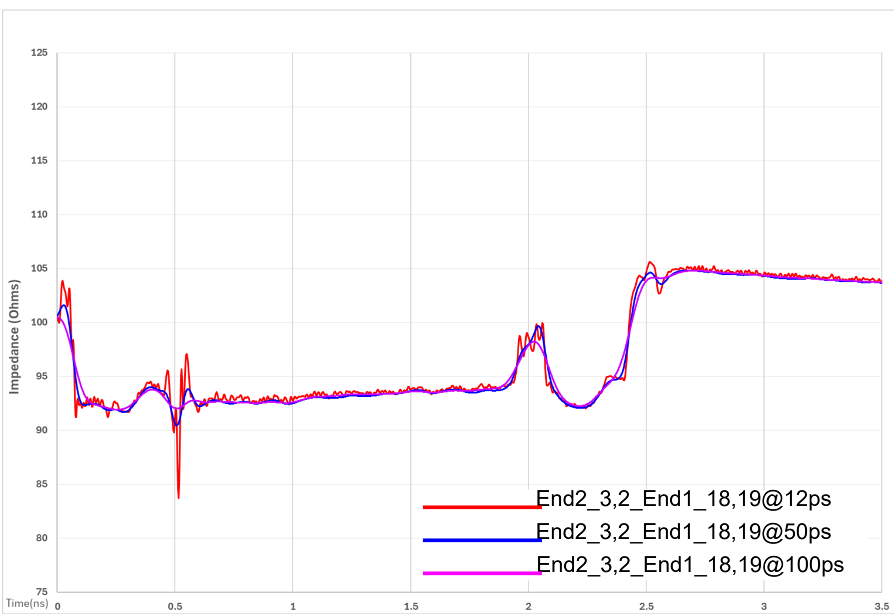

Figure 25

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

FSFP-01-12.0-1

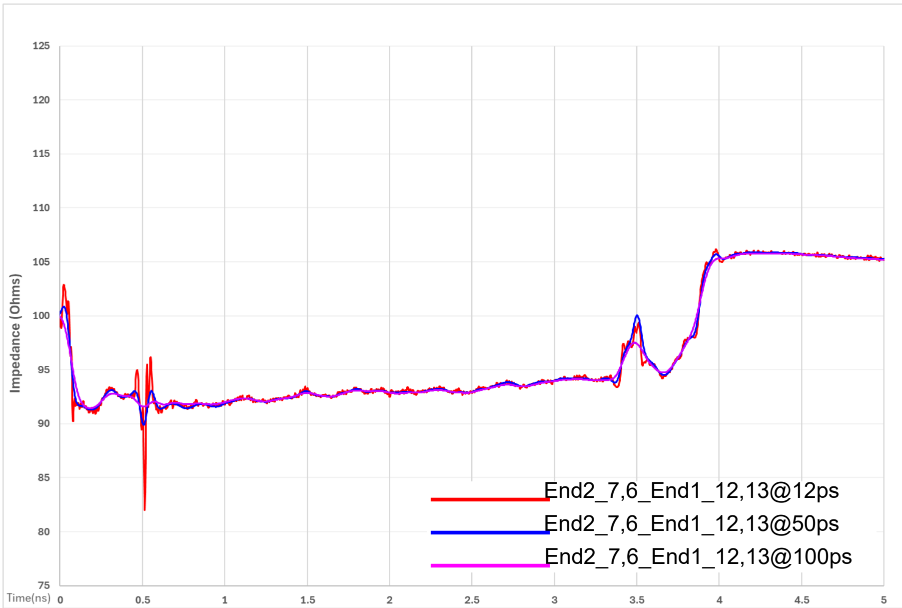

Figure 26

FSFP-01-12.0-1

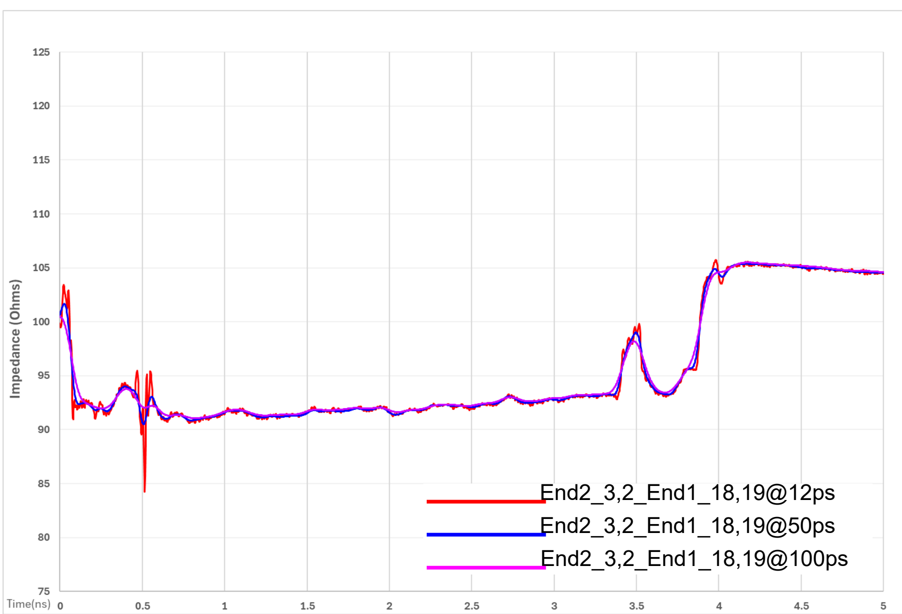

Figure 27

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

FSFP-01-20.0-1

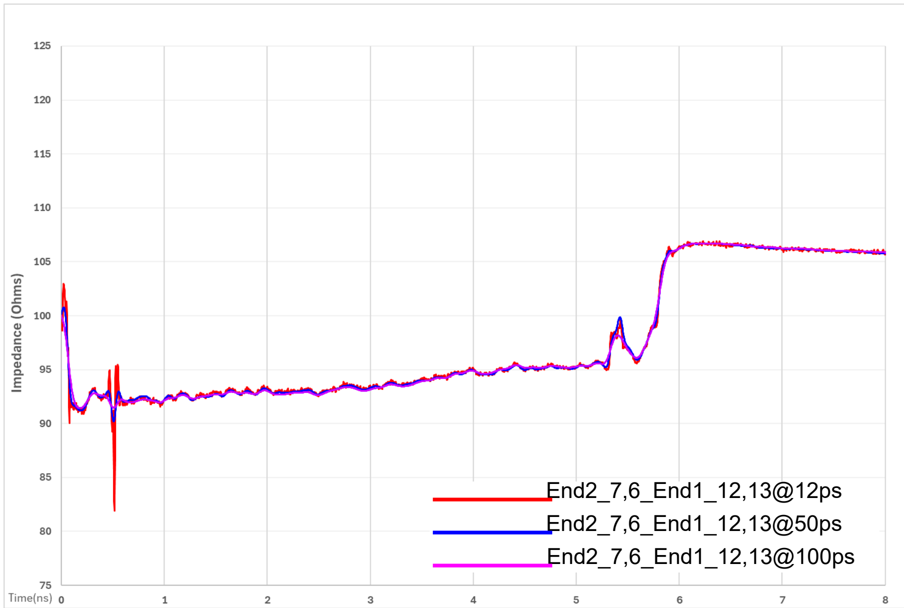

Figure 28

FSFP-01-20.0-1

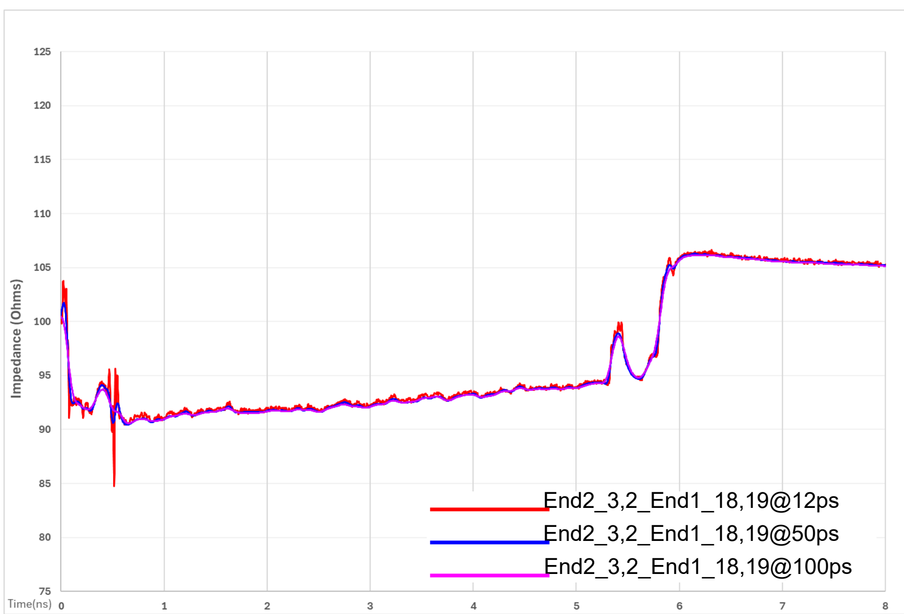

Figure 29

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Differential Application – Propagation Delay

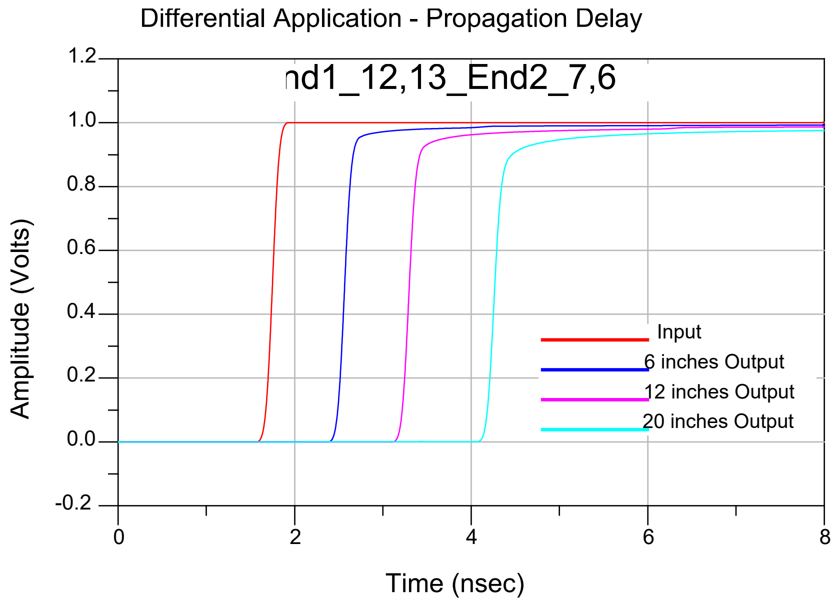

Figure 30

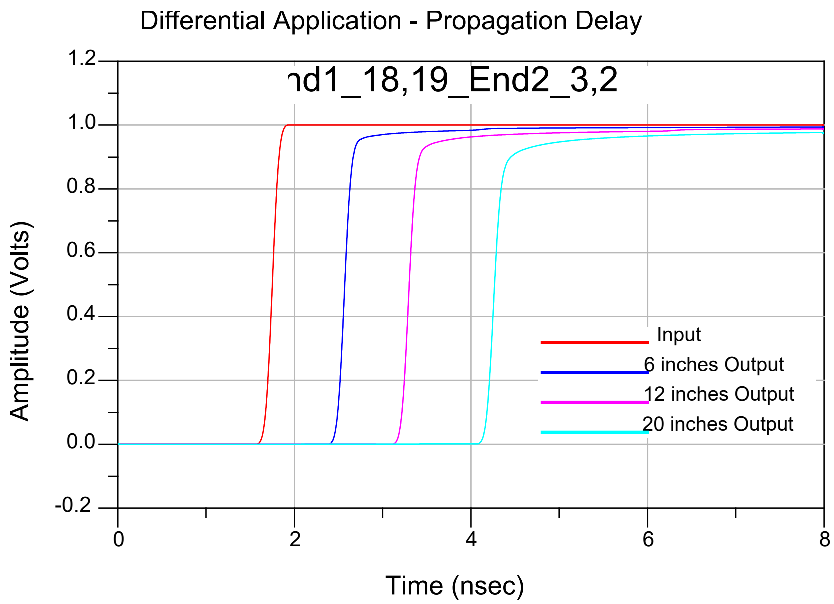

Figure 31

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Appendix C – Product and Test System Descriptions

Product Description

Product test samples are FSFP Cable Assemblies. The part numbers are FSFP-01-06.0-1, FSFP-01-12.0-1, and FSFP-01-20.0-1. They mate with edge card at end 1 and AMF6 at end 2. A photo of the mated test article mounted to SI test boards is shown below.

The cable assembly terminations had a particular signal mapping shown in Table 3.

SIGNAL MAPPING TO ARM6-02 (END 2 OPTION -1)					
J1	NAME	J2	J1	NAME	J2
1	GND	NC	11	GND	
2	TxFault	NC	12	RD-	7
3	TxDisable	NC	13	RD+	6
4	SDA	NC	14	GND	
5	SCL	NC	15	VccR	NC
6	Mod_ABS	NC	16	VccT	NC
7	Speed1	NC	17	GND	
8	RxLOS	NC	18	TD+	3
9	Speed2	NC	19	TD-	2
10	GND	NC	20	GND	
1, 4, 5, 8 OF J2 ARE GND					
ALL GROUNDS ARE COMMON AND TIED TO CABLE SHIELD					
ALL NC NETS DO NOT TRANSMIT THROUGH CABLE, THEY WILL ROUTE THROUGH CUSTOMER PCB					
ON THE MATING BOARD ASSEMBLY, SAMTEC RECOMMENDS IMPLEMENTING A GND REFERENCE TYING ALL GND'S TOGETHER					

Table 3：Signal line numbers

Test System Description

The test fixture PCB-112543-SIG-01_REV01 is composed of fourteen-layer and PCB-113058-SIG-01_REV00 is composed of six-layer Tachyon 100G material with 92.5Ω differential signal trace and pad configurations designed for the electrical characterization of Samtec high speed cable assembly products. A PCB mount 2.4mm connector is used to interface the PNA test cables to the test fixtures. Optimization of the 1.85mm launch was performed using full wave simulation tools to minimize reflections.

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PCB-112543-SIG-01_REV01 and PCB-113058-SIG-01_REV00 Test Fixtures

Figure 32

Artwork of the PCB design is shown below.

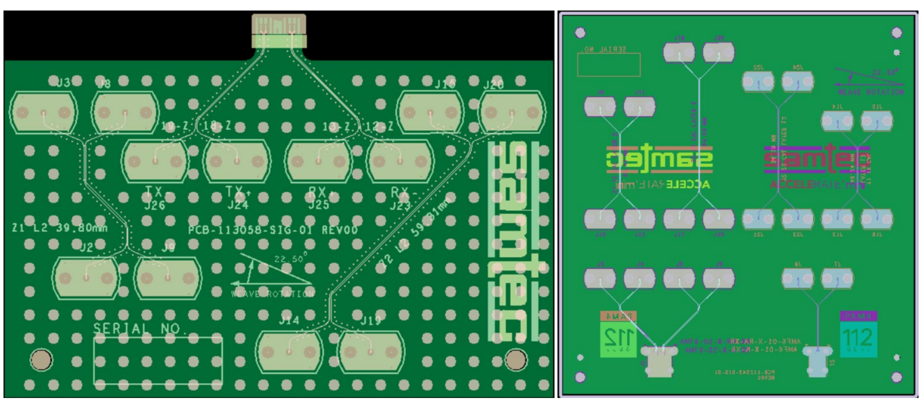

Figure 33

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

PCB Fixtures

The test fixtures used are as follows:

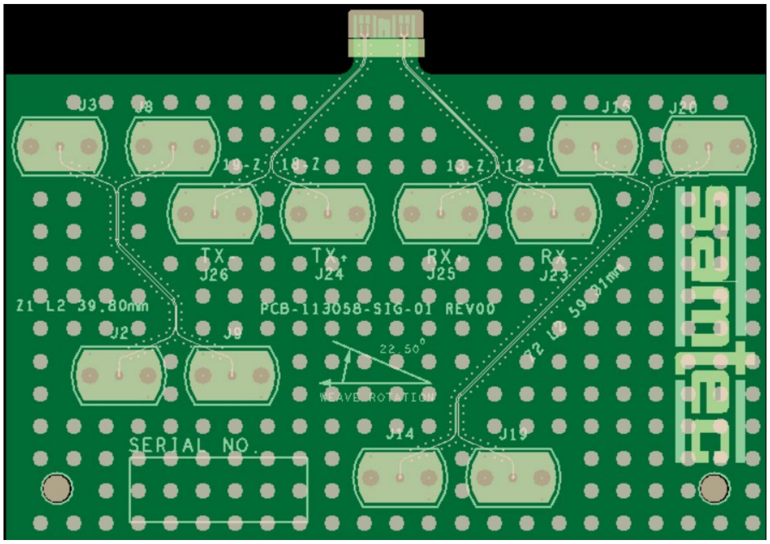

Figure 34

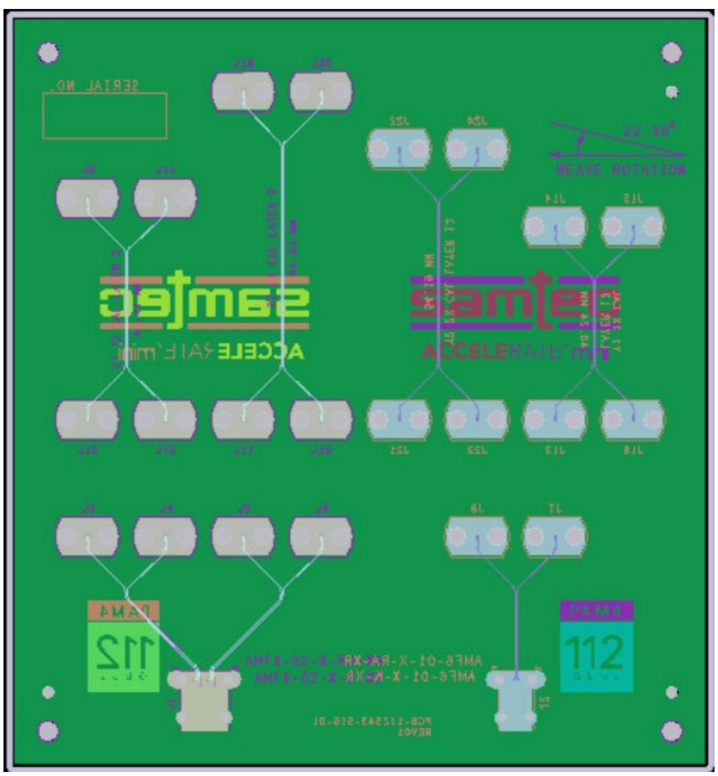

Figure 35

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

Appendix D – Test and Measurement Setup

For frequency domain measurements, the test instrument is the Agilent N5227B 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 – 43 GHz
IFBW – 1 KHz

N5227B Measurement Setup

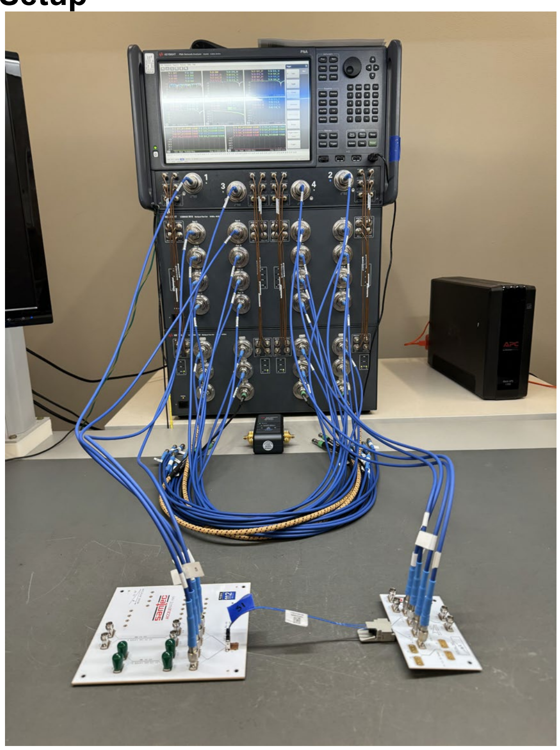

Figure 36

Test Instruments

QTY	Description
1	Agilent N5227B PNA-L Network Analyzer (10 MHz to 67 GHz)
1	Agilent N4694-60003 ECAL Module (10 MHz to 67 GHz)

Test Cables & Adapters

QTY	Description
8	1m Junkosha 2.4mm male to female cables

Series: FSFP
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For impedance measurements, the test instrument is the Keysight DCA-X86100D Wide-Bandwidth Oscilloscope Mainframe. The impedance data and profiles are obtained directly from the instrument. The Digital Analyzer is configured as follows:

Vertical Scale: 5 ohm / Div
Horizontal Resolution: 2.5ps
Averages: 128

DCA-X86100D Measurement Setup

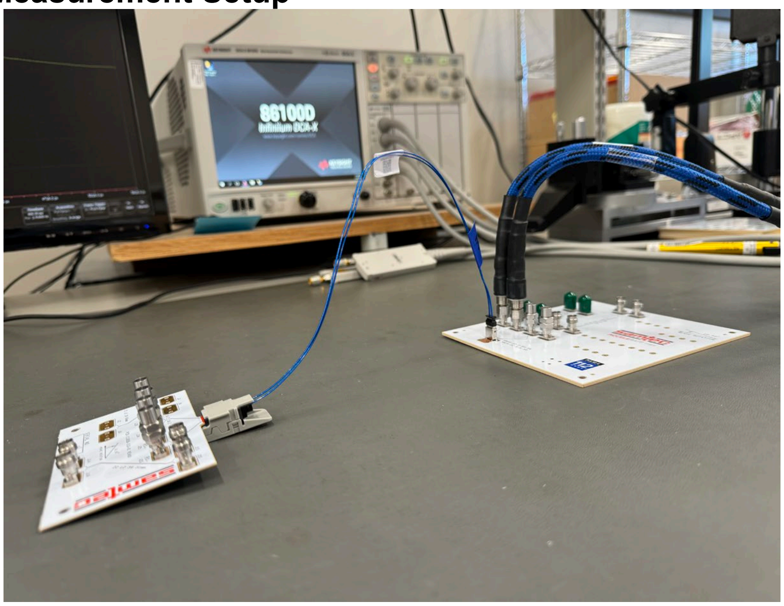

Figure 37

Test Instruments

QTY	Description
1	Keysight DCA-X86100D Wide-Bandwidth Oscilloscope Mainframe

Test Cables & Adapters

QTY	Description
4	Junkosha J12J103834-00

Series: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

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 2022 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://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: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

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: FSFP
Description: Flyover® SFP Cable System, 34AWG, 92-ohm Twinax, ARM6 End 2 Option

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

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

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

Phone: 812-944-6733
Fax: 812-948-5047
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