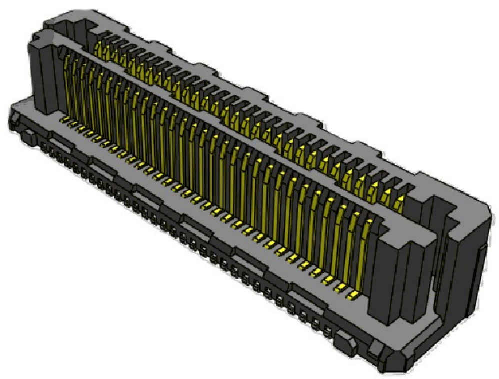
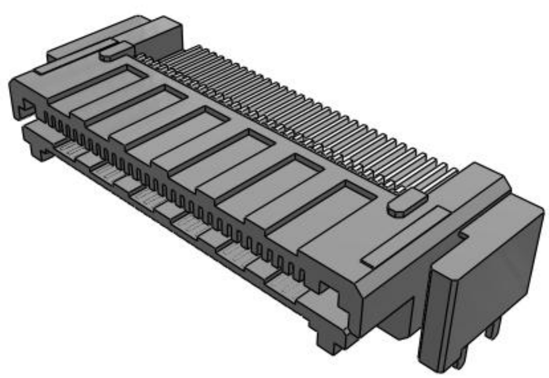
High Speed Characterization Report

LSHM-130-02.5-X-DV-X-N



Mated With

LSHM-130-X-X-X-RH-X-N



Description:

0.50 mm Razor Beam™ High-Speed Hermaphroditic Terminal/Socket Strip, Vertical to Reverse Right Angle

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

©Samtec, Inc. 2005

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

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

Report Revision: 08/15/2024

All Rights Reserved

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197") Pitch, Vertical to Reverse Right Angle

Table of Contents

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Connector Overview

The LSHM is a high-density, rugged connector for use in board-to-board and board-to-cable applications with optional shielding for EMI protection. Using the Razor Beam™ fine pitch contact system, the hermaphroditic design saves PCB real estate in the X, Y, and Z axes. The LSHM Series are available in 5,10, 20, 30, 40 and 50 positions per row. The data in this report is applicable to 2.5 mm (0.098”) vertical to reverse right angle.

Frequency Domain Data Summary

Bandwidth Chart – Single-Ended Insertion Loss

LSHM Connector Series

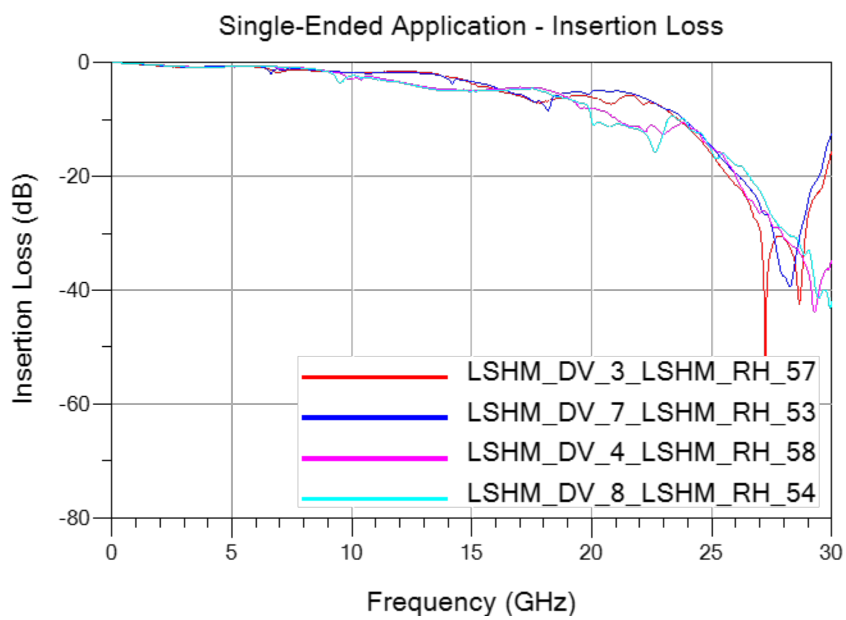


Figure 1

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Bandwidth Chart – Differential Insertion Loss

LSHM Connector Series

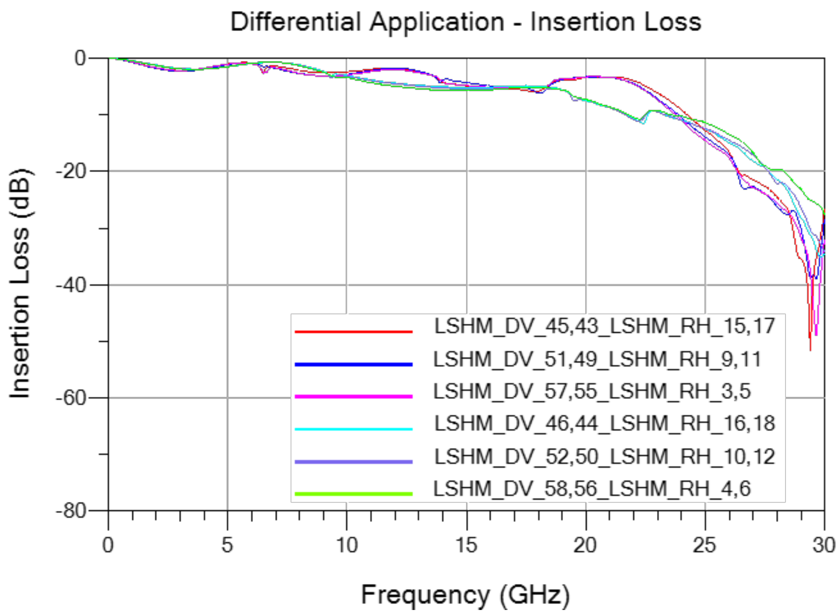


Figure 2

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Time Domain Data Summary

Table 1 – Single-Ended Impedance (Ω)				
Driver	**Signal Rise-time**	**30ps**	**50ps**	**100ps**
LSHM_3_DV	Maximum Impedance	50.9	50.8	50.6
	Minimum Impedance	31.1	33.5	37.5
LSHM_7_DV	Maximum Impedance	51.0	50.8	50.7
	Minimum Impedance	31.6	34.1	37.9
LSHM_4_DV	Maximum Impedance	51.8	51.3	51.0
	Minimum Impedance	32.8	36.1	39.7
LSHM_8_DV	Maximum Impedance	51.9	51.3	50.9
	Minimum Impedance	32.5	35.9	39.5

Table 2 - Differential Impedance (Ω)				
Driver	**Signal Rise-time**	**30ps**	**50ps**	**100ps**
LSHM_45,43_DV	Maximum Impedance	101.4	101.1	100.8
	Minimum Impedance	44.9	48.6	56.8
LSHM_51,49_DV	Maximum Impedance	100.8	100.7	100.6
	Minimum Impedance	42.7	46.7	55.6
LSHM_57,55_DV	Maximum Impedance	101.1	100.8	100.5
	Minimum Impedance	44.6	48.4	56.6
LSHM_46,44_DV	Maximum Impedance	101.1	101.0	100.9
	Minimum Impedance	47.4	52.8	62.0
LSHM_52,50_DV	Maximum Impedance	101.0	100.8	100.8
	Minimum Impedance	47.7	52.9	61.7
LSHM_58,52_DV	Maximum Impedance	100.8	100.7	100.7
	Minimum Impedance	47.7	52.9	61.5

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Table 3 – Single Ended Crosstalk (%)

Input(tr)	Driver	Receiver	30ps	50ps	100ps
NEXT	LSHM_DV_3	LSHM_DV_7	2.24	1.86	1.34
	LSHM_DV_3	LSHM_DV_4	1.10	0.88	0.53
	LSHM_DV_3	LSHM_DV_8	0.42	0.34	0.21
	LSHM_DV_4	LSHM_DV_8	2.36	1.95	1.45
	LSHM_DV_7	LSHM_DV_8	0.92	0.76	0.47
FEXT	LSHM_DV_3	LSHM_RH_53	1.66	0.99	0.41
	LSHM_DV_3	LSHM_RH_58	0.32	0.19	0.11
	LSHM_DV_3	LSHM_RH_54	0.15	<0.1	<0.1
	LSHM_DV_4	LSHM_RH_54	2.92	1.80	0.79
	LSHM_DV_7	LSHM_RH_54	0.25	0.17	0.11

Table 4 - Differential Crosstalk (%)

Input(tr)	Driver	Receiver	30ps	50ps	100ps
NEXT	LSHM_DV_45,43	LSHM_DV_51,49	0.40	0.31	0.22
	LSHM_DV_45,43	LSHM_DV_57,55	0.13	<0.1	<0.1
	LSHM_DV_45,43	LSHM_DV_46,44	0.15	0.12	<0.1
	LSHM_DV_46,44	LSHM_DV_52,50	0.36	0.30	0.24
	LSHM_DV_46,44	LSHM_DV_58,56	<0.1	<0.1	<0.1
	LSHM_DV_46,44	LSHM_DV_51,49	<0.1	<0.1	<0.1
	LSHM_DV_46,44	LSHM_DV_57,55	<0.1	<0.1	<0.1
	LSHM_DV_57,55	LSHM_DV_51,49	0.39	0.30	0.22
	LSHM_DV_57,55	LSHM_DV_58,56	0.16	0.14	<0.1
	LSHM_DV_57,55	LSHM_DV_52,50	<0.1	<0.1	<0.1
FEXT	LSHM_DV_45,43	LSHM_RH_9,11	0.26	0.19	0.10
	LSHM_DV_45,43	LSHM_RH_3,5	0.14	<0.1	<0.1
	LSHM_DV_45,43	LSHM_RH_16,18	<0.1	<0.1	<0.1
	LSHM_DV_46,44	LSHM_RH_10,12	0.41	0.24	<0.1
	LSHM_DV_46,44	LSHM_RH_4,6	<0.1	<0.1	<0.1
	LSHM_DV_46,44	LSHM_RH_9,11	<0.1	<0.1	<0.1
	LSHM_DV_46,44	LSHM_RH_3,5	<0.1	<0.1	<0.1
	LSHM_DV_57,55	LSHM_RH_9,11	0.24	0.19	<0.1
	LSHM_DV_57,55	LSHM_RH_4,6	<0.1	<0.1	<0.1
	LSHM_DV_57,55	LSHM_RH_10,12	<0.1	<0.1	<0.1

©Samtec, Inc. 2005

All Rights Reserved

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Table 5 - Propagation Delay (Mated Connector)	
LSHM_DV_3_ LSHM_RH_57	112 ps
LSHM_DV_7_ LSHM_RH_53	111 ps
LSHM_DV_4_ LSHM_RH_58	96 ps
LSHM_DV_8_ LSHM_RH_54	97 ps
LSHM_DV_45,43_ LSHM_RH_15,17	105 ps
LSHM_DV_51,49_ LSHM_RH_9,11	107 ps
LSHM_DV_57,55_ LSHM_RH_3,5	107 ps
LSHM_DV_46,44_ LSHM_RH_16,18	87 ps
LSHM_DV_52,50_ LSHM_RH_10,12	86 ps
LSHM_DV_58,56_ LSHM_RH_4,6	87 ps

©Samtec, Inc. 2005
All Rights Reserved

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

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 driven scenarios.

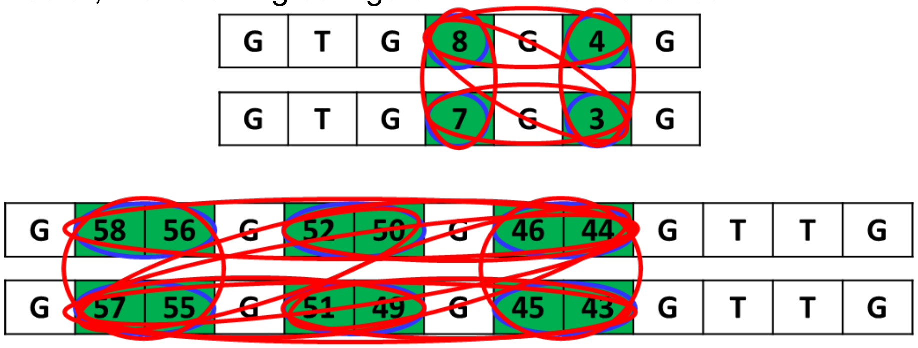
Connector Signal to Ground Ratio

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. But 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.

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

For this connector, the following configurations were evaluated:



pin number for LSHM Vertical

<u>Single-Ended and Differential Impedance (denoted by blue circles)</u>**:**

- GSG (Ground-Signal-Ground)
- GSSG (Ground-positive Signal-negative Signal-Ground)

<u>Single-Ended and Differential Crosstalk (denoted by red circles)</u>**:**

- 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.

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.

<u>Signal Edge Speed (Rise Time):</u>
In pulse signaling applications, the perceived performance of the interconnect can vary significantly depending on the edge rate or rise time of the exciting signal. For this report, the fastest rise time used was 30 ps. Generally, this should demonstrate worst-case performance.

In many systems, the signal edge rate will be significantly slower at the connector than at the driver launch point. To estimate interconnect performance at other edge rates, data is provided for several rise times between 30 ps and 100 ps.

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

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

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 Keysight 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 2.04 mm for Single-Ended and 2.1 mm for Differential of PCB trace on both LSHM sides each. Delay is measured at 100 picoseconds signal risetime. 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. The crosstalk ratio is tabulated in this report as a percentage. Measurements are made at both the near-end and far-end of the SUT.

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.

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Appendix A – Frequency Domain Responses

Single-Ended Application – Insertion Loss

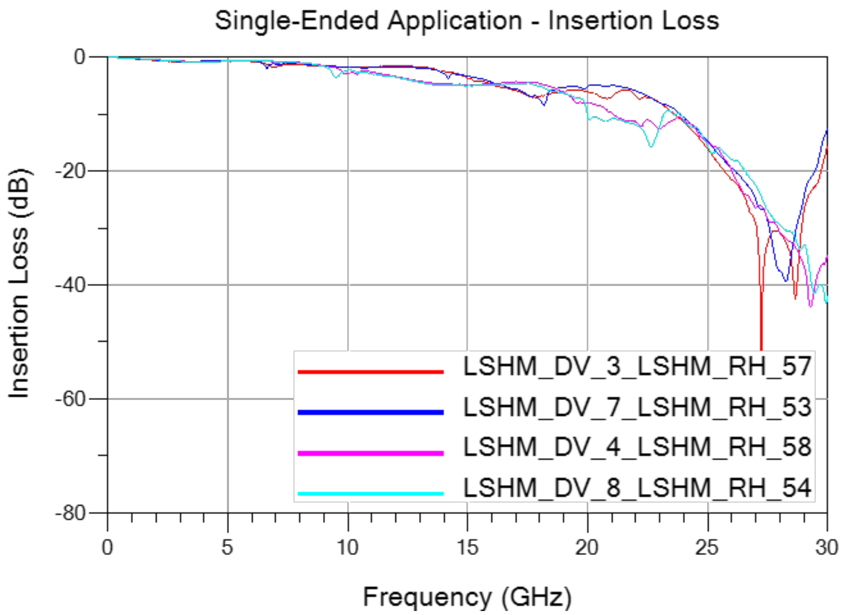


Figure 3

Single-Ended Application – Return Loss

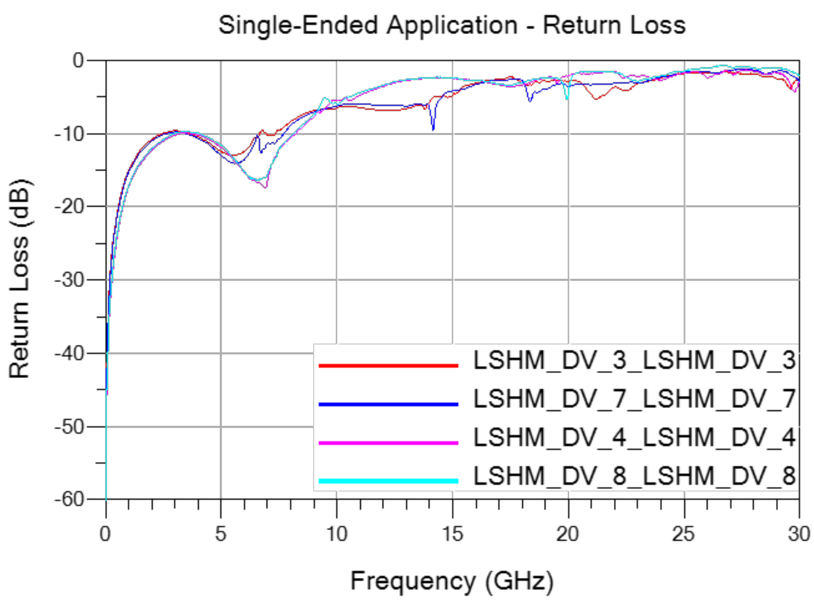


Figure 4

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Single-Ended Application – NEXT Configurations

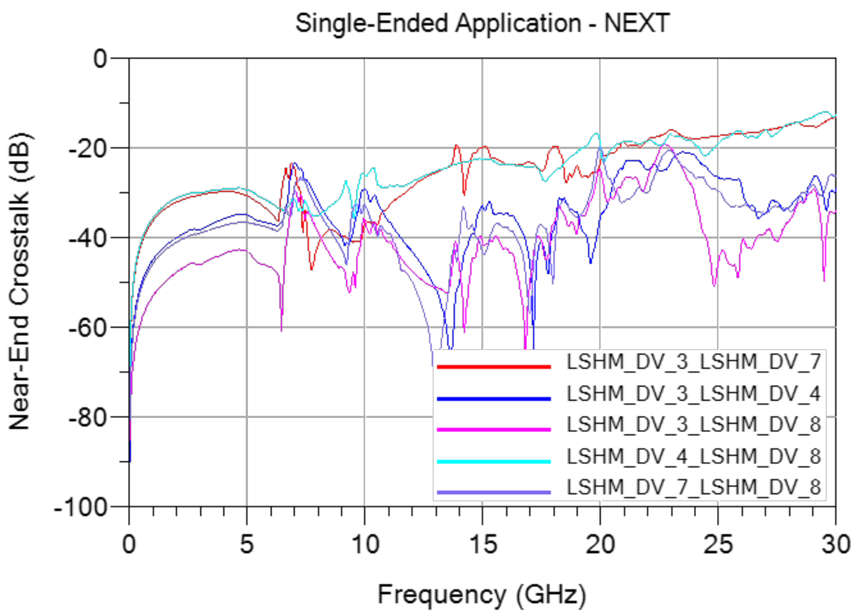


Figure 5

Single-Ended Application – FEXT Configurations

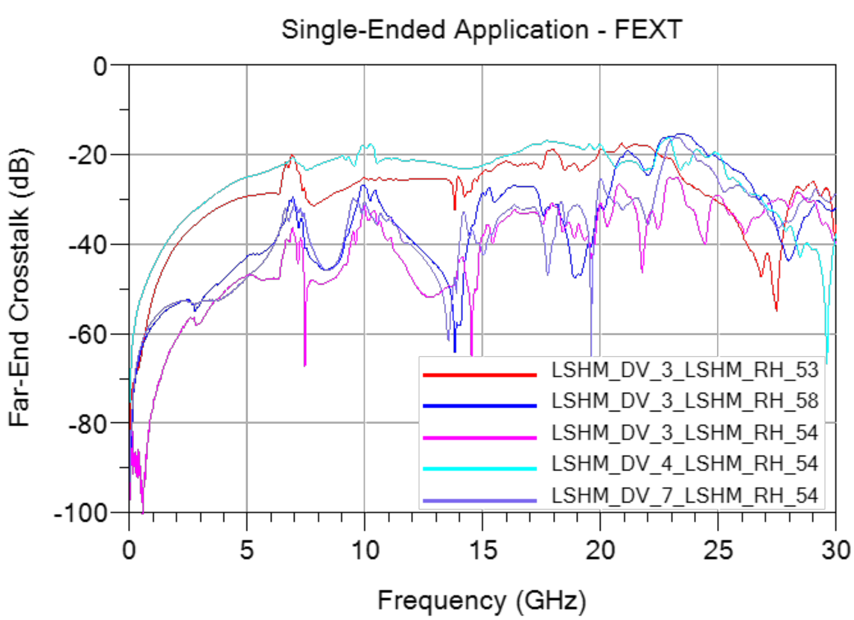


Figure 6

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Differential Application – Insertion Loss

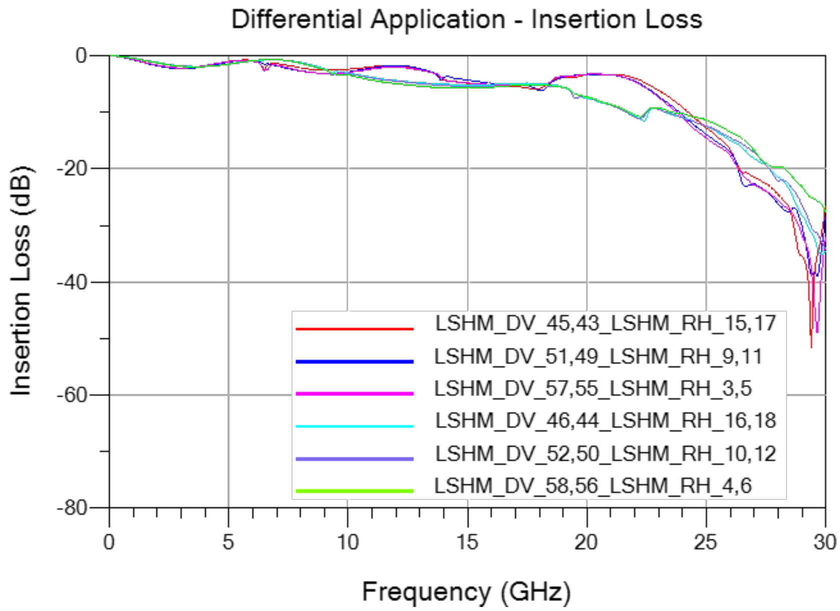


Figure 7

Differential Application – Return Loss

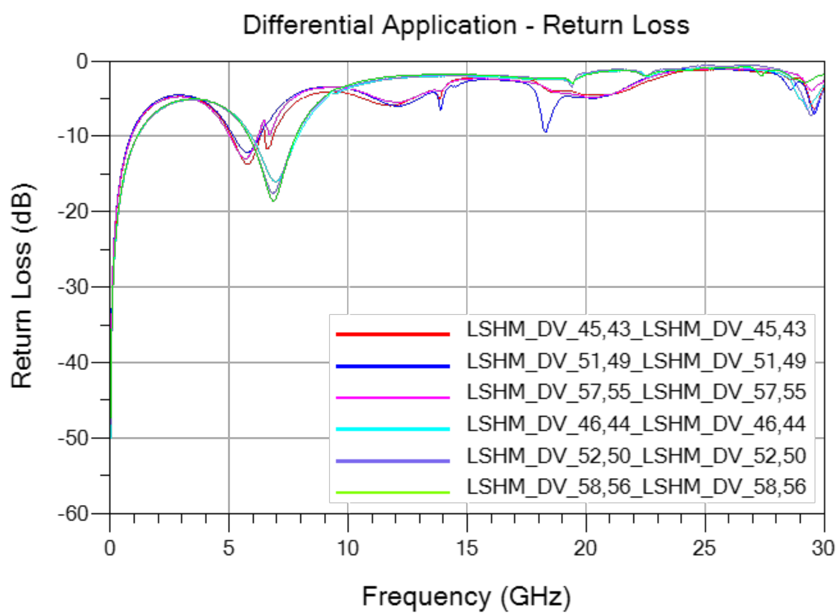


Figure 8

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Differential Application – NEXT Configurations

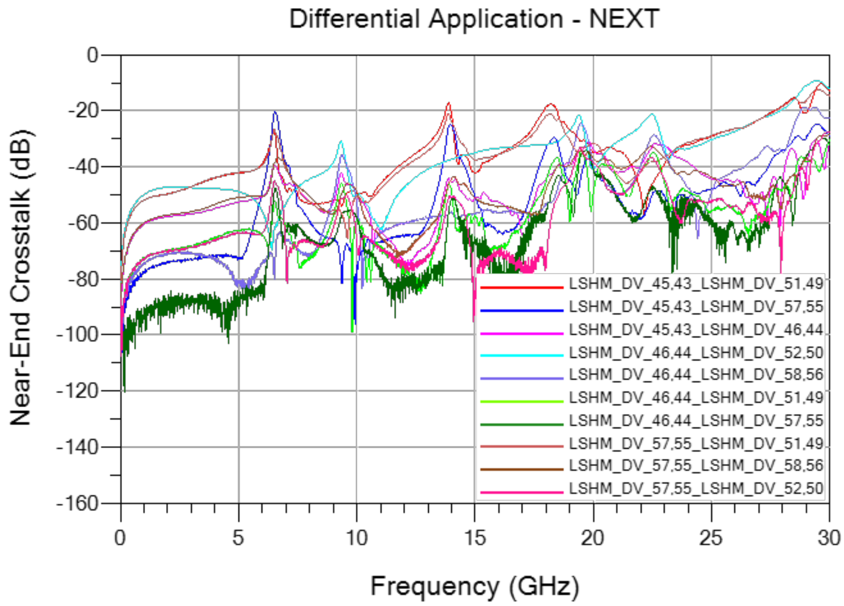


Figure 9

Differential Application – FEXT Configurations

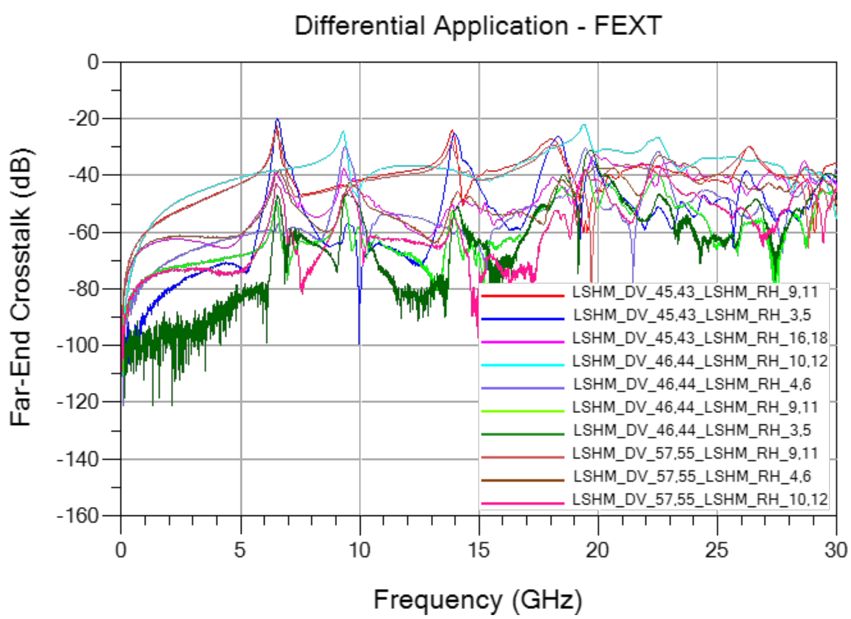


Figure 10

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Appendix B – Time Domain Responses

Single-Ended Application – Impedance

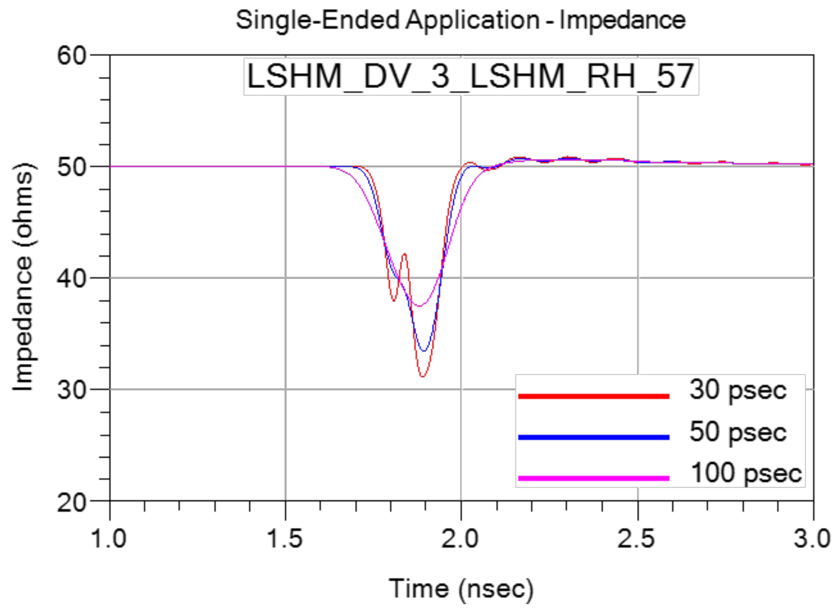


Figure 11

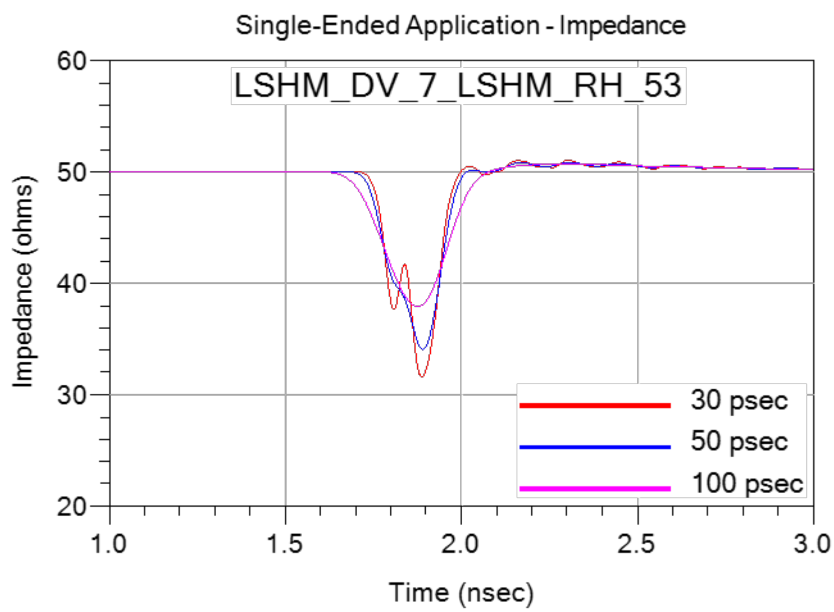


Figure 12

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197") Pitch, Vertical to Reverse Right Angle

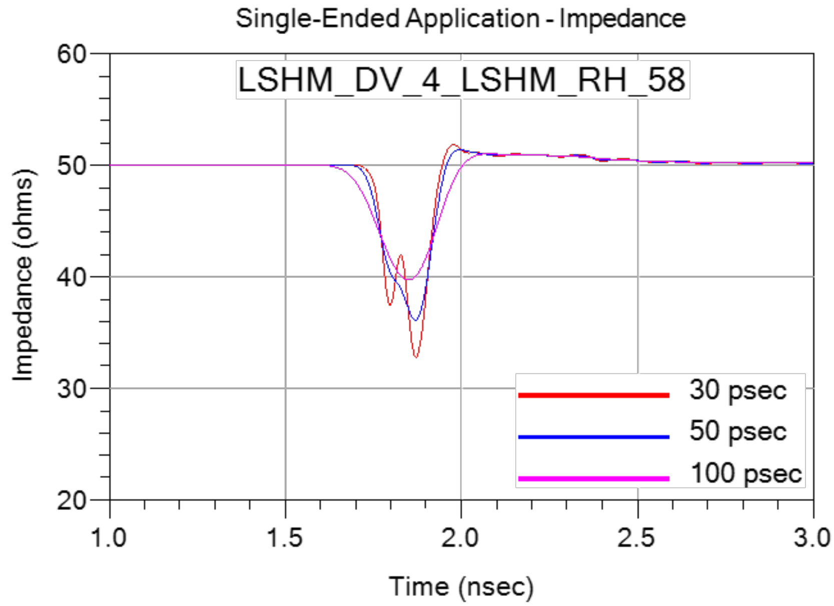


Figure 13

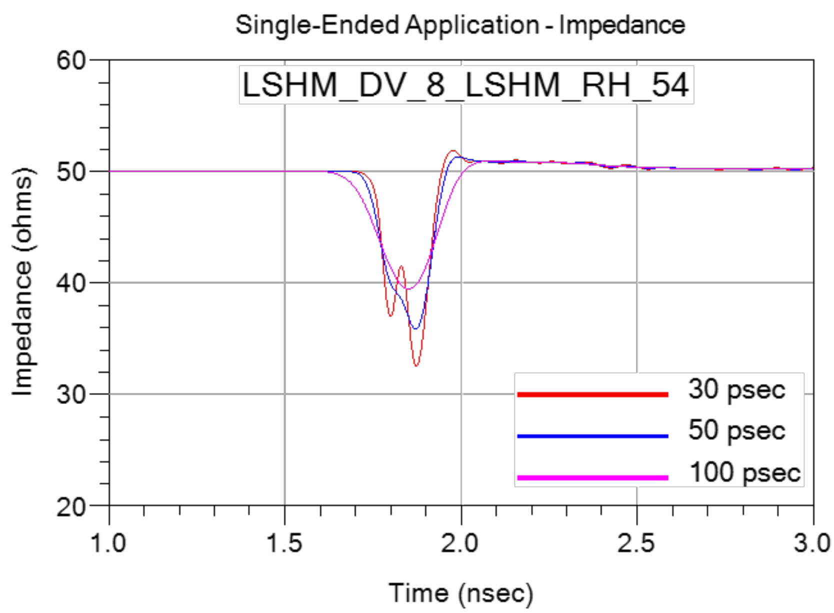


Figure 14

All Rights Reserved

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Single-Ended Application – Propagation Delay

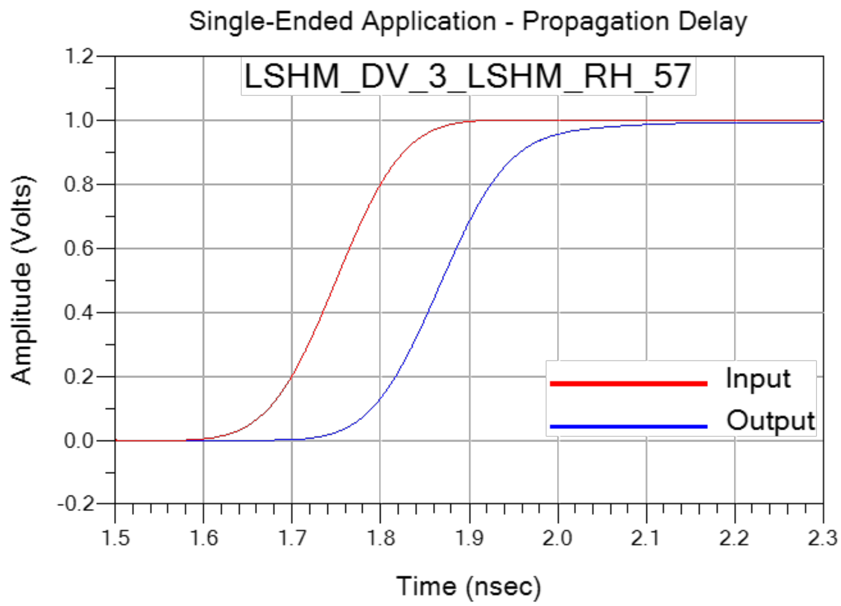


Figure 15

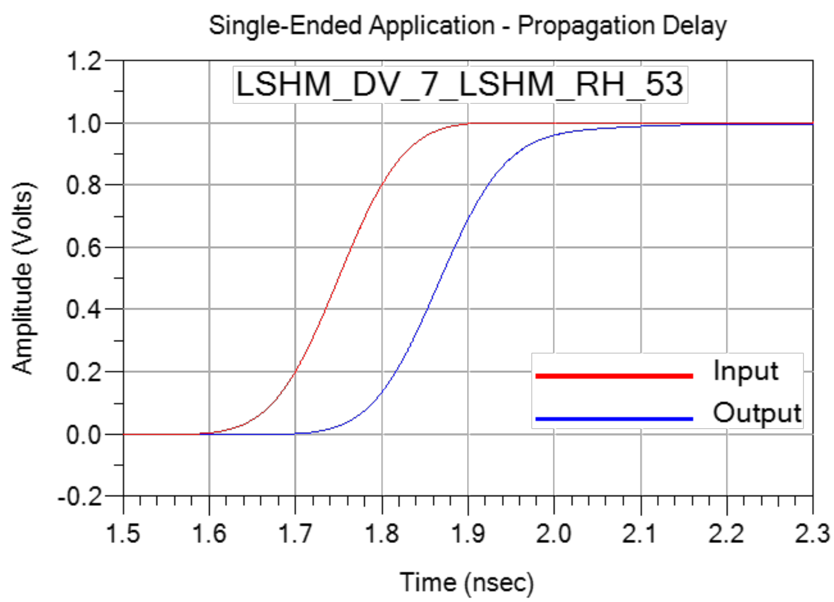


Figure 16

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

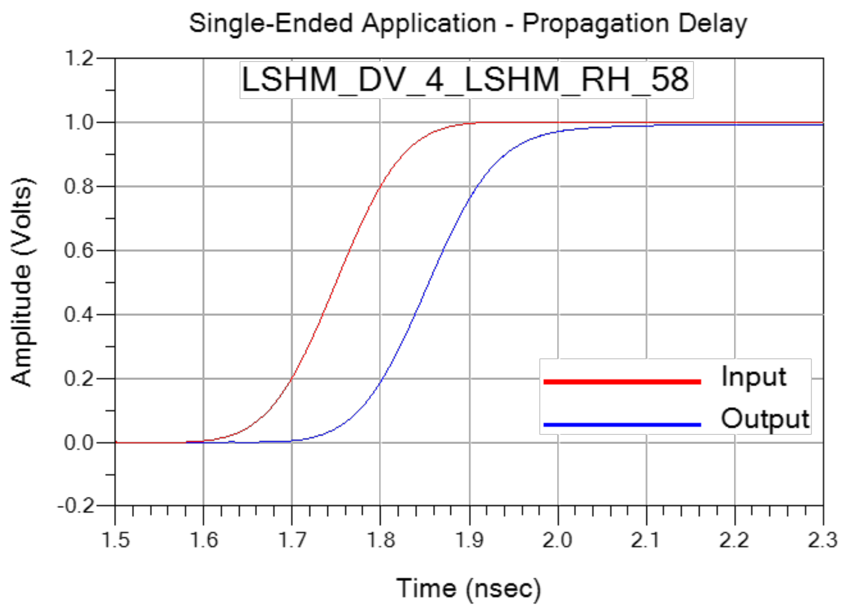


Figure 17

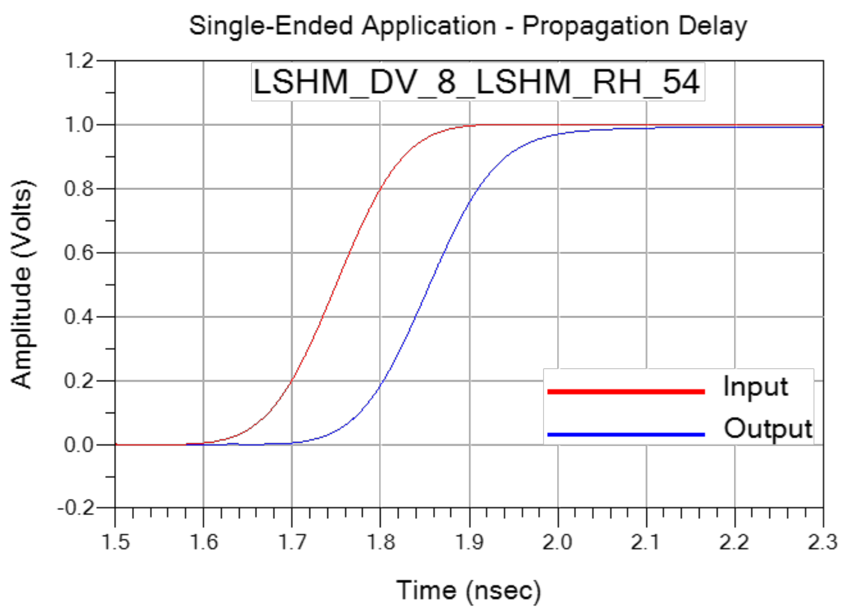


Figure 18

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Differential Application – Impedance

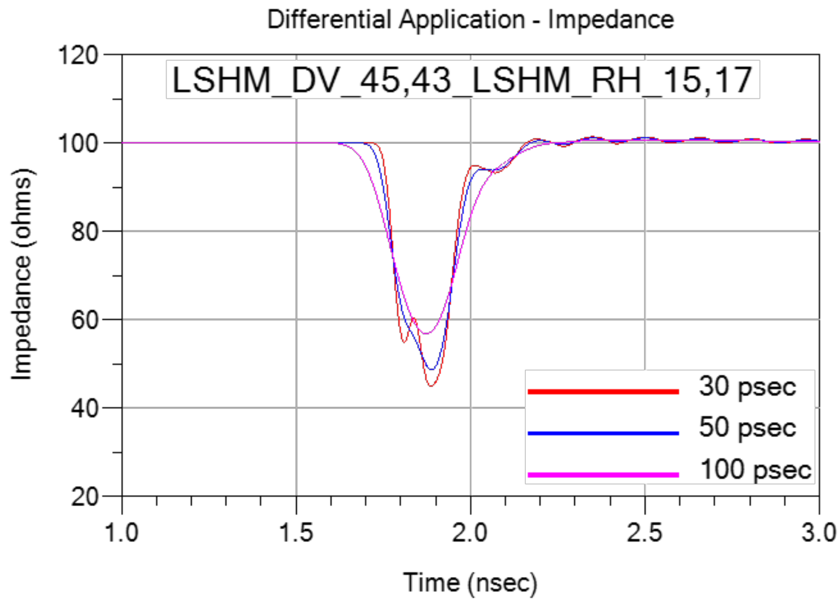


Figure 19

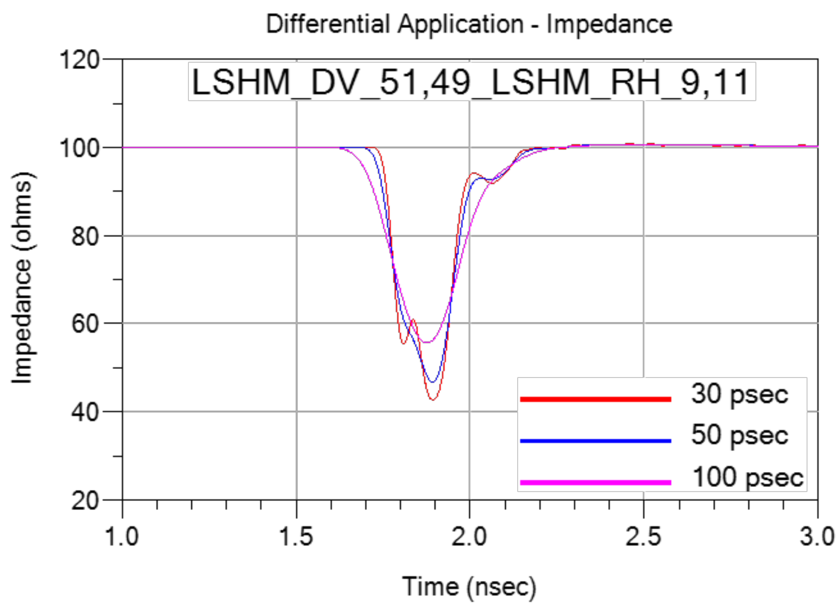


Figure 20

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

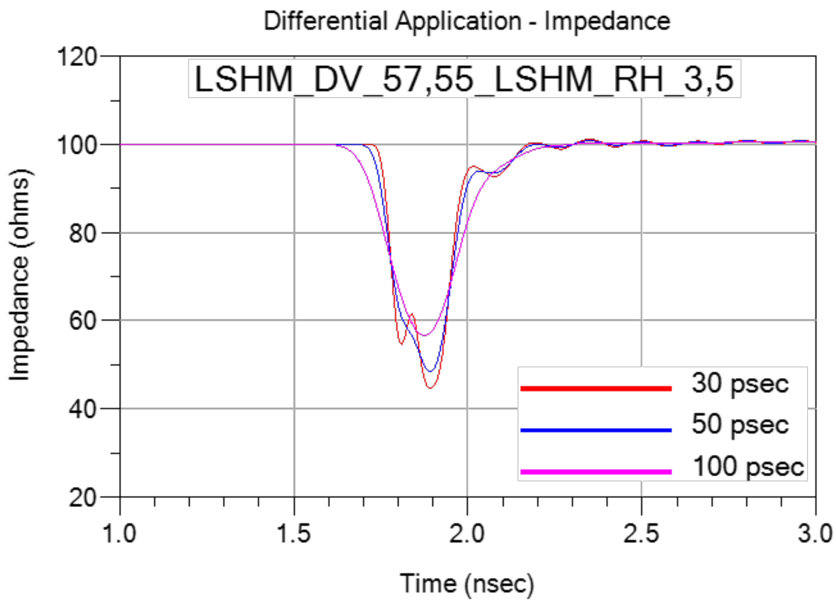


Figure 21

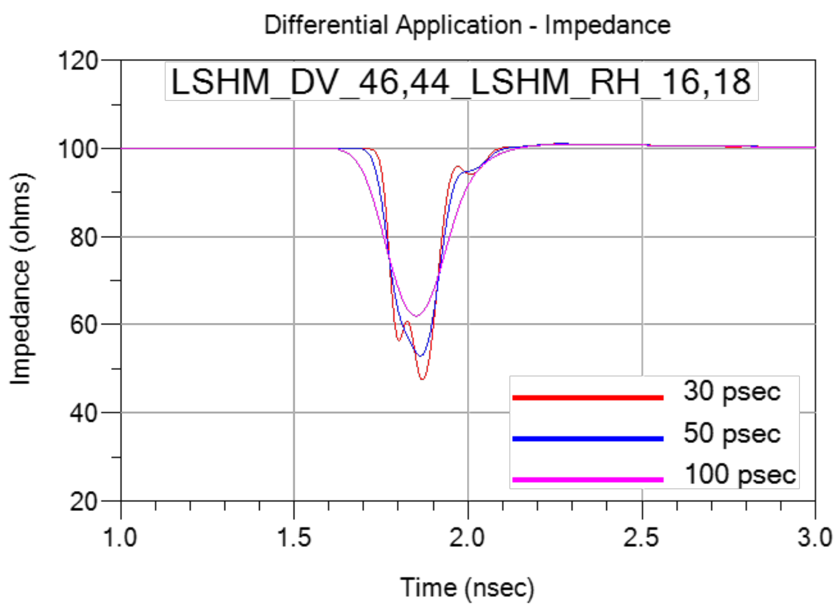


Figure 22

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197") Pitch, Vertical to Reverse Right Angle

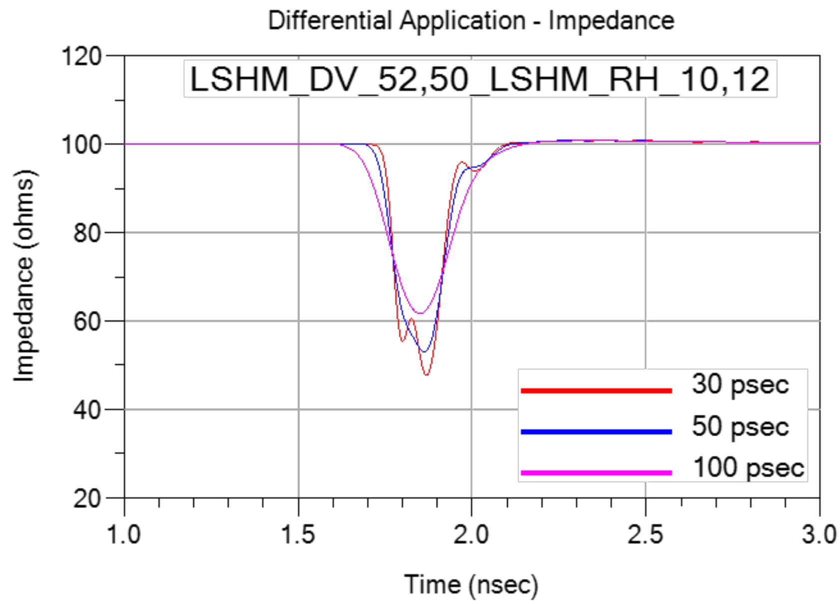


Figure 23

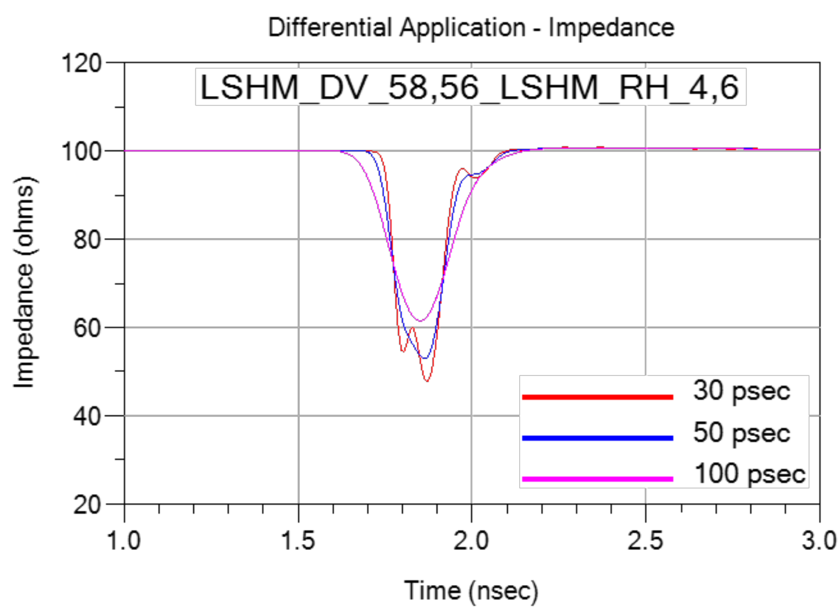


Figure 24

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Differential Application – Propagation Delay

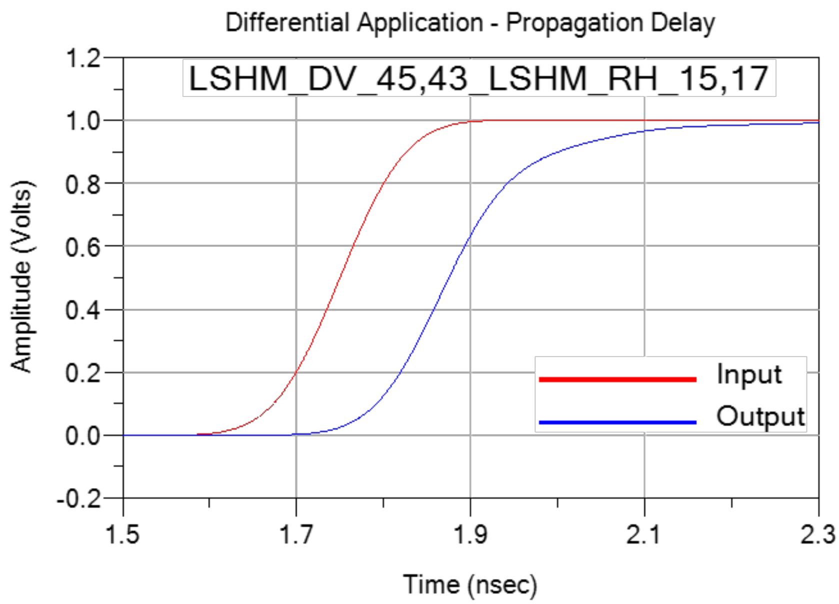


Figure 25

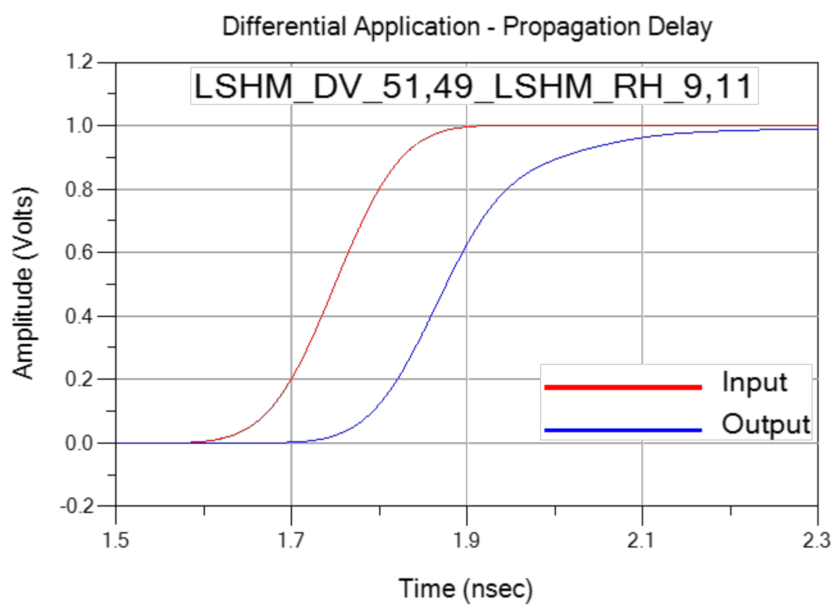


Figure 26

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

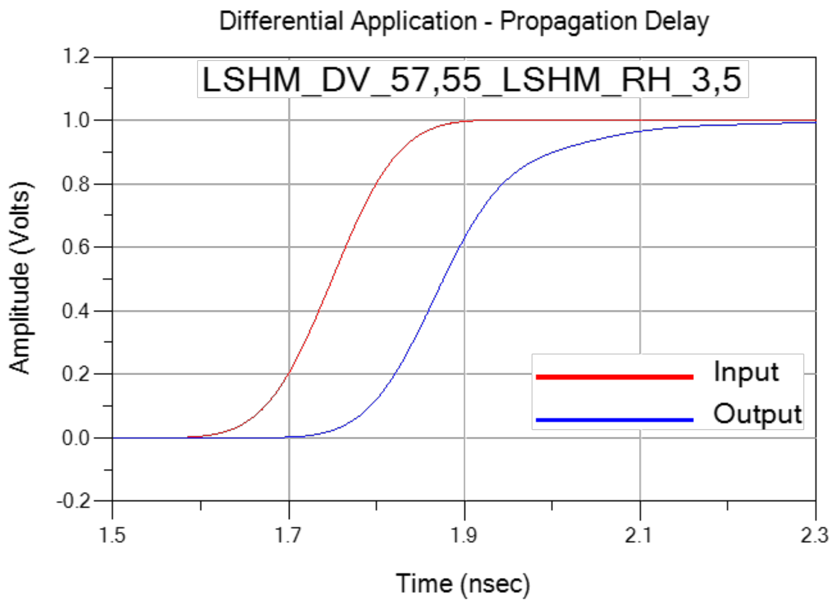


Figure 27

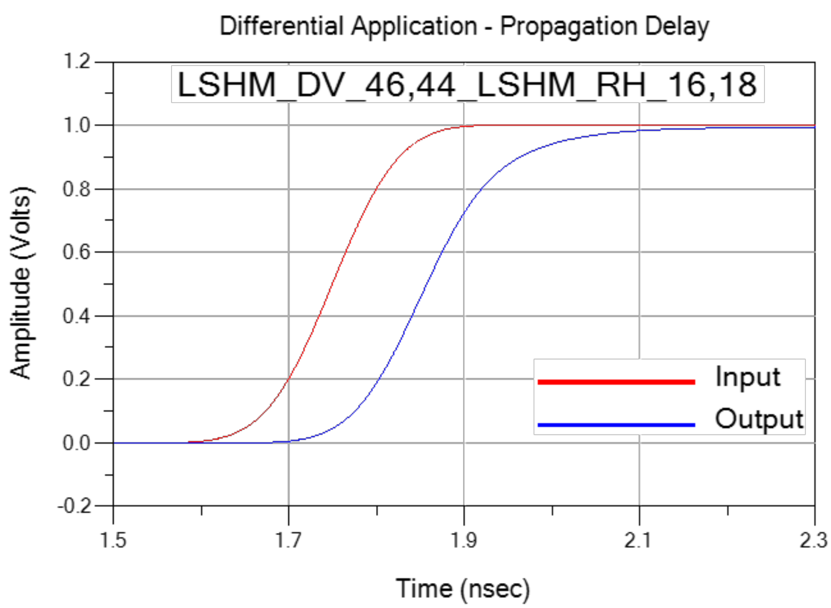


Figure 28

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

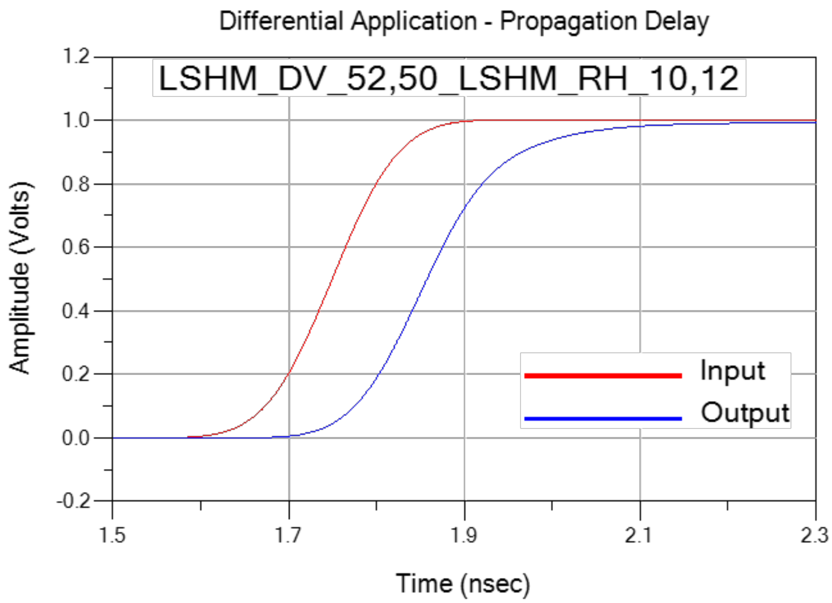


Figure 29

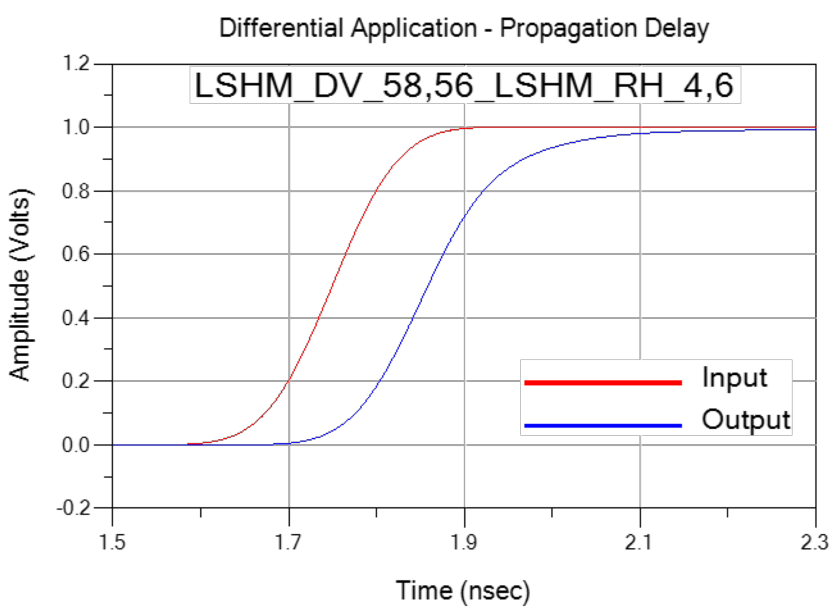


Figure 30

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Appendix C – Product and Test System Descriptions

Product Description
Product test samples are LSHM Series connectors. The part number is LSHM-130-02.5-X-DV-X-N and LSHM-130-X-X-RH-X-N. A photo of the test articles mounted to SI test boards is shown below.

Test System Description
The test fixtures are composed of six-layer MT40 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 LSHM series connector set and identified by part number PCB-LSHMDV-112313-SIG-0 and PCB-LSHMRH-112313-SIG-0.

PCB-LSHMDV-112313-SIG-0 and PCB-LSHMRH-112313-SIG-0 Test Fixtures

Shown below is a photograph of the test board set.

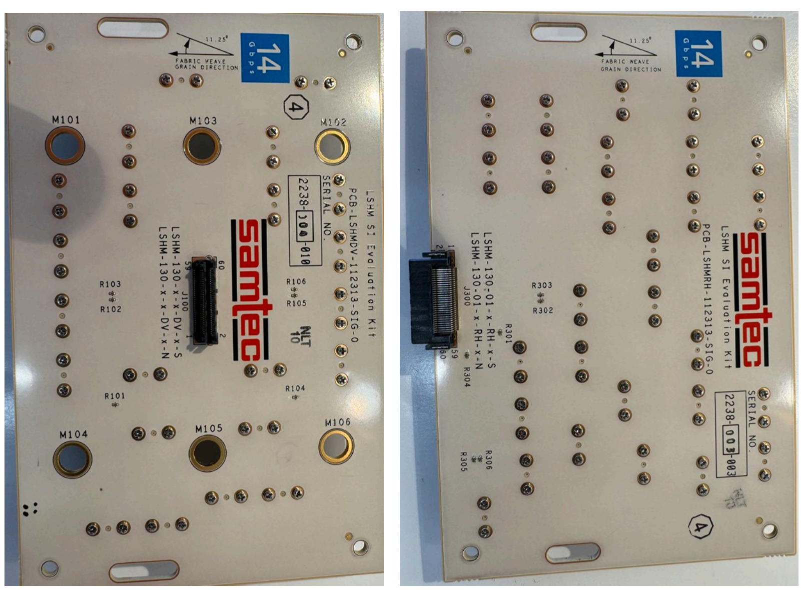


Figure 31

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

PCB Fixtures
The test fixtures used are as follows:

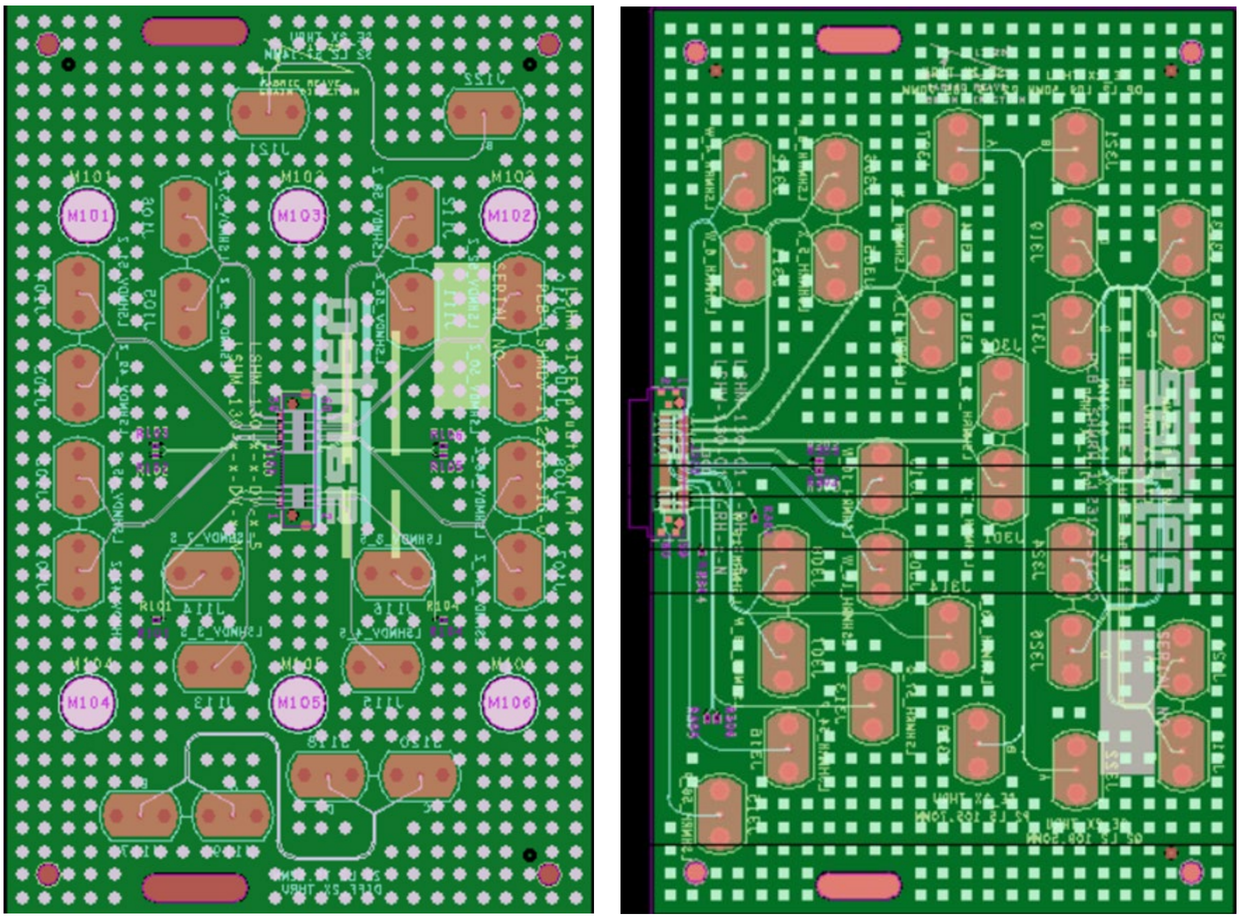


Figure 32

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

All traces on the test boards are length matched to 30.61 mm for Single- Ended and 39.86 mm for Differential measured from the edge of the pad to the 2.4mm connector. The AFR calibration effectively removes 28.57 mm of Single- Ended and 37.76mm of Differential test board trace effects. This means that 2.04 mm of Single- Ended and 2.1 mm of Differential test board trace length effects are included in both sides of test boards in the measurement. The S-Parameter measurement includes:

A- The LSHM Series connector set
B- Test board vias, pads (footprint effects) for the LSHM connector.
C- 2.04 mm Single- Ended of 0.151 mm wide microstrip trace.
D- 2.1 mm Differential of 0.142 mm wide microstrip trace

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

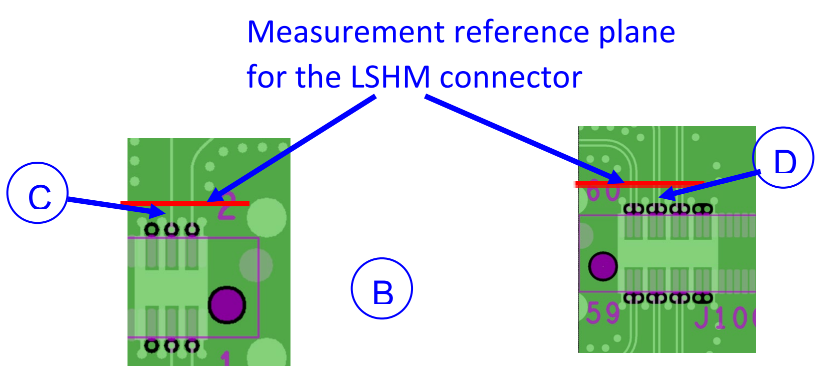


Figure 33

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Appendix D – Test and Measurement Setup

For frequency domain measurements, the test instrument is the Keysight N5225B PNA-L network analyzer. Frequency domain data are obtained directly from the instrument and figures are generated by Keysight ADS. The network analyzer is configured as follows:

Start Frequency – 10 MHz
Stop Frequency – 40 GHz
Number of points – 4000
IFBW – 1 KHz

N5225B Measurement Setup

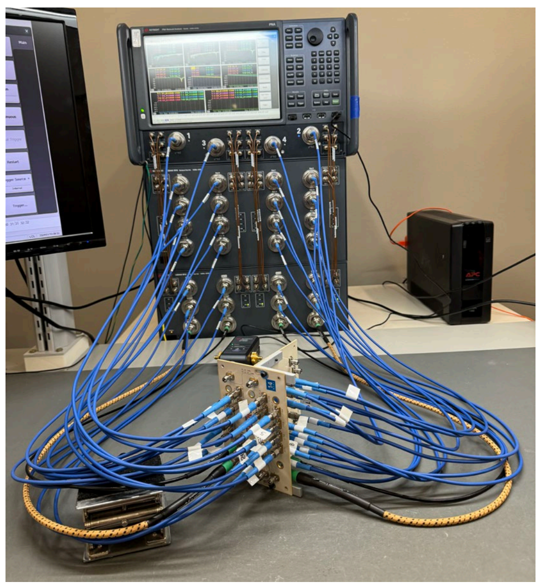


Figure 34

Test Instruments

QTY	Description
1	Keysight N5225B PNA Network Analyzer
1	1.85mm e-cal N4694-60003

Test Cables & Adapters

QTY	Description
32	1m Junkosha 2.4mm male to female cables

©Samtec, Inc. 2005
All Rights Reserved

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

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

A coaxial SOLT calibration is performed using N4694-60003 E-Cal 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/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.

©Samtec, Inc. 2005
All Rights Reserved

Series: LSHM
Description: High-Speed Hermaphroditic Terminal/Socket Strip, 0.50 mm (0.0197”) Pitch, Vertical to Reverse Right Angle

Appendix F – Glossary of Terms

ADS – Advanced Design Systems
FD – Frequency domain
FEXT – Far-End Crosstalk
GSG – Ground–Signal-Ground; geometric configuration
GSSG - Ground–Signal-Signal-Ground; geometric configuration
NEXT – Near-End Crosstalk
PCB – Printed Circuit Board
SE – Single-Ended
SI – Signal Integrity
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
Z – Impedance (expressed in ohms)

©Samtec, Inc. 2005
All Rights Reserved