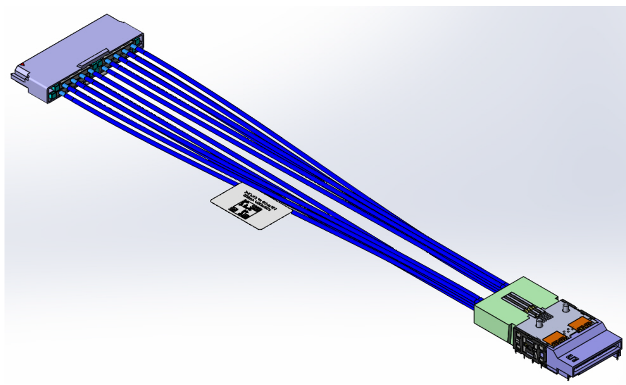
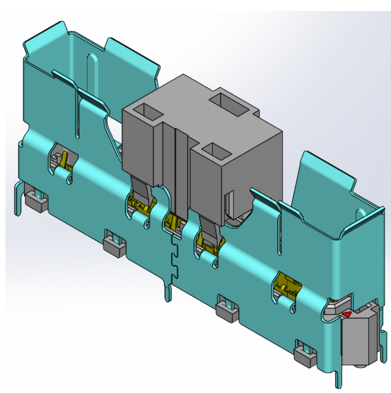
High Speed Characterization Report

FQSFP-D8-05-A-XX.X-2



Mated with:

NVAM-DP-02-2-02.0-S-2-CT-TR



Description:

800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2 Option

Samtec Inc.
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Report Revision: 1/6/2025

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Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

Table of Contents

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Cable Assembly Overview

The Flyover® QSFP Double Density Cable Assembly (FQSFP-D8) is constructed using 34 AWG, 92 Ω ultra-low skew twinax cable, backward compatible with QSFP and QSFP-DD modules, up to 800 Gbps aggregate (112 Gbps PAM4). The data in this report is applicable only 6-inch, 12-inch, and 20-inch-long cable assemblies with the NVAC end 2 option.

Each FQSFP-D8 cable assembly was mated to an FQSFP-D8 Edge card test board at end 1 and a NVAC test board at end 2. One sample of each assembly was tested. The 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.

Length	Part Number	End 1	End 2
6 inches	FQSFP-D8-05-A-06.0-2	FQSFP-D8	NVAC
12 Inches	FQSFP-D8-05-A-12.0-2	FQSFP-D8	NVAC
20 inches	FQSFP-D8-05-A-20.0-2	FQSFP-D8	NVAC

Table 1: Sample Description

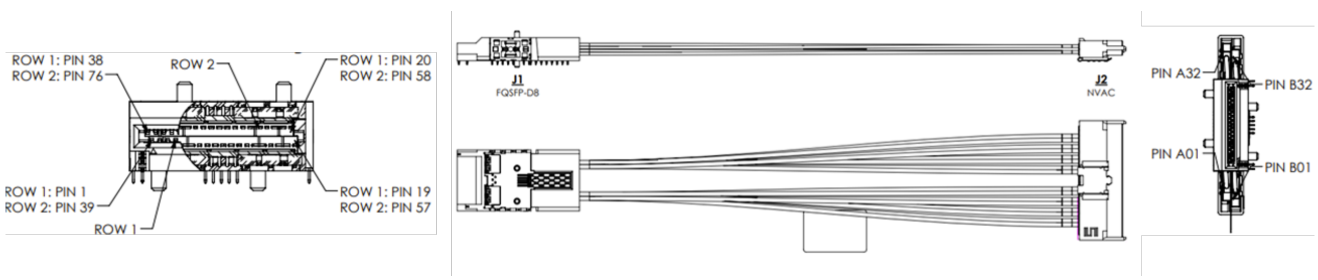

Figure 1: Test Sample

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

Frequency Domain Data Summary

Bandwidth Figures – Differential Insertion Loss

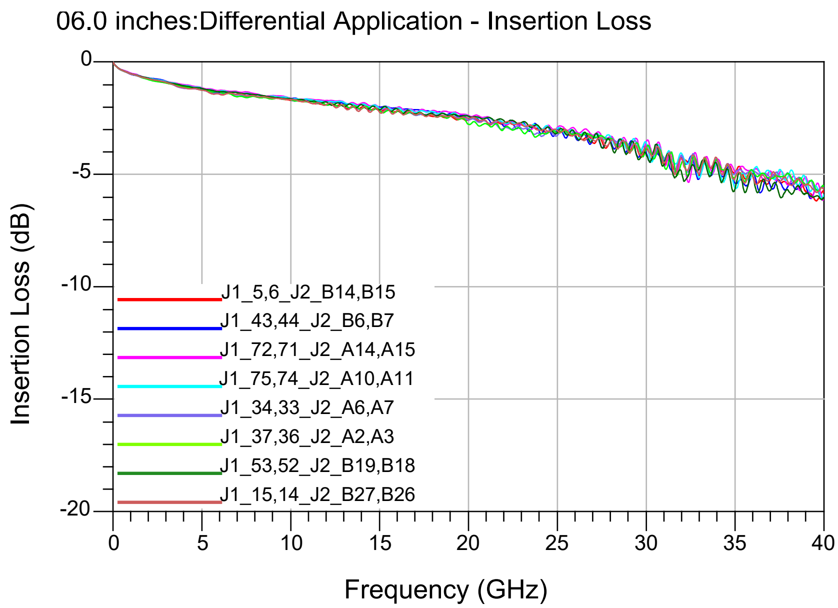

Figure 2

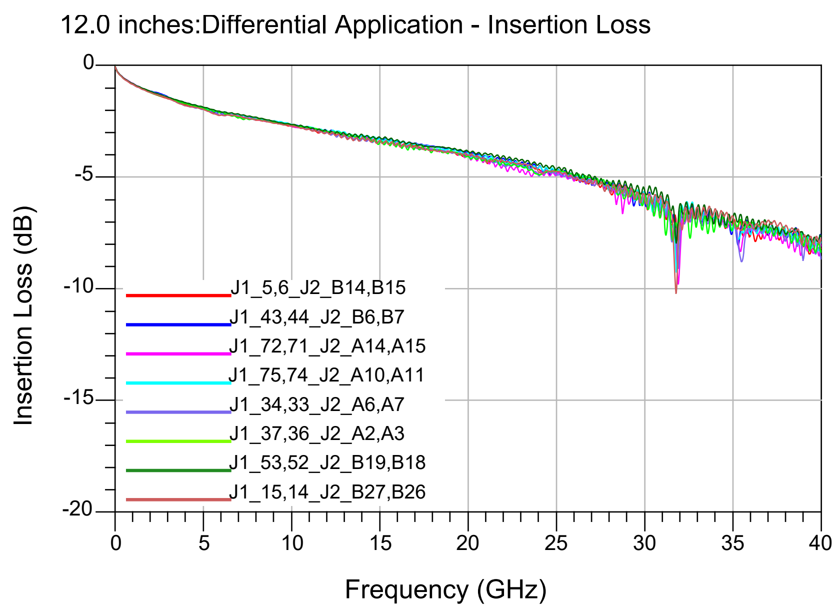

Figure 3

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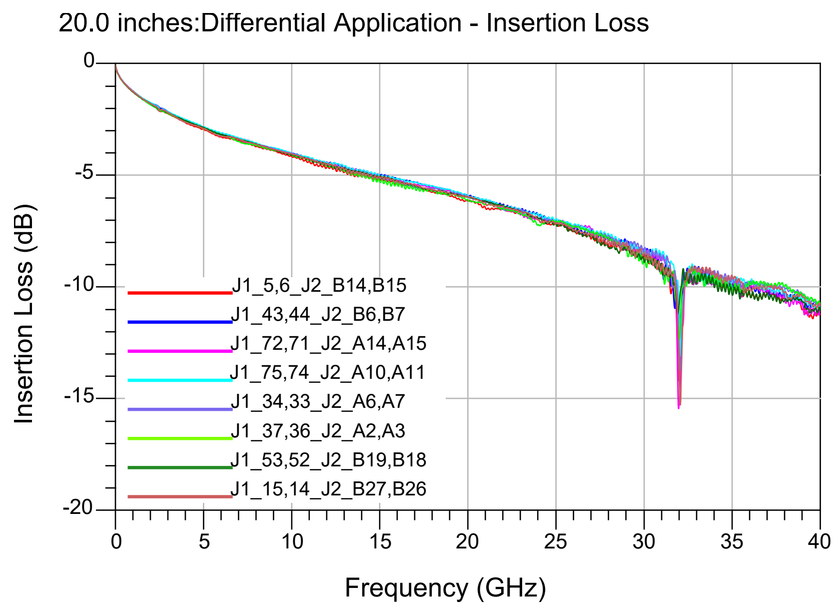

Figure 4

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Series: FQSFP-D8
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Time Domain Data Summary

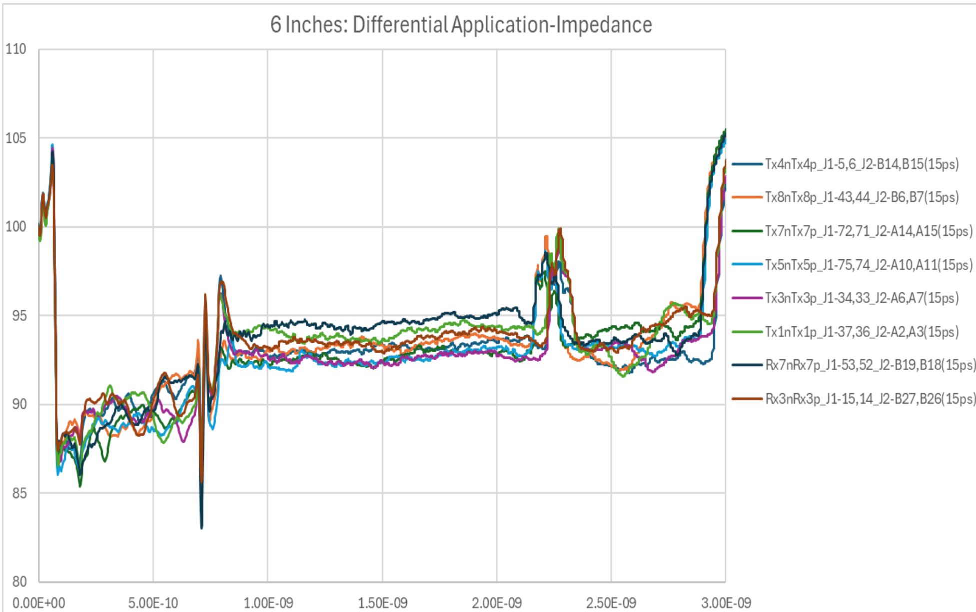

Figure 5

Because the same type of cable 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**
J1_5,6	J2_B14,B15	0.844 ns	1.566 ns	2.526 ns
J1_43,44	J2_B6,B7	0.814 ns	1.536 ns	2.494 ns
J1_72,71	J2_A14,A15	0.809 ns	1.533 ns	2.491 ns
J1_75,74	J2_A10,A11	0.811 ns	1.535 ns	2.489 ns
J1_34,33	J2_A6,A7	0.843 ns	1.566 ns	2.520 ns
J1_37,36	J2_A2,A3	0.841 ns	1.563 ns	2.523 ns
J1_53,52	J2_B19,B18	0.814 ns	1.537 ns	2.498 ns
J1_15,14	J2_B27,B26	0.844 ns	1.571 ns	2.524 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.

Cable assembly Signal to Ground Ratio

The QSFP-DD MSA defines the FQSFP-D8 connector's signal and ground definitions. The pinout is shown below:

TABLE 3

SIGNAL MAPPING TO NVAC (END OPTION -2)

J1	NAME	J2	J1	NAME	J2	J1	NAME	J2	J1	NAME	J2
1	GND 1	GND	20	GND 2	GND	39	GND 1	GND	58	GND 2	GND
2	TX2N	B10	21	RX2N	A23	40	TX6N	B2	59	RX6N	A31
3	TX2P	B11	22	RX2P	A22	41	TX6P	B3	60	RX6P	A30
4	GND 1	GND	23	GND 2	GND	42	GND 1	GND	61	GND 2	GND
5	TX4N	B14	24	RX4N	A19	43	TX8N	B6	62	RX8N	A27
6	TX4P	B15	25	RX4P	A18	44	TX8P	B7	63	RX8P	A26
7	GND 1	GND	26	GND 2	GND	45	GND 1	GND	64	GND 2	GND
8	MODSELL	NC	27	MODPRSL	NC	46	RESERVED	NC	65	NC	NC
9	RESETL	NC	28	INTL	NC	47	VS1	NC	66	RESERVED	NC
10	VCCRX	NC	29	VCCTX	NC	48	VCCRX1	NC	67	VCCTX1	NC
11	SCL	NC	30	VCC1	NC	49	VS2	NC	68	VCC2	NC
12	SDA	NC	31	INITMODE	NC	50	VS3	NC	69	RESERVED	NC
13	GND 2	GND	32	GND 1	GND	51	GND 2	GND	70	GND 1	GND
14	RX3P	B26	33	TX3P	A7	52	RX7P	B18	71	TX7P	A15
15	RX3N	B27	34	TX3N	A6	53	RX7N	B19	72	TX7N	A14
16	GND 2	GND	35	GND 1	GND	54	GND 2	GND	73	GND 1	GND
17	RX1P	B30	36	TX1P	A3	55	RX5P	B22	74	TX5P	A11
18	RX1N	B31	37	TX1N	A2	56	RX5N	B23	75	TX5N	A10
19	GND 2	GND	38	GND 1	GND	57	GND 2	GND	76	GND 1	GND

ALL LIKE NAMED 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

Respective signal line numbers as viewed from End 1

Series: FQSFP-D8
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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

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 the rise time of the exciting signal. For this report, the fastest rise time used was 15 ps. Generally, this should demonstrate the 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 between15ps and 100ps.

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 from network analyzer measurements.

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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.

The measured S-Parameters from the network analyzer are post-processed using Agilent ADS to obtain the time domain response. Time Domain procedure is provided in Appendix E of this report. Parameters or formats not included in this report may be available upon request. Please contact our Signal Integrity Group at sig@samtec.com for more information.

In this report, propagation delay is defined as the signal propagation time through the cable assembly, mating connectors, and connector footprint. It also includes 1 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.

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Appendix A – Frequency Domain Responses

Differential Application – Insertion Loss

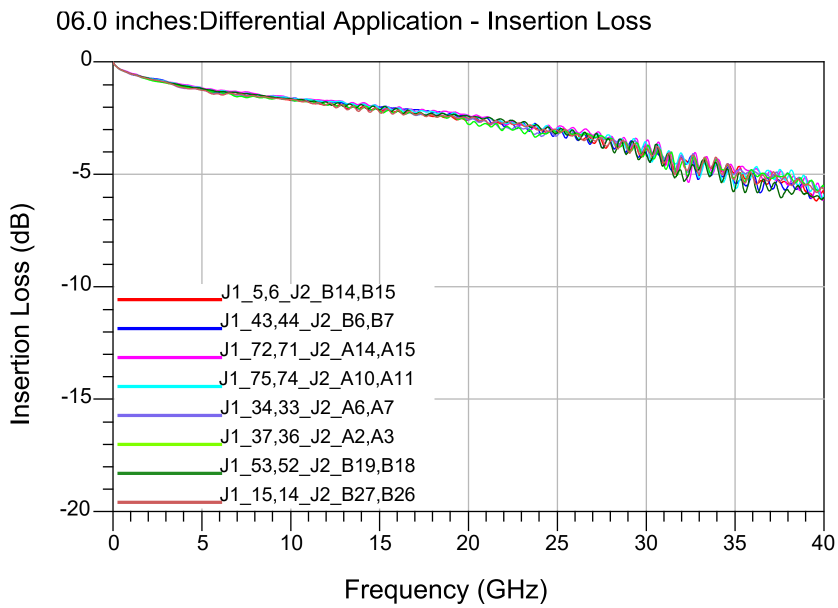

Figure 6

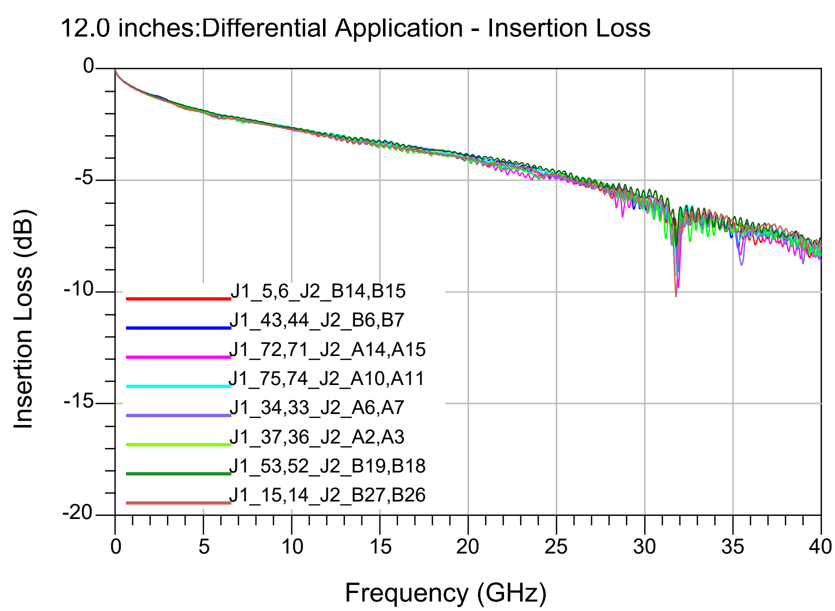

Figure 7

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

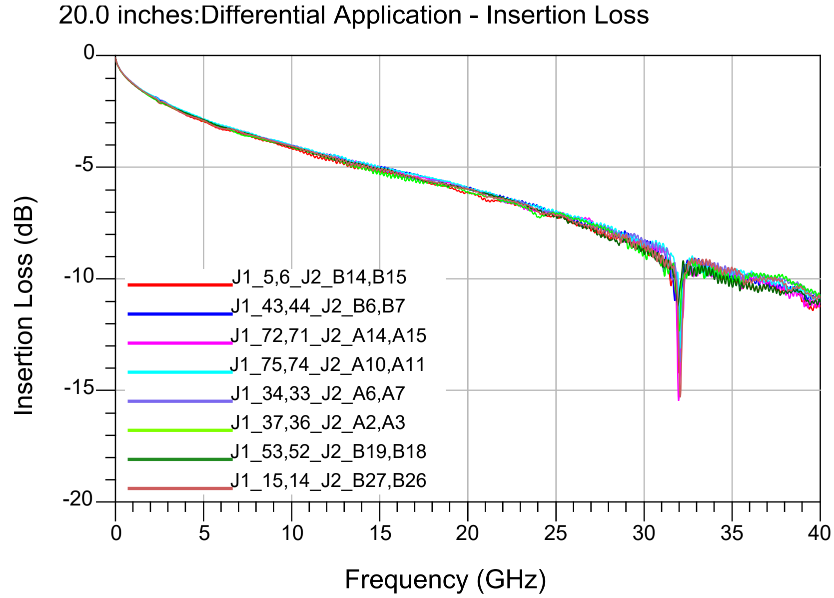

Figure 8

Differential Application – Return Loss

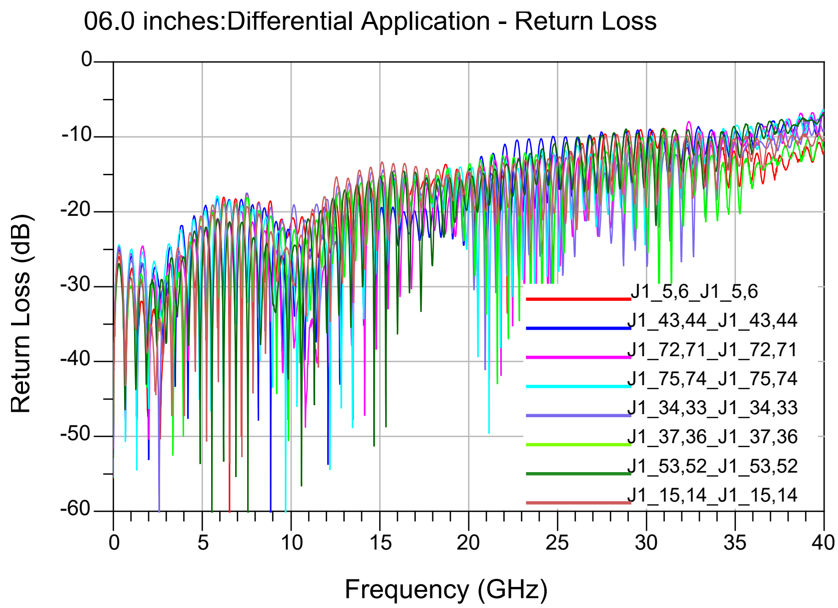

Figure 9

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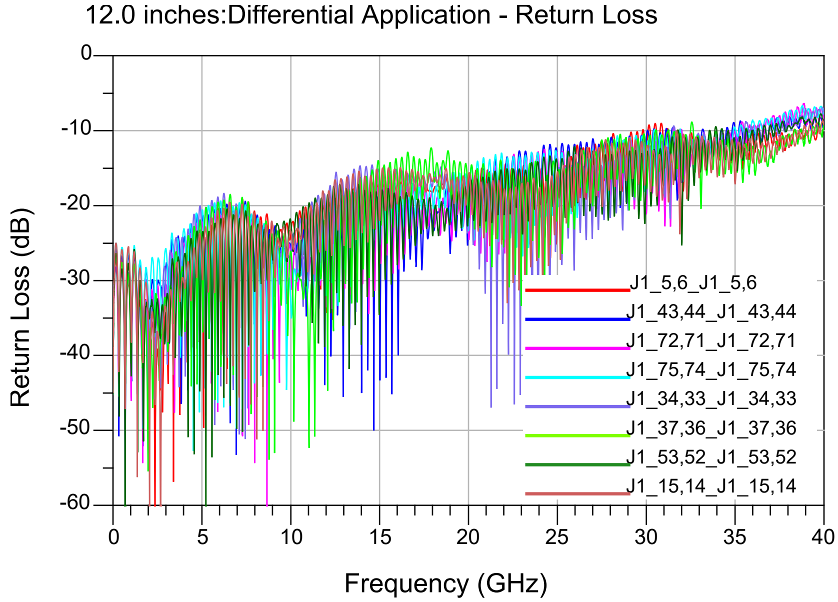

Figure 10

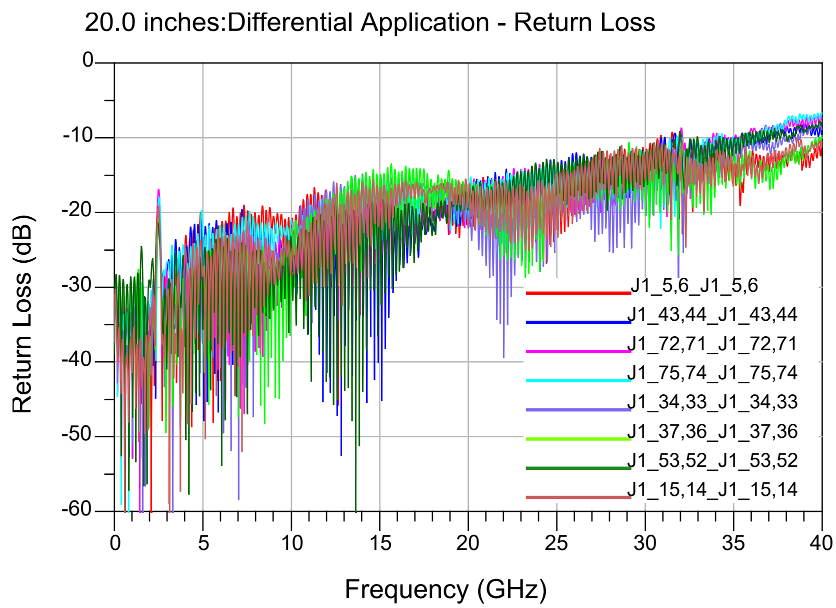

Figure 11

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

Differential Application – NEXT Configurations

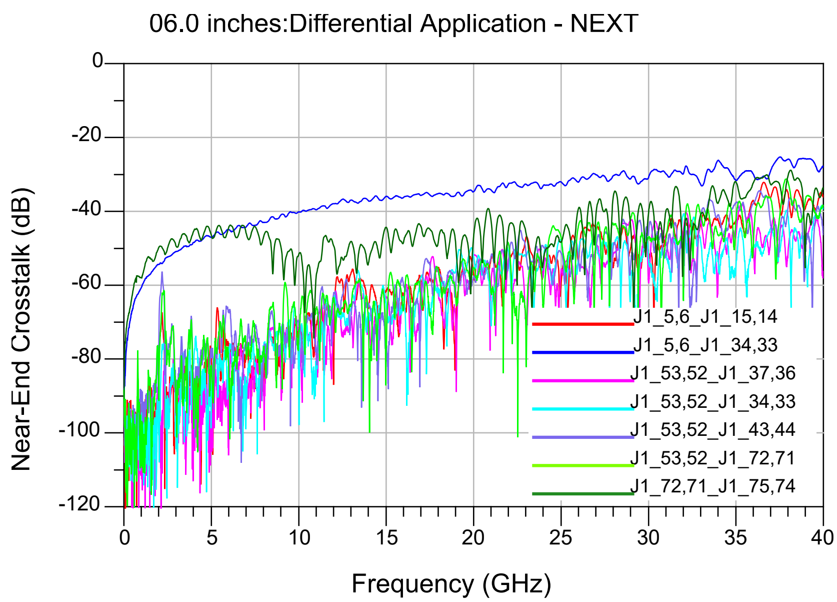

Figure 12

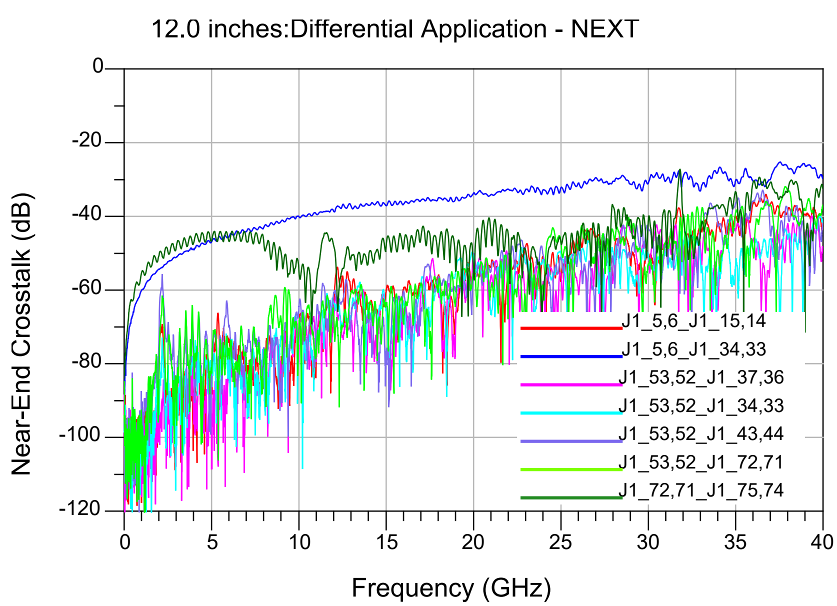

Figure 13

Series: FQSFP-D8
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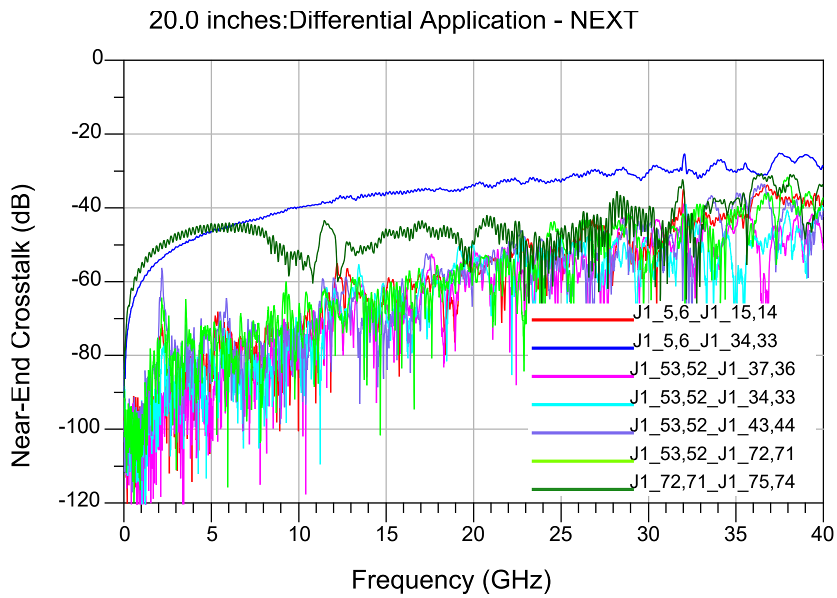

Figure 14

Differential Application – FEXT Configurations

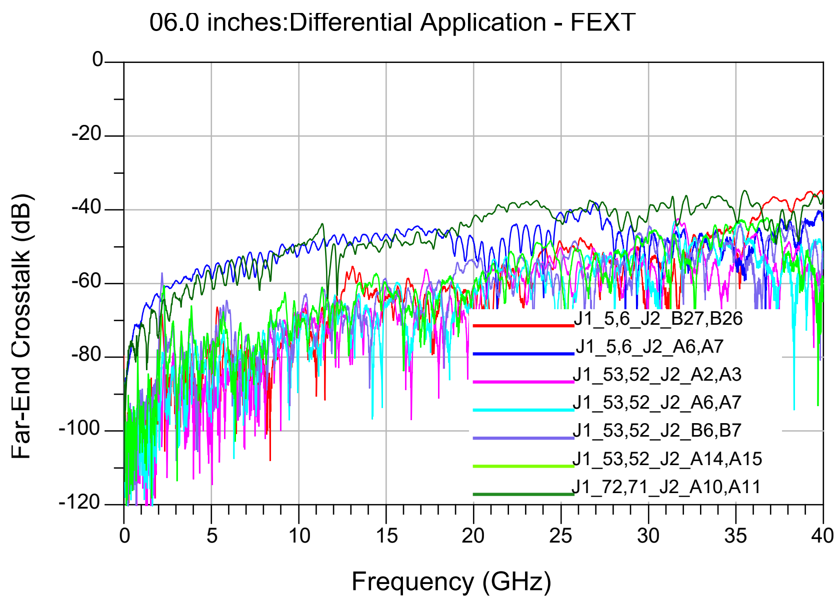

Figure 15

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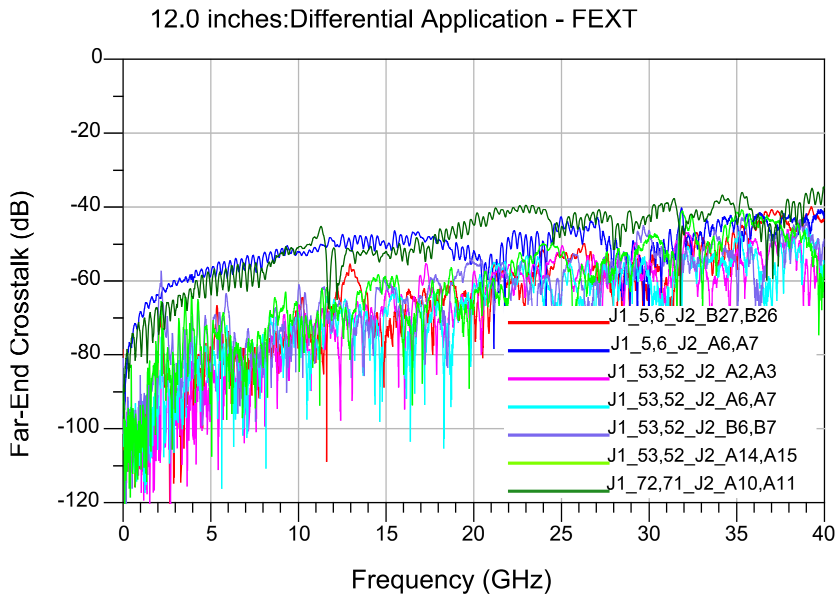
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2



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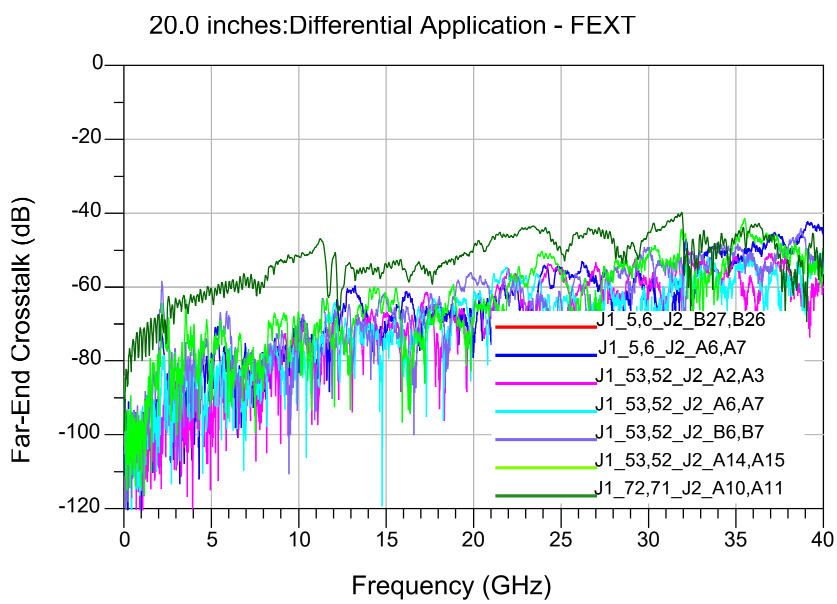

Figure 17

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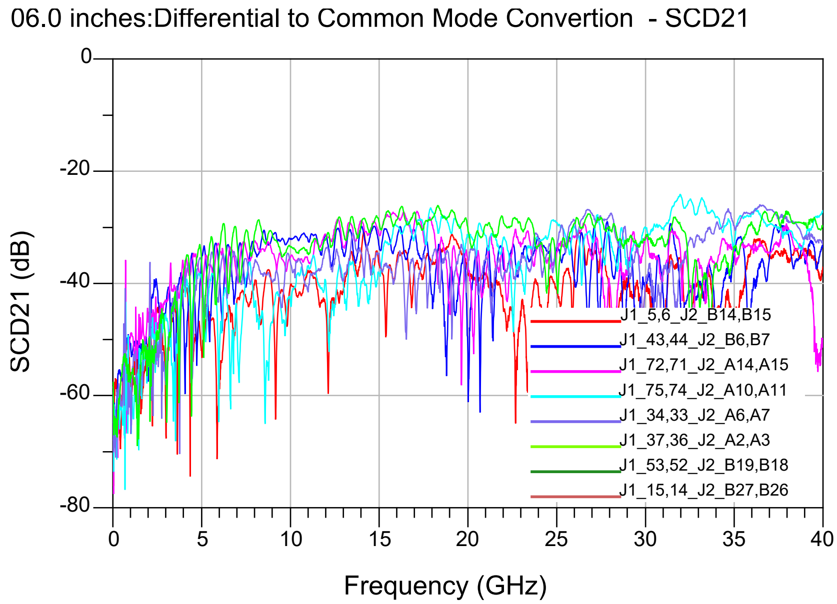
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

Differential Application – Differential to Common Mode Conversion



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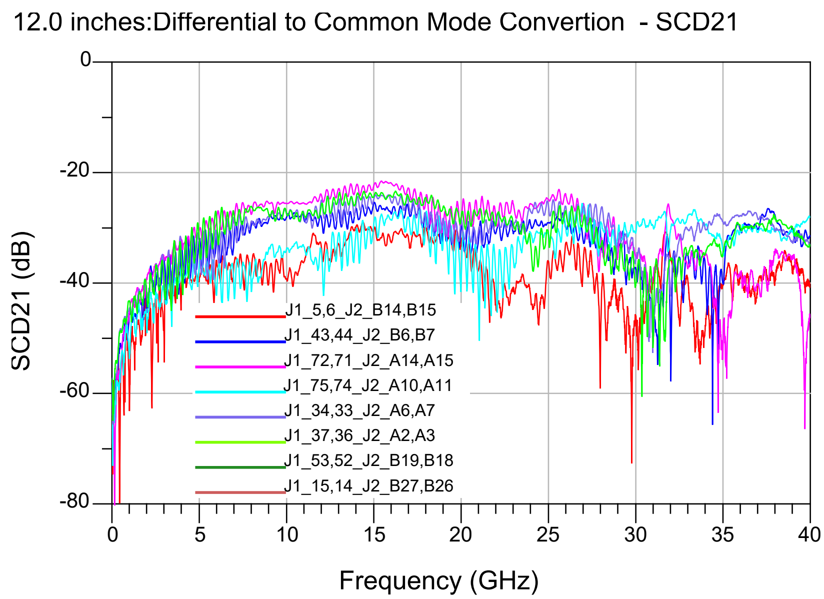

Figure 19

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Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

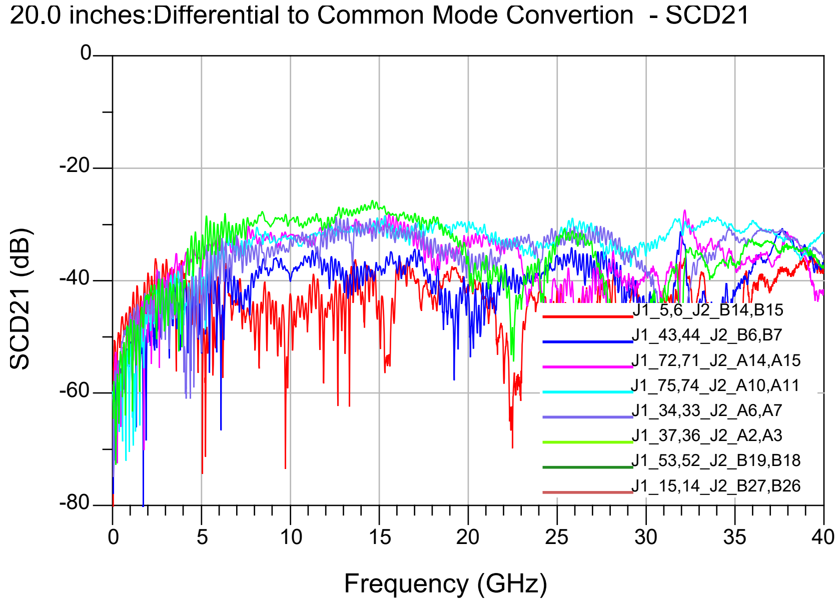

Figure 20

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

Appendix B – Time Domain Responses

Differential Application – Input Pulse

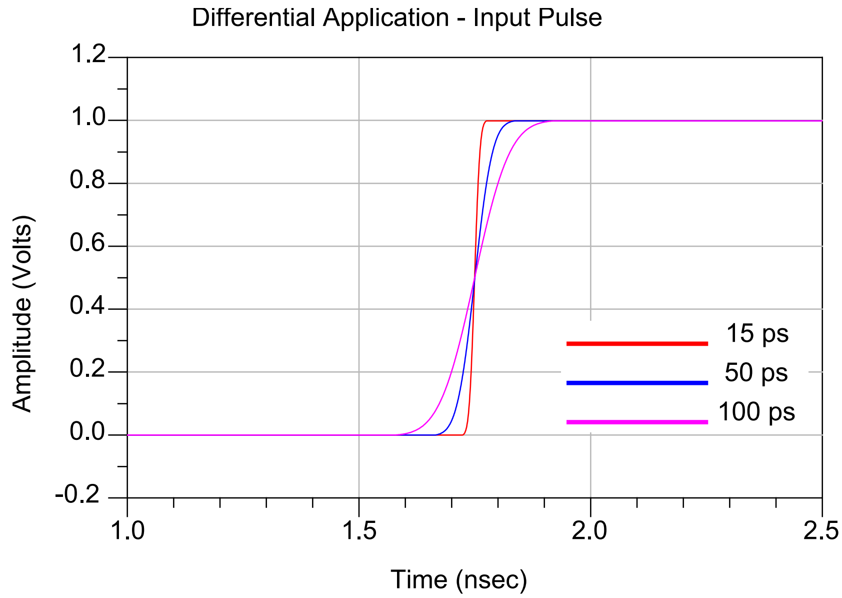

Figure 21

Differential Application – Cable assembly Impedance

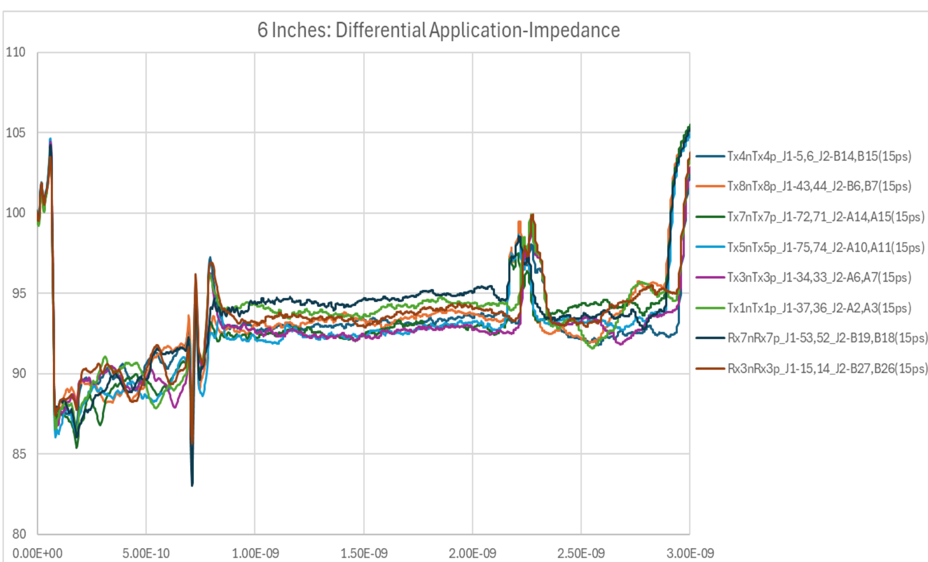

Figure 22

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

Differential Application – Cable assembly Impedance

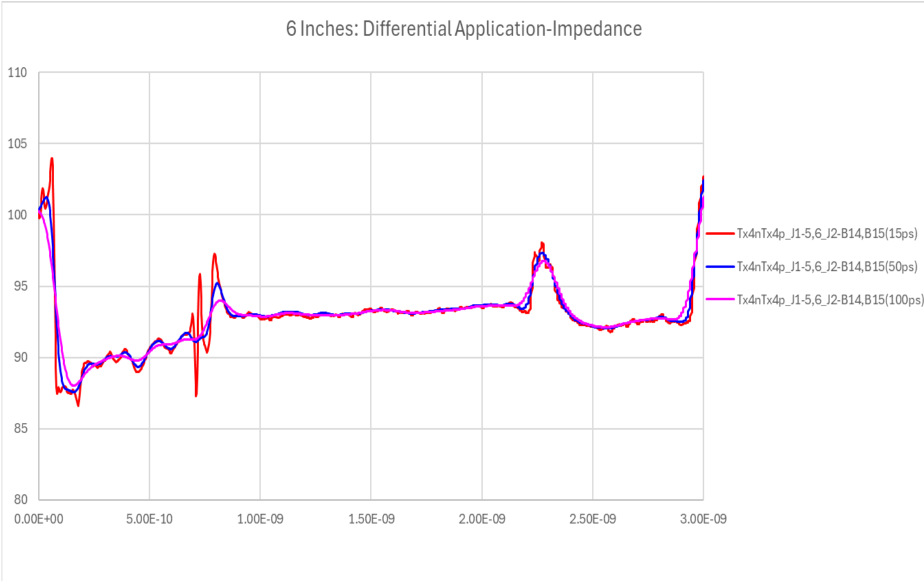

Figure 23

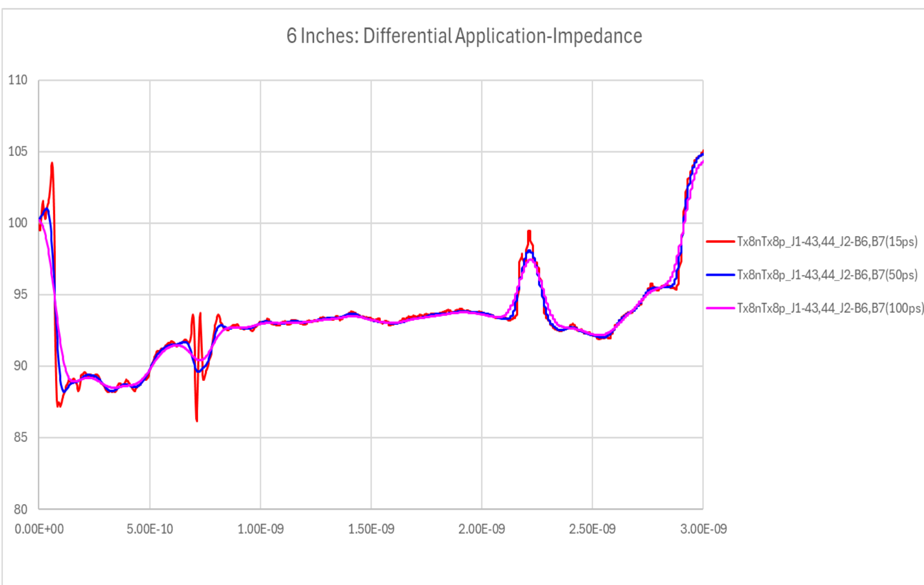

Figure 24

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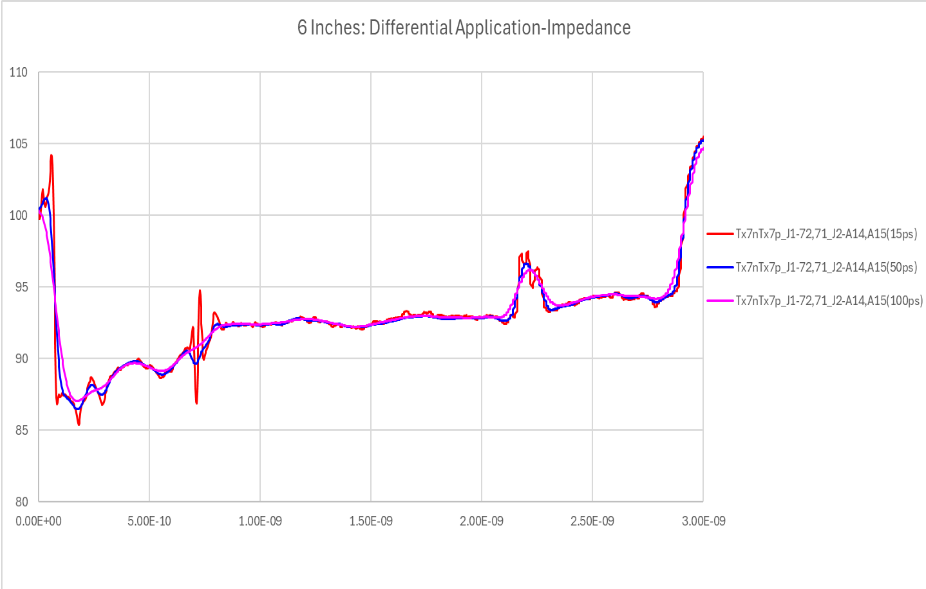

Figure 25

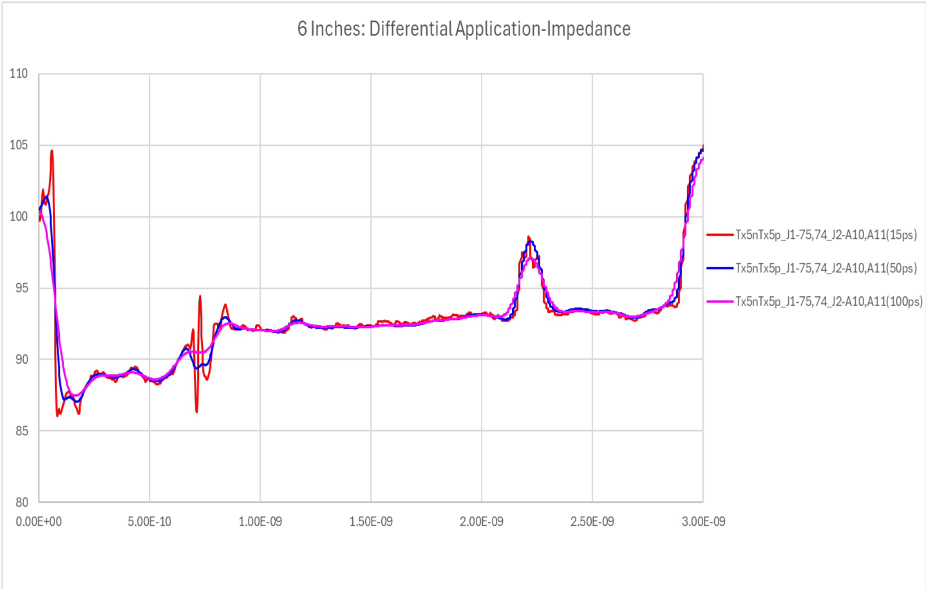

Figure 26

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

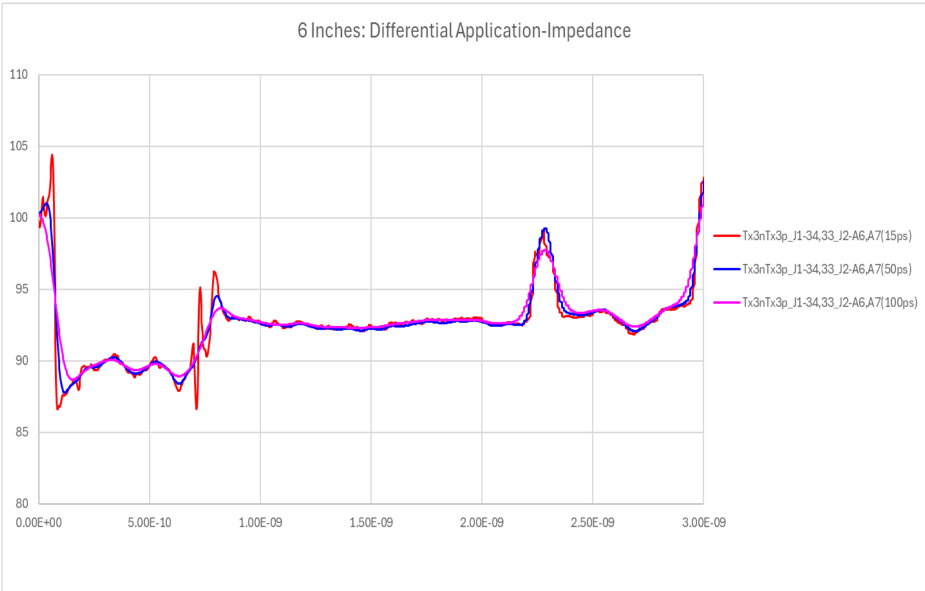

Figure 27

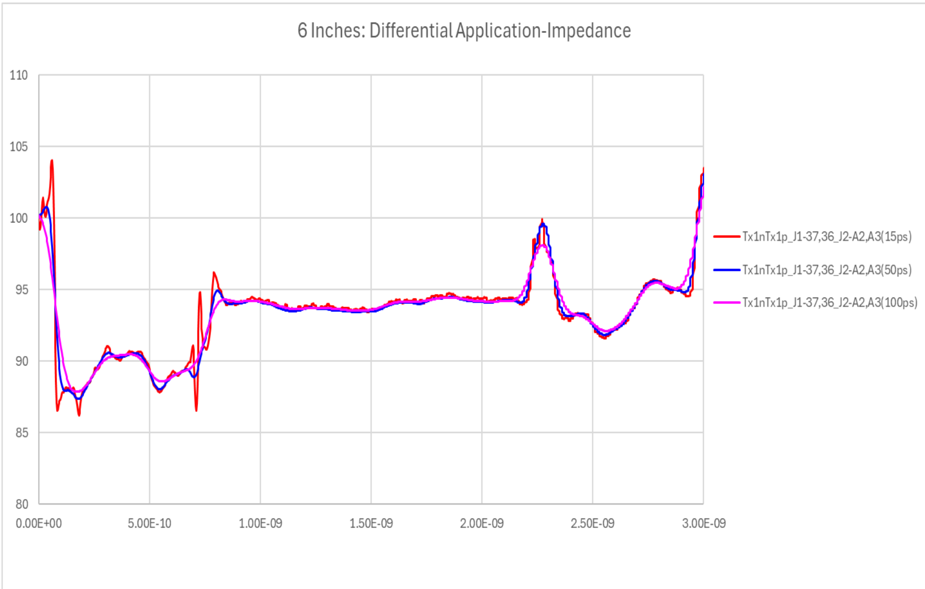

Figure 28

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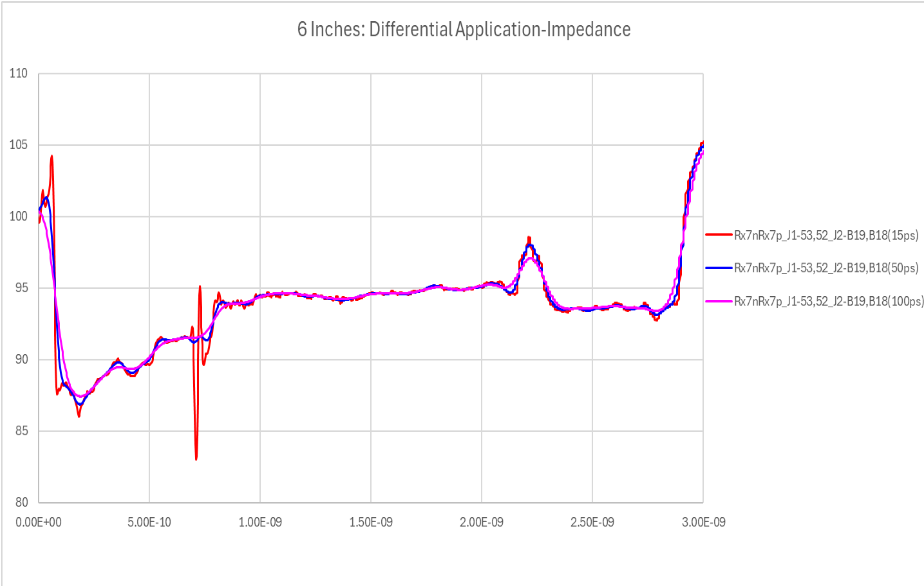

Figure 29

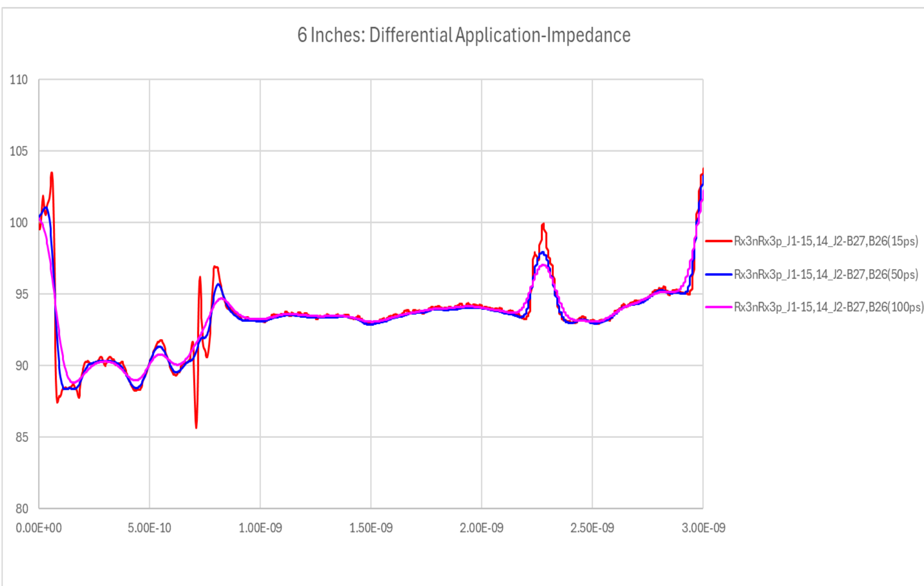

Figure 30

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

Differential Application – Propagation Delay

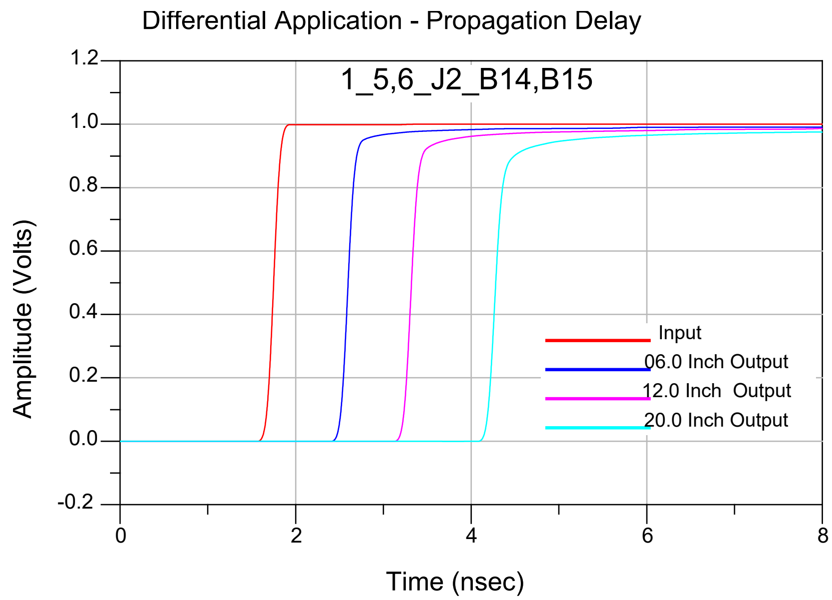

Figure 31

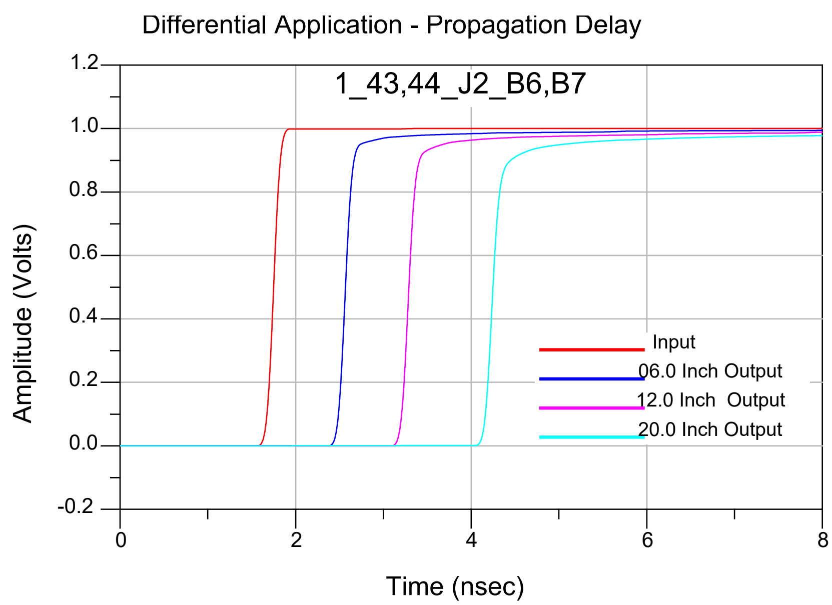

Figure 32

Series: FQSFP-D8
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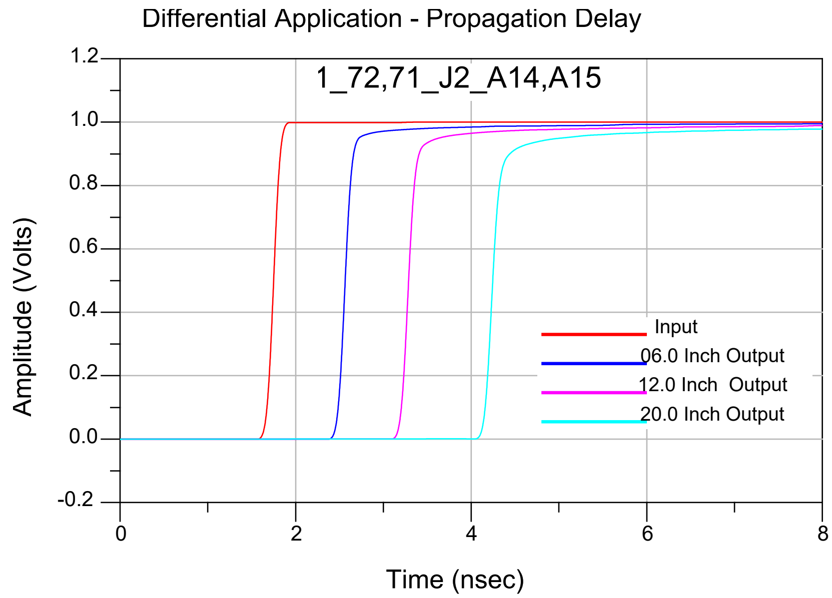

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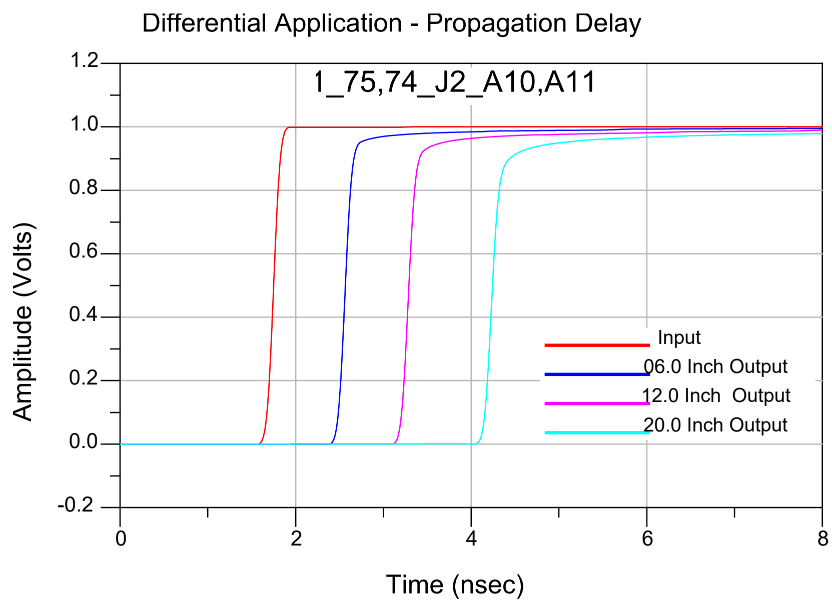

Figure 34

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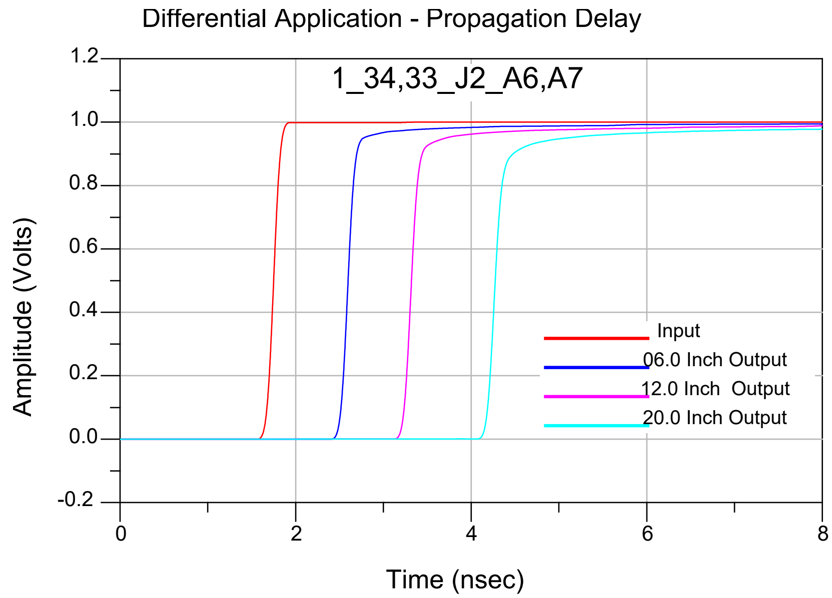

Figure 35

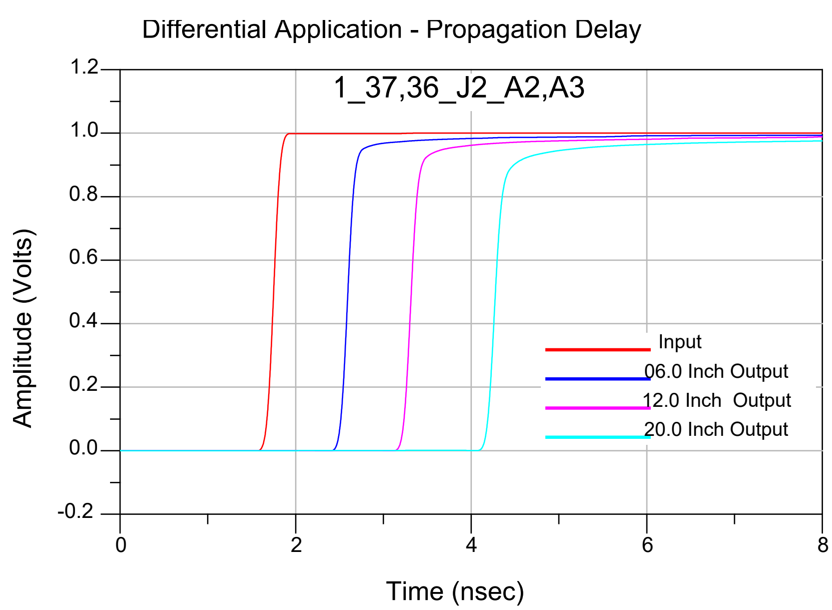

Figure 36

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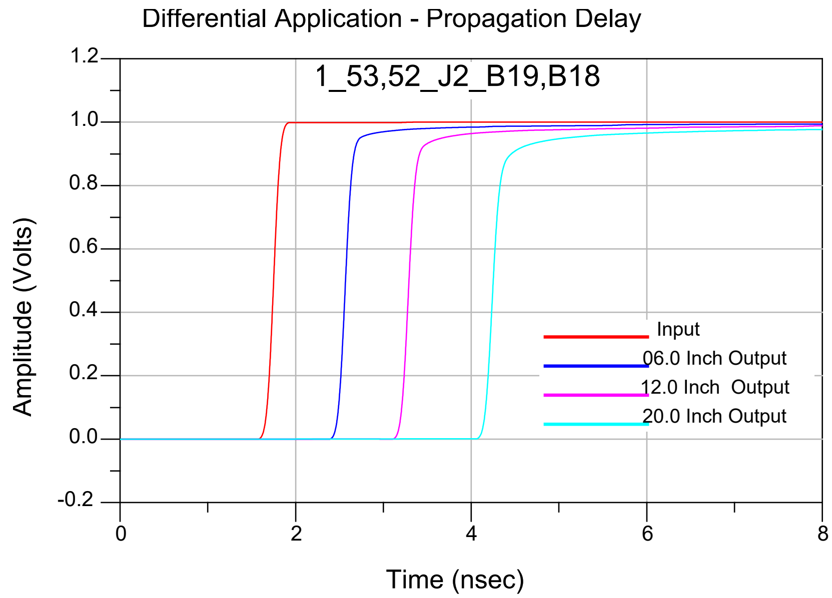

Figure 37

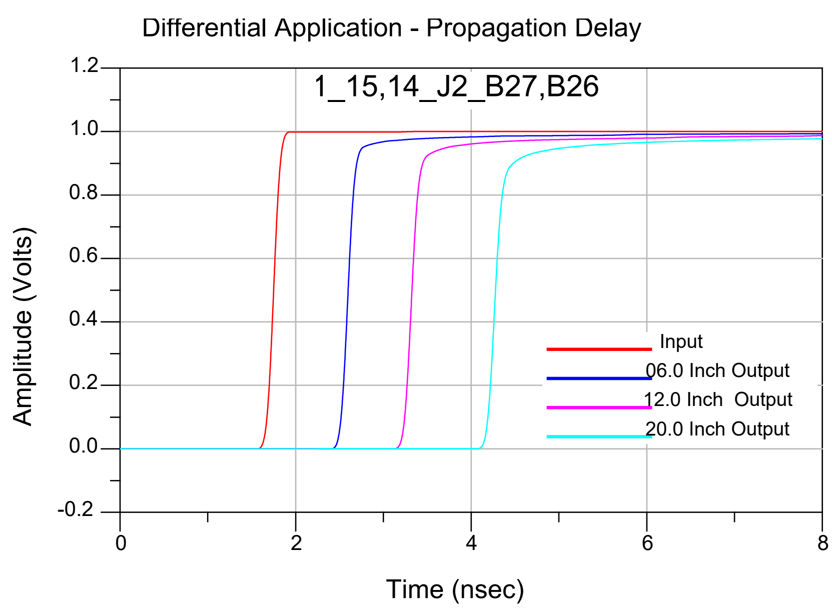

Figure 38

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

Appendix C – Product and Test System Descriptions

Product Description

Product test samples are FQSFP-D8 Flyover® QSFP Double Density Cable Assemblies. The part numbers are FQSFP-D8-05-A-06.0-2, FQSFP-D8-05-A-12.0-2 and FQSFP-D8-05-A-20.0-2. They mate with Edge Card and NVAM-DP-02-2-02.0-S-2-CT-TR. A photo of the mated test article mounted to SI test boards is shown below.

The test fixtures are composed of six-layer TACHYON 100G material with 46.25Ω 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 Edge Card identified by part number PCB-FQSFPD8-111867-SIG-0 and NVAx series connector set identified by part number PCB-NVAM-109157-SIG-0.

PCB-FQSFPD8-111867-SIG-0 and PCB-NVAM-109157-SIG-0 Test Fixtures

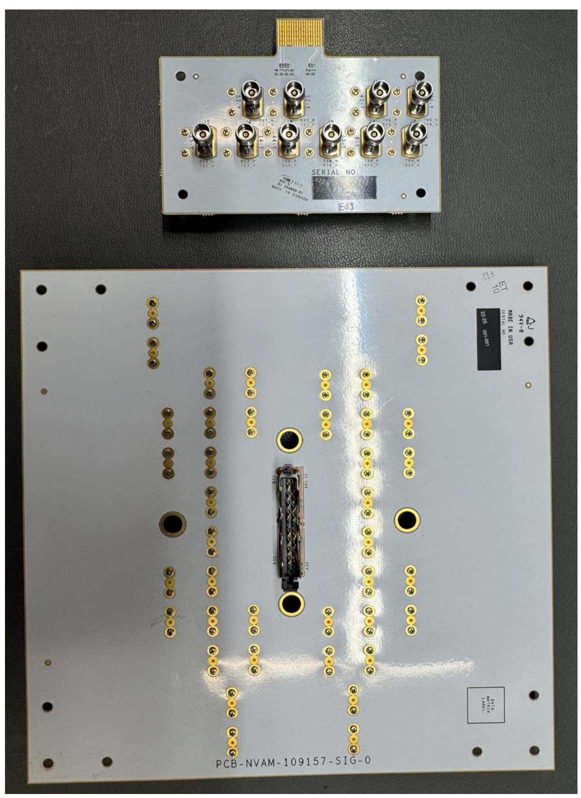

Figure 39

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

PCB Fixtures

The test fixtures used are as follows:

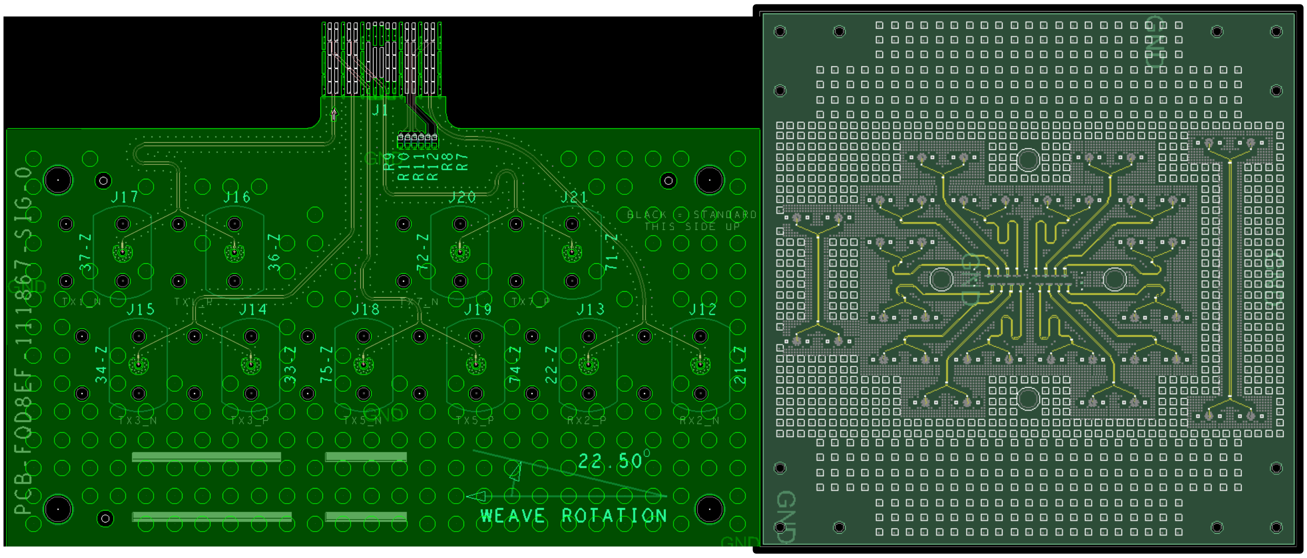

Figure 40

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

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 – 40 GHz
IFBW – 1 KHz

N5227B Measurement Setup

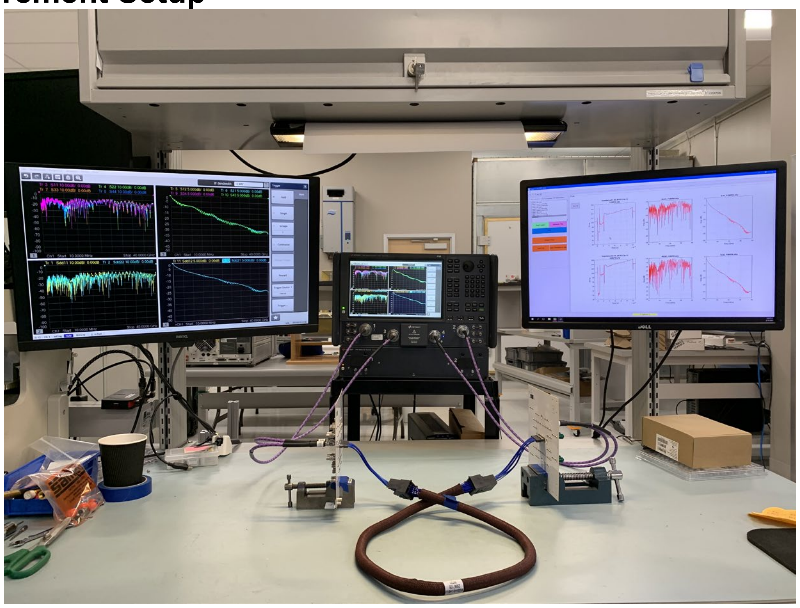

Figure 41

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
32	1 m Junkosha 2.4mm male to female cables

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

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

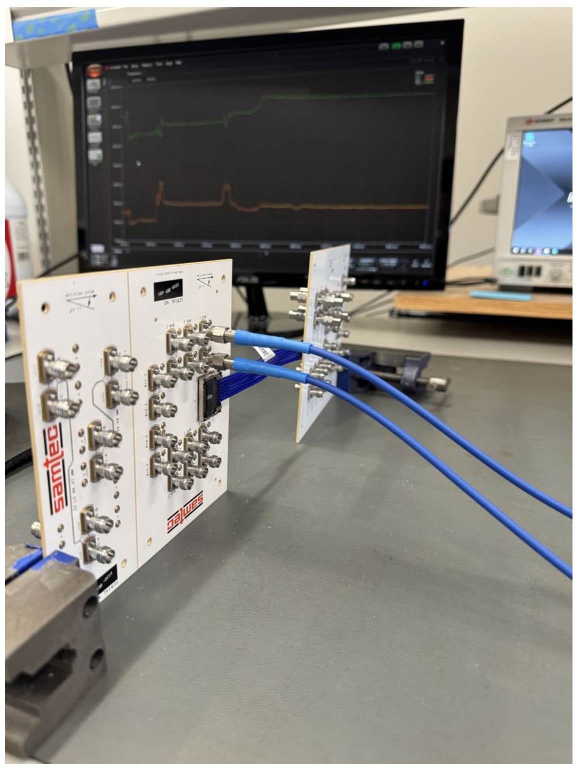

Figure 42

Test Instruments

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

Test Cables & Adapters

QTY	Description
4	Junkosha J12J103834-00

Series: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

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 AFR 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 2023. 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 figure. The difference in time, measured at the 50% point of the step voltage is the propagation delay.

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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: FQSFP-D8
Description: 800G Flyover® QSFP Double Density, 34AWG, 92-Ohm Twinax, NVAC End 2

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