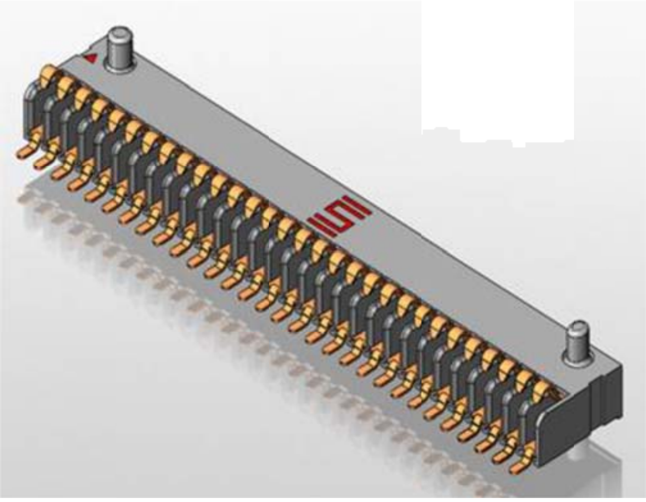
High Speed Characterization Report

SIBF-2X-F-S-AD



Description:
High Speed One Piece Interface
Board-to-Board, 1.27mm (.050”) Pitch, 3mm Stack Height

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Report Revision: 5/8/2013

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Connector Overview

The 1.27 mm (0.050”) pitch SIBF High Speed One Piece Interface is a system ideal for rugged applications. SIBF is a single row contact system available with 3 to 30 contacts that are surface mount on one side and compression mated to pads on the other. Stack height is 3mm (0.118”).

Connector System Speed Rating

High Speed SIBF One Piece Interface, Board-to-Board, 1.27mm (.050”) Pitch, 3mm (0.118”) Stack Height

Signaling	Speed Rating
Single-Ended:	**7.0 GHz/ 14.0 Gbps**
Differential:	**7.5 GHz/ 15.0 Gbps**

The Speed Rating is based on the -3 dB insertion loss point of the connector system. The -3 dB point can be used to estimate usable system bandwidth in a typical, two-level signaling environment.

To calculate the Speed Rating, the measured -3 dB point is rounded-up to the nearest half-GHz level. The resulting loss value is then doubled to determine the approximate maximum data rate in Gigabits per second (Gbps).

For example, a connector with a -3 dB point of 7.8 GHz would have a Speed Rating of 8 GHz/ 16 Gbps. A connector with a -3 dB point of 7.2 GHz would have a Speed Rating of 7.5 GHz/ 15 Gbps.

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Frequency Domain Data Summary

Table 1 - Single-Ended Connector System Performance		
Test Parameter	**Configuration**	
Insertion Loss	GSG	3dB @ 6.713 GHz
Return Loss	GSG	>10dB to 4.838 GHz
Near-End Crosstalk	GAQG	< -20dB to 0.600 GHz
	GAGQG	< -20dB to 5.950 GHz
	Xrow, GAG to GQG	N/A
Far-End Crosstalk	GAQG	< -20dB to 3.688 GHz
	GAGQG	< -20dB to 6.125 GHz
	Xrow, GAG to GQG	N/A

Table 2 - Differential Connector System Performance		
Test Parameter	**Configuration**	
Insertion Loss	GSSG	3dB @ 7.550 GHz
Return Loss	GSSG	>10dB to 5.450 GHz
Near-End Crosstalk	GAAQQG	< -20dB to 12.213 GHz
	GAAGQQG	< -20dB to 13.500 GHz
	Xrow, GAAG to GQQG	N/A
Far-End Crosstalk	GAAQQG	< -20dB to 12.575 GHz
	GAAGQQG	< -20dB to 14.038 GHz
	Xrow, GAAG to GQQG	N/A

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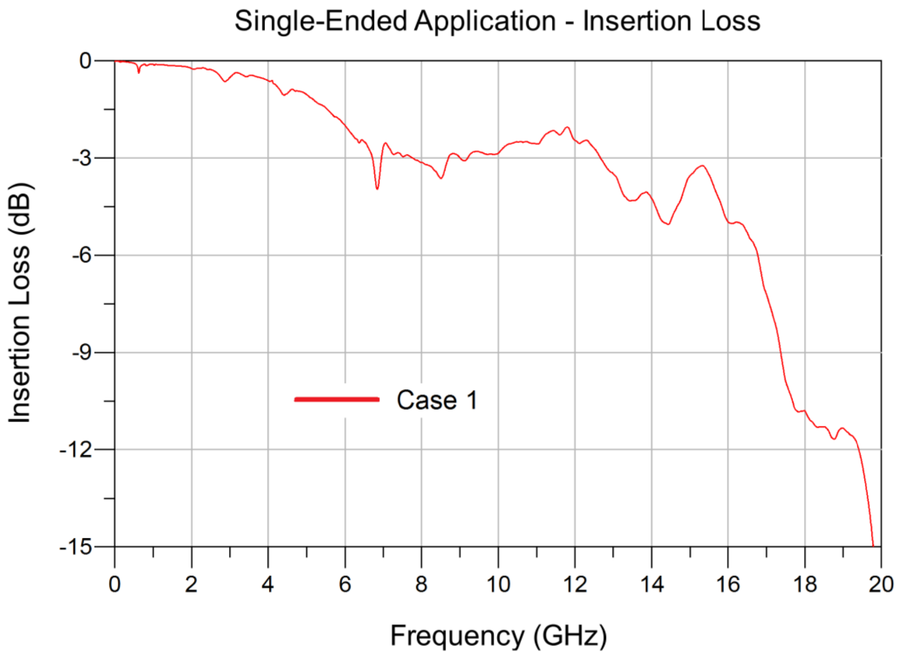
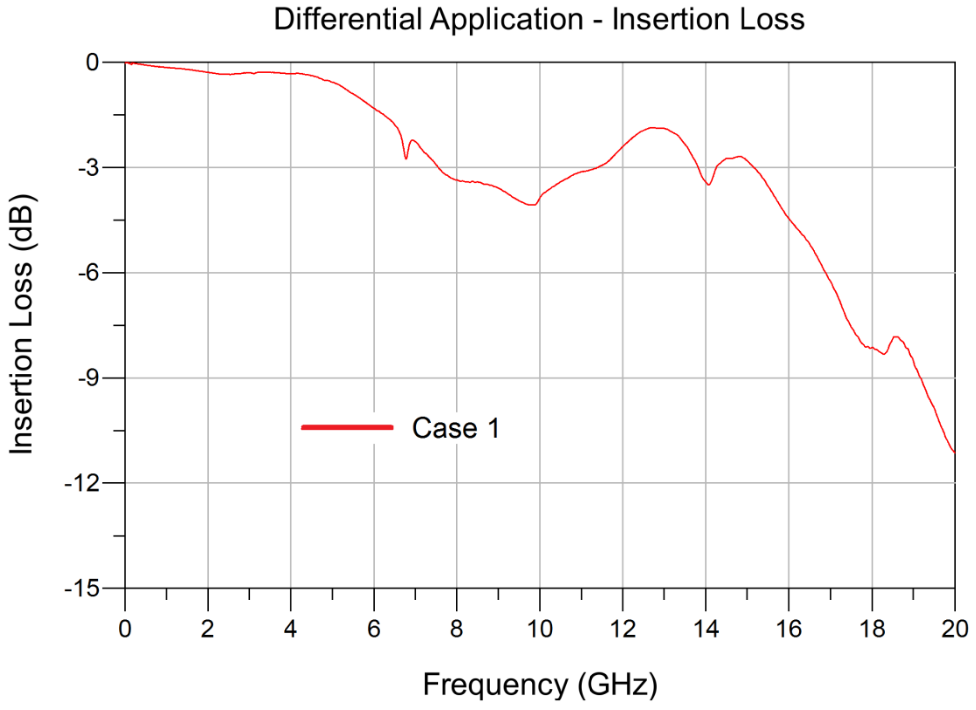
Bandwidth Chart – Single-Ended & Differential Insertion Loss

SIBF One Piece Interface





Time Domain Data Summary

Table 3 – Single-End Impedance (Ω)					
Signal Rise-time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**
Maximum Impedance	68.471	64.229	55.670	50.720	50.519
Minimum Impedance	40.092	43.239	47.217	49.534	49.600

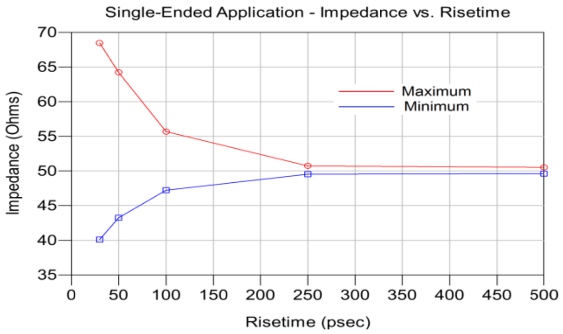


Table 4 - Differential Impedance (Ω)					
Signal Rise-time	**30 ps**	**50 ps**	**100 ps**	**250 ps**	**500 ps**
Maximum Impedance	109.104	104.417	103.532	101.526	100.375
Minimum Impedance	67.137	74.694	85.499	90.456	94.774

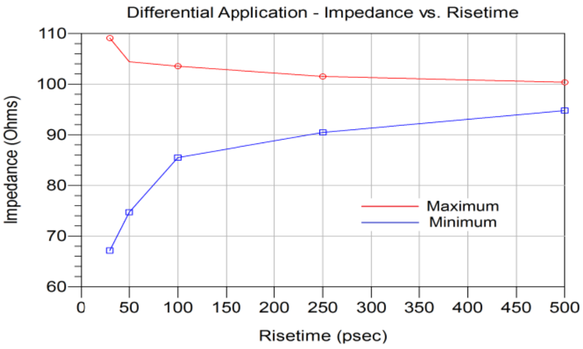


Table 5 - Single-Ended Crosstalk (%)

Input(tr)		30ps	50 ps	100 ps	250 ps	500 ps
NEXT	GAQG	15.612	13.945	12.546	7.440	4.212
	GAGQG	5.189	3.392	2.473	1.127	0.699
	Xrow	N/A	N/A	N/A	N/A	N/A
FEXT	GAQG	7.240	4.584	2.778	1.464	1.005
	GAGQG	4.427	3.598	2.319	1.021	0.592
	Xrow	N/A	N/A	N/A	N/A	N/A

Table 6 - Differential Crosstalk (%)

Input(tr)		30ps	50 ps	100 ps	250 ps	500 ps
NEXT	GAAQQG	4.779	4.622	4.161	2.501	1.375
	GAAGQQG	1.050	0.425	0.161	0.065	0.031
	Xrow	N/A	N/A	N/A	N/A	N/A
FEXT	GAAQQG	1.579	0.968	0.668	0.436	0.233
	GAAGQQG	0.586	0.322	0.123	0.018	0.006
	Xrow	N/A	N/A	N/A	N/A	N/A

Table 7 - Propagation Delay (Mated Connector)

Single-Ended	85ps
Differential	86ps

Characterization Details

This report presents data that characterizes the signal integrity response of a connector pair 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 connector pair 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 connector'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 connectors 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 both differential and single-ended drive scenarios.

Connector Signal to Ground Ratio

Samtec connectors 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 connectors, a ground plane or blade, or an outer shield, is used as the signal return, while in others, connector 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. However, dedicating pins to ground reduces signal density of a connector. Therefore, care must be taken when choosing signal/ground ratios in cost or density-sensitive applications.

For this connector, the following array configurations were evaluated:

Single-Ended Impedance**:**
- GSG (ground-signal-ground)

Single-Ended Crosstalk**:**
- Electrical “worst case”: GAQG (ground-active-quiet-ground)
- Electrical “best case”: GAGQG (ground-active-ground-quiet-ground)
- Across row: “xrow case”: GAG to GQG (from one row of terminals to the other row)

Differential Impedance**:**
- GSSG (Ground-positive signal-negative signal-ground)

Differential Crosstalk**:**
- Electrical “worst case”: GAAQQG (ground-active-active-quiet-quiet-ground)
- Electrical “best case”: GAAGQQG (ground-active-active-ground-quiet-quiet-ground)
- Across row: “xrow case”: GAAG to GQQG (from one row of terminals to the other row)

Only one single-ended signal or differential pair was driven for crosstalk measurements.

Other configurations can be evaluated upon request. Please contact sig@samtec.com for more information.

In a real system environment, active signals might be located at the outer edges of the signal contacts of concern, as opposed to the ground signals utilized in laboratory testing. For example, in a single-ended system, a pin-out of “SSSS”, or four adjacent single ended signals might be encountered as opposed to the “GSG” and “GSSG” configurations tested in the laboratory. Electrical characteristics in such applications could vary slightly from laboratory results. However, 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.

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In many systems, the signal edge rate will be significantly slower at the connector 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.

For this report, measured rise times were at 10%-90% signal levels.

Frequency Domain Data

Frequency Domain parameters are helpful in evaluating the connector 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, and Near-End and Far-End Crosstalk. 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, signal propagation time, and crosstalk in a pulsed signal environment. The measured S-Parameters from the network analyzer are post-processed using Agilent Advanced Design System 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 connector and connector footprint. It includes 49.50 mils of PCB trace on the terminal connector side and 89.00 mils of PCB trace on the socket connector side. Delay is measured at 30 picoseconds signal rise-time. Delay is calculated as the difference in time measured between the 50% amplitude levels of the input and output pulses.

Crosstalk or coupled noise data is provided for various signal configurations. All measurements are single disturber. Crosstalk is calculated as a ratio of the input line voltage to the coupled line voltage. The input line is sometimes described as the active or drive line. The coupled line is sometimes described as the quiet or victim line. Crosstalk ratio is tabulated in this report as a percentage. Measurements are made at both the near-end and far-end of the SUT.

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

As a rule of thumb, 10% crosstalk levels are often used as a general first pass limit for determining acceptable interconnect performance. But modern system crosstalk tolerance can vary greatly. For advice on connector suitability for specific applications, please contact our Signal Integrity Group at sig@samtec.com.

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.

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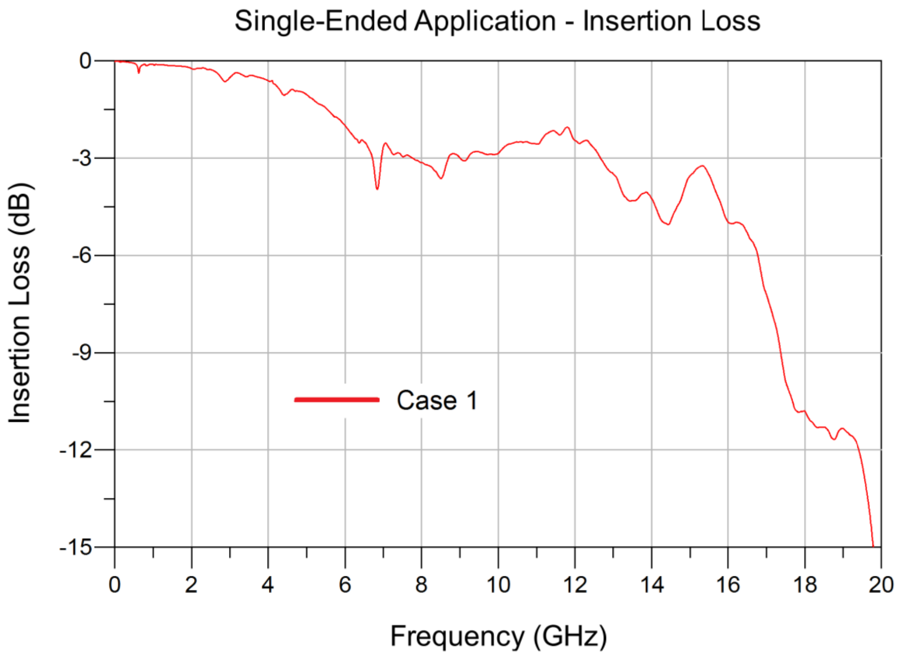
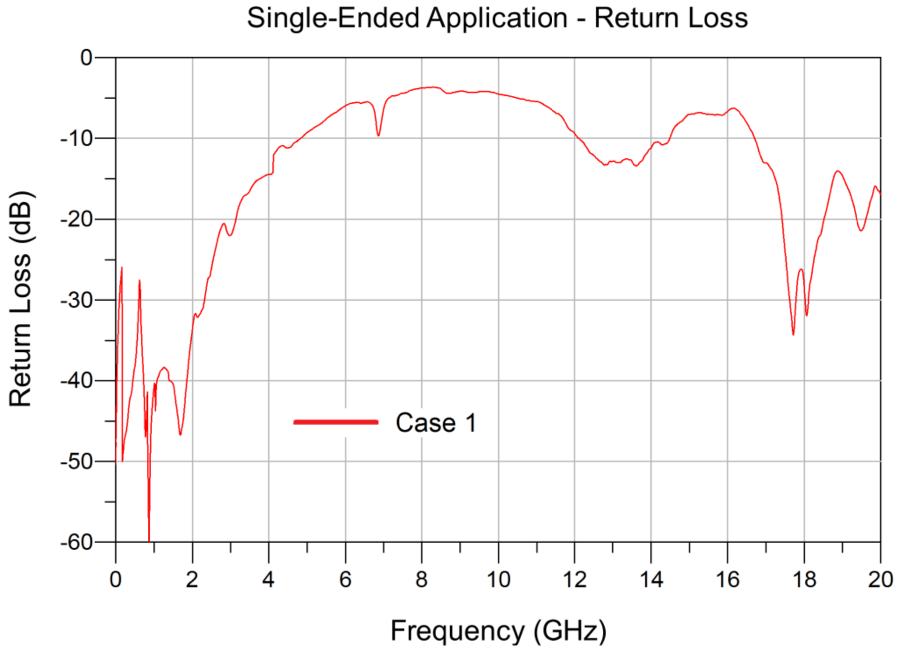
Appendix A – Frequency Domain Response Graphs

Single-Ended Application – Insertion Loss



Single-Ended Application – Return Loss



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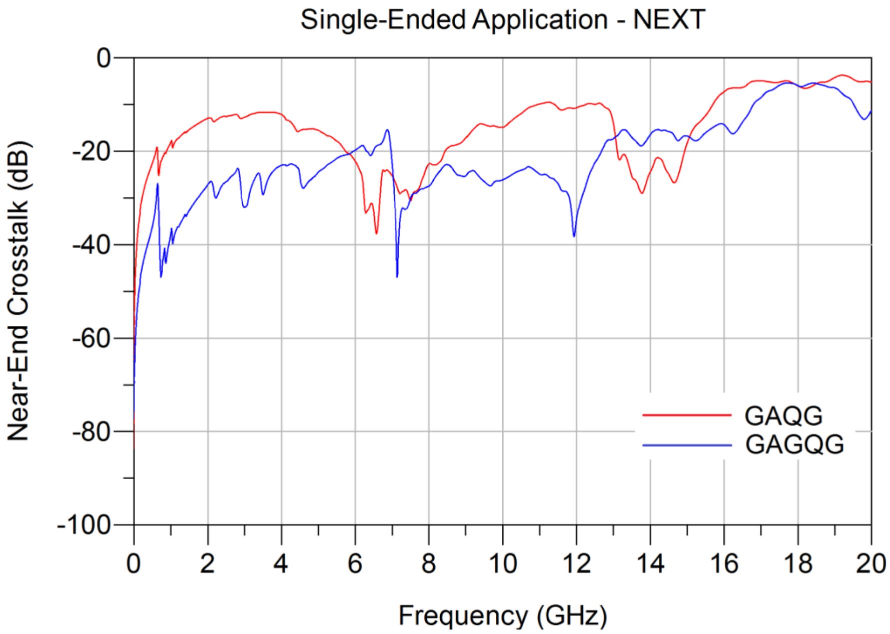
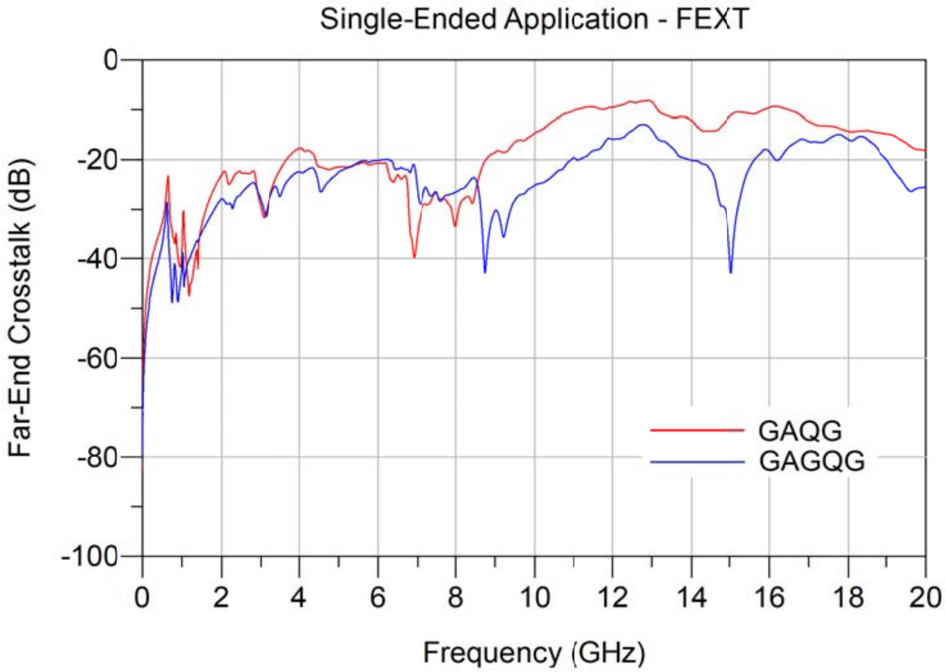
Single-Ended Application – NEXT Configurations



Single-Ended Application – FEXT Configurations



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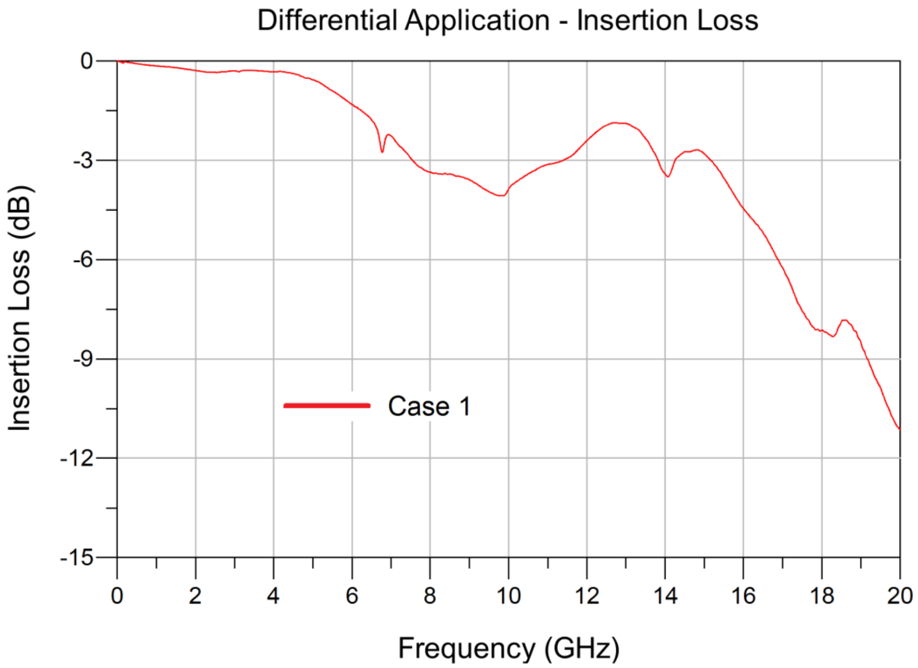
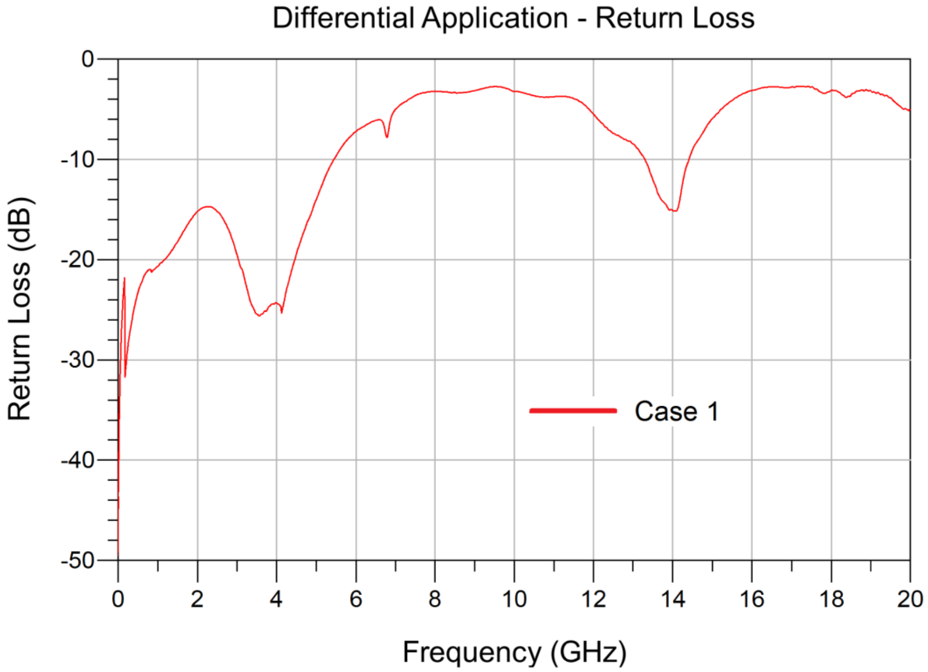
Differential Application – Insertion Loss

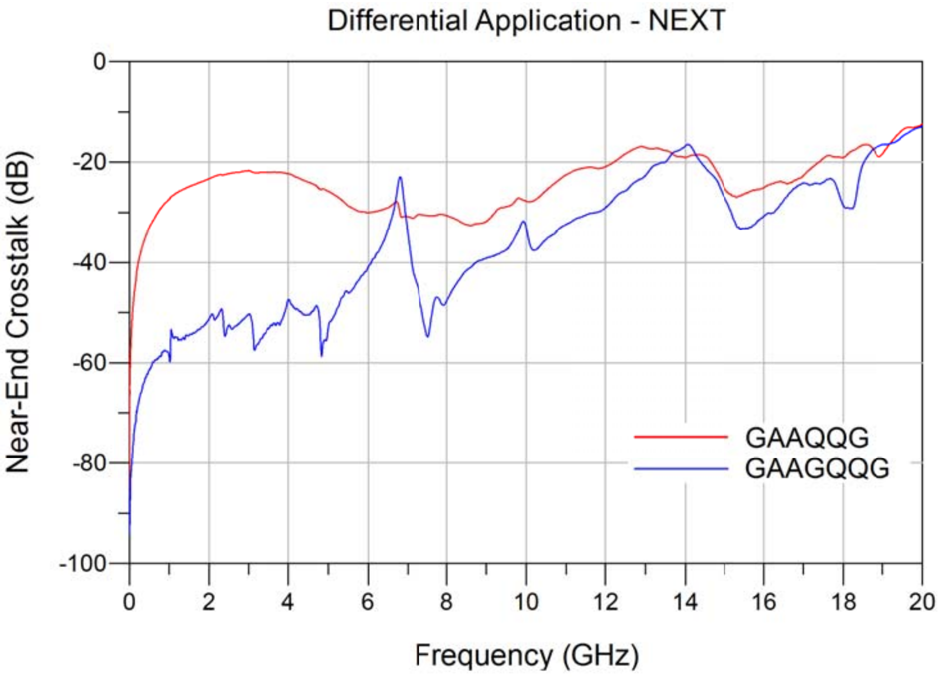


Differential Application – Return Loss

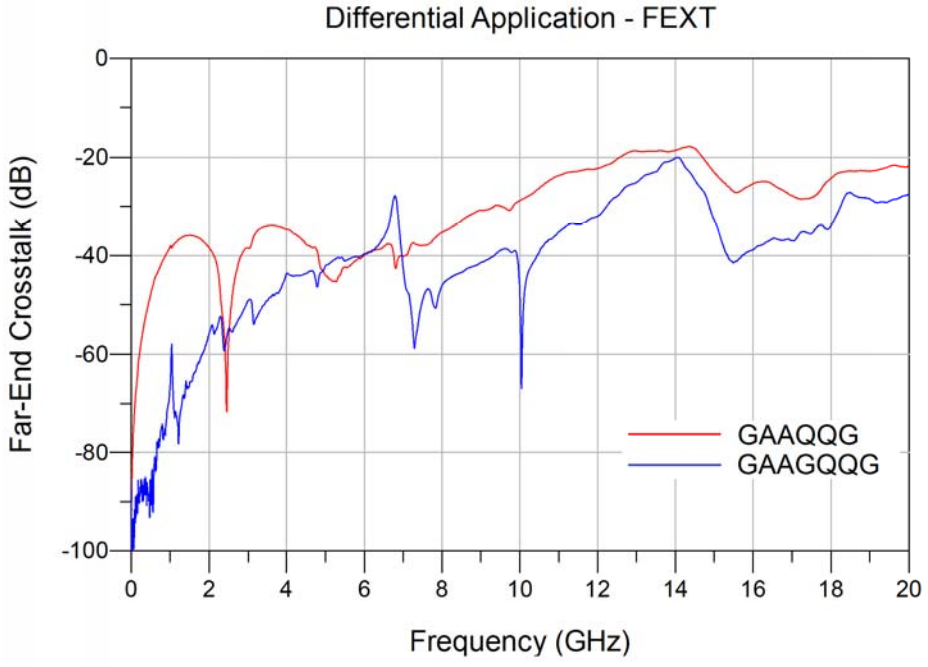


Series: SIBF
Description: High Speed One Piece Interface, 1.27mm Pitch, 3mm Stack Height

Differential Application – NEXT Configurations



Differential Application – FEXT Configurations



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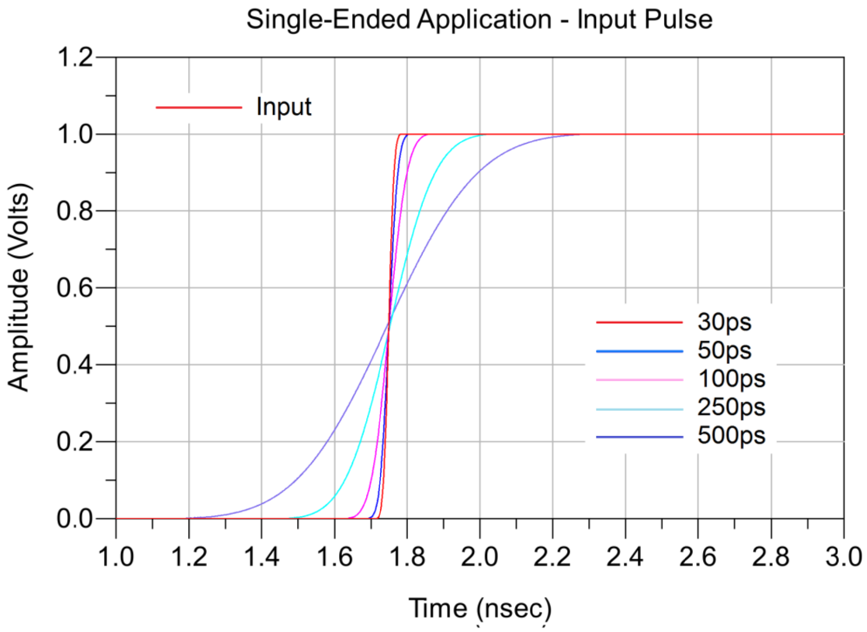
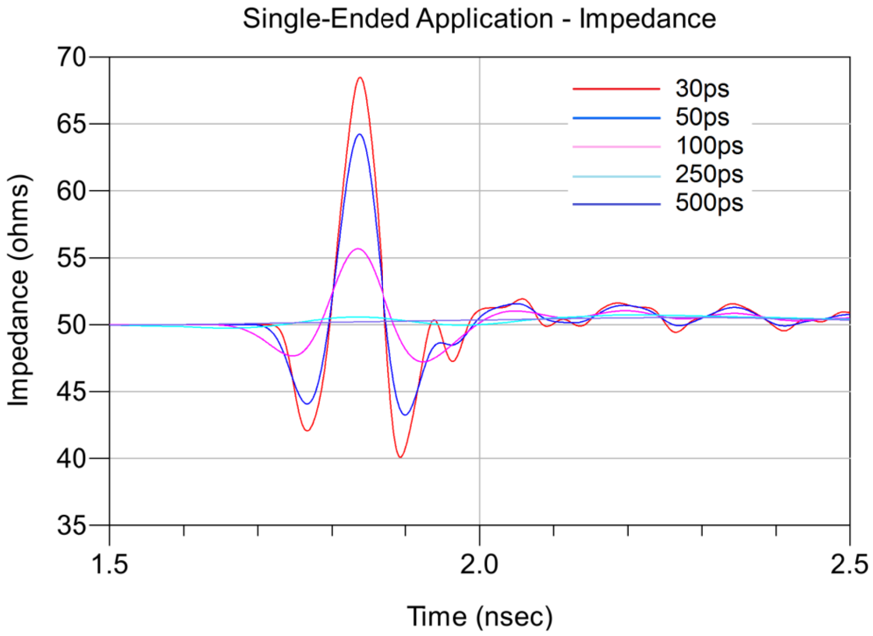
Appendix B – Time Domain Response Graphs

Single-Ended Application – Input Pulse



Single-Ended Application – Impedance



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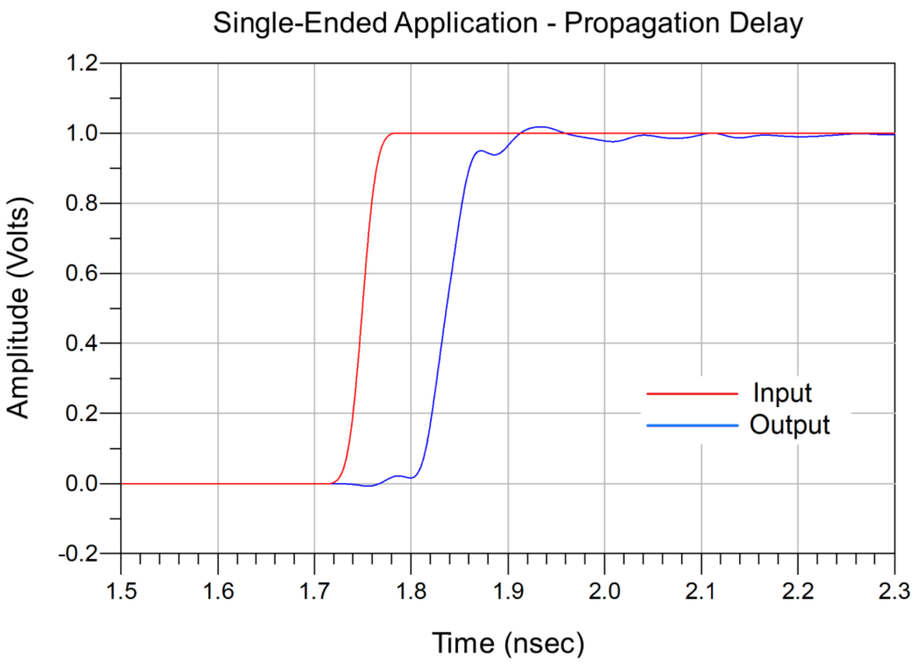
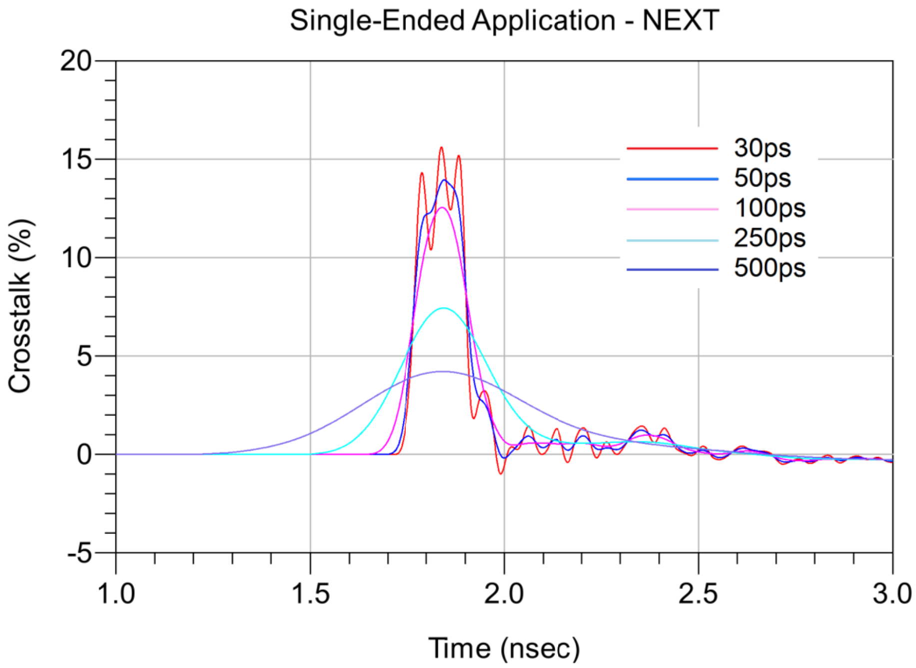
Single-Ended Application – Propagation Delay

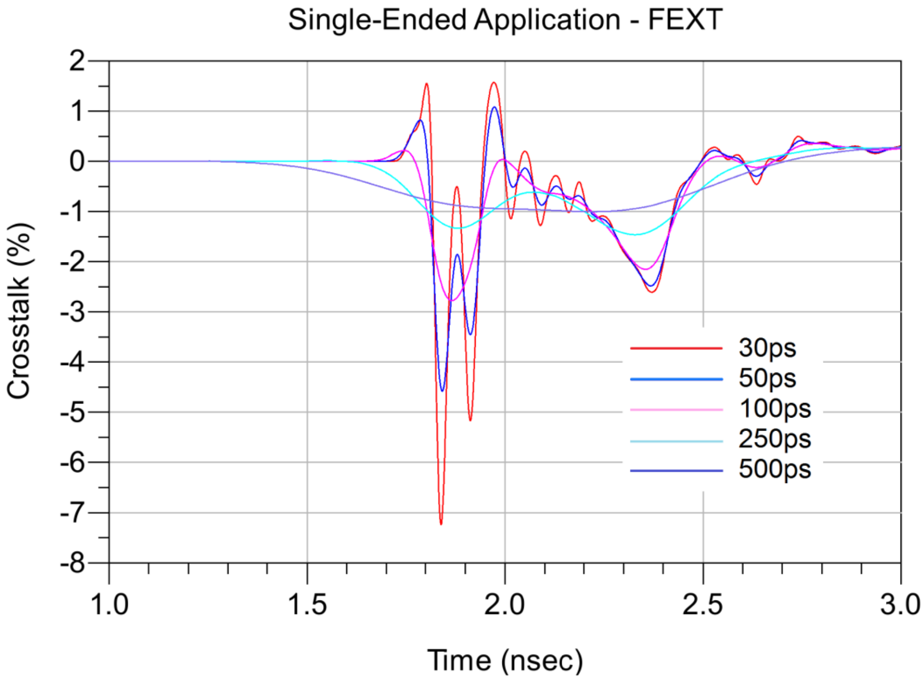


Single-Ended Application – NEXT, Worst Case Configuration

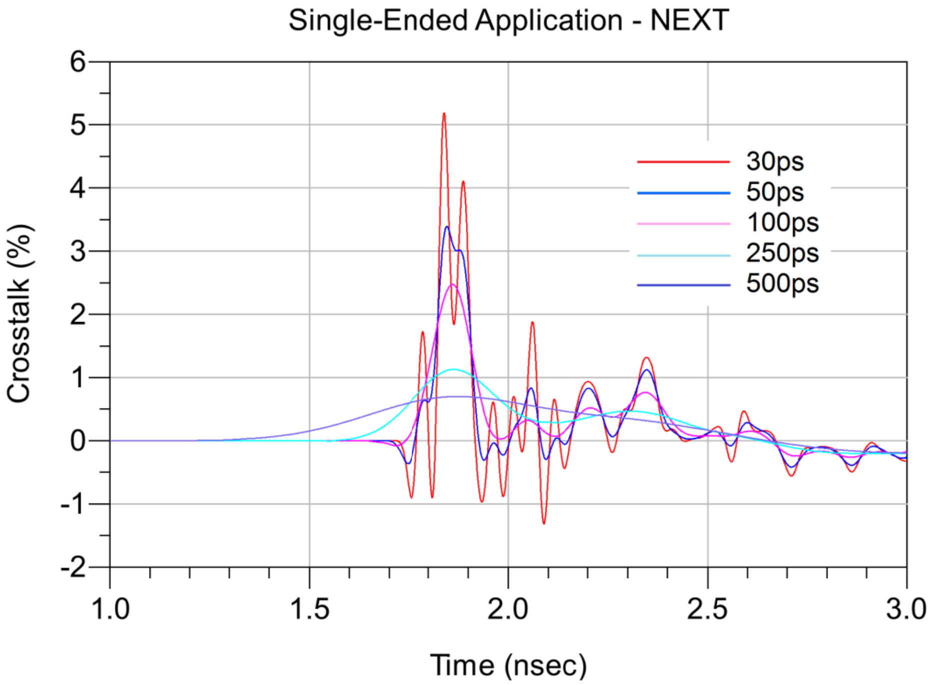


Series: SIBF
Description: High Speed One Piece Interface, 1.27mm Pitch, 3mm Stack Height

Single-Ended Application – FEXT, Worst Case Configuration

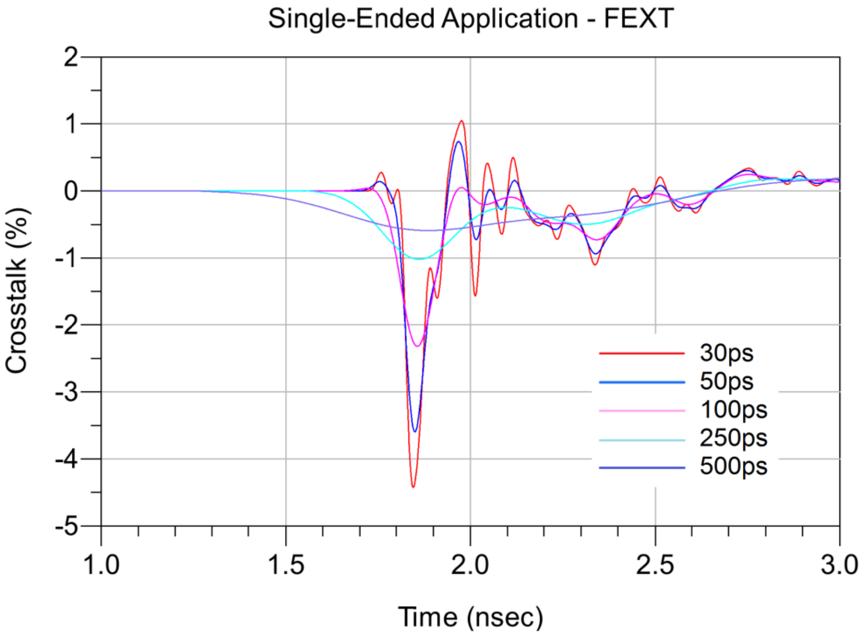


Single-Ended Application – NEXT, Best Case Configuration

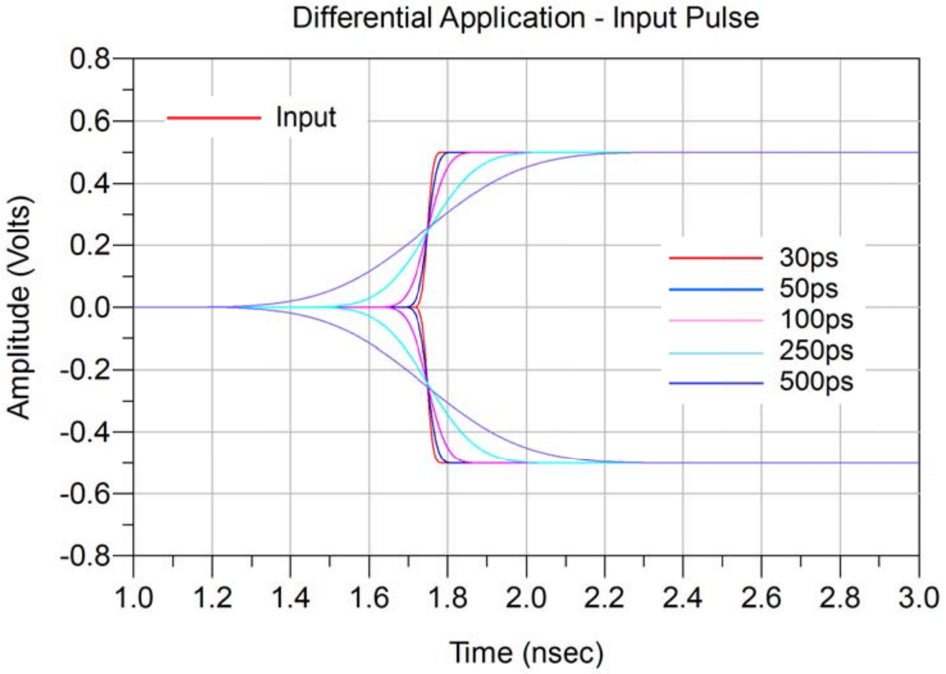


Series: SIBF
Description: High Speed One Piece Interface, 1.27mm Pitch, 3mm Stack Height

Single-Ended Application – FEXT, Best Case Configuration



Differential Application – Input Pulse



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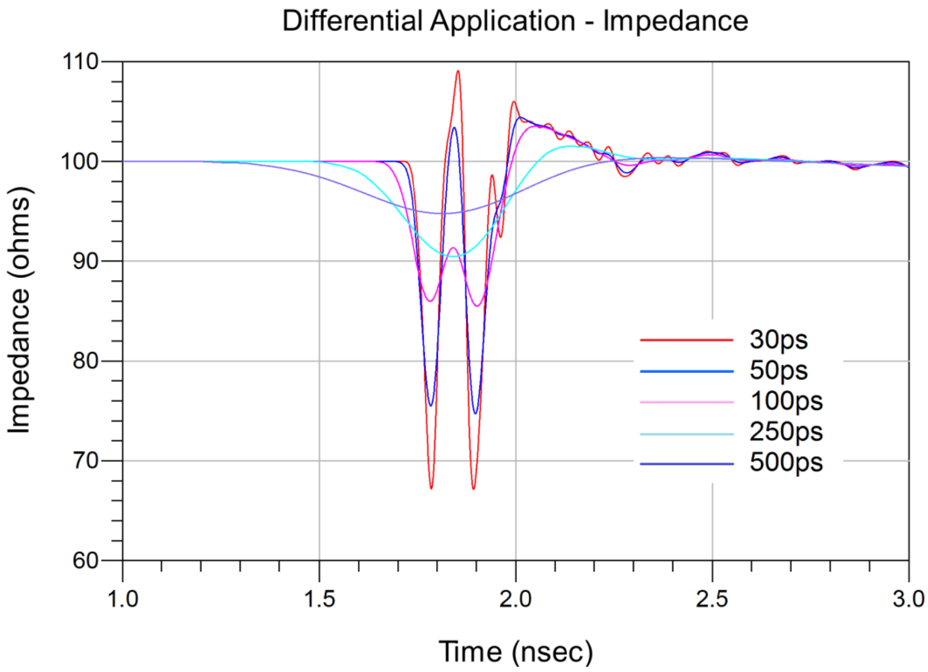
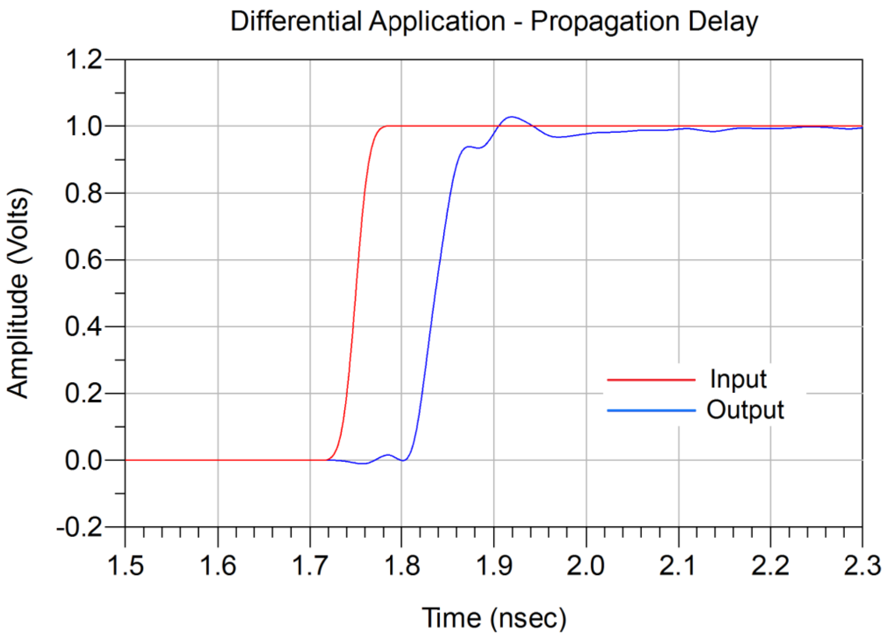
Differential Application – Impedance



Differential Application – Propagation Delay



Series: SIBF
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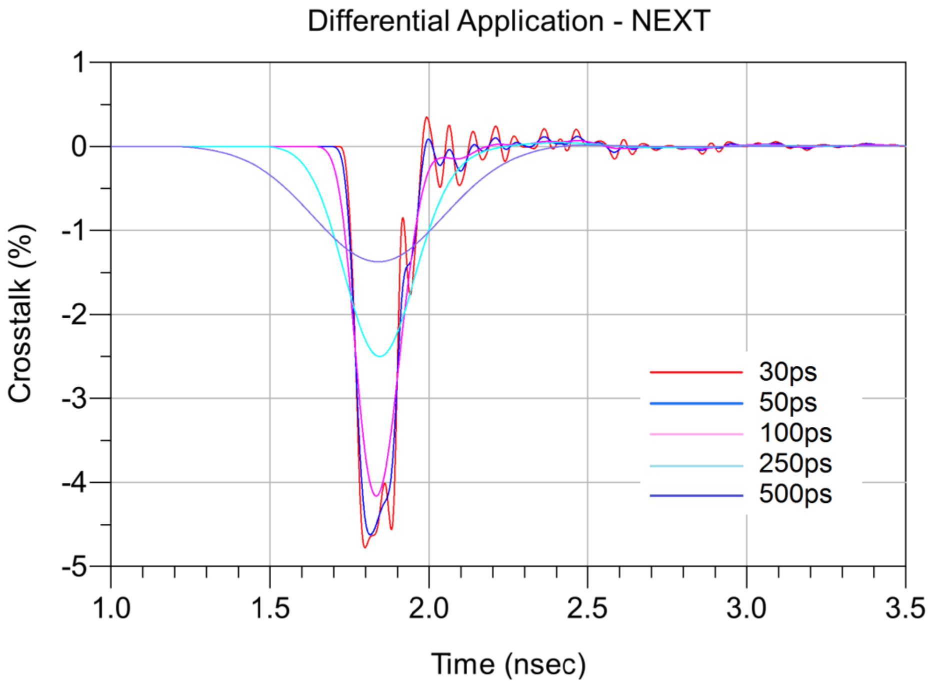
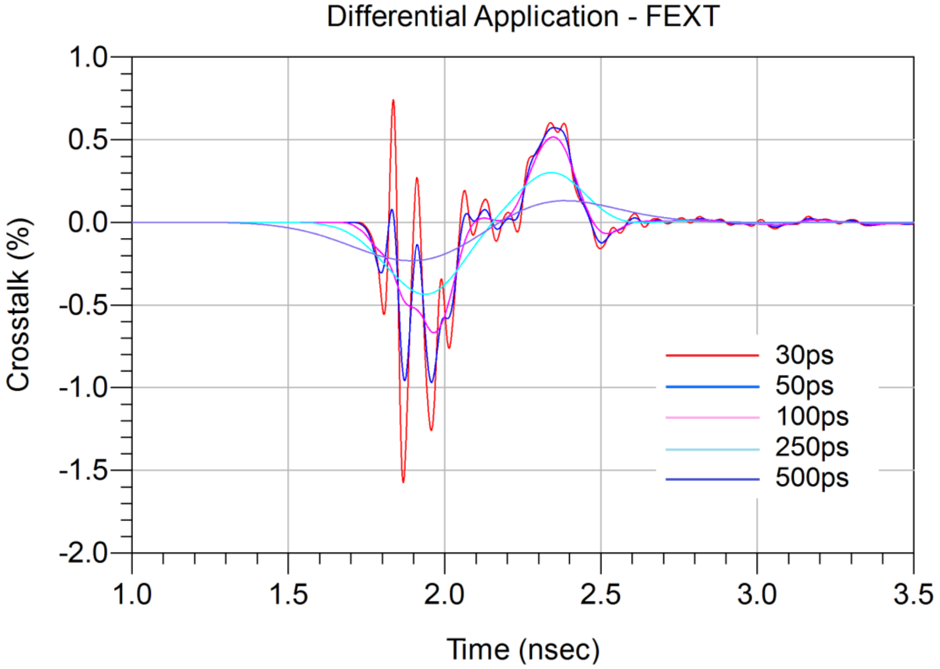
Differential Application – NEXT, Worst Case Configuration



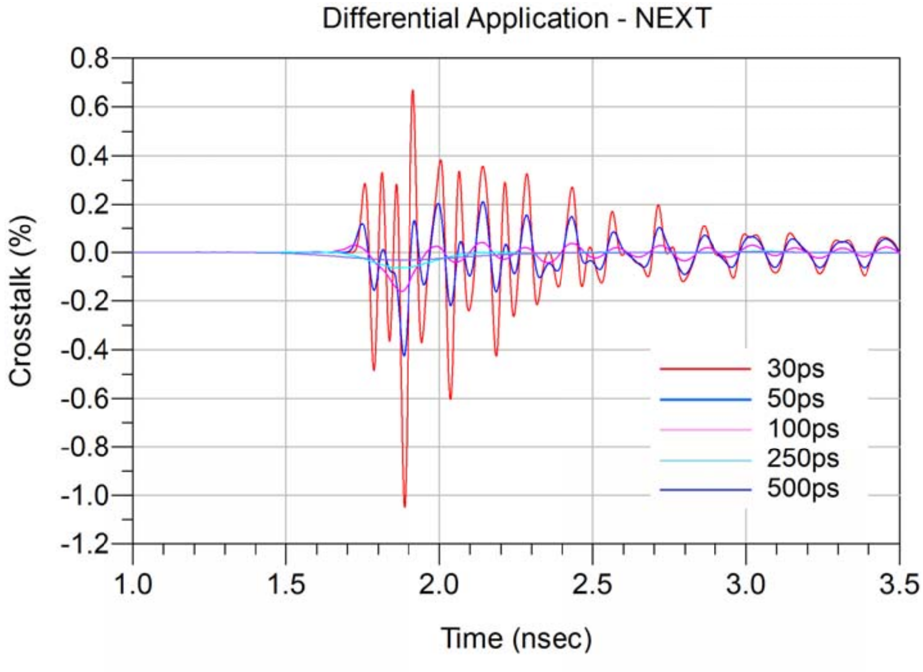
Differential Application – FEXT, Worst Case Configuration



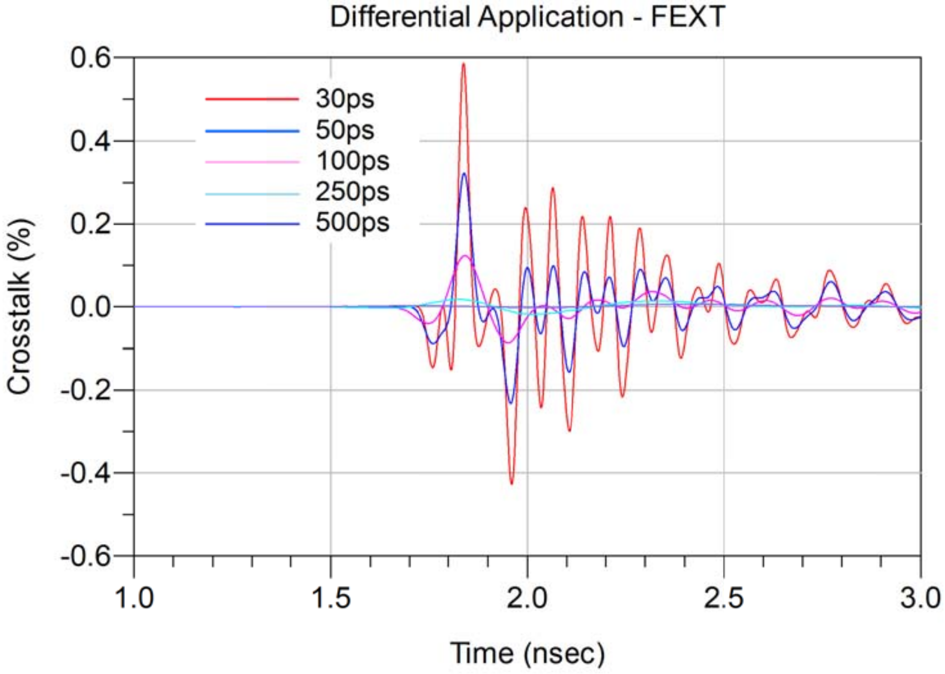
Series: SIBF

Description: High Speed One Piece Interface, 1.27mm Pitch, 3mm Stack Height

Differential Application – NEXT, Best Case Configuration



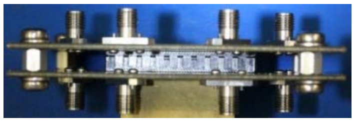
Differential Application – FEXT, Best Case Configuration



Appendix C – Product and Test System Descriptions

Product Description

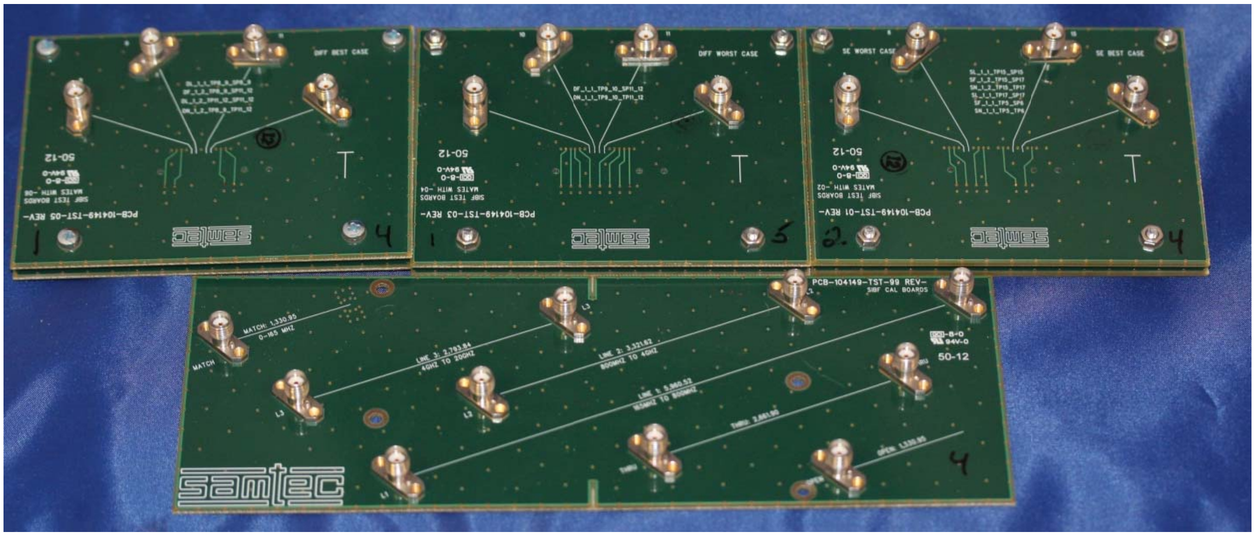
Product test samples are High Speed Hermaphroditic SIBF Strip. The part number is SIBF-25-F-S-AD and it mates to pads on the opposing board via compression. The connector has one row of 25 contacts evenly spaced on a 1.27 mm (0.050") pitch. A photo of the mated test article mounted to SI test boards is shown at right.



Test System Description

The test fixtures are composed of four-layer FR-406 material with 50Ω signal trace and pad configurations designed for the electrical characterization of Samtec high speed connector 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. There are seven test fixtures specific to the SIBF series connector set. Six test fixtures are specific to the SIBF Series connector set and identified by part numbers PCB-104149 -TST-01 through PCB-104152-TST-06. Calibration standards specific to the SIBF Series are located on the calibration boards PCB-104149-TST-07. Displayed on the following pages is information for the SMA/LRM calibration structure and directives for mating SIBF fixtures.

PCB-104149-TST-XX Test Fixtures



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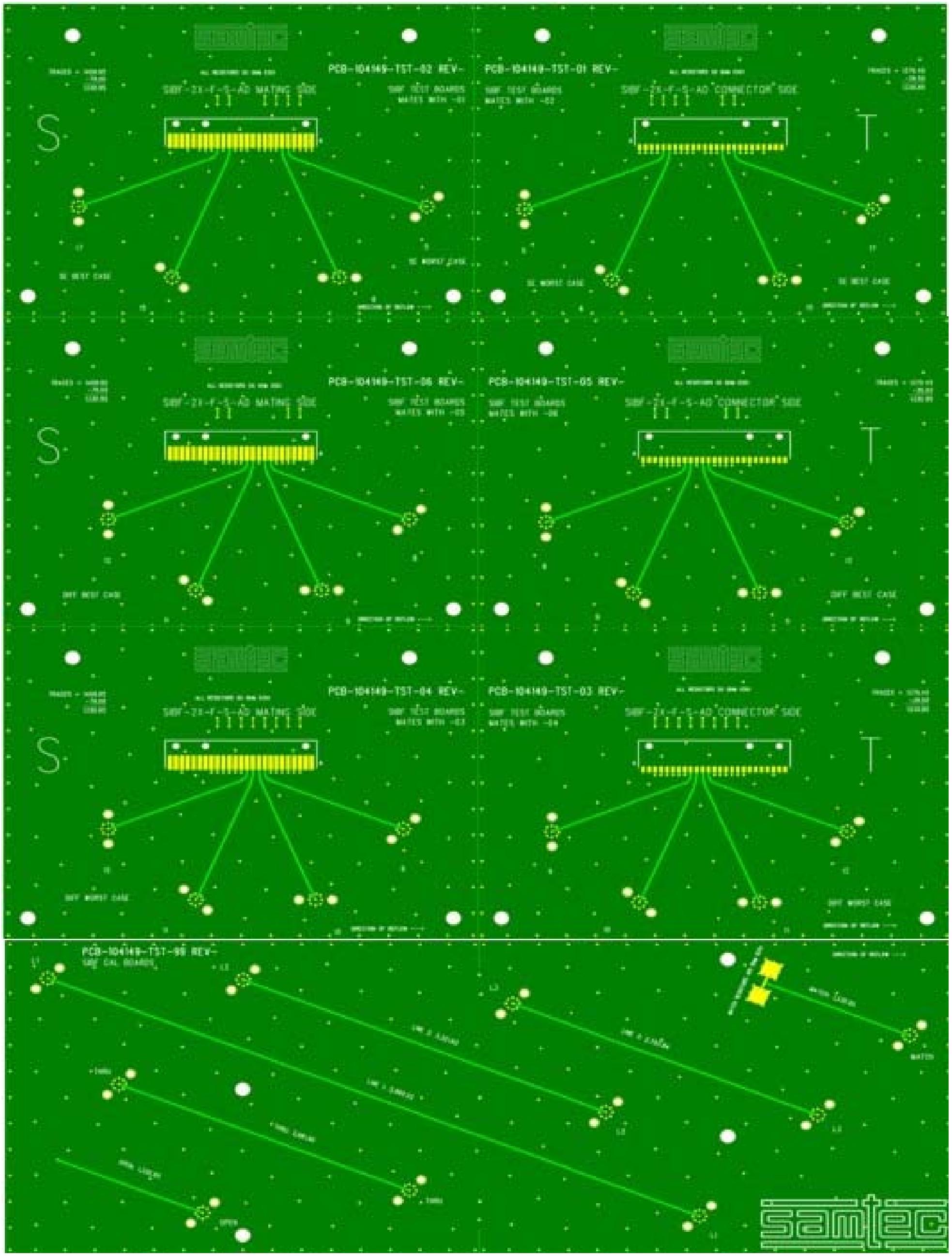
PCB-104149-TST-XX PCB Layout Panel

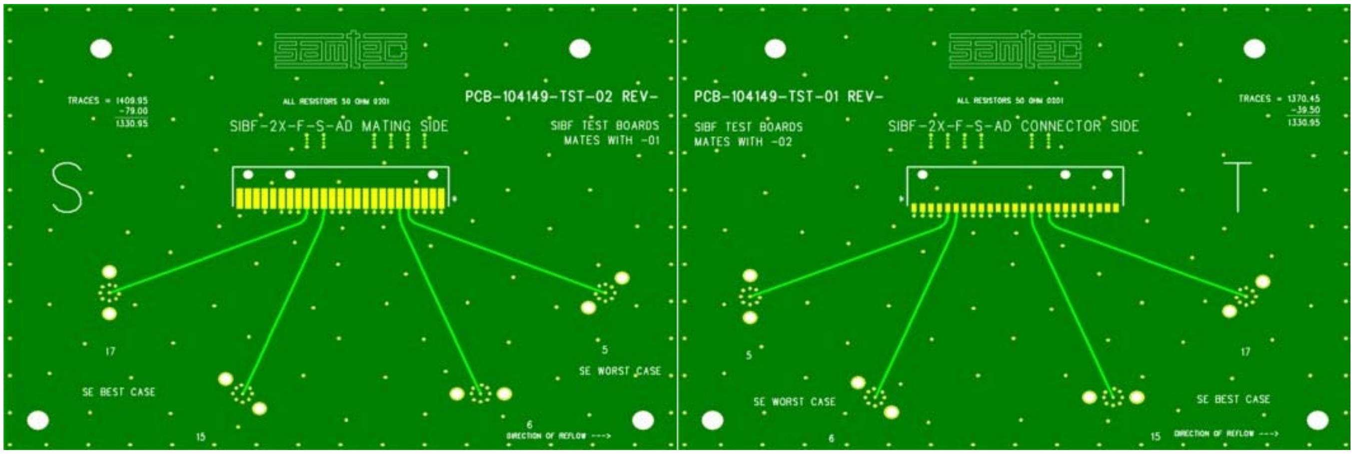
PCB design artwork shown below.



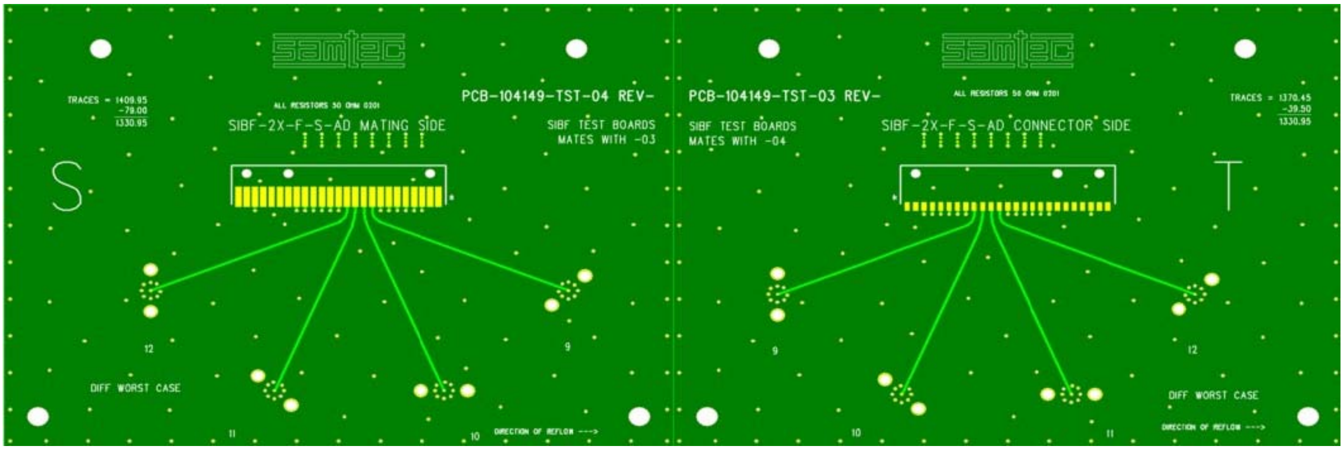
PCB Fixtures

The test fixtures used are as follows:

PCB-104149 -TST-01 Rev, SIBF One Piece Interface *mates with* PCB-104149-TST-02, Rev, SIBF One Piece Interface, Single Ended, Transmission/Reflection Parameters, Crosstalk Parameters

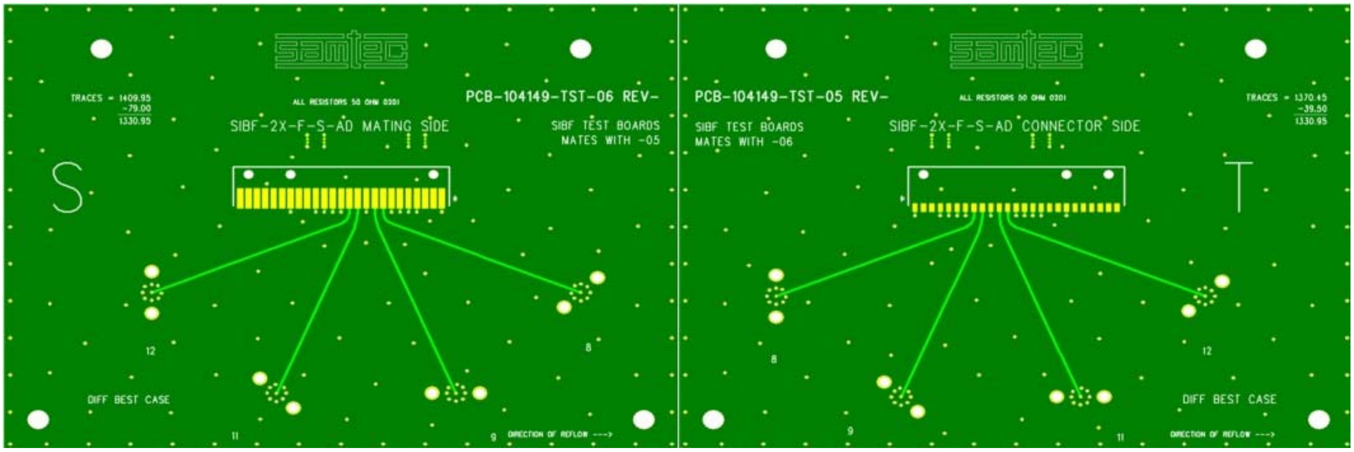


PCB-104149-TST-03 Rev, SIBF One Piece Interface *mates with* PCB-104149-TST-04 Rev, SIBF One Piece Interface, Differential Worst Case Configuration, Crosstalk Parameters



PCB Fixtures (Cont.)

PCB-104149-TST-05 Rev, SIBF One Piece Interface *mates with* PCB-104149-TST-06 Rev, SIBF One Piece Interface, <u>Differential Best Case</u>, Crosstalk Parameters



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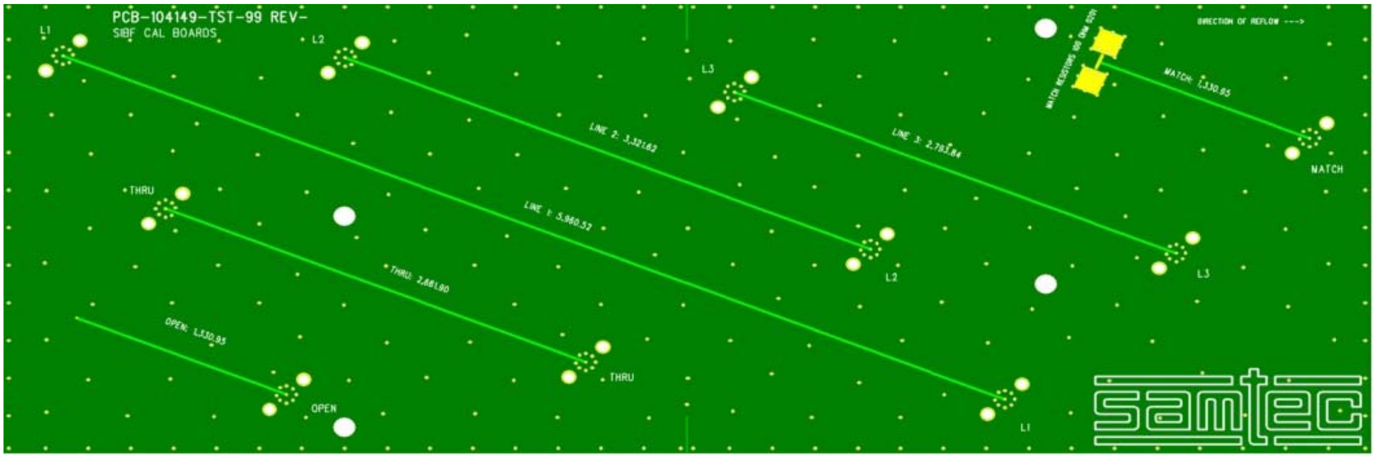
Calibration Board

Test fixture losses and test point reflections were removed from the data by use of LRM calibration. The calibration boards are shown below. Prior to making any measurements, the calibration board is characterized to obtain parameters required to define the calibration kit. Once a calibration kit is defined, calibration using the standards on the calibration board can be performed. Finally, the device can be measured and the test board effects are automatically removed.



Line - Reflect - Match (LRM) Calibration Standards

PCB-104149-TST-99

Line 1 - Length = 5960.52 mils
Line 2 - Length = 3321.62 mils
Line 3 - Length = 2793.84mils

Thru Line (2X) = 2661.90 mils
Reflect Standard - Length = 1330.95 mils
Match Standard - Length = 1330.95 mils

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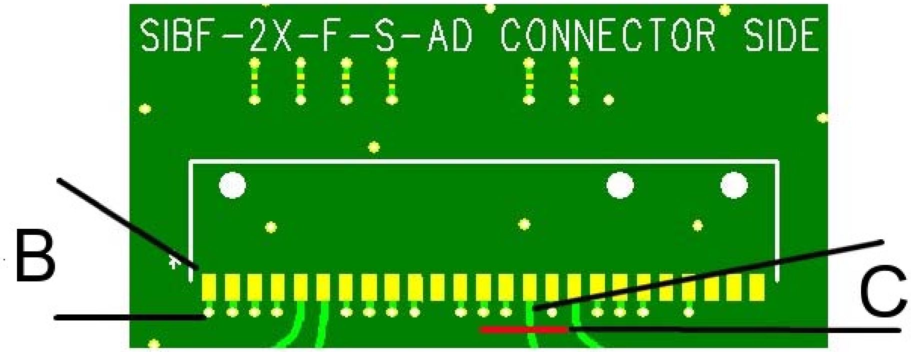
All traces on the T connector test boards are length matched to 1380.45 mils measured from the bottom edge of the signal pad to the SMA center contact pad. The LRM calibration effectively removes 1330.95 mils of PCB signal trace effects. All traces on the S mating test boards are length matched to 1419.95 mils measured from the bottom edge of the signal pad to the SMA center contact pad. The LRM calibration effectively removes 1330.95 mils of PCB signal trace effects. This means the calibrated reference plane is located 49.50 mils out from the pad on the T side and 89.00 mils out on the S side. The S-Parameter measurements include:

A. The SIBF One Piece Interface Connector
B. Test board vias, pads (footprint effects) for the SIBF T connector side.
C. 49.50 mils of 16 mil wide microstrip signal trace
D. Test board vias, pads (pad effects) for the SIBF S mating side.
E. 89.00 mils of 16 mil wide microstrip signal trace

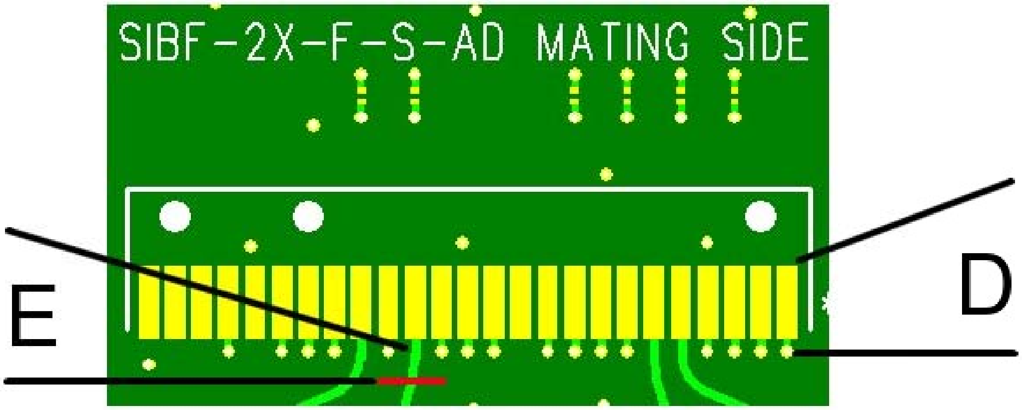
The figure below shows the location of the measurement reference plane.

Measurement reference plane for the SIBF One Piece Interface T Connector Side



Series: SIBF
Description: High Speed One Piece Interface, 1.27mm Pitch, 3mm Stack Height

Measurement reference plane for the
SIBF One Piece Interface
S Mating Side



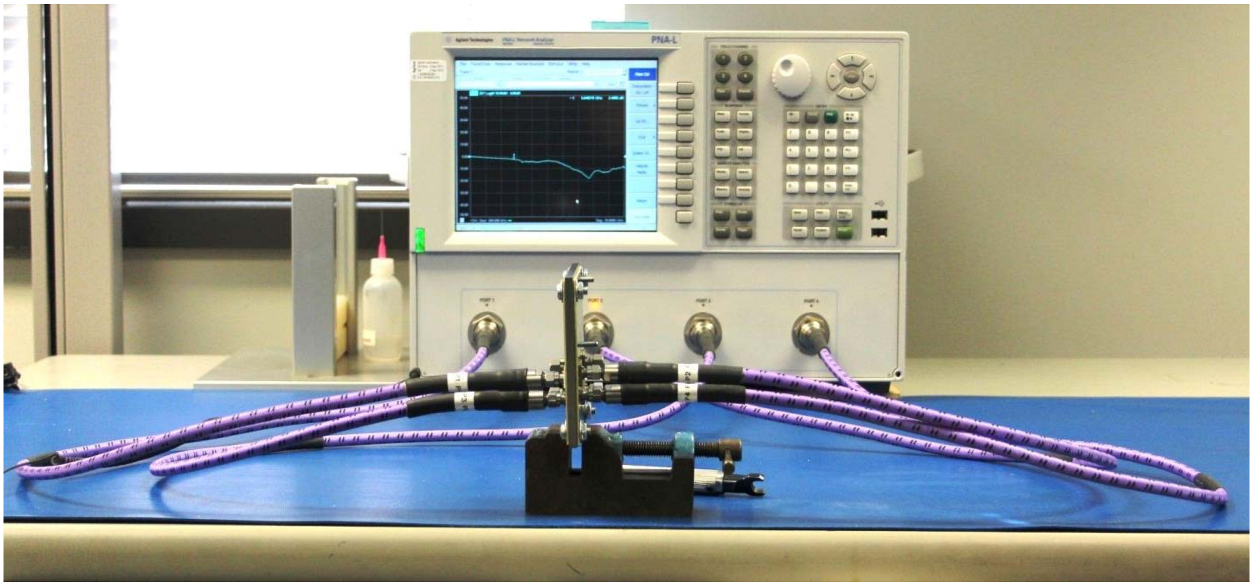
Appendix D – Test and Measurement Setup

The test instrument is the Agilent N5230C PNA-L network analyzer. Frequency domain data and graphs are obtained directly from the instrument. Post-processed time domain data and graphs are generated using convolution algorithms within Agilent ADS. The network analyzer is configured as follows:

Start Frequency – 300 KHz	Number of points -1601
Stop Frequency – 20 GHz	IFBW – 1 KHz

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

N5230C Measurement Setup



Test Instruments

QTY	Description
1	Agilent N5230C PNA-L 4-Port Network Analyzer (300 KHz to 20 GHz)
1	Agilent N4433A Ecal module (300 KHz to 20 GHz)

Test Cables & Adapters

QTY	Description
4	WL Gore –Z0CJ0CK0360 3.5 mm(f) to 3.5mm(m) Test Port Cables

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

The measurement process begins with a measurement of the LRM 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 reflect and 2x through line standard can be used to determine the maximum frequency for which the calibration standards are valid. For the LSEM Series test boards, this is greater than 20 GHz.

From the LRM calibration standard measurements, a user defined calibration kit is developed and stored in the network analyzer. Calibration is then performed on all 4 ports following the calibration wizard within the Agilent N5230C. This calibration is saved and can be recalled at any time. Calibration takes roughly 30 minutes to perform.

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 2011 update 10. 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/Technical_Library/reference/articles/pdfs/tech-note_using-PLTS-for-time-domain-data_web.pdf

Impedance (TDR)

A step pulse is applied to the touchstone model of the connector and the reflected voltage is monitored. The reflected voltage is converted to a reflection coefficient and then transformed into an impedance profile. All ports of the Touchstone model are terminated in 50 ohms.

Propagation Delay (TDT)

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

Near-End Crosstalk (TDT) & Far End Crosstalk (TDT)

A step pulse is applied to the touchstone model of the connector and the coupled voltage is monitored. The amplitude of the peak-coupled voltage is recorded and reported as a percentage of the input pulse.

Appendix F – Glossary of Terms

ADS – Advanced Design Systems
BC – Best Case crosstalk configuration
DUT – Device under test, term used for TDA IConnect & Propagation Delay waveforms
FD – Frequency domain
FEXT – Far-End Crosstalk
GSG – Ground–Signal-Ground; geometric configuration
GSSG - Ground–Signal-Signal-Ground; geometric configuration
HDV – High Density Vertical
NEXT – Near-End Crosstalk
OV – Optimal Vertical
OH – Optimal Horizontal
PCB – Printed Circuit Board
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
WC – Worst Case crosstalk configuration
Z – Impedance (expressed in ohms)