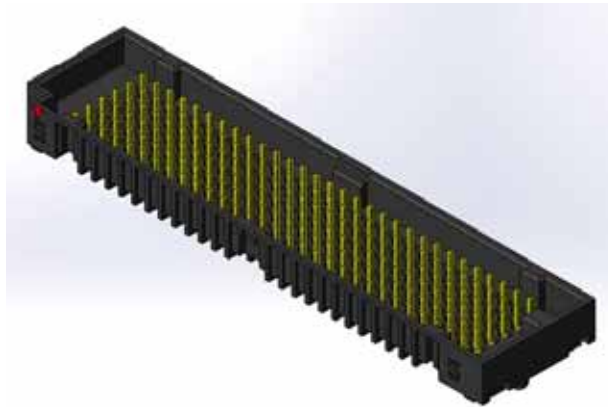




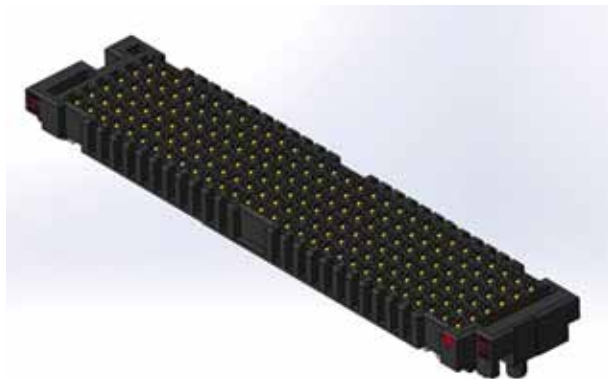
High Speed Characterization Report

LPAM-XX-01.5-X-XX-2



Mates with

LPAF-XX-03.5-X-XX-2



Description:
Low Profile, Open Pin Field Array,
1.27mm x 1.27mm Pitch, 5mm Stack Height

Series: LPAM/LPAF**Description:** Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

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Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

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Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

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Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Connector Overview

LPAM/LPAF is a low profile, 1.27mm x 1.27mm pitch array interconnect system for high-speed board-to-board applications. The open pin field design allows for dual signaling and is suitable for Fiber Channel, Rapid I/O, PCIe, SATA and Infiniband data rates.

The LPAM/LPAF Series has been designed in 4, 6, 8 and 10 rows arrays. Positions per row options designed include 10, 20, 30, 40 or 50. This report presents the high-speed electrical characteristics specific to LPAM-1.5mm/LPAF-3.5mm, 5mm mated stack height test system.

Connector System Speed Rating

LPAM/LPAF Series, 1.27mm x 1.27mm (.050" x .050") pitch interconnect, 5mm Stack Height.

| <u>Signaling</u> | <u>Speed Rating</u> |
|-------------------------------------|-------------------------|
| Single-Ended: 1:1 S/G | 20 GHz/ 40Gbps |
| Single-Ended: 2:1 S/G | 17.5 GHz/ 35Gbps |
| Differential: Optimal Horizontal | 20 GHz/ 40Gbps |
| Differential: Optimal Vertical | 16.5 GHz/ 33Gbps |
| Differential: High Density Vertical | 15.5 GHz/ 31Gbps |

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 up-rounding corrects for a portion of the test board's trace loss, since a short length of trace loss is included in the loss data in this report. 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.

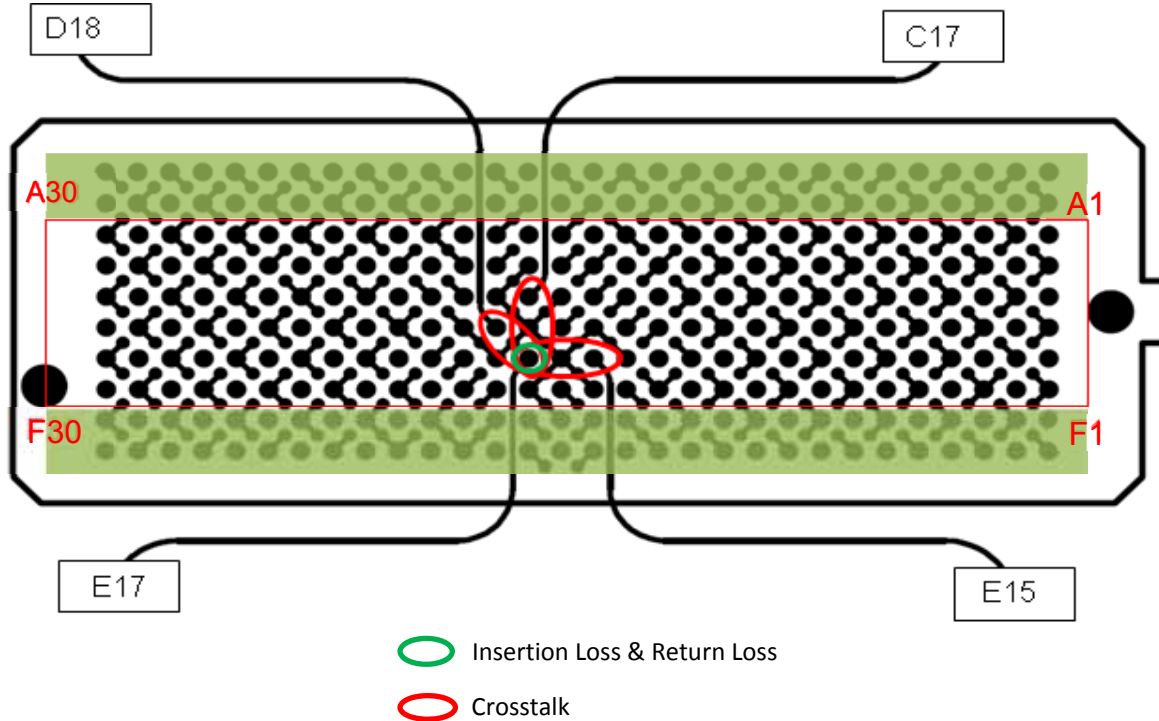
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Frequency Domain Data Summary

| Table 1 - Single-Ended 1:1 S/G Pattern Performance | | | |
|--|----------|----------|------------------|
| Test Parameter | Driver | Receiver | |
| Insertion Loss | LPAM_E17 | LPAF_E17 | <-3dB to 20 GHz |
| Return Loss | LPAM_E17 | LPAM_E17 | >10dB to 11 GHz |
| Near-End Crosstalk | LPAM_E17 | LPAM_C17 | <-20dB to 20 GHz |
| | LPAM_E17 | LPAM_D18 | <-20dB to 20 GHz |
| | LPAM_E17 | LPAM_E15 | <-20dB to 20 GHz |
| Far-End Crosstalk | LPAM_E17 | LPAF_C17 | <-20dB to 20 GHz |
| | LPAM_E17 | LPAF_D18 | <-20dB to 20 GHz |
| | LPAM_E17 | LPAF_E15 | <-20dB to 20 GHz |

Single-Ended 1:1 S/G Pattern Pin Map

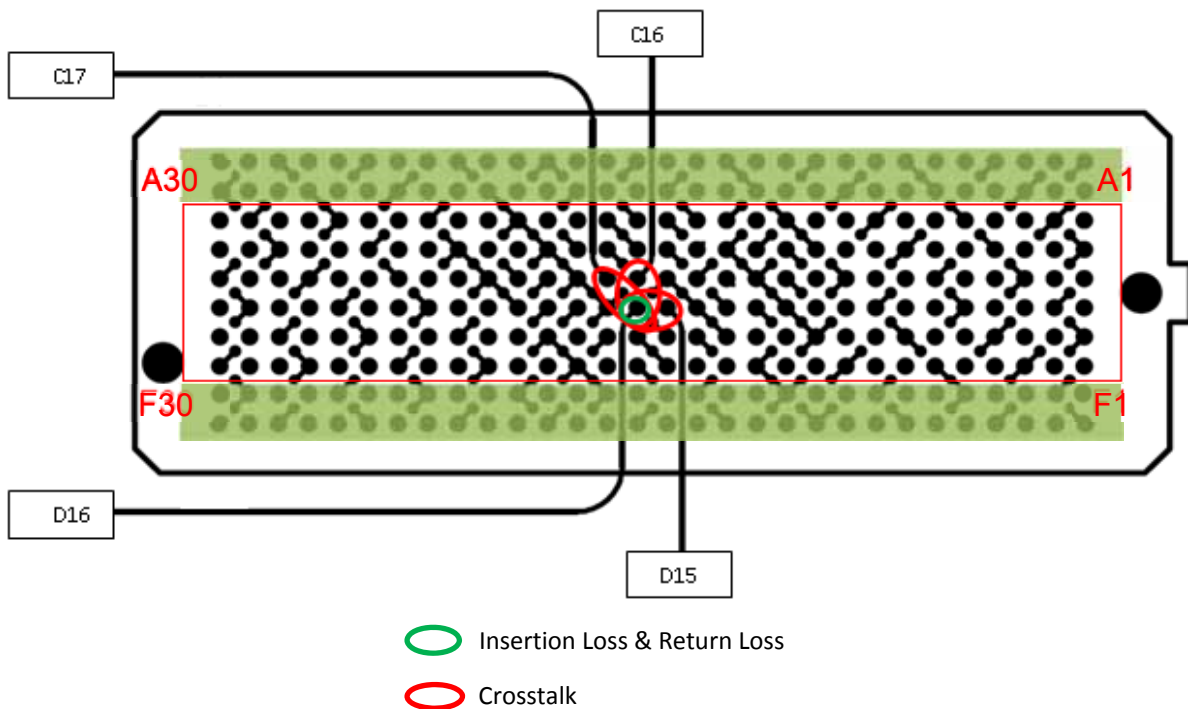


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 2 - Single-Ended 2:1 S/G Pattern Performance | | | |
|--|----------|----------|--------------------|
| Test Parameter | Driver | Receiver | |
| Insertion Loss | LPAM_D16 | LPAF_D16 | -3dB @ 17.3 GHz |
| Return Loss | LPAM_D16 | LPAM_D16 | >10dB to 10.6 GHz |
| Near-End Crosstalk | LPAM_D16 | LPAM_C16 | <-20dB to 2.8 GHz |
| | LPAM_D16 | LPAM_C17 | <-20dB to 3.8 GHz |
| | LPAM_D16 | LPAM_D15 | <-20dB to 20 GHz |
| Far-End Crosstalk | LPAM_D16 | LPAF_C16 | <-20dB to 8.1 GHz |
| | LPAM_D16 | LPAF_C17 | <-20dB to 10.2 GHz |
| | LPAM_D16 | LPAF_D15 | <-20dB to 20 GHz |

Single-Ended 2:1 S/G Pattern Pin Map

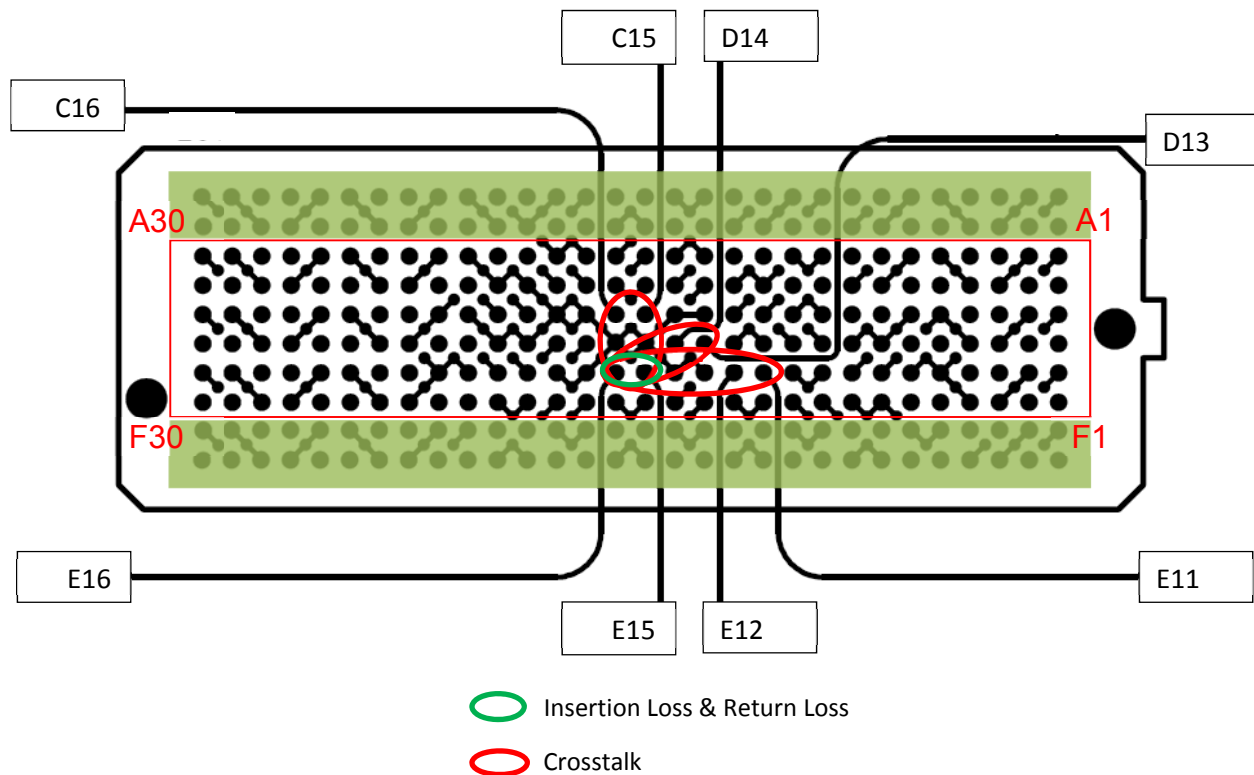


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 3 - Differential Optimal Horizontal Performance | | | |
|---|--------------|--------------|-------------------|
| Test Parameter | Driver | Receiver | |
| Insertion Loss | LPAM_E15,E16 | LPAF_E15,E16 | -3dB @ 20 GHz |
| Return Loss | LPAM_E15,E16 | LPAM_E15,E16 | >10dB to 13.6 GHz |
| Near-End Crosstalk | LPAM_E15,E16 | LPAM_C15,C16 | <-20dB to 20 GHz |
| | LPAM_E15,E16 | LPAM_D13,D14 | <-20dB to 20 GHz |
| | LPAM_E15,E16 | LPAM_E11,E12 | <-20dB to 20 GHz |
| Far-End Crosstalk | LPAM_E15,E16 | LPAF_C15,C16 | <-20dB to 20 GHz |
| | LPAM_E15,E16 | LPAF_D13,D14 | <-20dB to 20 GHz |
| | LPAM_E15,E16 | LPAF_E11,E12 | <-20dB to 20 GHz |

Differential Optimal Horizontal Pin Map

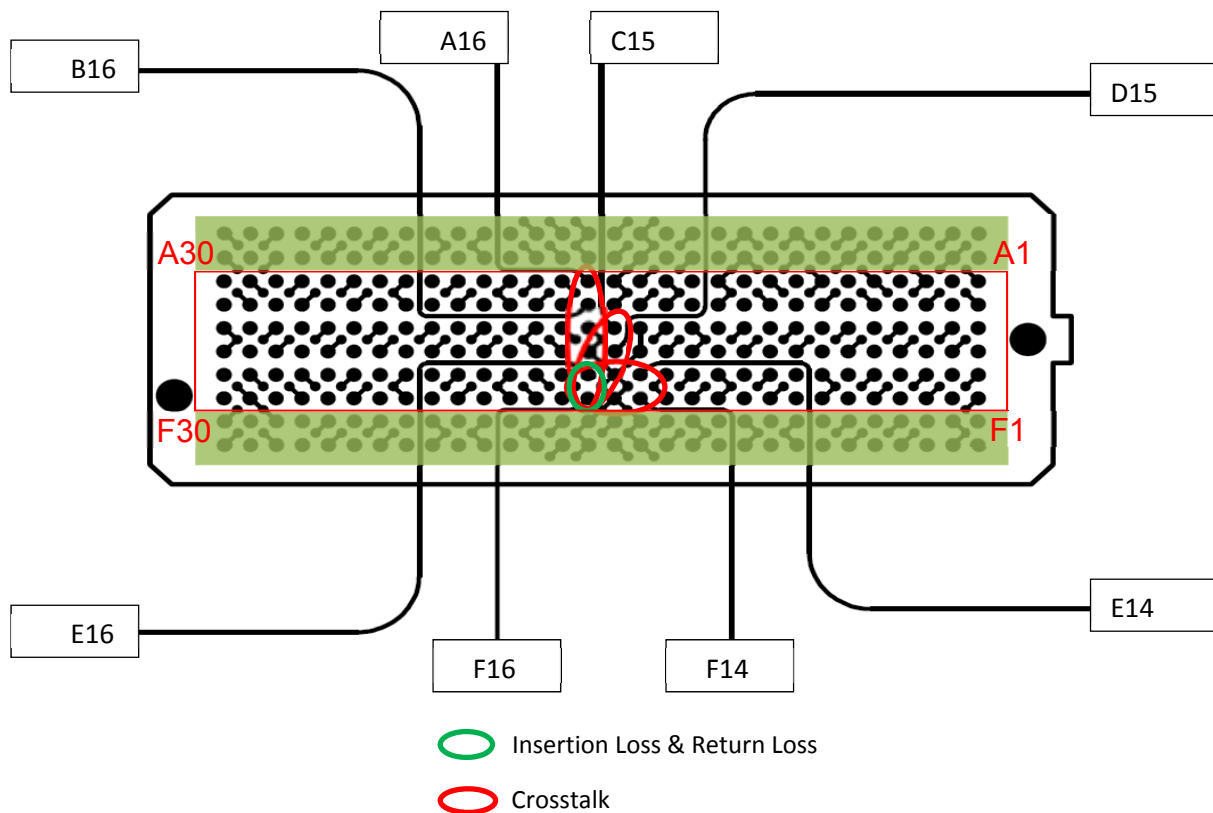


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 4 - Differential Optimal Vertical Performance | | | |
|---|--------------|--------------|-------------------|
| Test Parameter | Driver | Receiver | |
| Insertion Loss | LPAM_E16,F16 | LPAF_E16,F16 | -3dB @ 16.2 GHz |
| Return Loss | LPAM_E16,F16 | LPAM_E16,F16 | >10dB to 14.8 GHz |
| Near-End Crosstalk | LPAM_E16,F16 | LPAM_A16,B16 | <-20dB to 20 GHz |
| | LPAM_E16,F16 | LPAM_C15,D15 | <-20dB to 20 GHz |
| | LPAM_E16,F16 | LPAM_E14,F14 | <-20dB to 20 GHz |
| Far-End Crosstalk | LPAM_E16,F16 | LPAF_A16,B16 | <-20dB to 20 GHz |
| | LPAM_E16,F16 | LPAF_C15,D15 | <-20dB to 20 GHz |
| | LPAM_E16,F16 | LPAF_E14,F14 | <-20dB to 20 GHz |

Differential Optimal Vertical Pin Map

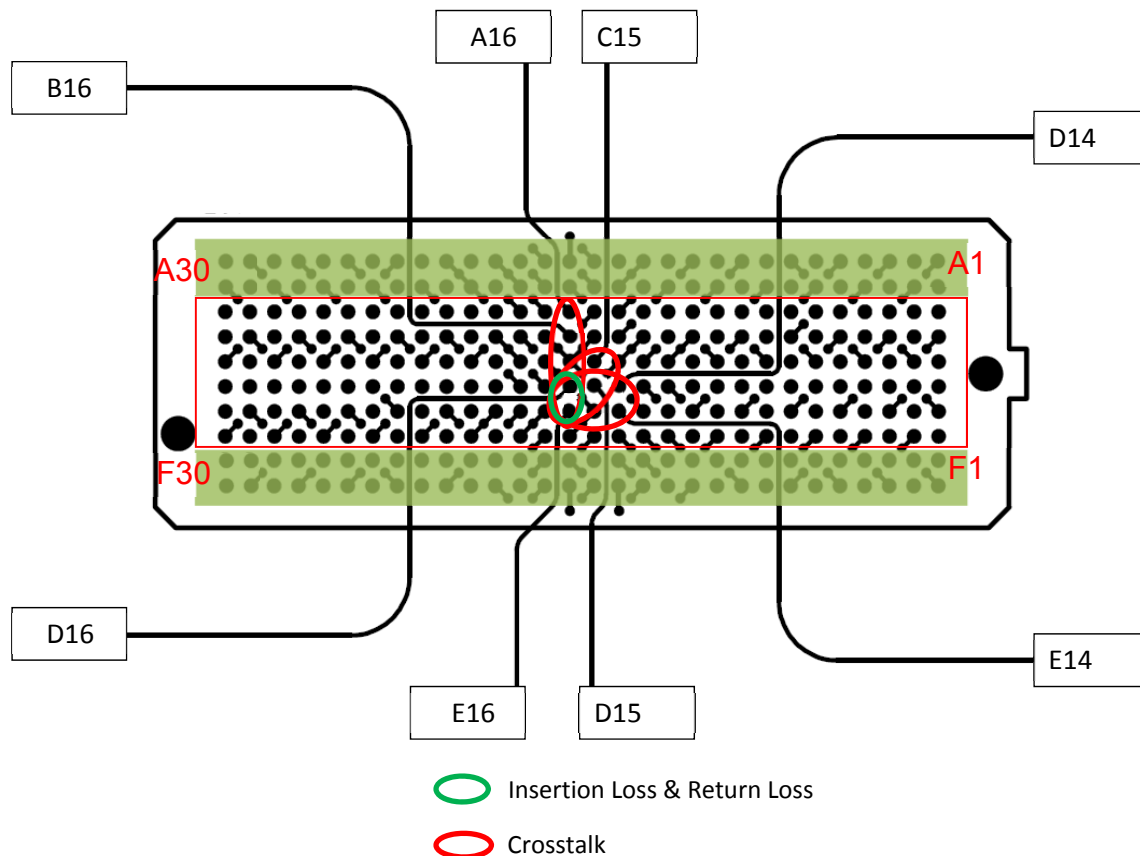


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 5 - Differential High Density Vertical Performance | | | |
|--|--------------|--------------|------------------|
| Test Parameter | Driver | Receiver | |
| Insertion Loss | LPAM_D16,E16 | LPAF_D16,E16 | -3dB @ 15.4 GHz |
| Return Loss | LPAM_D16,E16 | LPAM_D16,E16 | >10dB to 13 GHz |
| Near-End Crosstalk | LPAM_D16,E16 | LPAM_A16,B16 | <-20dB to 20 GHz |
| | LPAM_D16,E16 | LPAM_C15,D15 | <-20dB to 20 GHz |
| | LPAM_D16,E16 | LPAM_D14,E14 | <-20dB to 20 GHz |
| Far-End Crosstalk | LPAM_D16,E16 | LPAF_A16,B16 | <-20dB to 20 GHz |
| | LPAM_D16,E16 | LPAF_C15,D15 | <-20dB to 20 GHz |
| | LPAM_D16,E16 | LPAF_D14,E14 | <-20dB to 20 GHz |

Differential High Density Vertical Pin Map

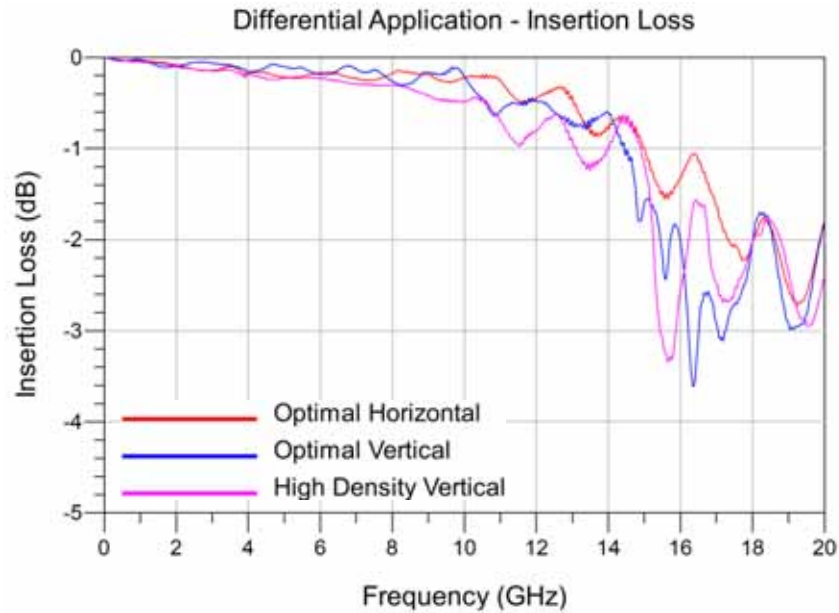
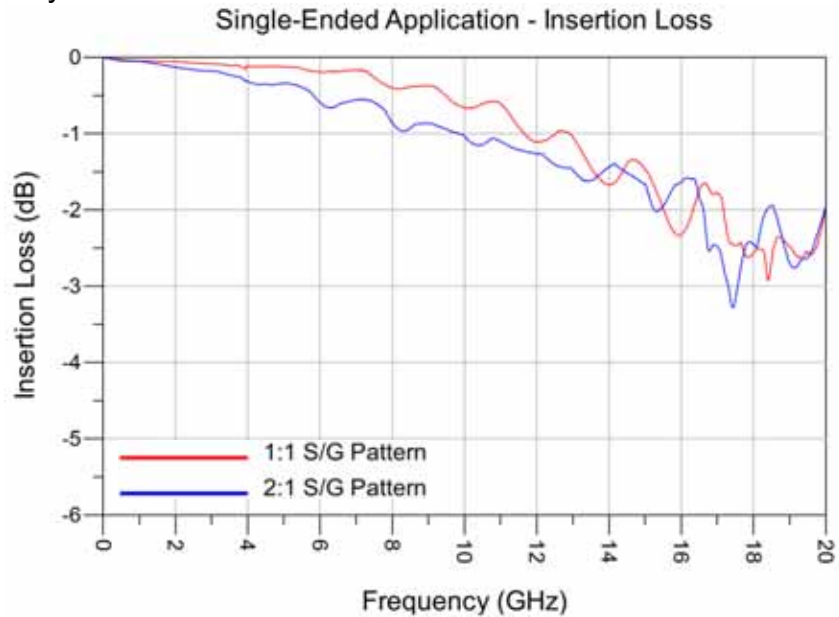


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Bandwidth Charts – Single-Ended & Differential Insertion Loss

LPAM/LPAF Array Series

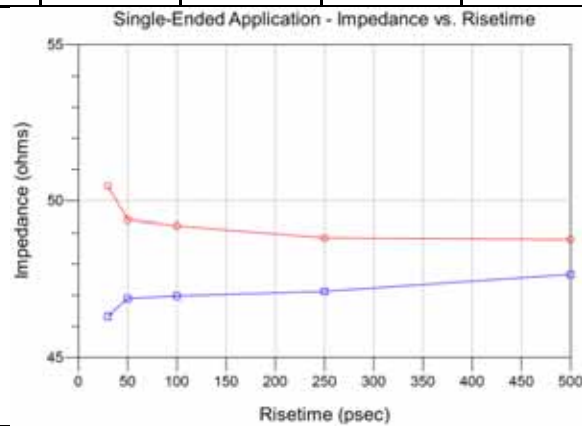


Series: LPAM/LPAF

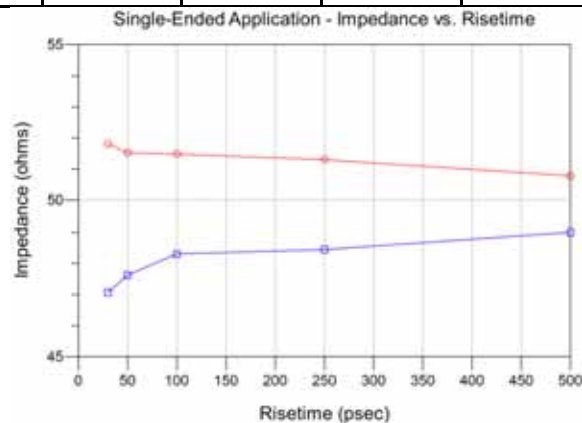
Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Time Domain Data Summary

| Table 6 – Single-End Impedance (Ω) – 1:1 S/G Pattern | | | | | |
|---|-------|-------|--------|--------|--------|
| Signal Risetime | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| Maximum Impedance | 50.47 | 49.40 | 49.21 | 48.83 | 48.78 |
| Minimum Impedance | 46.32 | 46.89 | 46.97 | 47.12 | 47.66 |



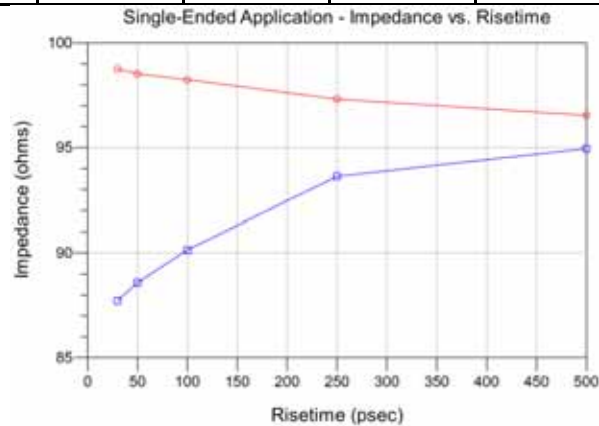
| Table 7 – Single-End Impedance (Ω) – 2:1 S/G Pattern | | | | | |
|---|-------|-------|--------|--------|--------|
| Signal Risetime | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| Maximum Impedance | 51.81 | 51.52 | 51.48 | 51.30 | 50.78 |
| Minimum Impedance | 47.06 | 47.62 | 48.30 | 48.44 | 48.99 |



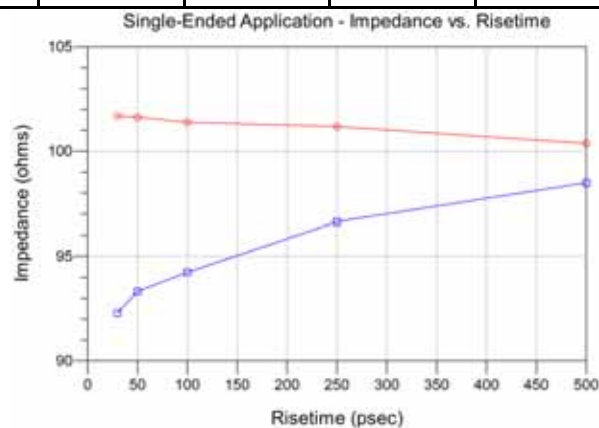
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 8 – Differential Impedance (Ω) – Optimal Horizontal | | | | | |
|--|-------|-------|--------|--------|--------|
| Signal Risetime | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| Maximum Impedance | 98.75 | 98.52 | 98.24 | 97.31 | 96.54 |
| Minimum Impedance | 87.72 | 88.59 | 90.14 | 93.62 | 94.95 |



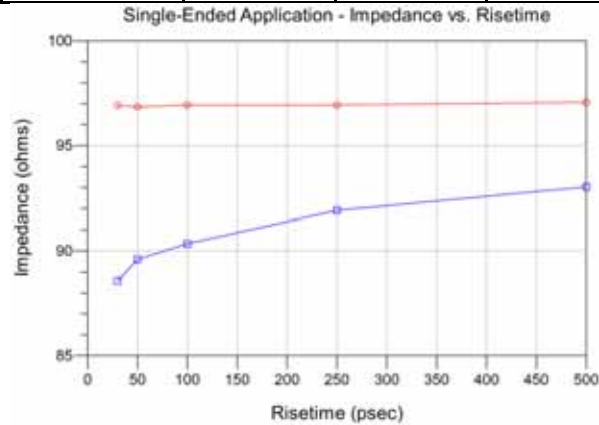
| Table 9 – Differential Impedance (Ω) – Optimal Vertical | | | | | |
|--|--------|--------|--------|--------|--------|
| Signal Risetime | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| Maximum Impedance | 101.69 | 101.62 | 101.38 | 101.18 | 100.37 |
| Minimum Impedance | 92.29 | 93.33 | 94.24 | 96.64 | 98.48 |



Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 10 – Differential Impedance (Ω) – High Density Vertical | | | | | |
|--|--------------|--------------|---------------|---------------|---------------|
| Signal Risetime | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| Maximum Impedance | 96.91 | 96.85 | 96.93 | 96.94 | 97.06 |
| Minimum Impedance | 88.57 | 89.60 | 90.34 | 91.91 | 93.03 |

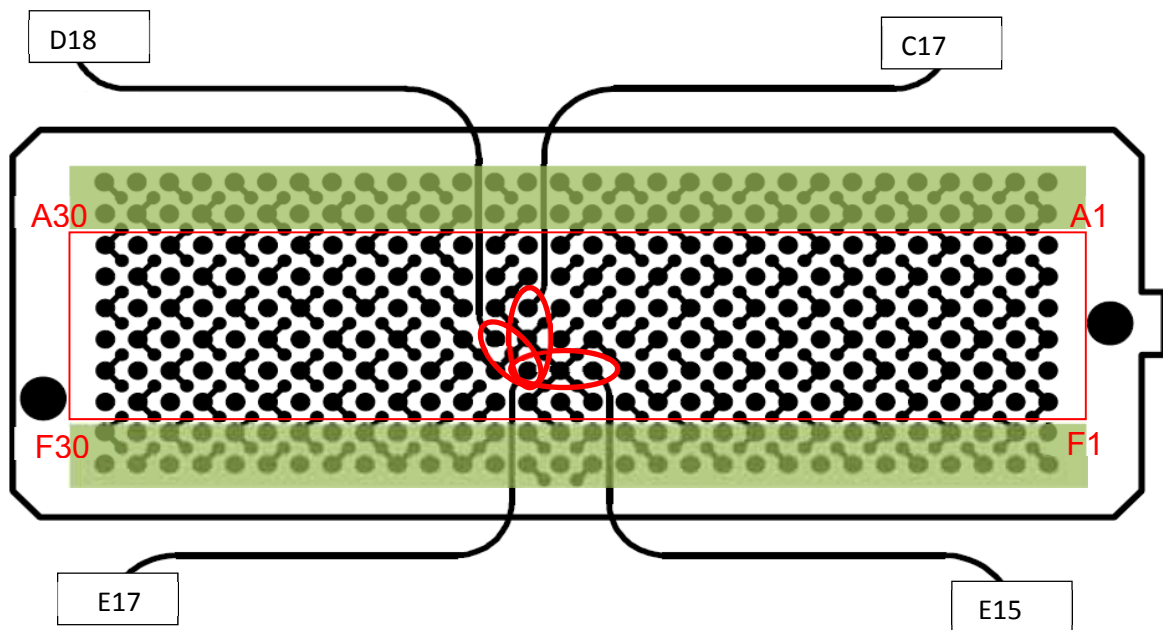


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 11 - Single-Ended Crosstalk (%) – 1:1 S/G Pattern | | | | | | | |
|---|----------|----------|-------|-------|--------|--------|--------|
| Input(tr) | Driver | Receiver | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| NEXT | LPAM_E17 | LPAM_C17 | 0.34 | 0.29 | 0.18 | <0.1 | <0.1 |
| | LPAM_E17 | LPAM_D18 | 0.26 | 0.21 | 0.13 | <0.1 | <0.1 |
| | LPAM_E17 | LPAM_E15 | 2.50 | 1.99 | 1.21 | 0.52 | 0.23 |
| FEXT | LPAM_E17 | LPAF_C17 | 0.45 | 0.33 | 0.19 | <0.1 | <0.1 |
| | LPAM_E17 | LPAF_D18 | 0.25 | 0.15 | <0.1 | <0.1 | <0.1 |
| | LPAM_E17 | LPAF_E15 | 0.86 | 0.61 | 0.30 | 0.12 | <0.1 |

Single-Ended 1:1 S/G Pattern Crosstalk Pin Map

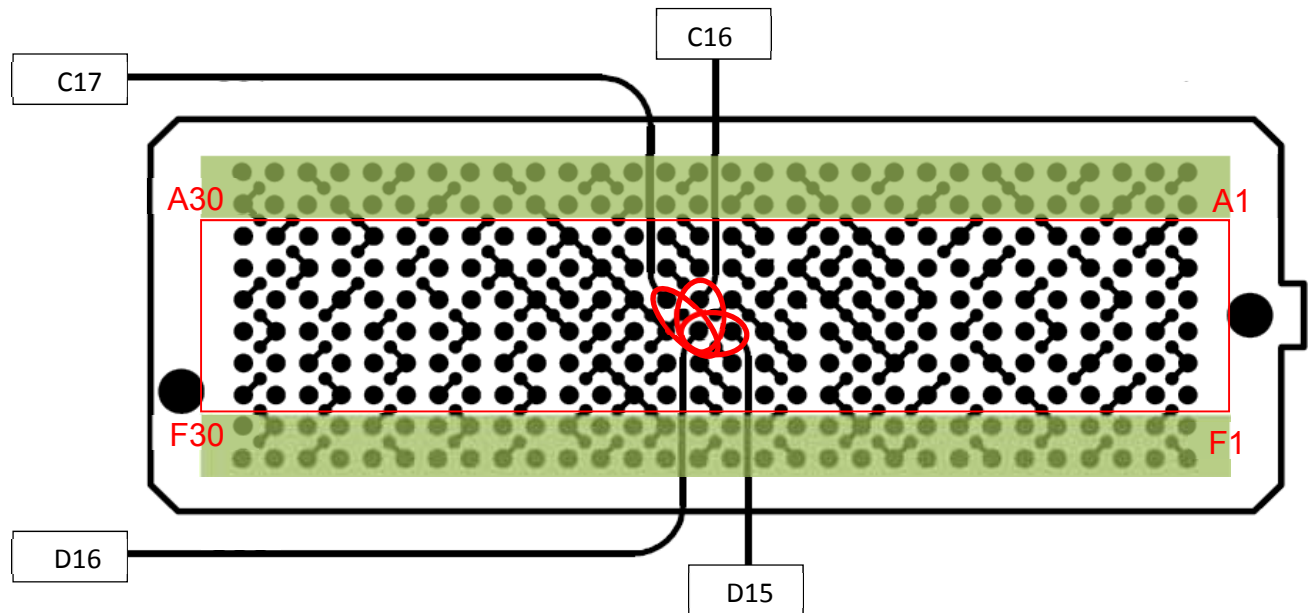


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 12 - Single-Ended Crosstalk (%) – 2:1 S/G Pattern | | | | | | | |
|---|----------|----------|-------|-------|--------|--------|--------|
| Input(tr) | Driver | Receiver | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| NEXT | LPAM_D16 | LPAM_C16 | 11.61 | 9.53 | 5.90 | 2.59 | 1.40 |
| | LPAM_D16 | LPAM_C17 | 9.17 | 7.39 | 4.50 | 1.95 | 1.08 |
| | LPAM_D16 | LPAM_D15 | 3.69 | 3.09 | 2.01 | 0.90 | 0.49 |
| FEXT | LPAM_D16 | LPAF_C16 | 4.44 | 3.36 | 1.92 | 0.81 | 0.48 |
| | LPAM_D16 | LPAF_C17 | 4.51 | 3.51 | 2.04 | 0.87 | 0.50 |
| | LPAM_D16 | LPAF_D15 | 2.38 | 1.84 | 1.08 | 0.47 | 0.27 |

Single-Ended 2:1 S/G Pattern Crosstalk Pin Map

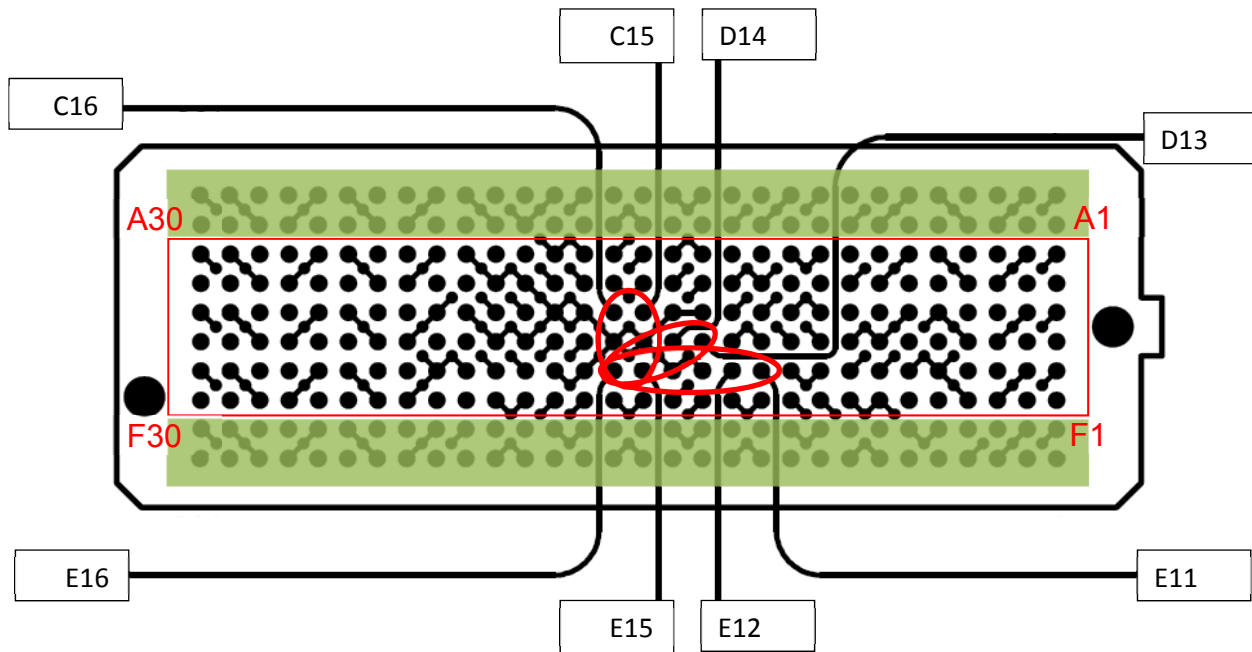


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 13 - Differential Crosstalk (%) – Optimal Horizontal | | | | | | | |
|--|--------------|--------------|-------|-------|--------|--------|--------|
| Input(tr) | Driver | Receiver | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| NEXT | LPAM_E15,E16 | LPAM_C15,C16 | 0.28 | 0.17 | <0.1 | <0.1 | <0.1 |
| | LPAM_E15,E16 | LPAM_D13,D14 | 0.87 | 0.71 | 0.41 | 0.17 | <0.1 |
| | LPAM_E15,E16 | LPAM_E11,E12 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| FEXT | LPAM_E15,E16 | LPAF_C15,C16 | 0.77 | 0.56 | 0.31 | 0.13 | <0.1 |
| | LPAM_E15,E16 | LPAF_D13,D14 | 0.17 | 0.10 | <0.1 | <0.1 | <0.1 |
| | LPAM_E15,E16 | LPAF_E11,E12 | 0.10 | <0.1 | <0.1 | <0.1 | <0.1 |

Differential Optimal Horizontal Crosstalk Pin Map

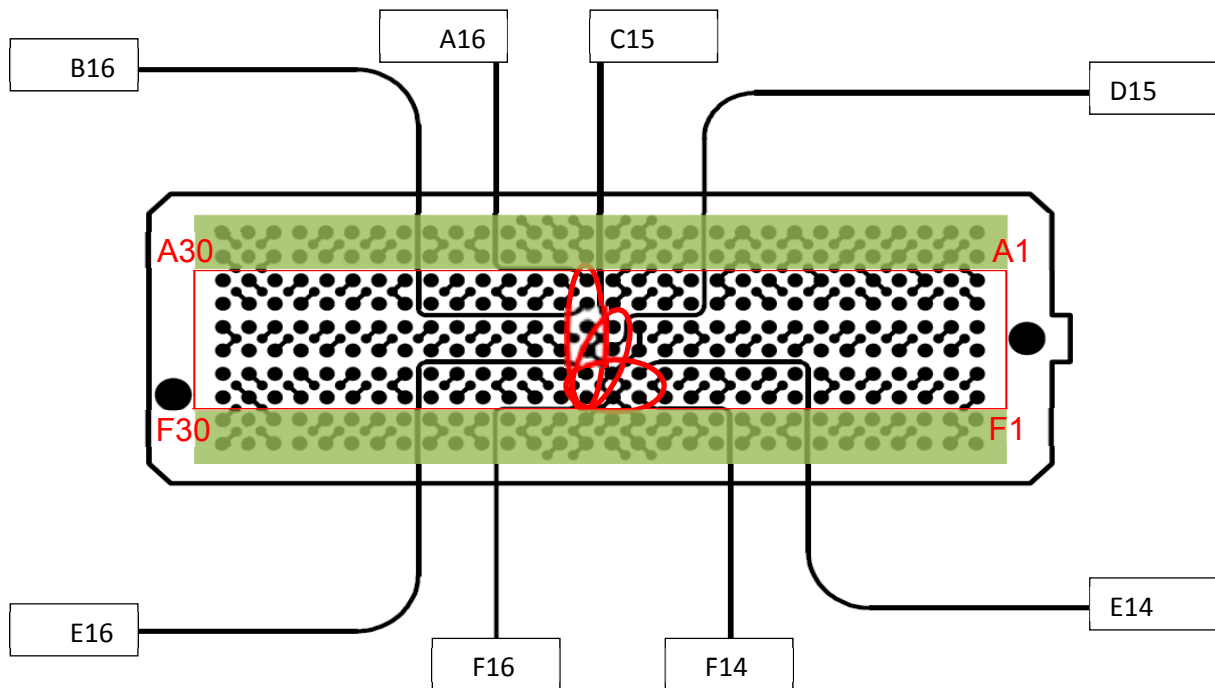


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 14 - Differential Crosstalk (%) – Optimal Vertical | | | | | | | |
|--|--------------|--------------|-------|-------|--------|--------|--------|
| Input(tr) | Driver | Receiver | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| NEXT | LPAM_E16,F16 | LPAM_A16,B16 | 0.62 | 0.49 | 0.29 | 0.12 | <0.1 |
| | LPAM_E16,F16 | LPAM_C15,D15 | 0.96 | 0.78 | 0.45 | 0.19 | 0.10 |
| | LPAM_E16,F16 | LPAM_E14,F14 | 0.26 | 0.11 | <0.1 | <0.1 | <0.1 |
| FEXT | LPAM_E16,F16 | LPAF_A16,B16 | 0.38 | 0.26 | 0.13 | <0.1 | <0.1 |
| | LPAM_E16,F16 | LPAF_C15,D15 | 0.14 | 0.10 | <0.1 | <0.1 | <0.1 |
| | LPAM_E16,F16 | LPAF_E14,F14 | 0.43 | 0.27 | 0.13 | <0.1 | <0.1 |

Differential Optimal Vertical Crosstalk Pin Map

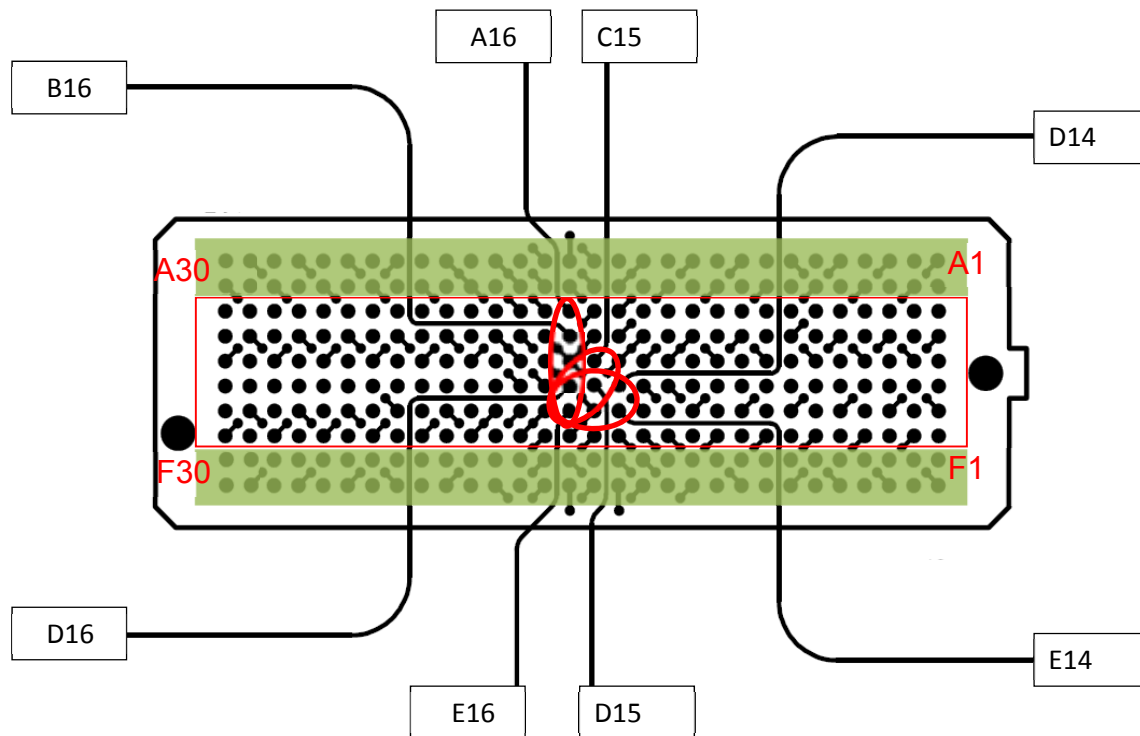


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 15 - Differential Crosstalk (%) – High Density Vertical | | | | | | | |
|---|--------------|--------------|-------|-------|--------|--------|--------|
| Input(tr) | Driver | Receiver | 30 ps | 50 ps | 100 ps | 250 ps | 500 ps |
| NEXT | LPAM_D16,E16 | LPAM_A16,B16 | 0.51 | 0.45 | 0.30 | 0.14 | <0.1 |
| | LPAM_D16,E16 | LPAM_C15,D15 | 2.93 | 2.45 | 1.43 | 0.66 | 0.35 |
| | LPAM_D16,E16 | LPAM_D14,E14 | 0.13 | <0.1 | <0.1 | <0.1 | <0.1 |
| FEXT | LPAM_D16,E16 | LPAF_A16,B16 | 0.55 | 0.46 | 0.28 | 0.12 | <0.1 |
| | LPAM_D16,E16 | LPAF_C15,D15 | 0.35 | 0.22 | <0.1 | <0.1 | <0.1 |
| | LPAM_D16,E16 | LPAF_D14,E14 | 0.25 | 0.16 | <0.1 | <0.1 | <0.1 |

Differential High Density Vertical Crosstalk Pin Map



Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

| Table 16 - Propagation Delay (Mated Connector) | |
|---|-------|
| Single-Ended: 1:1 S/G | 35 ps |
| Single-Ended: 2:1 S/G | 32 ps |
| Differential: Optimal Horizontal | 30 ps |
| Differential: Optimal Vertical | 26 ps |
| Differential: High Density Vertical | 32 ps |

Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

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.

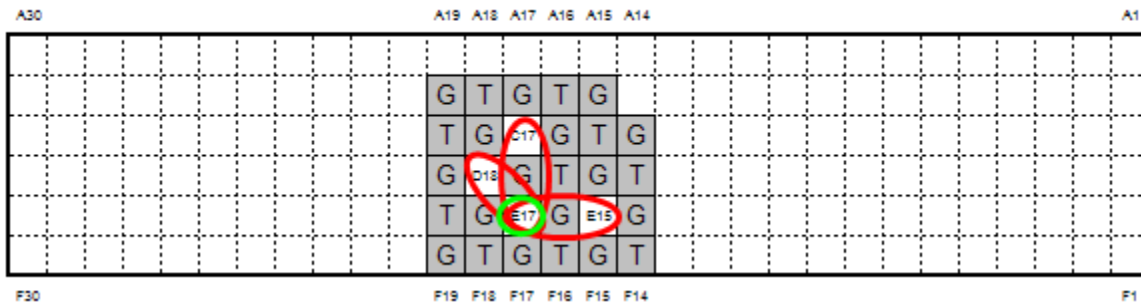
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

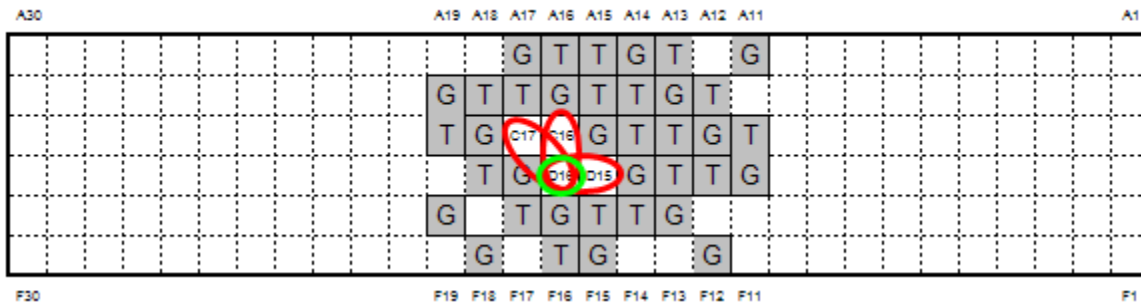
For this connector, the following array configurations are evaluated:

-  Open pin field
-  Grounded pin field
-  Signal pin field
-  50 ohm termination field

Single-Ended 1:1



Single-Ended 2:1



Single-Ended Impedance (denoted by green circles):

- 1:1 S:G ratio
- 2:1 S:G ratio

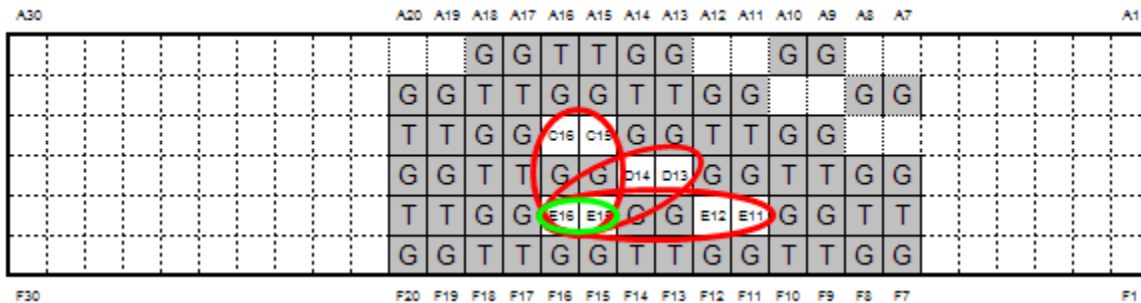
Single-Ended Crosstalk (denoted by red circles):

- 1:1 S:G ratio
- 2:1 S:G ratio

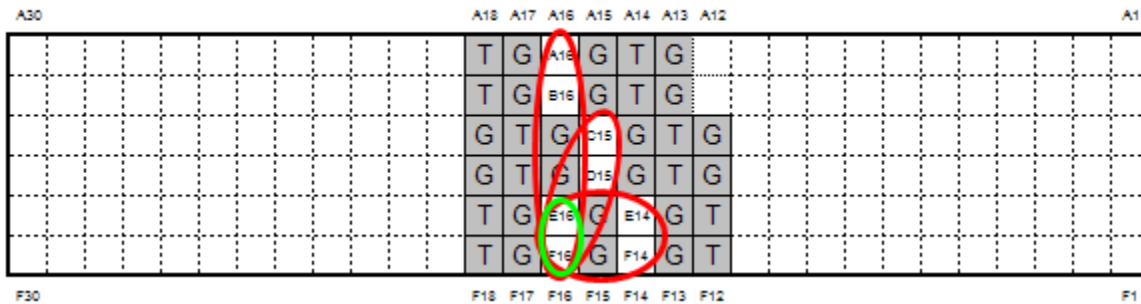
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

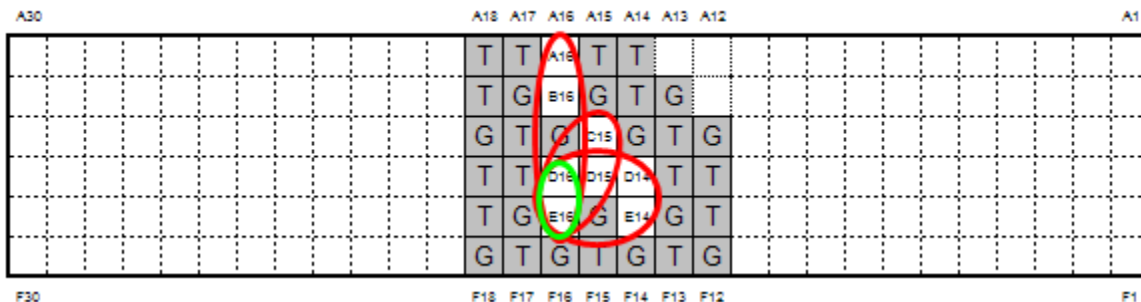
Optimal Horizontal



Optimal Vertical



Vertical High Density



Differential Impedance (denoted by green circles):

- Optimal Horizontal
- Optimal Vertical
- High Density Vertical

Differential Crosstalk (denoted by red circles):

- Optimal Horizontal
- Optimal Vertical
- High Density Vertical

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

Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

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.

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.

Impedance mismatch versus length is measured by DSA8200 Digital Serial Analyzer. Board related effects, such as pad-to-ground capacitance and trace loss, are included in

Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

the data presented in this report. The impedance data is provided in [Appendix E](#) of this report.

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

In this report, propagation delay is defined as the signal propagation time through the connector and connector footprint. It includes 10 mils of PCB trace on each end of the connector. 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.

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. However, 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.

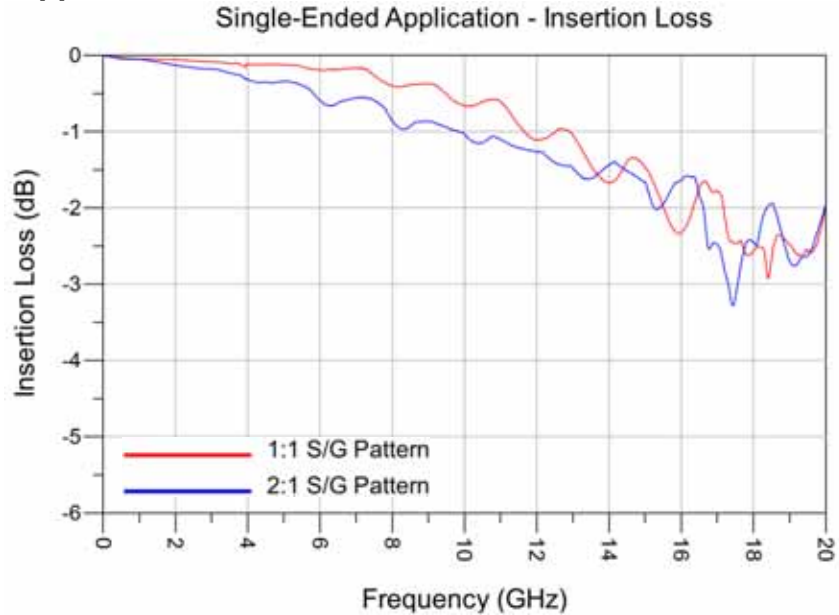
Additional information concerning test conditions and procedures is located in the appendices of this report. Further information may be obtained by contacting our Signal Integrity Group at sig@samtec.com.

Series: LPAM/LPAF

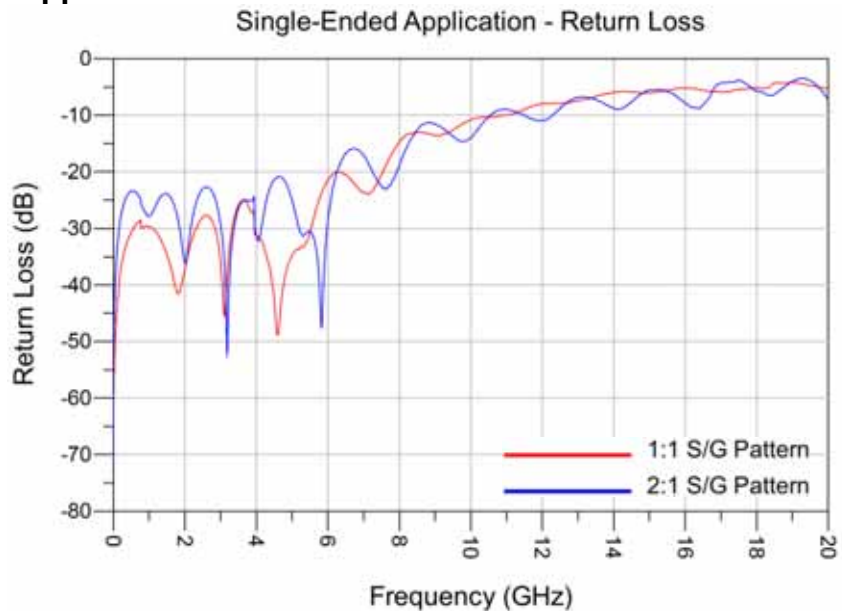
Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Appendix A – Frequency Domain Response Graphs

Single-Ended Application – Insertion Loss



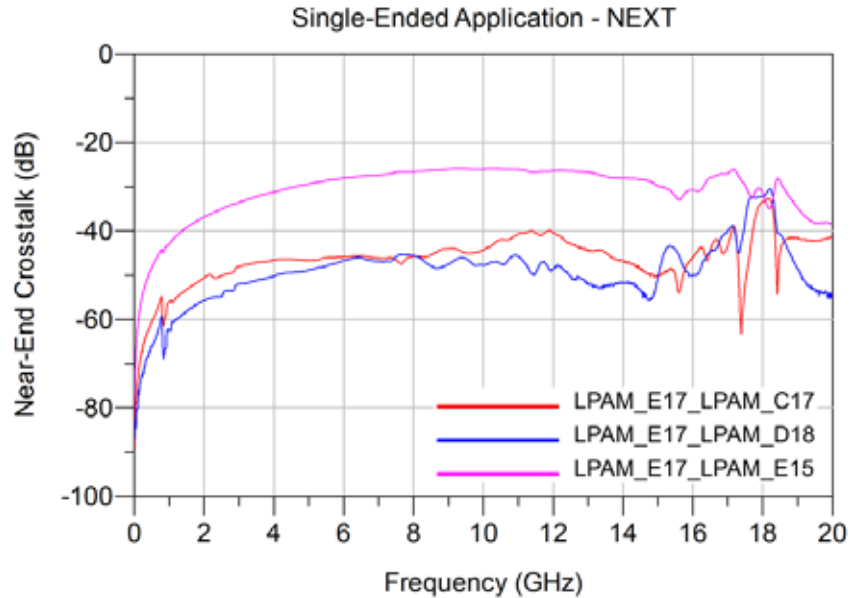
Single-Ended Application – Return Loss



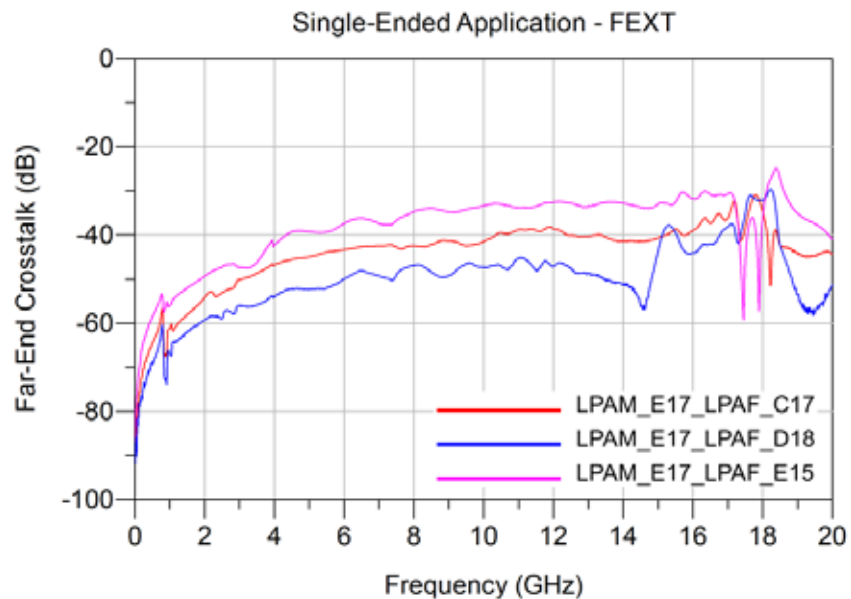
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 1:1 S/G Pattern Application – NEXT



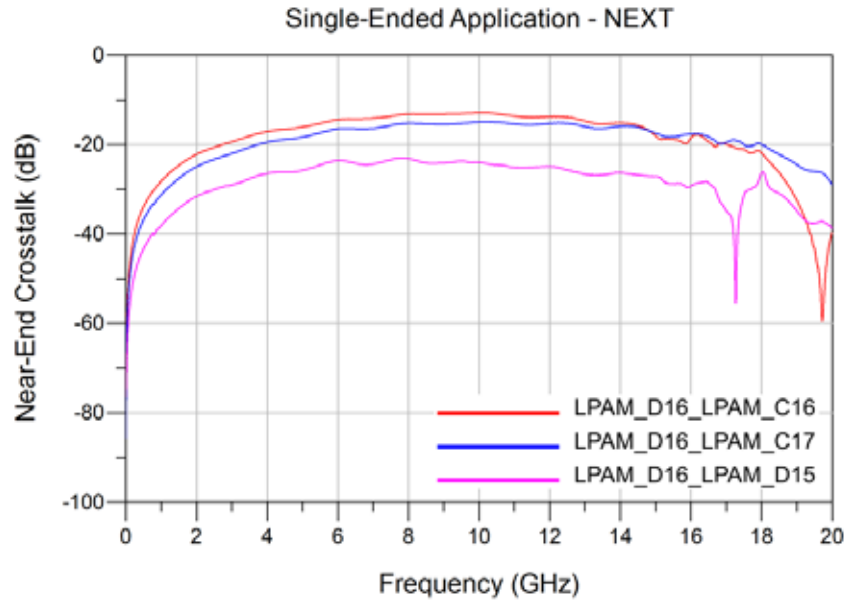
Single-Ended 1:1 S/G Pattern Application – FEXT



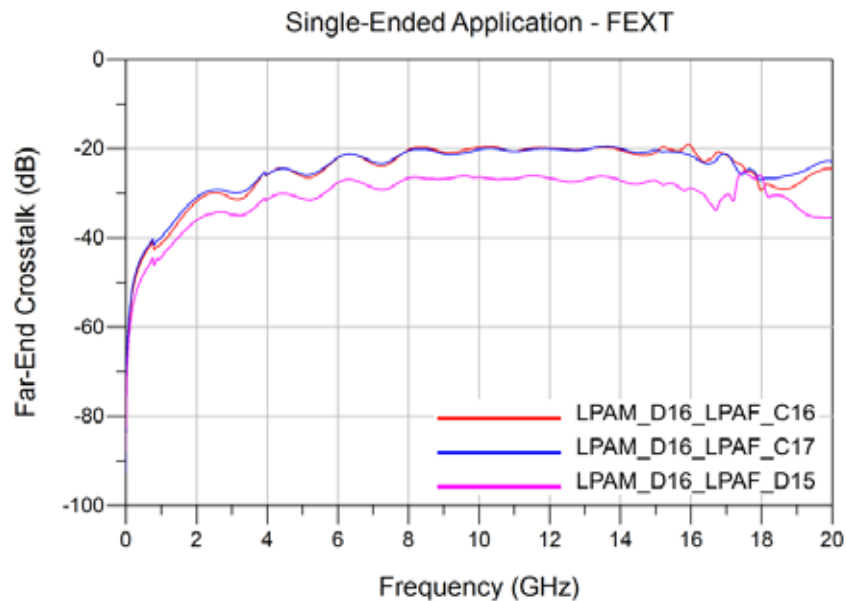
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 2:1 S/G Pattern Application – NEXT



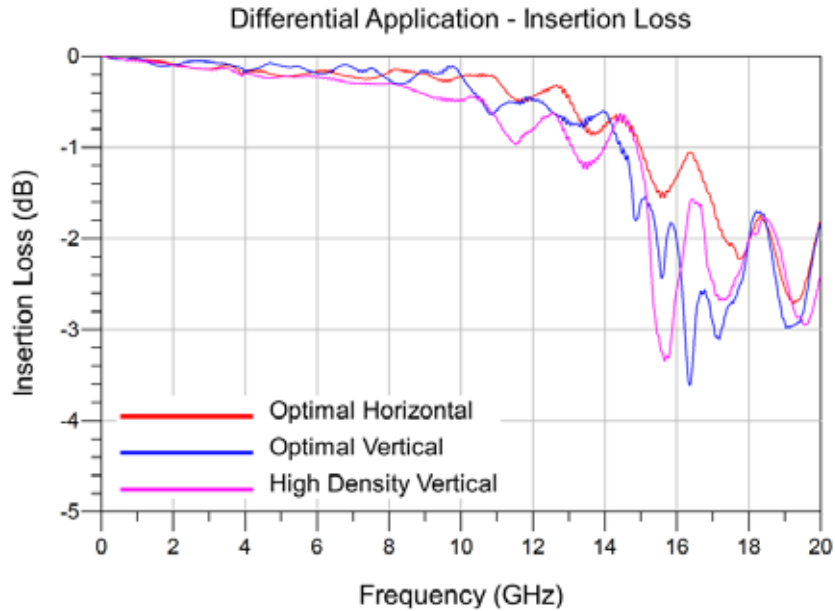
Single-Ended 2:1 S/G Pattern Application – FEXT



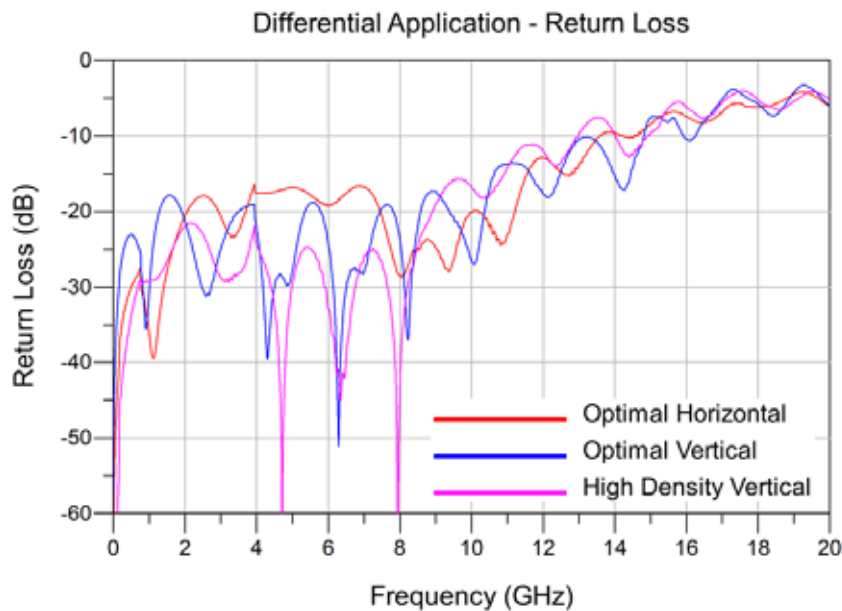
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Differential Application – Insertion Loss



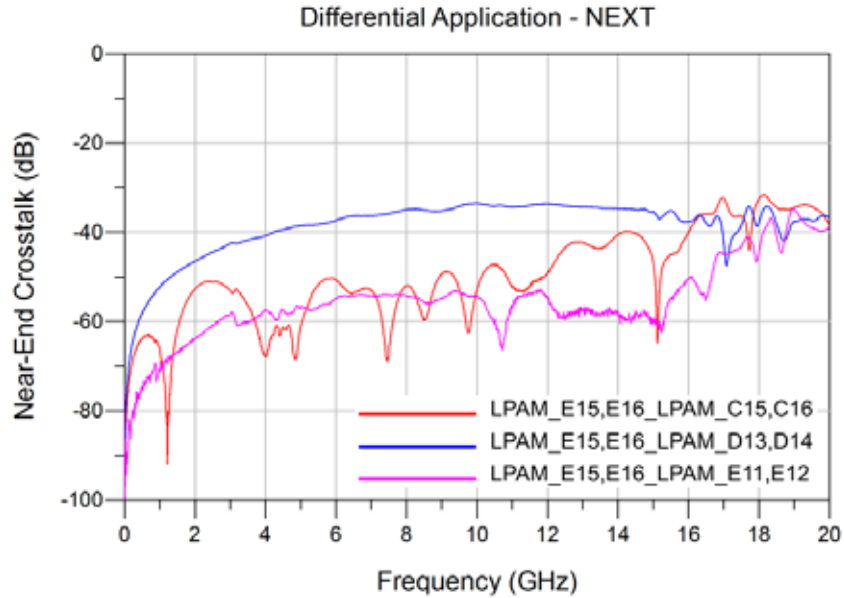
Differential Application – Return Loss



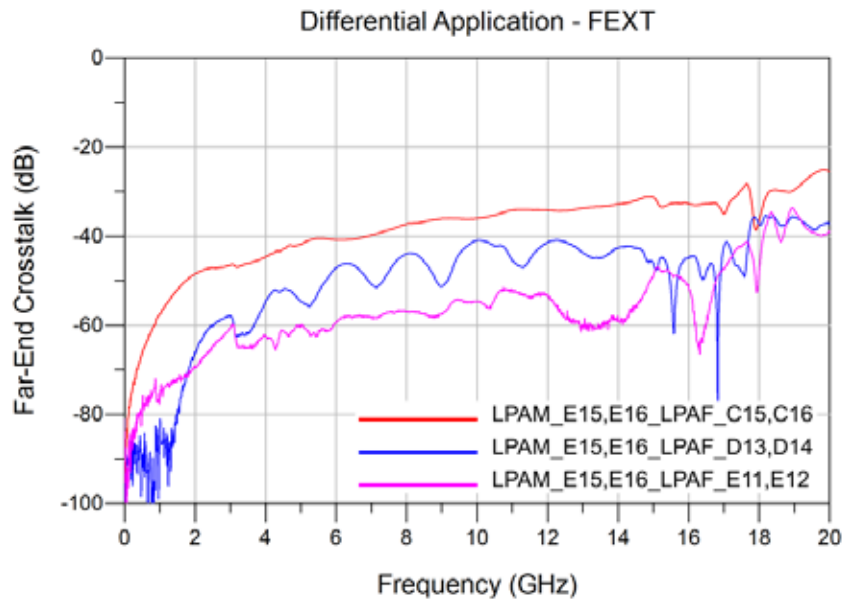
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Differential Optimal Horizontal Application – NEXT



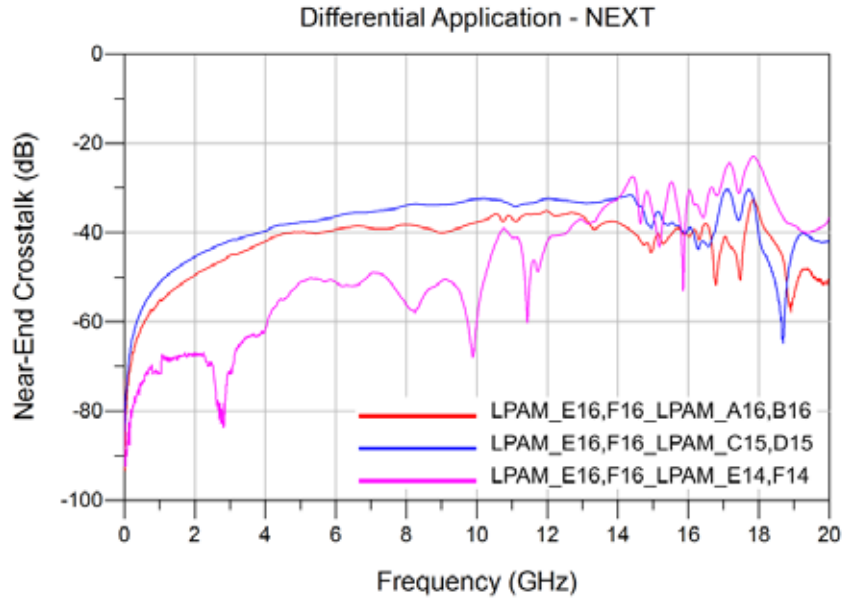
Differential Optimal Horizontal Application – FEXT



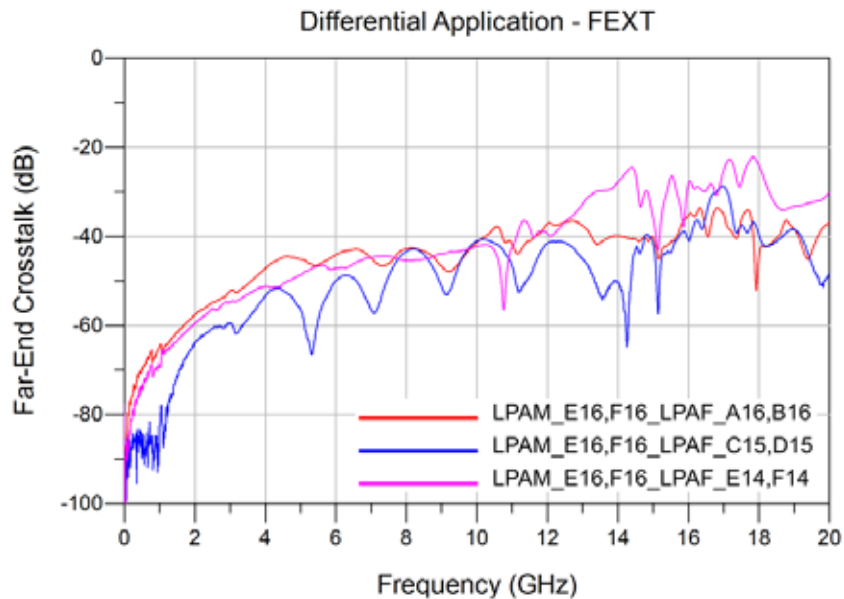
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Differential Optimal Vertical Application – NEXT



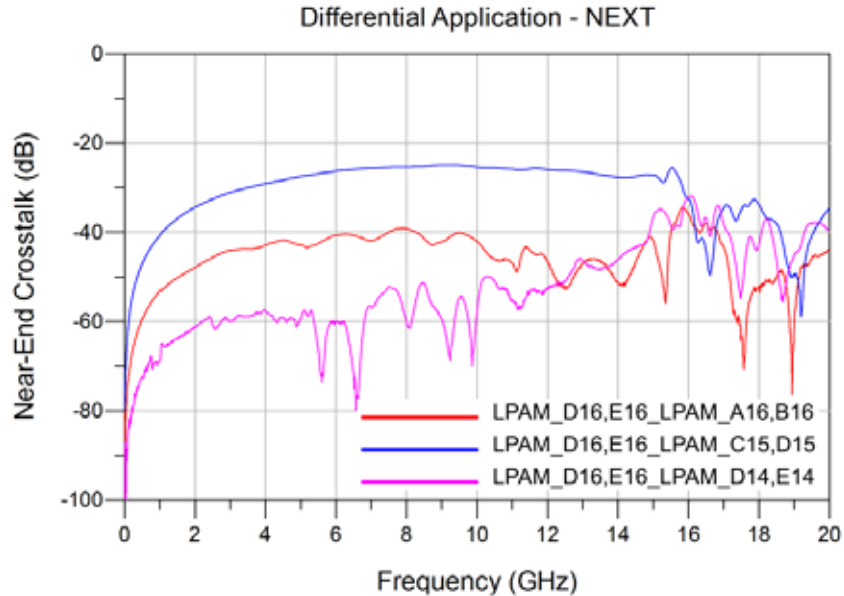
Differential Optimal Vertical Application – FEXT



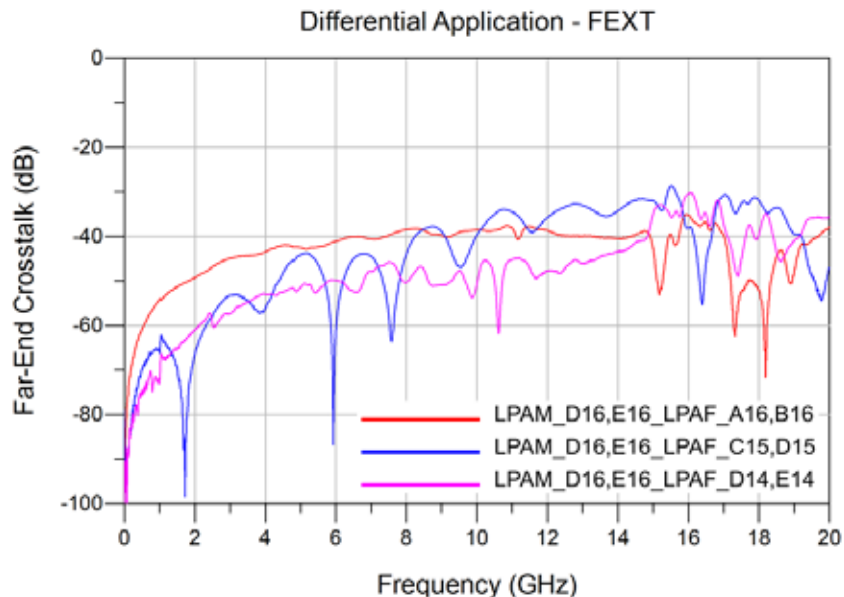
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Differential High Density Vertical Application – NEXT



Differential High Density Vertical Application – FEXT

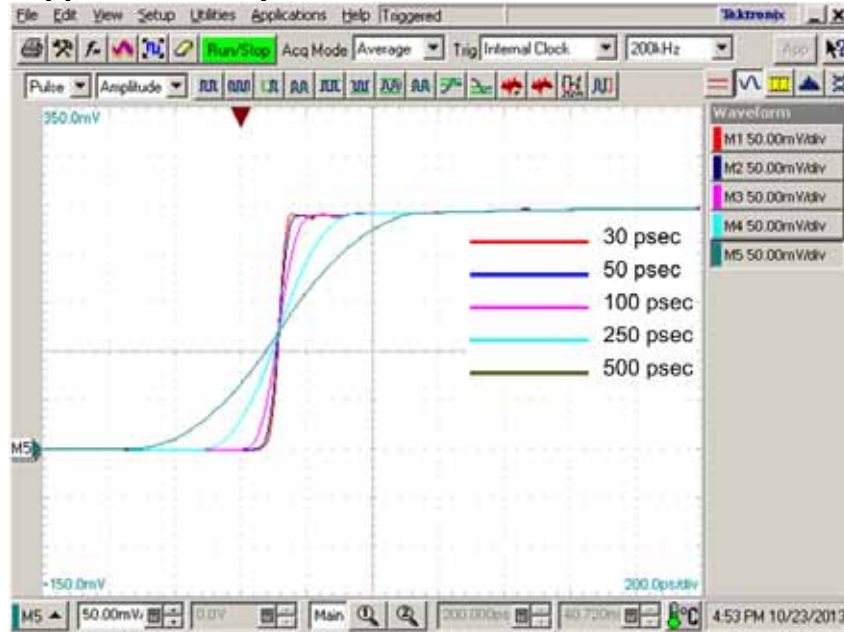


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Appendix B – Time Domain Response Graphs

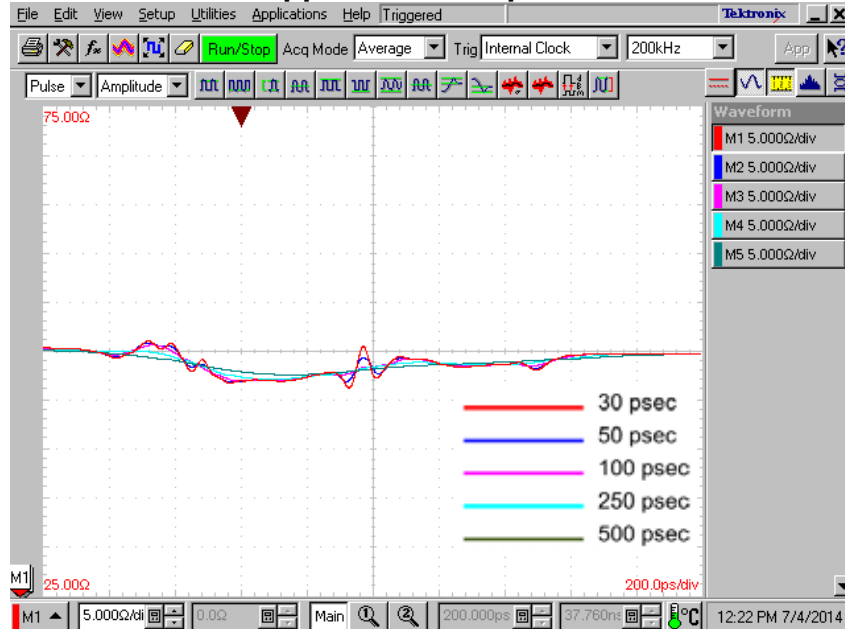
Single-Ended Application – Input Pulse



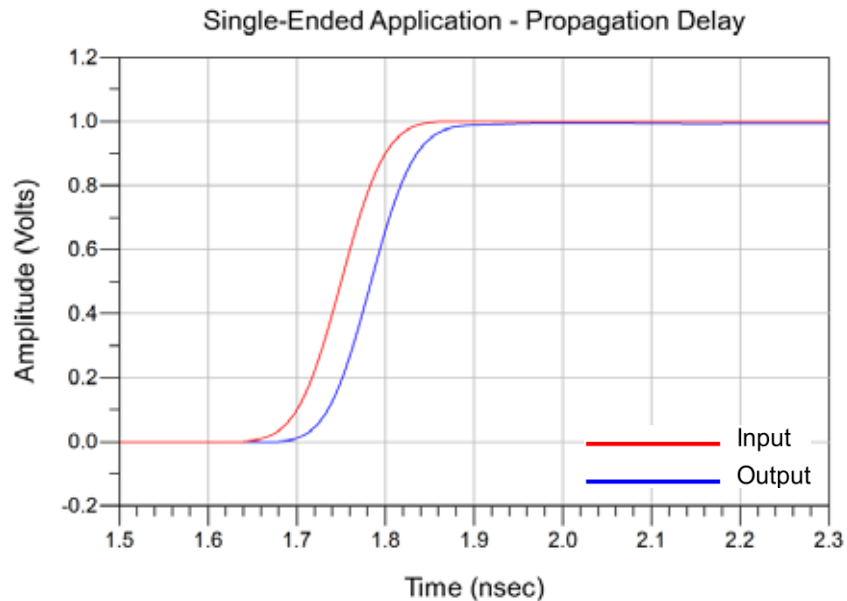
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 1:1 S/G Pattern Application – Impedance



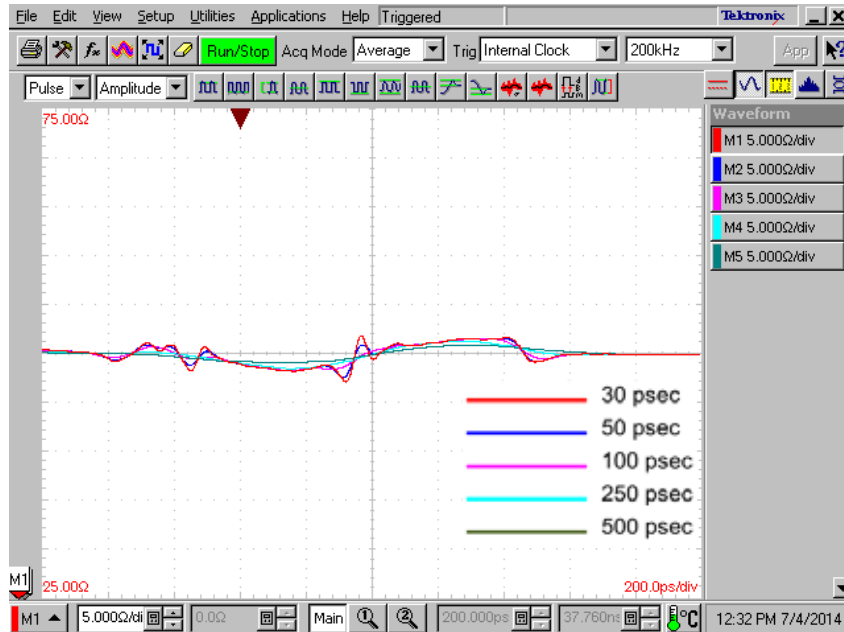
Single-Ended 1:1 S/G Pattern Application – Propagation Delay



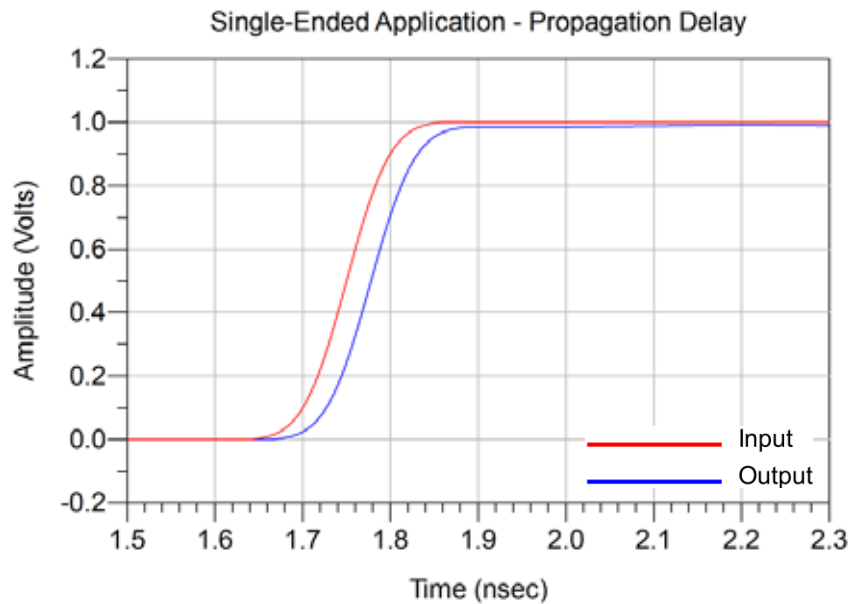
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 2:1 S/G Pattern Application – Impedance



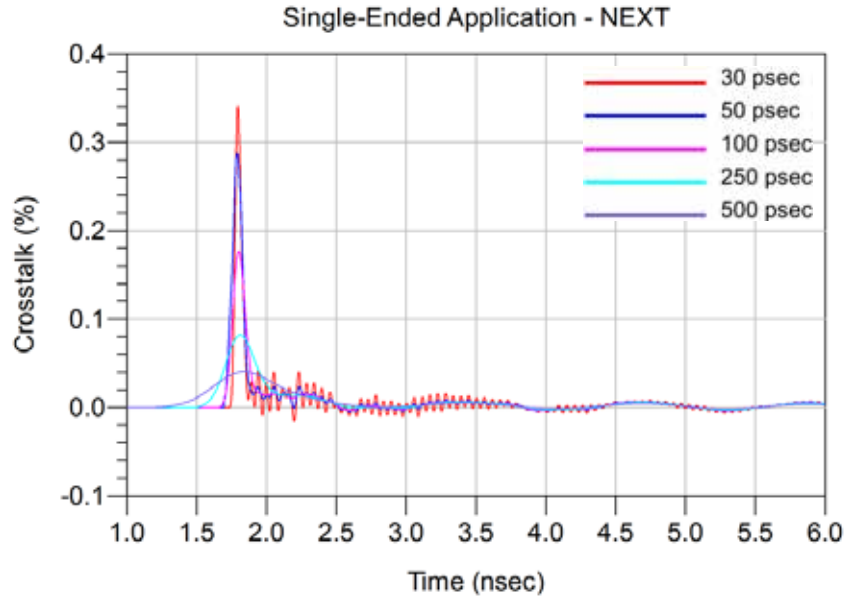
Single-Ended 2:1 S/G Pattern Application – Propagation Delay



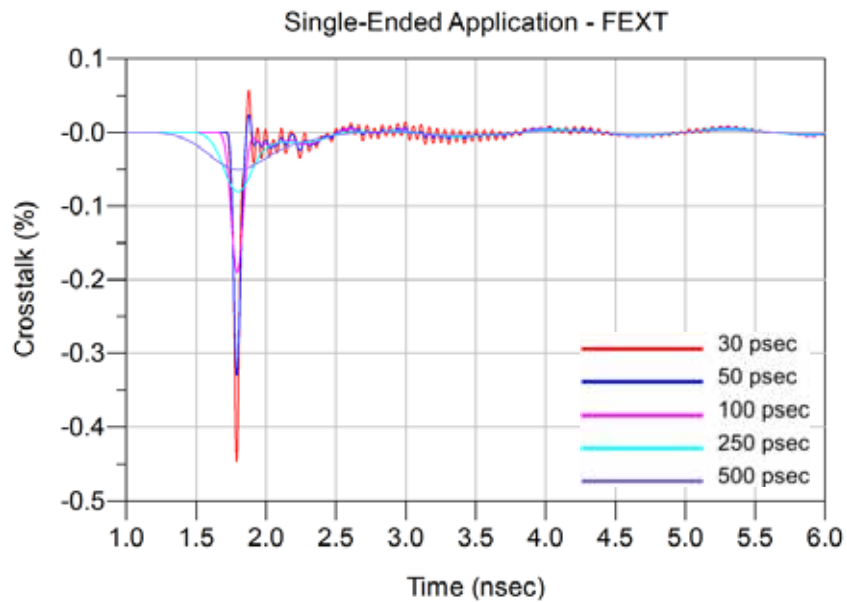
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 1:1 S/G Pattern Application – NEXT, LPAM_E17_LPAM_C17



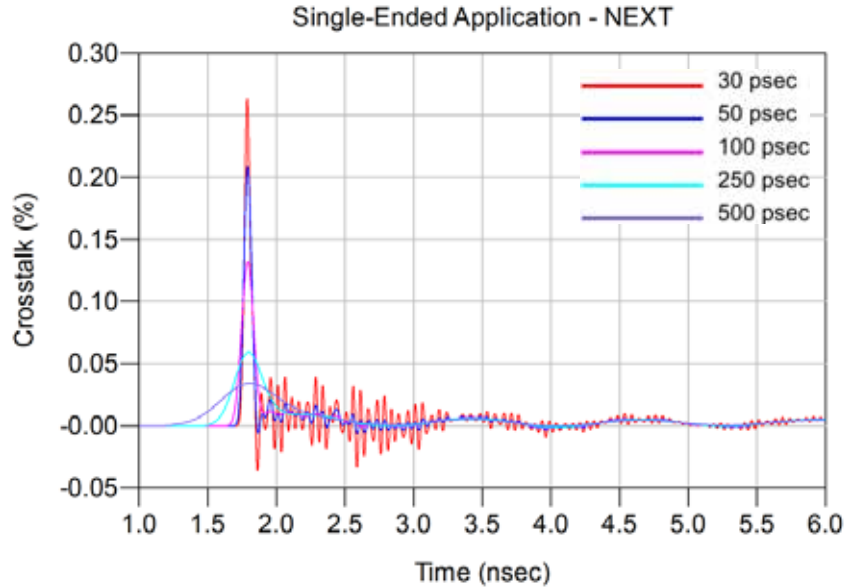
Single-Ended 1:1 S/G Pattern Application – FEXT, LPAM_E17_LPAF_C17



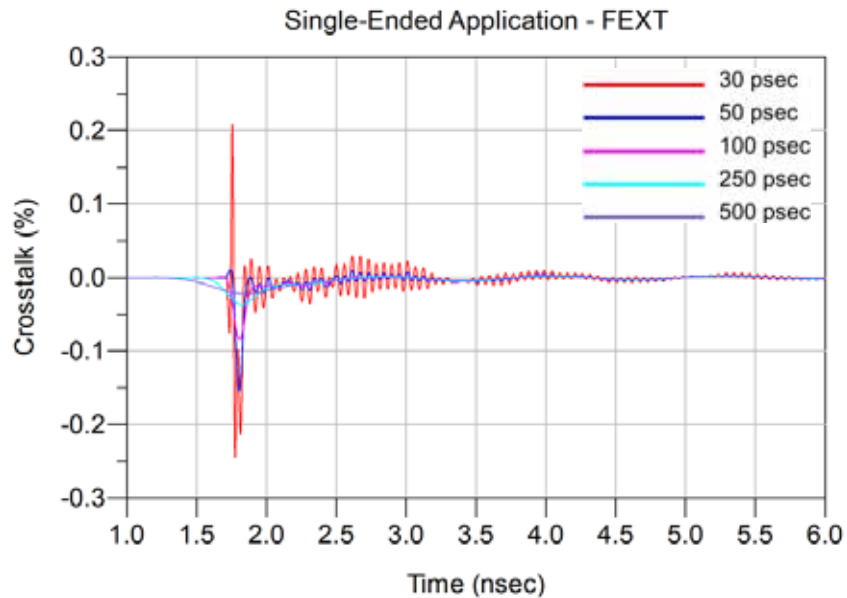
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 1:1 S/G Pattern Application – NEXT, LPAM_E17_LPAM_D18



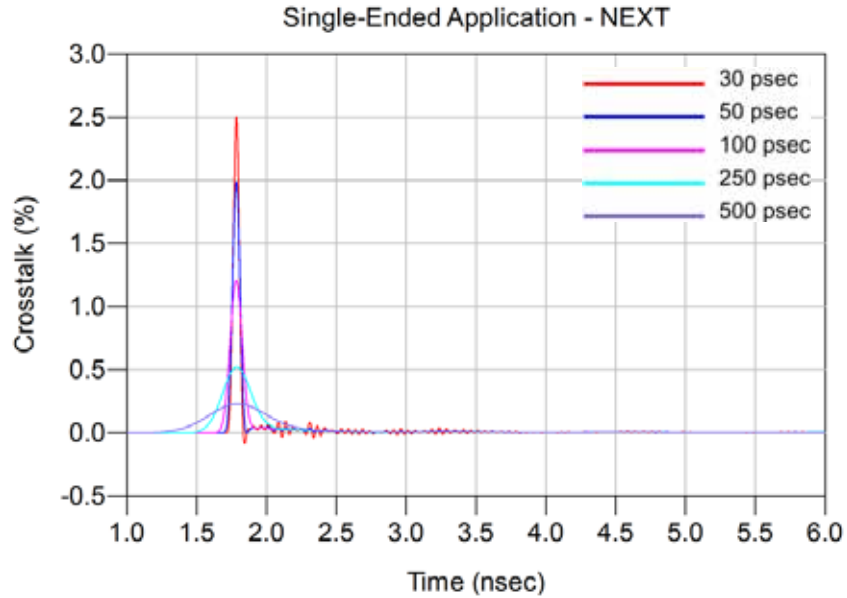
Single-Ended 1:1 S/G Pattern Application – FEXT, LPAM_E17_LPAF_D18



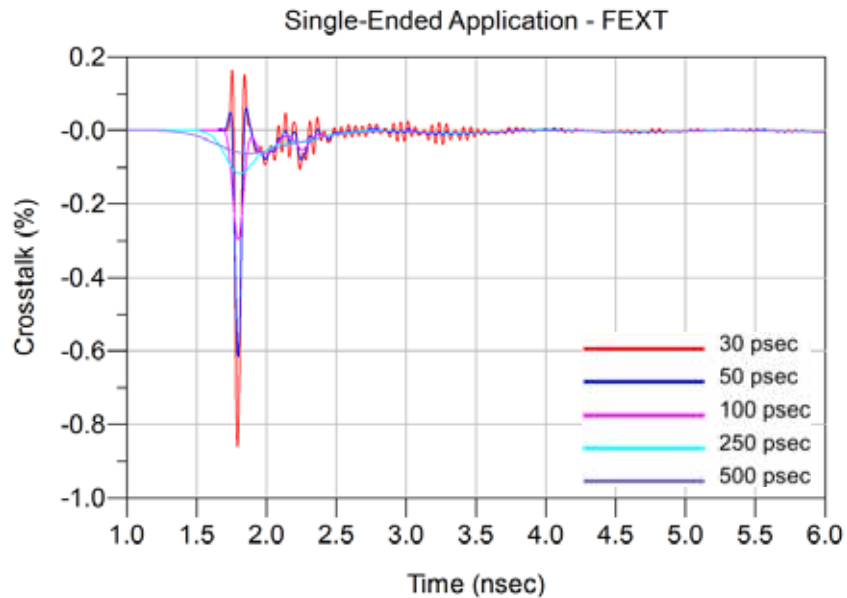
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 1:1 S/G Pattern Application – NEXT, LPAM_E17_LPAM_E15



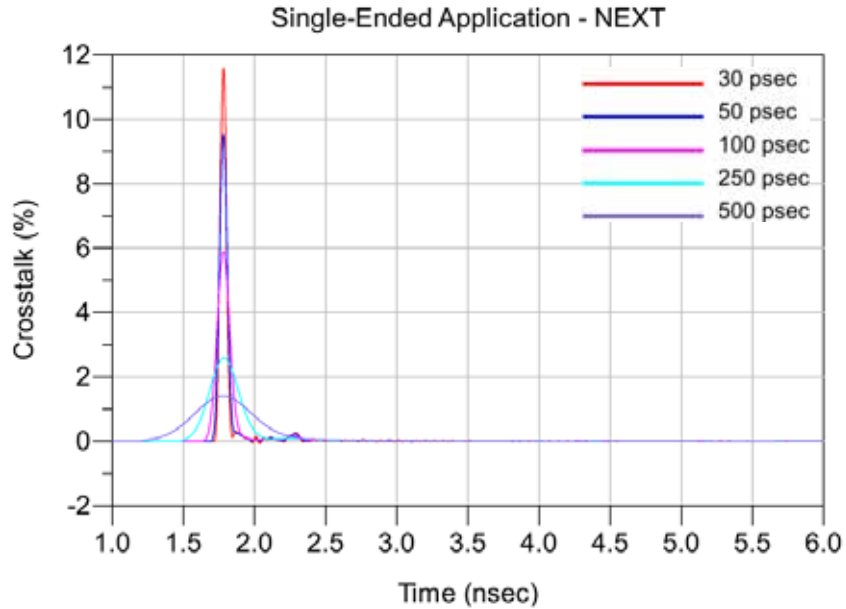
Single-Ended 1:1 S/G Pattern Application – FEXT, LPAM_E17_LPAF_E15



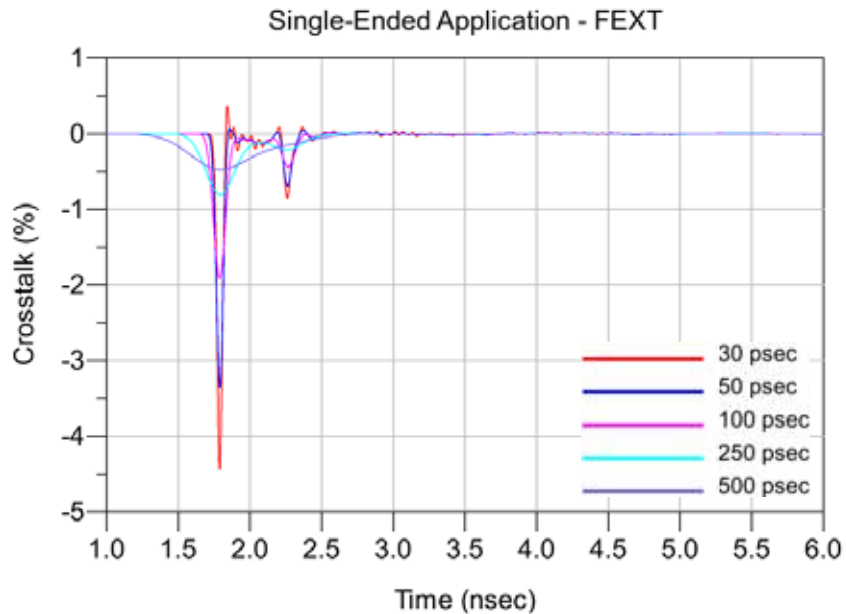
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 2:1 S/G Pattern Application – NEXT, LPAM_D16_LPAM_C16



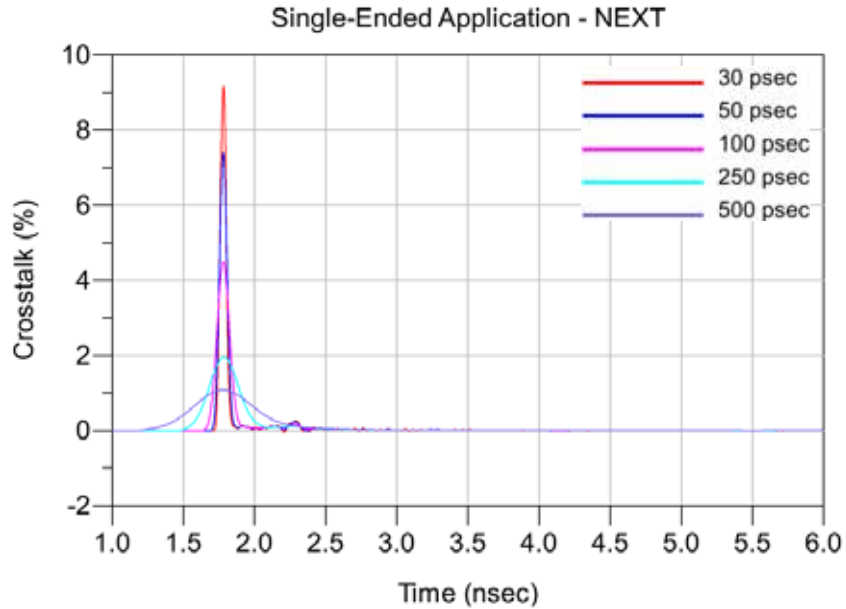
Single-Ended 2:1 S/G Pattern Application – FEXT, LPAM_D16_LPAF_C16



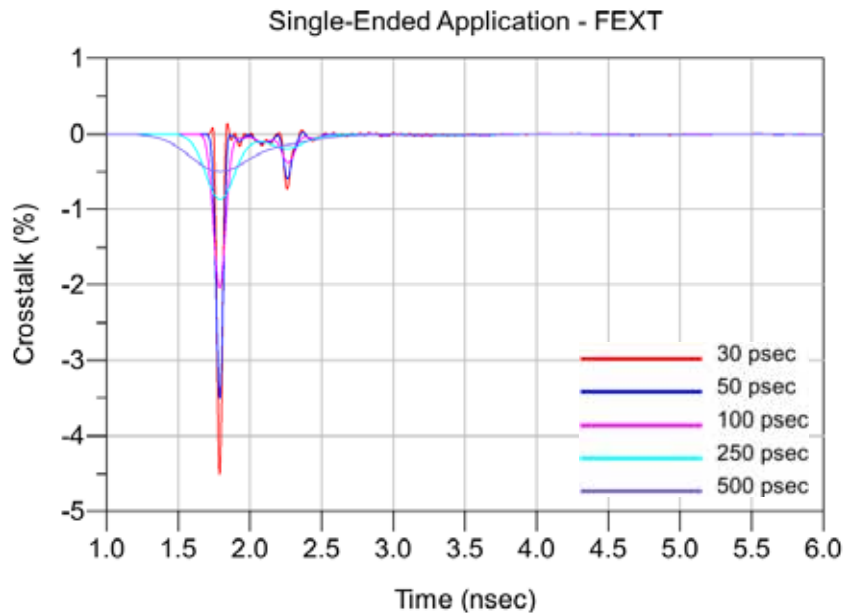
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 2:1 S/G Pattern Application – NEXT, LPAM_D16_LPAM_C17



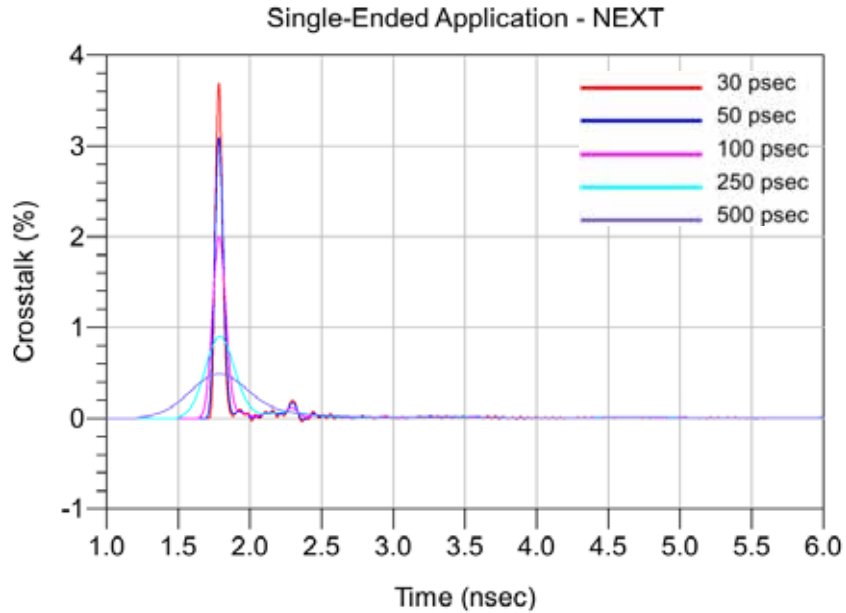
Single-Ended 2:1 S/G Pattern Application – FEXT, LPAM_D16_LPAF_C17



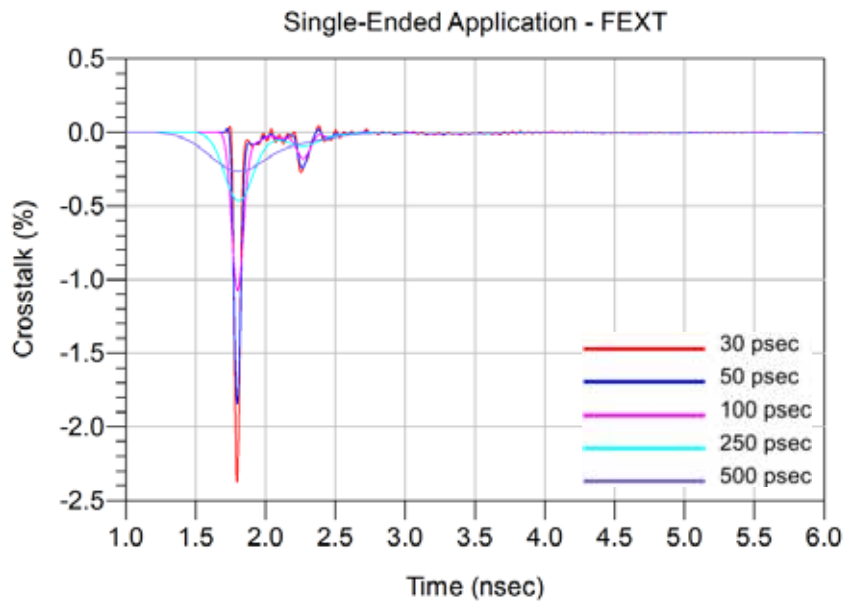
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Single-Ended 2:1 S/G Pattern Application – NEXT, LPAM_D16_LPAM_D15



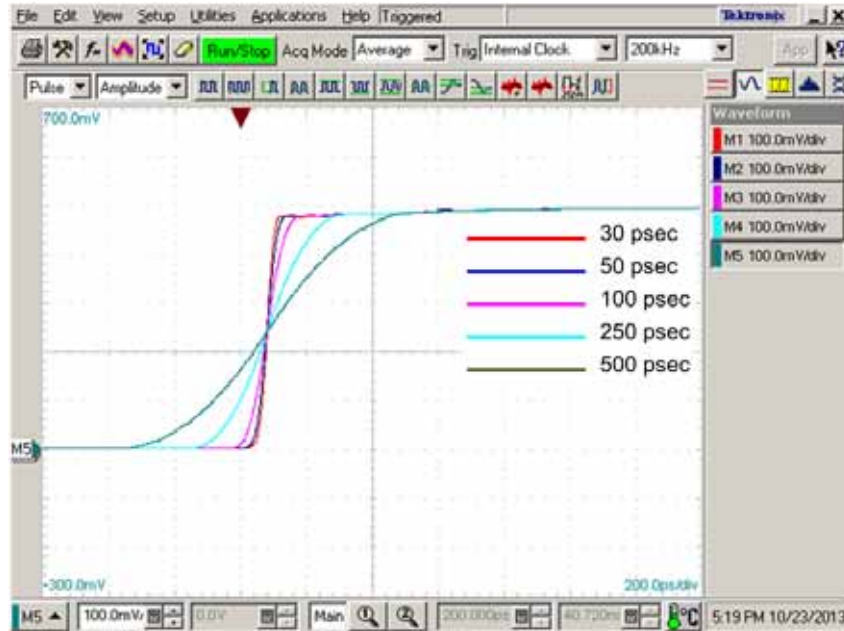
Single-Ended 2:1 S/G Pattern Application – FEXT, LPAM_D16_LPAF_D15



Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

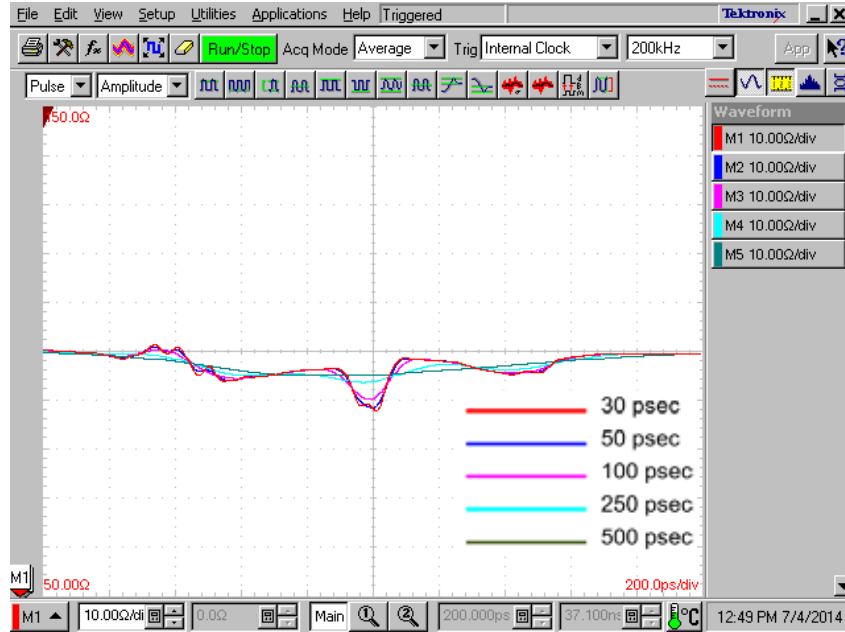
Differential Application – Input Pulse



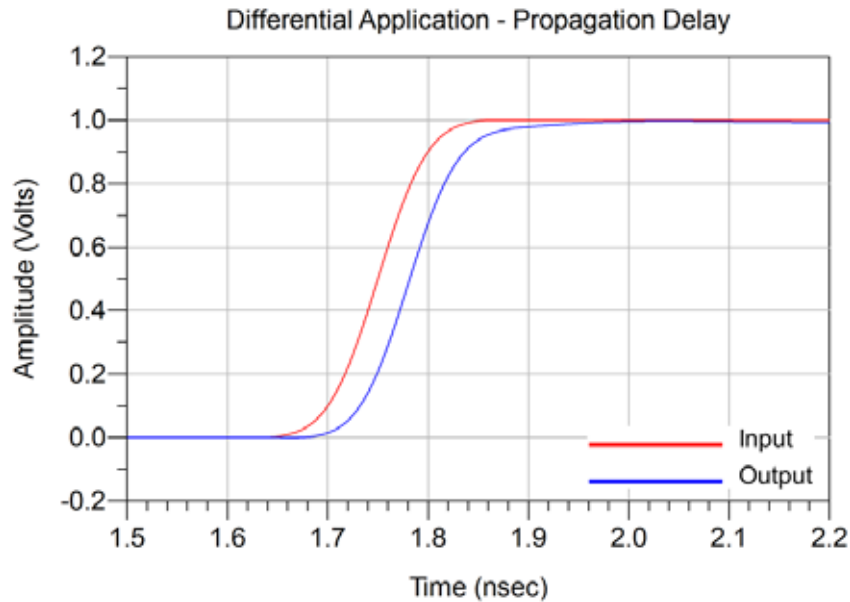
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Differential Optimal Horizontal Application – Impedance



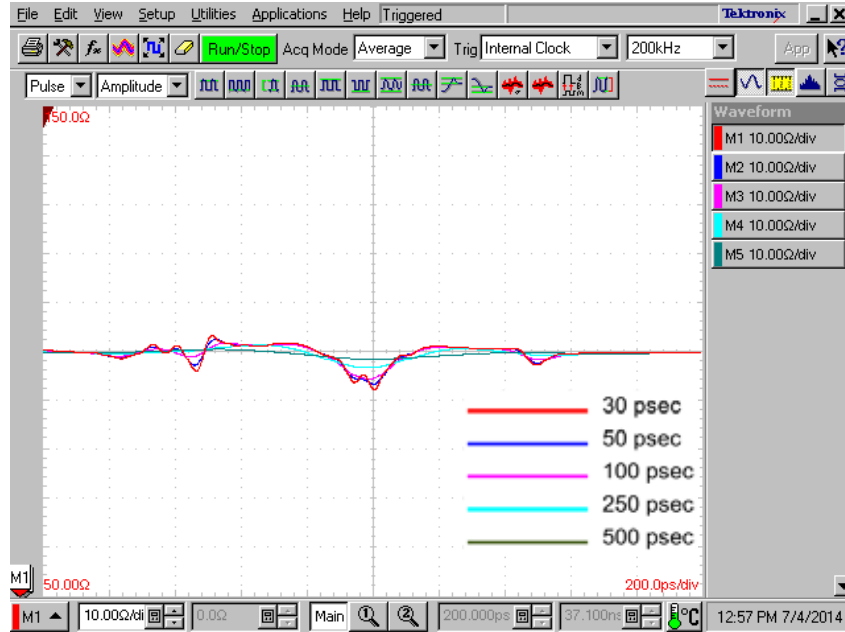
Differential Optimal Horizontal Application – Propagation Delay



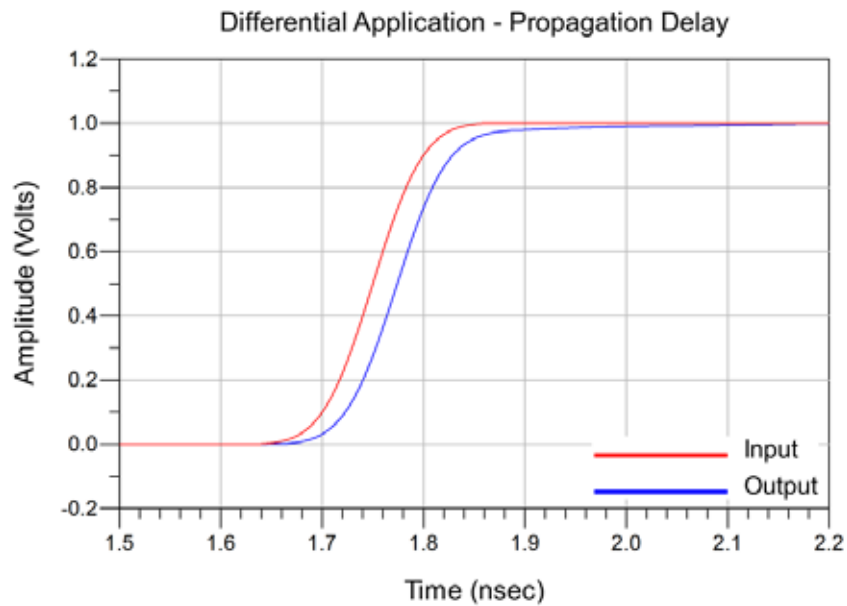
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Differential Optimal Vertical Application – Impedance



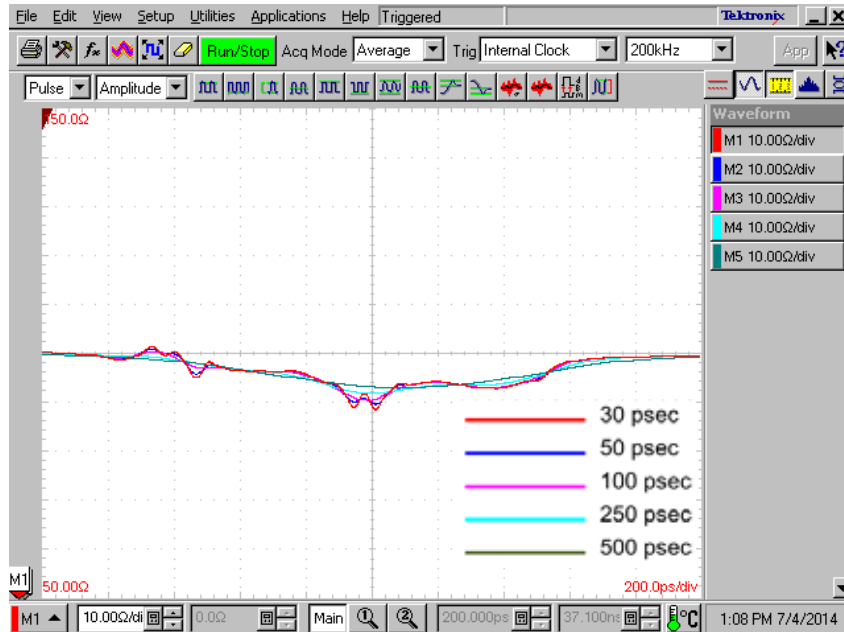
Differential Optimal Vertical Application – Propagation Delay



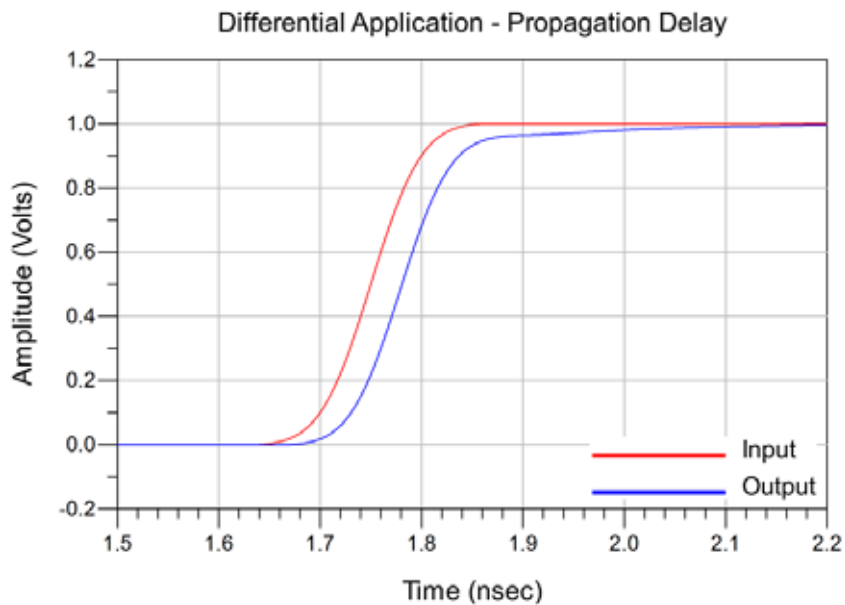
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Differential High Density Vertical Application – Impedance



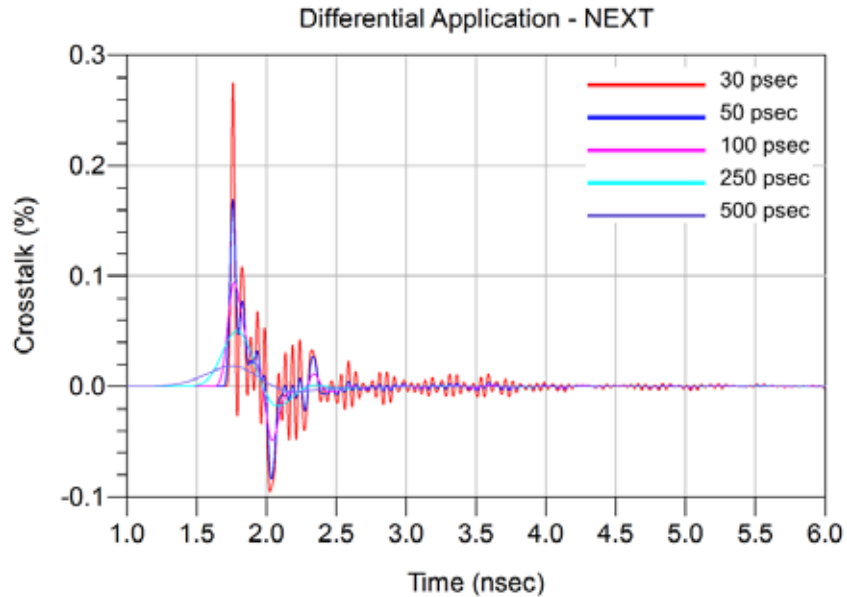
Differential High Density Vertical Application – Propagation Delay



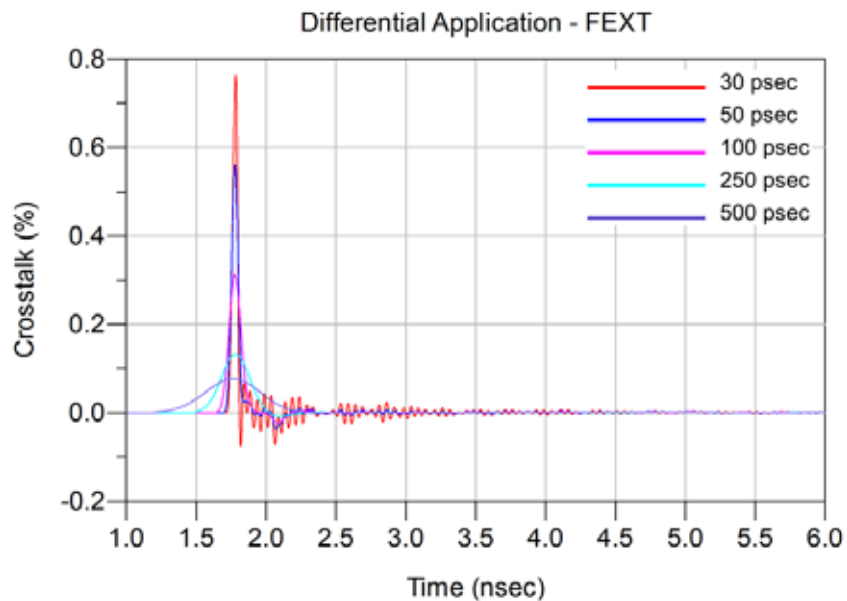
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff Optimal Horizontal Application – NEXT, LPAM_E15,E16_LPAM_C15,C16



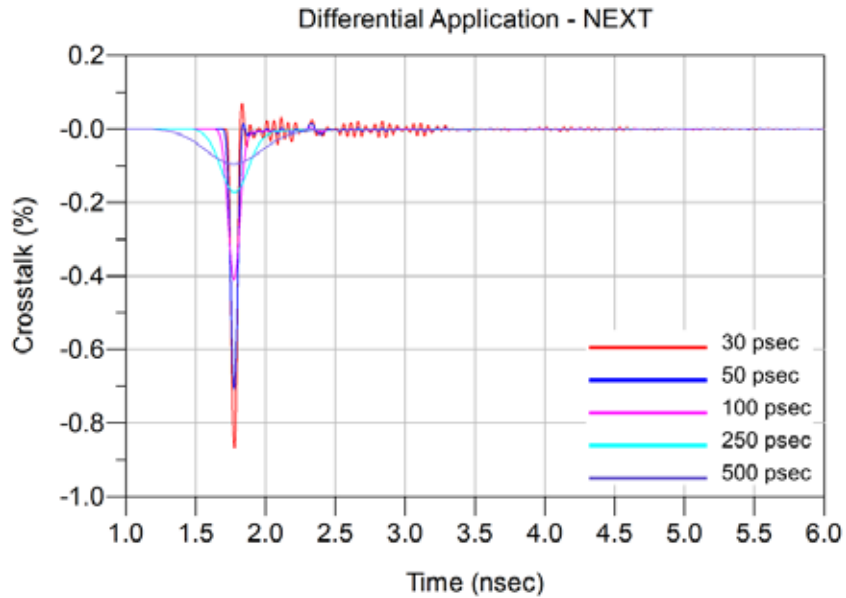
Diff Optimal Horizontal Application – FEXT, LPAM_E15,E16_LPAF_C15,C16



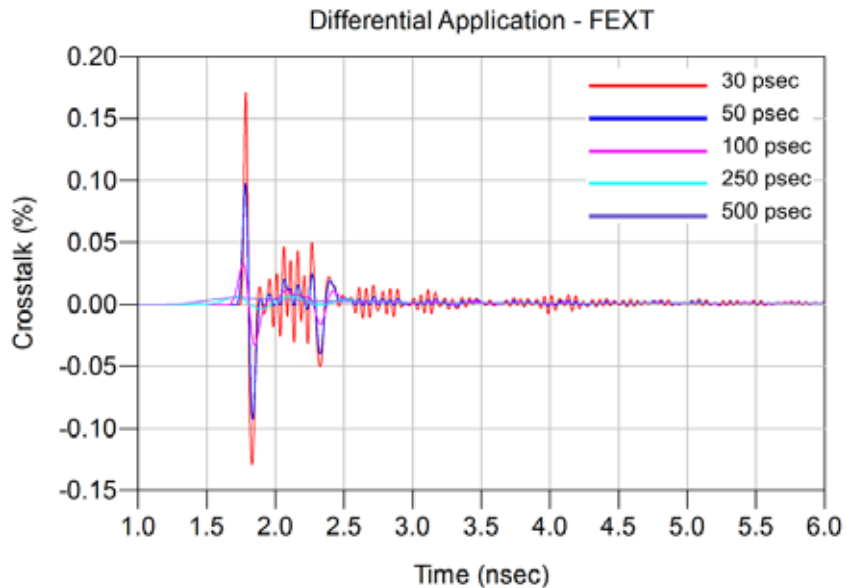
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff Optimal Horizontal Application – NEXT, LPAM_E15,E16_LPAM_D13,D14



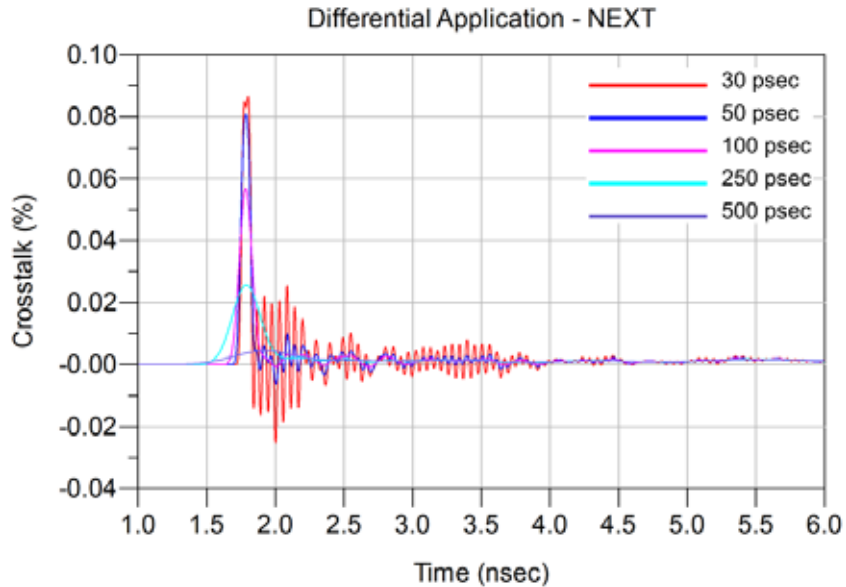
Diff Optimal Horizontal Application – FEXT, LPAM_E15,E16_LPAF_D13,D14



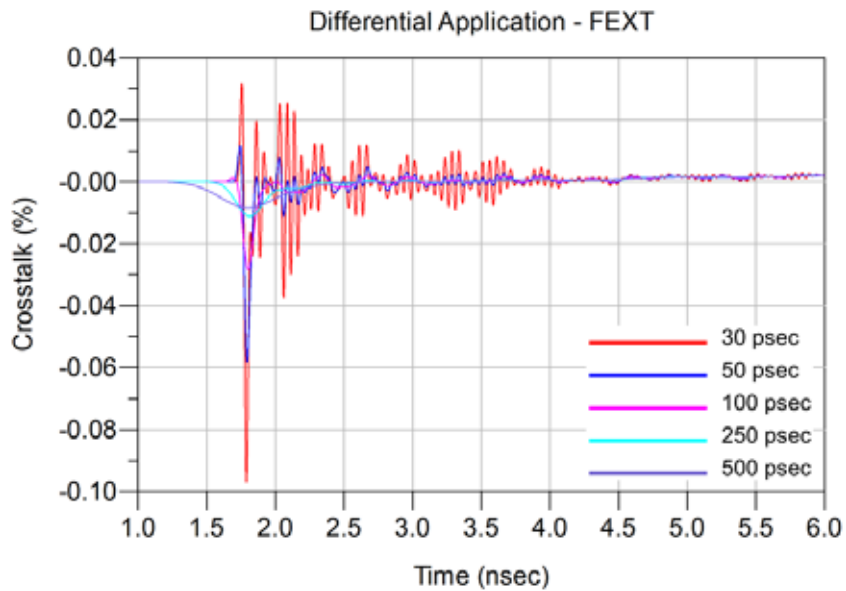
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff Optimal Horizontal Application – NEXT, LPAM_E15,E16_LPAM_E11,E12



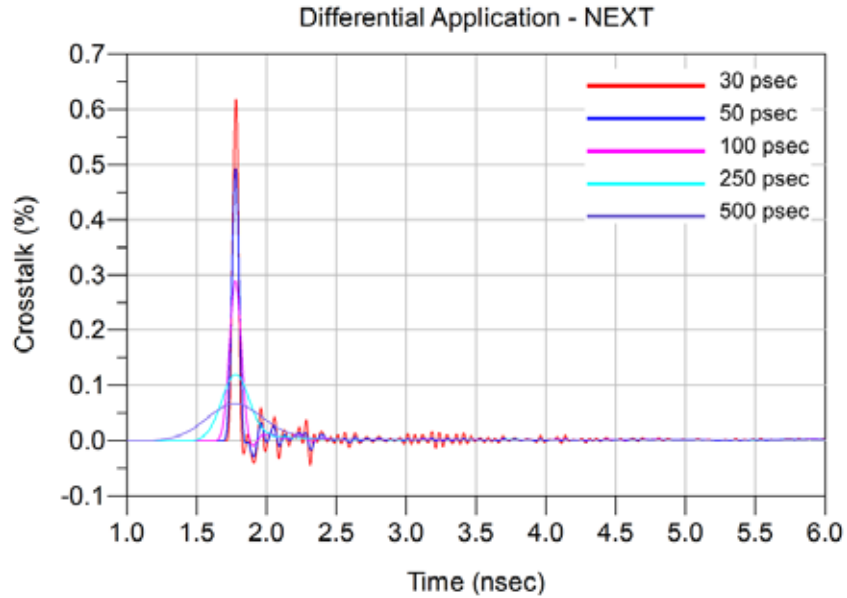
Diff Optimal Horizontal Application – FEXT, LPAM_E15,E16_LPAF_E11,E12



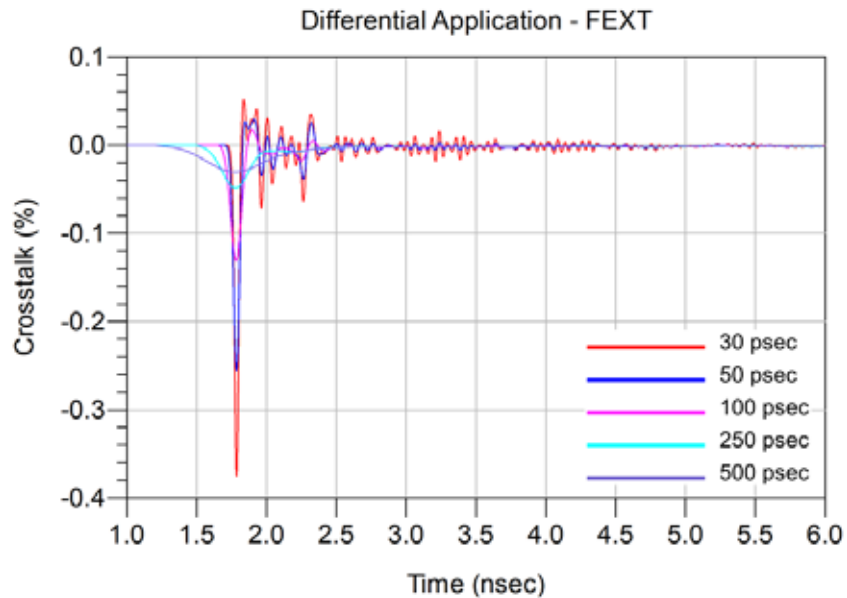
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff Optimal Vertical Application – NEXT, LPAM_E16,F16_LPAM_A16,B16



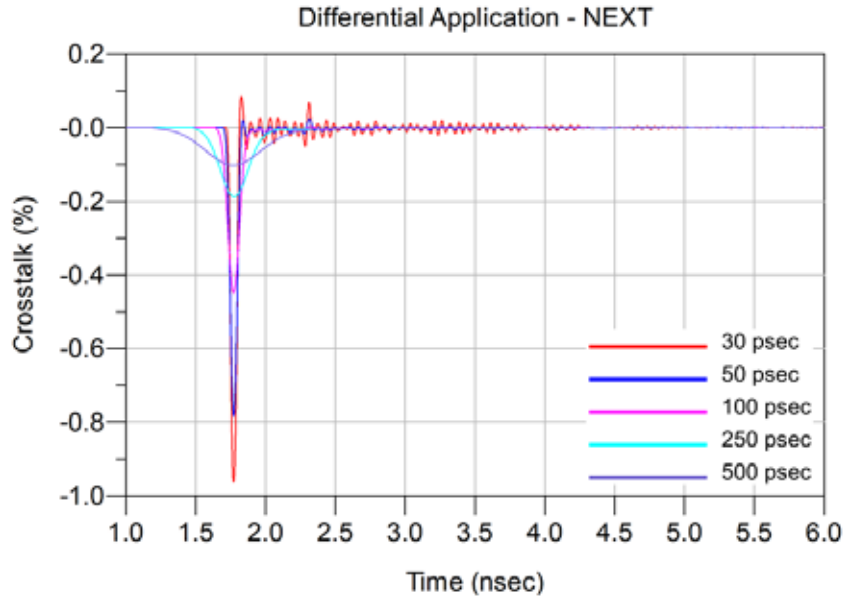
Diff Optimal Vertical Application – FEXT, LPAM_E16,F16_LPAF_A16,B16



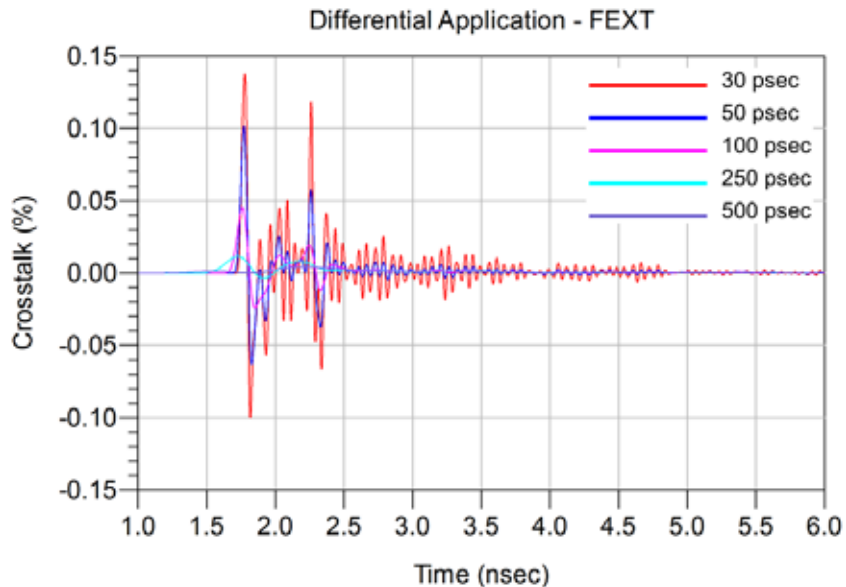
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff Optimal Vertical Application – NEXT, LPAM_E16,F16_LPAM_C15,D15



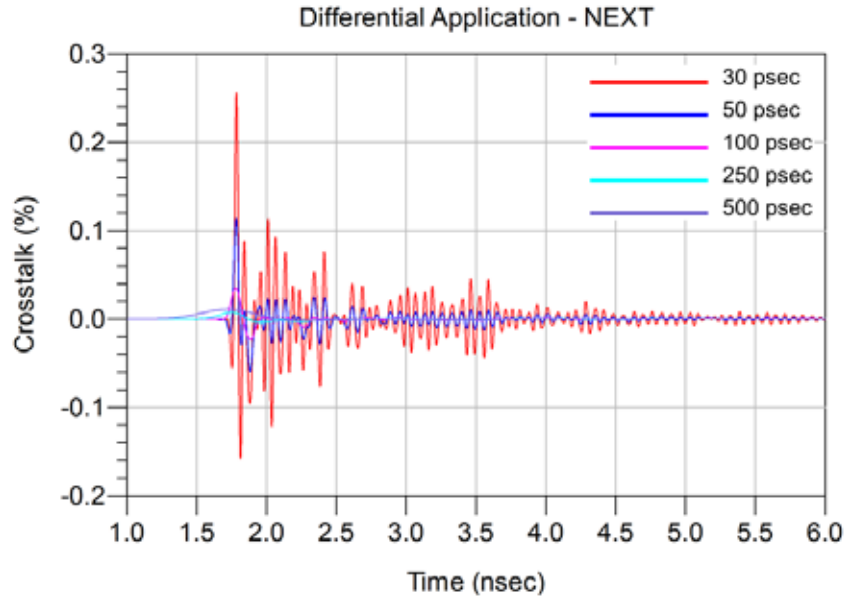
Diff Optimal Vertical Application – FEXT, LPAM_E16,F16_LPAF_C15,D15



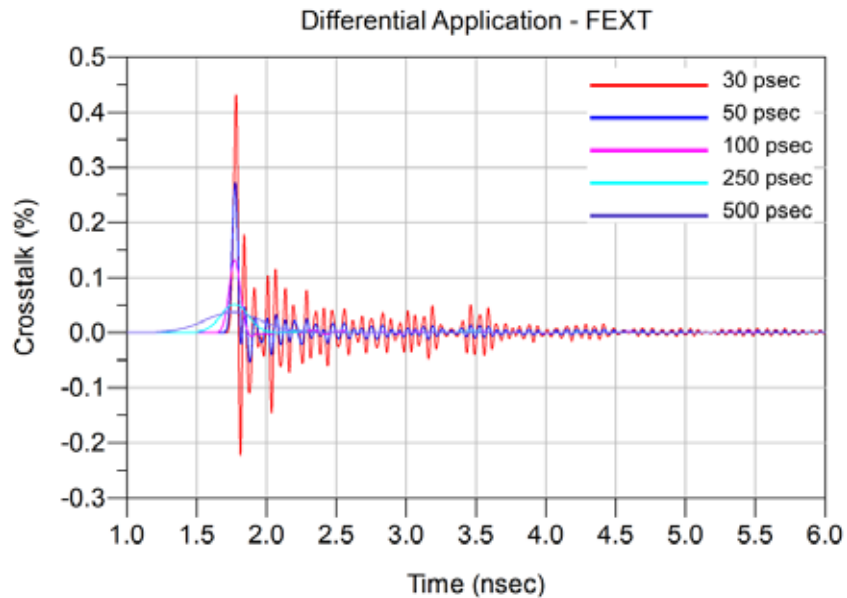
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff Optimal Vertical Application – NEXT, LPAM_E16,F16_LPAM_E14,F14



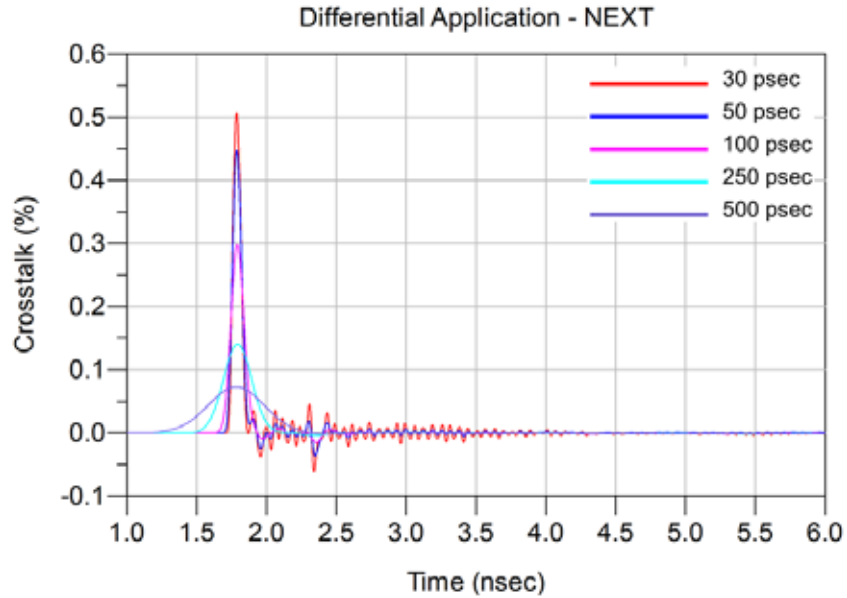
Diff Optimal Vertical Application – FEXT, LPAM_E16,F16_LPAF_E14,F14



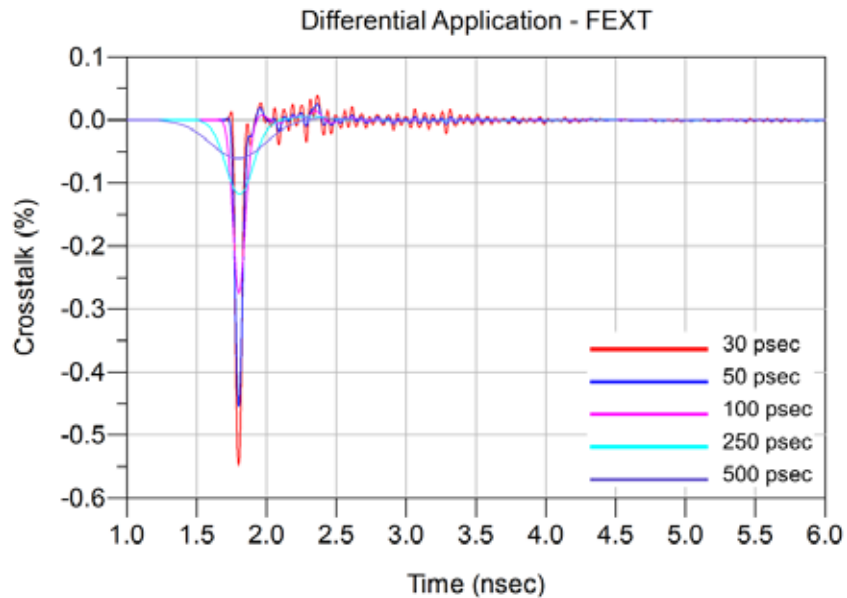
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff High Density Vertical Application – NEXT, LPAM_D16,E16_LPAM_A16,B16



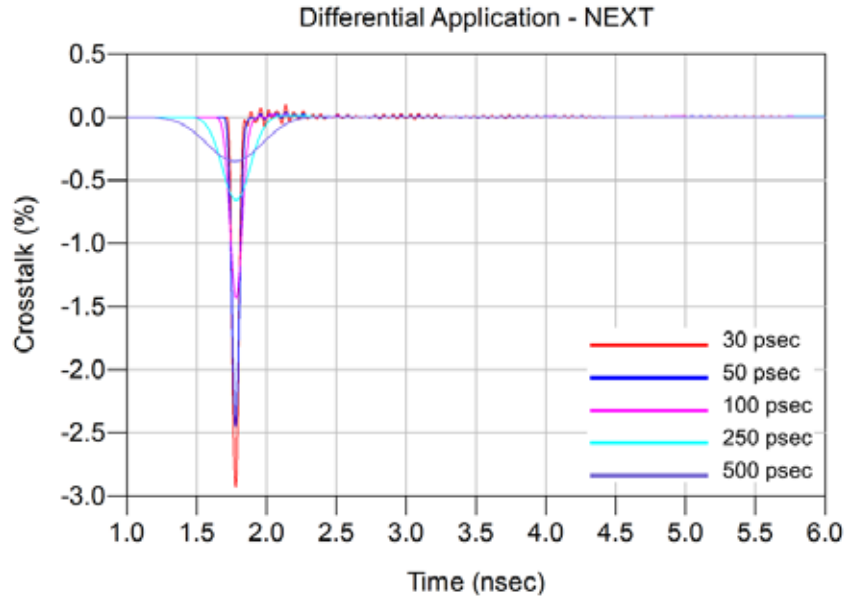
Diff High Density Vertical Application – FEXT, LPAM_D16,E16_LPAF_A16,B16



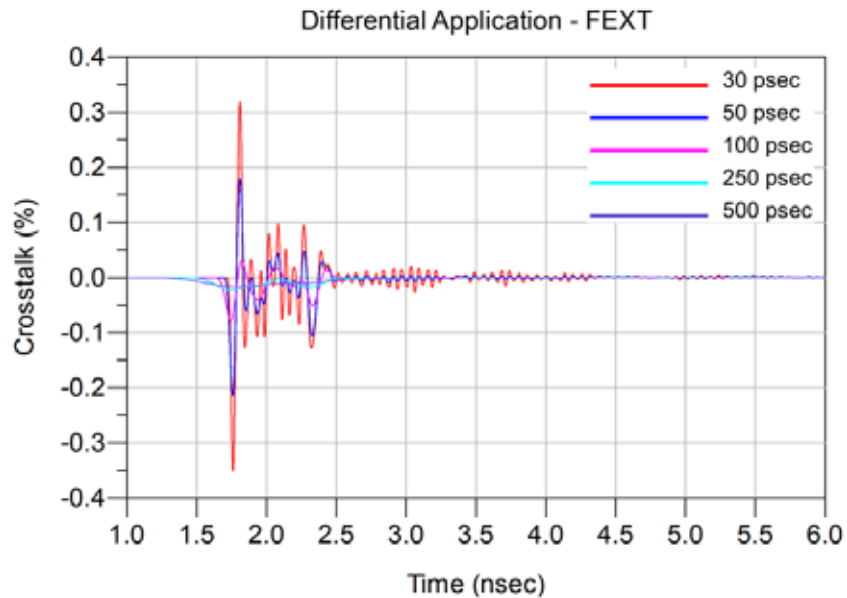
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff High Density Vertical Application – NEXT, LPAM_D16,E16_LPAM_C15,D15



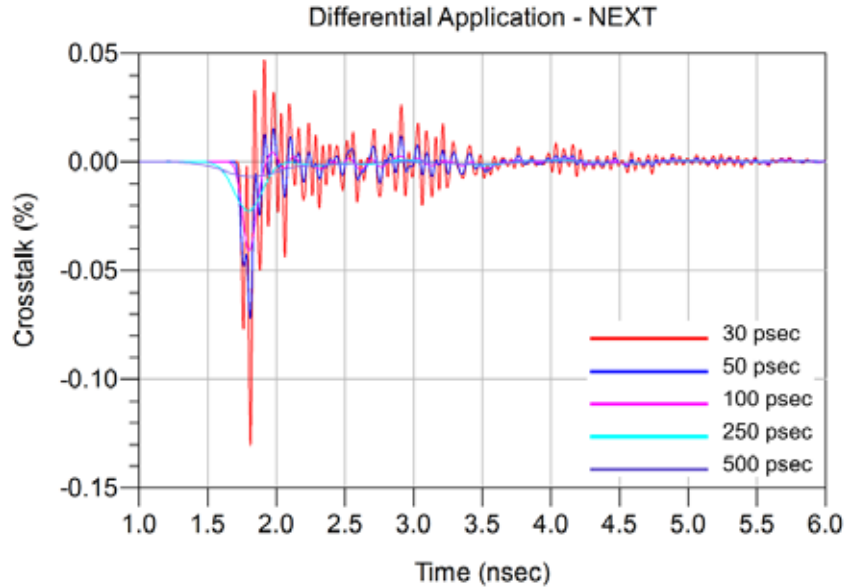
Diff High Density Vertical Application – FEXT, LPAM_D16,E16_LPAF_C15,D15



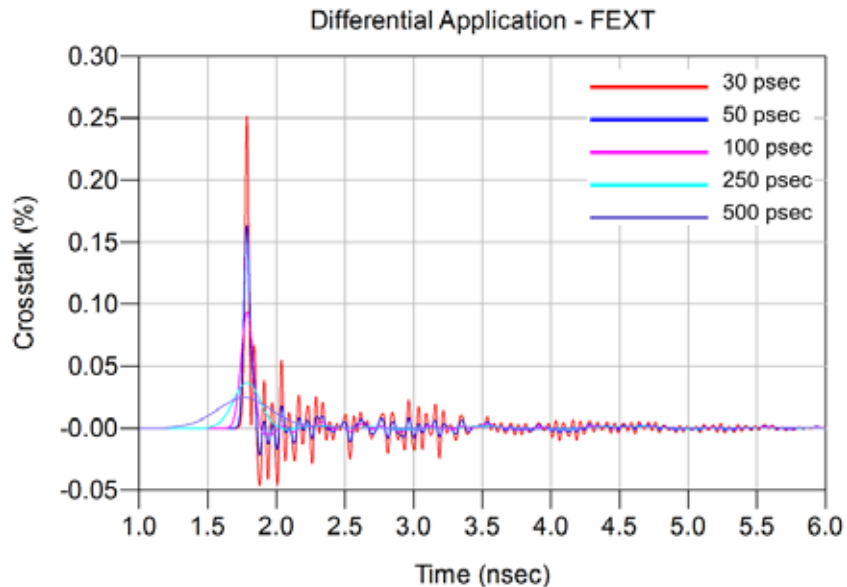
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Diff High Density Vertical Application – NEXT, LPAM_D16,E16_LPAM_D14,E14



Diff High Density Vertical Application – FEXT, LPAM_D16,E16_LPAF_D14,E14



Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Appendix C – Product and Test System Descriptions

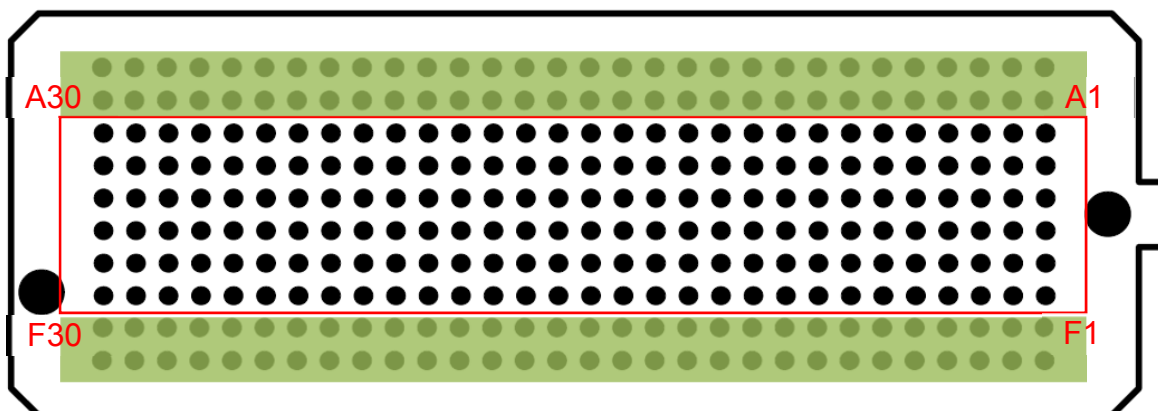
Product Description

Product test samples are 5mm (0.197") stack height LPAM/LPAF Series connectors. The part numbers are LPAM-30-01.5-L-06-2-A-K-TR and LPAF-30-03.5-L-06-2-A-K-TR. The LPAM/LPAF Series is a low profile, open pin field connector designed for single-ended signals with various options for differential signaling configurations. The open pin field array is 6 row providing 30 signal pins per row. A photo of the test articles mounted to SI test boards is shown below.

Test System Description

The test fixtures are composed of four-layer FR-4 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. Ten test fixtures are specific to the LPAM/LPAF Series connector set and identified by part numbers PCB-103314-TST-01-A and B to PCB-103314-TST-05 A and B. Calibration standards specific to the LPAM/LPAF Series are located on the calibration boards PCB-103314-TST-06 and PCB-103314-TST-07. To keep trace lengths short, five different test board sets were required to access the necessary signal pins.

Since LPAM/LPAF series connectors have the same pitch as SEAM/SEAF series connectors, we utilized the SEAM/SEAF test boards (PCB103314) for LPAM/LPAF connector measurement. Referring to the following picture, the LPAM/LPAF connectors were soldered onto the middle of the soldering paste in the red square area.

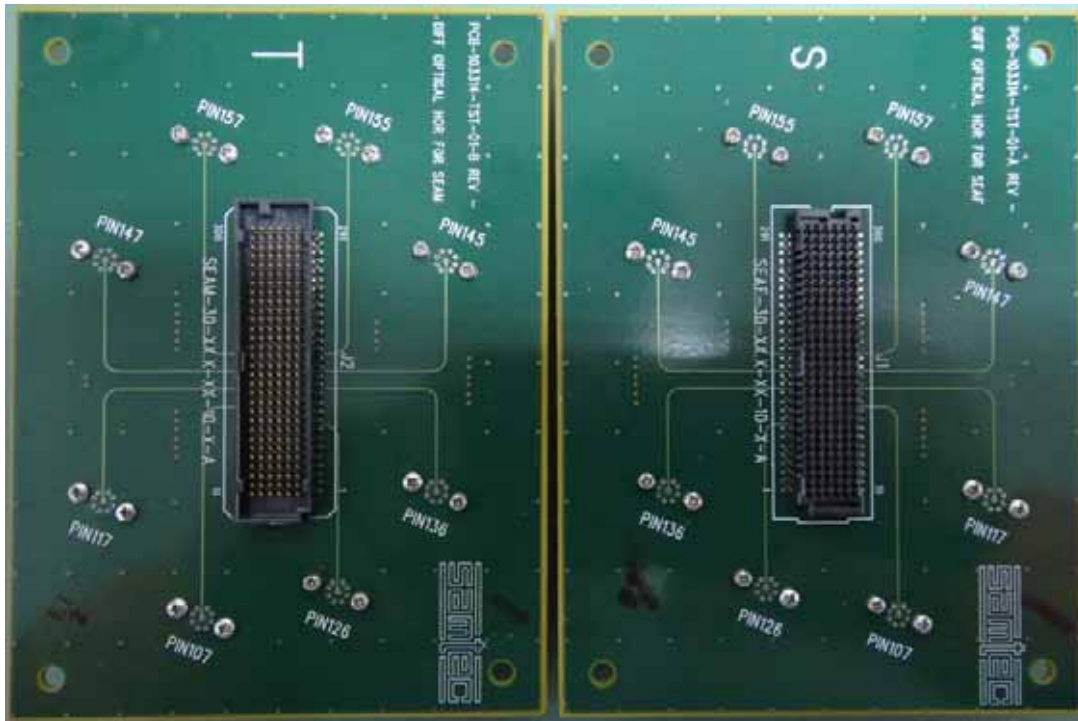


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

PCB-103314-TST-XX Test Fixtures

Shown below is a photograph of one of the five test board sets. The LPAM/LPAF connectors were soldered in the middle of the solder paste area.

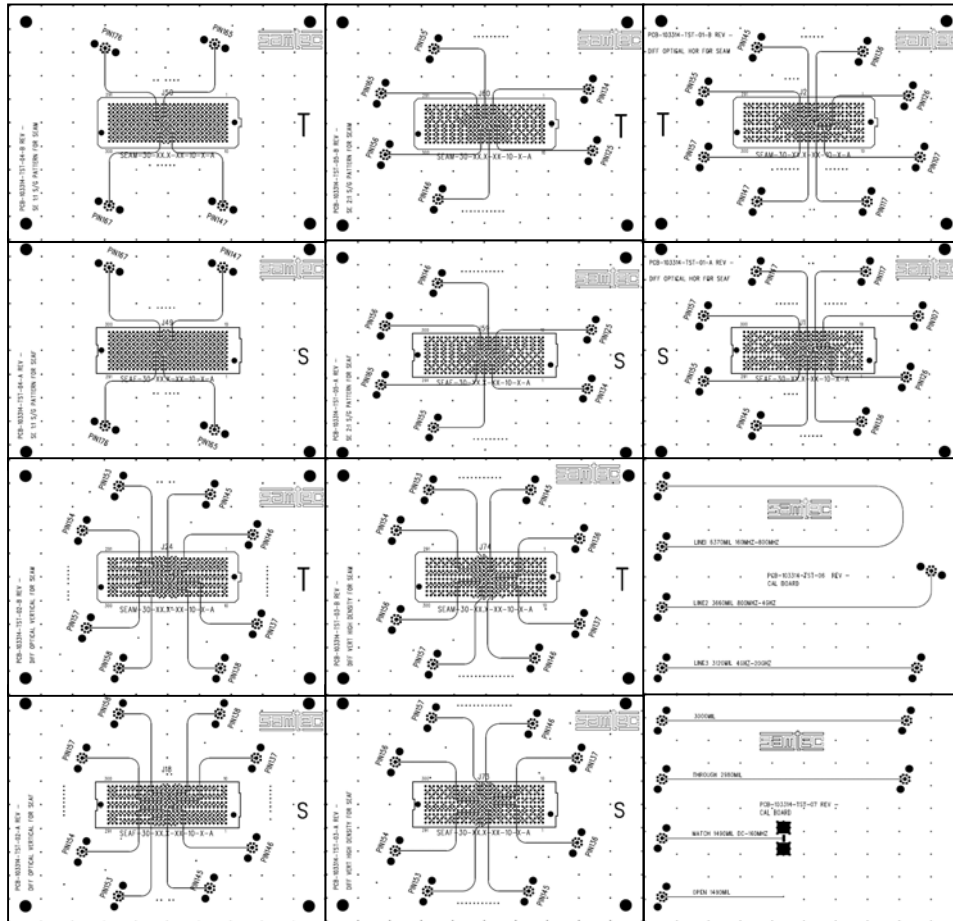


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

PCB-103314-TST-XX PCB Layout Panel

Artwork of the PCB design is shown below.



Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

PCB Fixtures

The test fixtures used are as follows:

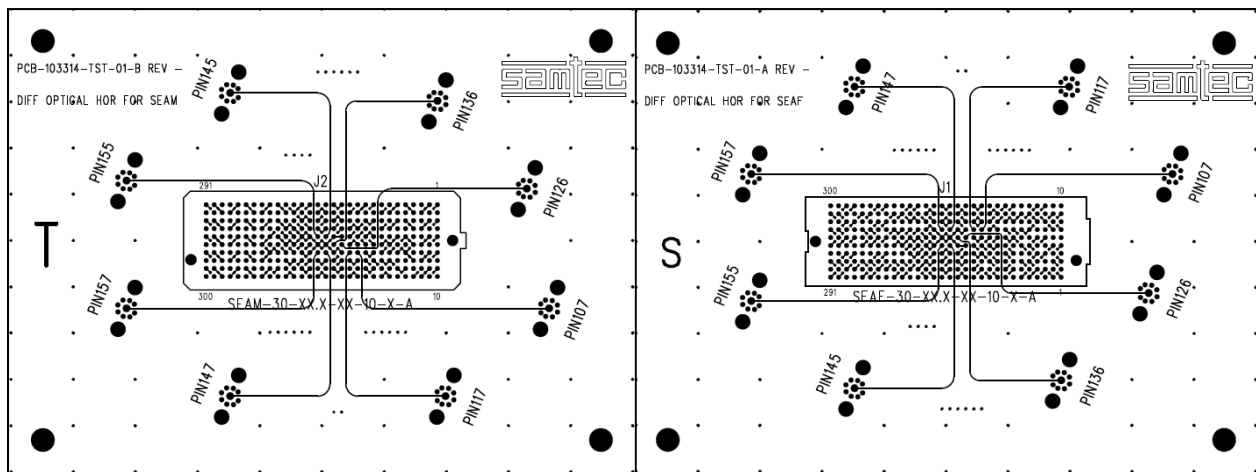
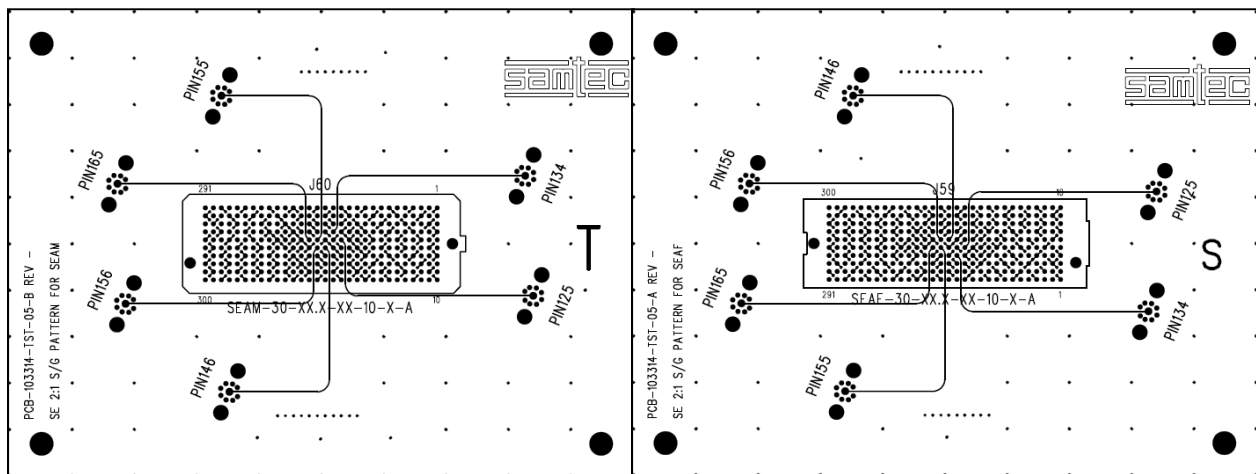
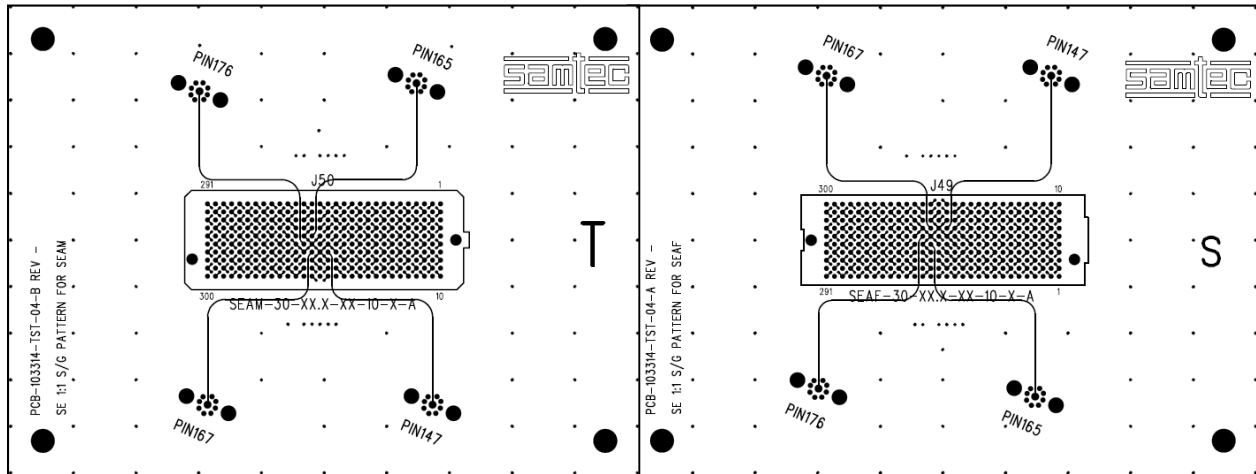
- PCB-103314 -TST-04-B Rev – LPAM Series Test Board for SE 1:1 S/G Pattern
- PCB-103314 -TST-04-A Rev – LPAF Series Test Board for SE 1:1 S/G Pattern
- PCB-103314 -TST-05-B Rev – LPAM Series Test Board for SE 2:1 S/G Pattern
- PCB-103314 -TST-05-A Rev – LPAF Series Test Board for SE 2:1 S/G Pattern
- PCB-103314 -TST-01-B Rev – LPAM Series Test Board for Differential Optimal Horizontal
- PCB-103314 -TST-01-A Rev – LPAF Series Test Board for Differential Optimal Horizontal
- PCB-103314 -TST-02-B Rev – LPAM Series Test Board for Differential Optimal Vertical
- PCB-103314 -TST-02-A Rev – LPAF Series Test Board for Differential Optimal Vertical
- PCB-103314 -TST-03-B Rev – LPAM Series Test Board for Differential High Density Vertical
- PCB-103314 -TST-03-A Rev – LPAF Series Test Board for Differential High Density Vertical

The pin numbers in the PCB layout are for SEAM/SEAF series connectors. The corresponding pin numbers for LPAM/LPAF connectors are listed as below.

| | SEAM/SEAF | LPAM/LPAF |
|-----------------------|------------|-------------|
| Single-Ended 1:1 | PIN167 | PIN_E17 |
| | PIN165 | PIN_C17 |
| | PIN176 | PIN_D18 |
| | PIN147 | PIN_E15 |
| Single-Ended 2:1 | PIN156 | PIN_D16 |
| | PIN155 | PIN_C16 |
| | PIN165 | PIN_C17 |
| | PIN146 | PIN_D15 |
| Optimal Horizontal | PIN147,157 | PIN_E15,E16 |
| | PIN145,155 | PIN_C15,C16 |
| | PIN126,136 | PIN_D13,D14 |
| | PIN107,117 | PIN_E11,E12 |
| Optimal Vertical | PIN157,158 | PIN_E16,F16 |
| | PIN153,154 | PIN_A16,B16 |
| | PIN145,146 | PIN_C15,D15 |
| | PIN137,138 | PIN_E14,F14 |
| Vertical High Density | PIN156,157 | PIN_D16,E16 |
| | PIN153,154 | PIN_A16,B16 |
| | PIN145,146 | PIN_C15,D15 |
| | PIN136,137 | PIN_D14,E14 |

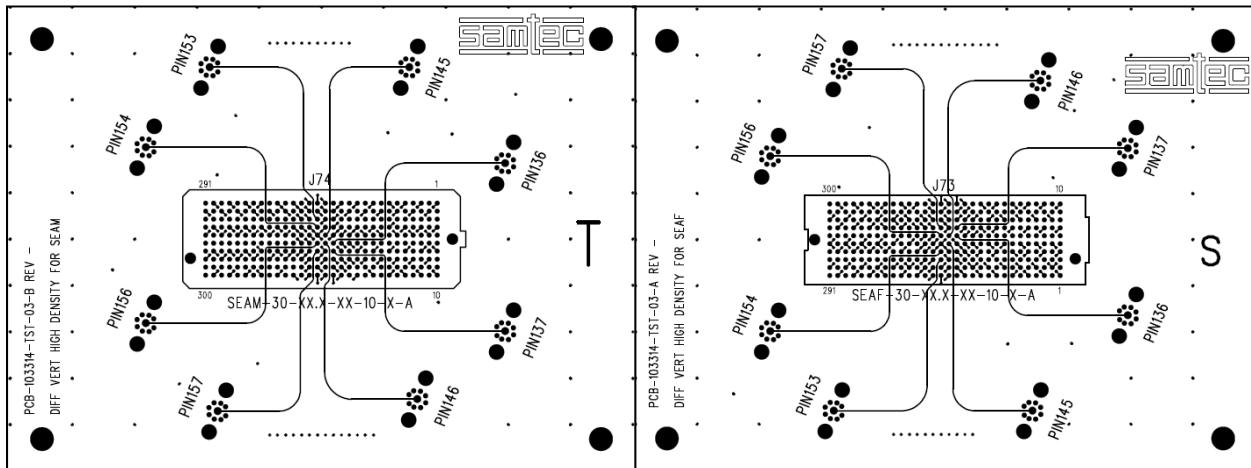
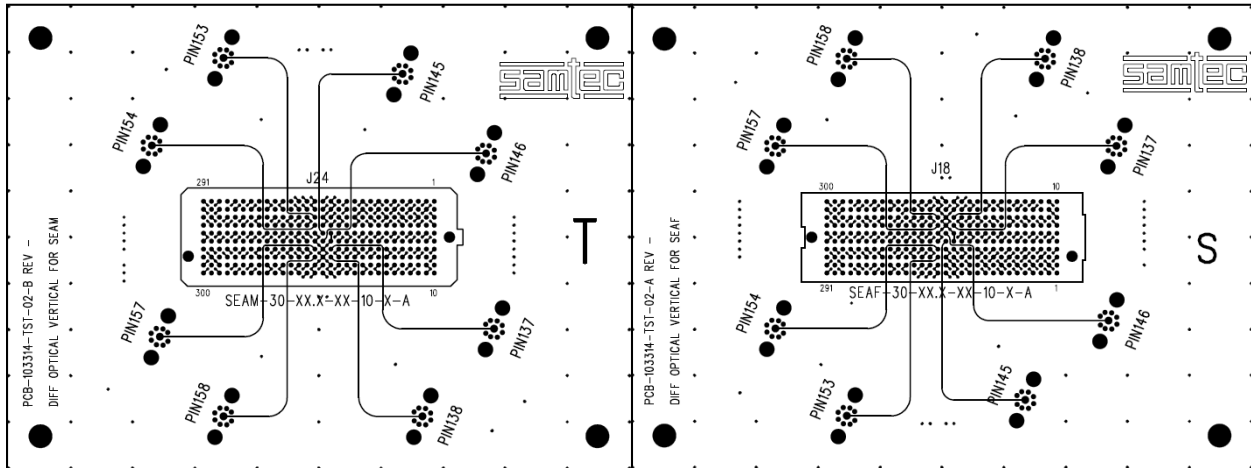
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height



Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

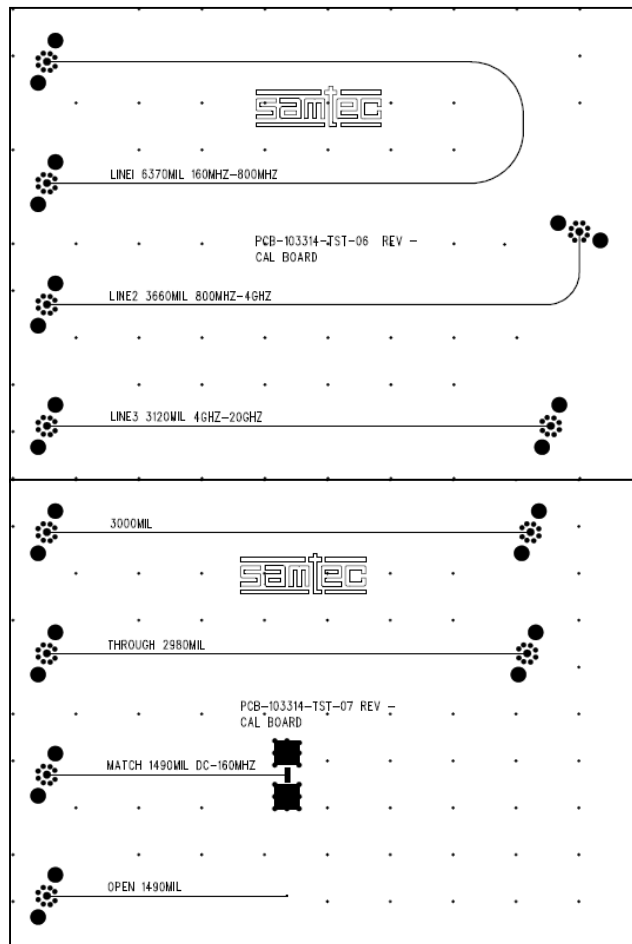


Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Calibration Board

Test fixture losses and test point reflections were removed from the data by use of TRL calibration. The calibration board is shown below. Prior to making any measurements, the calibration board is characterized to obtain parameters required to define the calibration kit. Once a cal 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.



- Thru line – 2980 mils
- Open Reflect – 1490 mils
- Line 1 – 6370 mils
- Line 2 – 3660 mils
- Line 3 – 3120 mils
- Match – 1490 mils

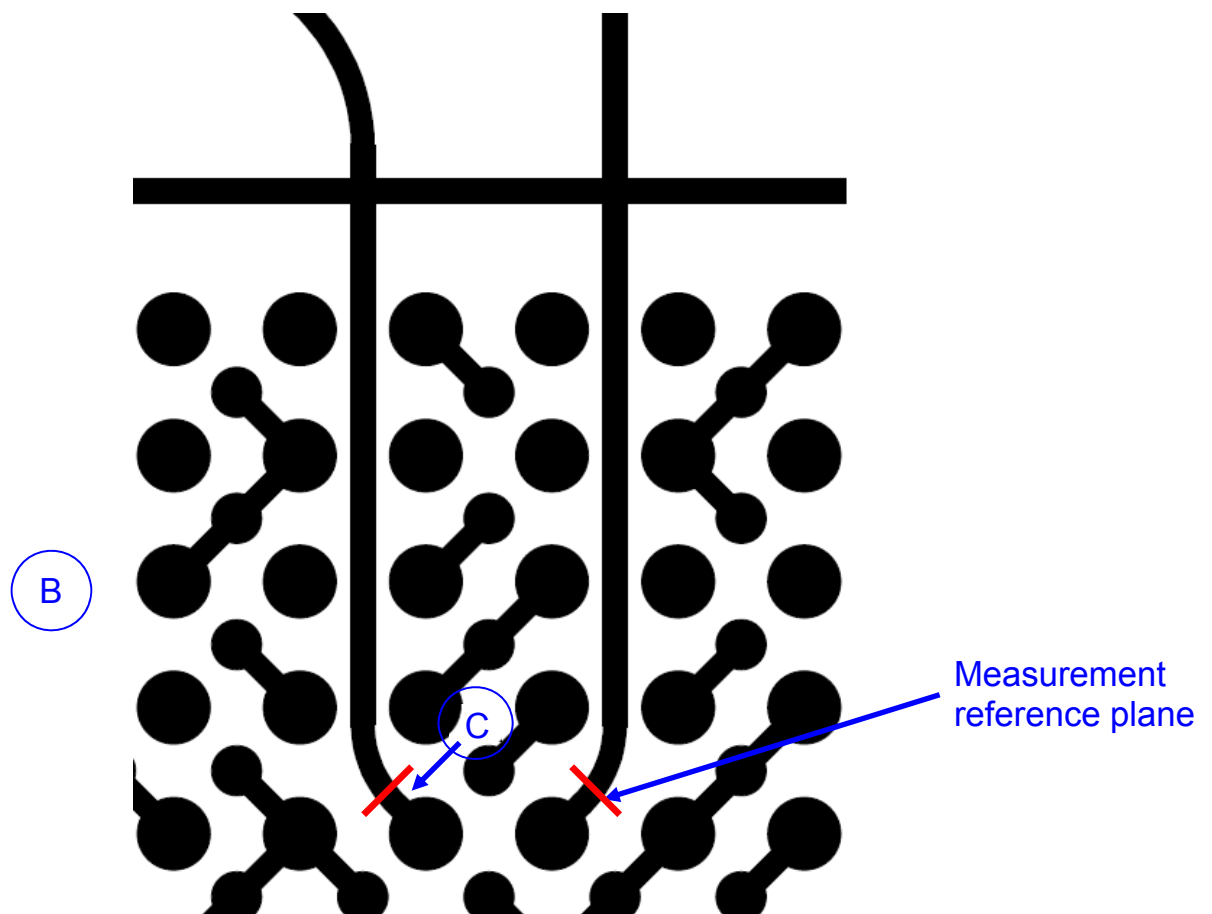
Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

All traces on the test boards are length matched to 1.5" measured from the edge of the pad to the SMA. The TRL calibration effectively removes 1.490" of test board trace effects. This means that 10 mils of test board trace length effects are included in the measurement. The S-Parameter measurement includes:

- A- The LPAM/LPAF Series connector set
- B- Test board vias and pads (footprint effects)
- C- 10 mils of 9.5 mil wide microstrip trace

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



Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

Appendix D – Test and Measurement Setup

For frequency domain measurements, 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

Stop Frequency – 20 GHz

Number of points -1601

IFBW – 1 KHz

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

N5230C Measurement Setup



Test Instruments

| <u>QTY</u> | <u>Description</u> |
|------------|---|
| 1 | Agilent N5230C PNA-L Network Analyzer (300 KHz to 20 GHz) |
| 1 | Agilent N4433A ecal module (300 KHz to 20 GHz) |

Test Cables & Adapters

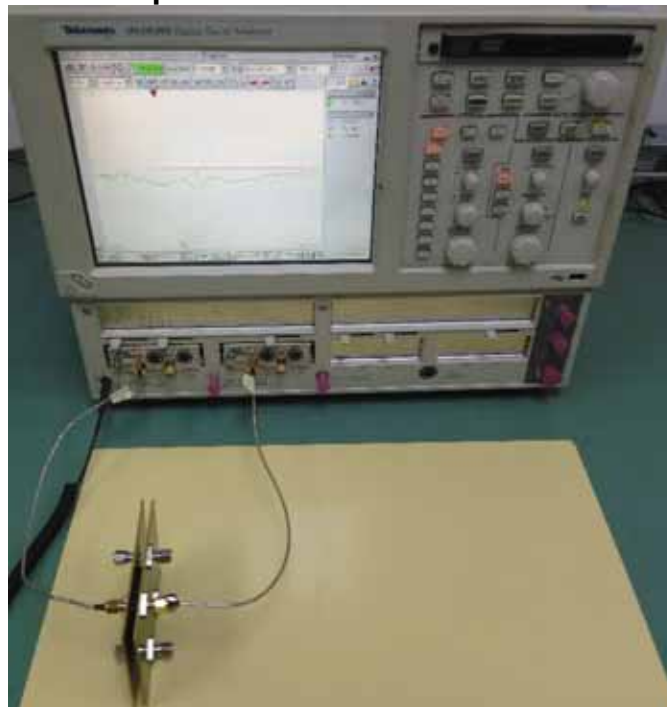
| <u>QTY</u> | <u>Description</u> |
|------------|--------------------------------|
| 4 | Gore OWD01D02039-4 (DC-50 GHz) |

Series: LPAM/LPAF**Description:** Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

For impedance measurements, the test instrument is the Tektronix DSA8200 Digital Serial Analyzer mainframe and 80E04 sampling module. The impedance data and profiles are obtained directly from the instrument. The Digital Analyzer is configured as follows:

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

DSA8200 Measurement Setup



Test Instruments

| <u>QTY</u> | <u>Description</u> |
|------------|---|
| 1 | Tektronix DSA8200 Digital Serial Analyzer |
| 2 | Tektronix 80E04 Dual Channel 20 GHz TDR Sampling Module |

Test Cables & Adapters

| <u>QTY</u> | <u>Description</u> |
|------------|---|
| 2 | Samtec RF405-01SP1-01SP1-0305 (DC-20 GHz) |

Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

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 ecal 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 LPAM/LPAF 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 2009 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://www.samtec.com/Technical_Library/reference/articles/pdfs/tech-note_using-PLTS-for-time-domain-data_web.pdf](http://www.samtec.com/Technical_Library/reference/articles/pdfs/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 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.

Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

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.

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 is limited. The "best case" signal mapping was tested and is presented in this report.

Series: LPAM/LPAF

Description: Low Profile, Open Pin Field Array, 1.27mm x 1.27mm Pitch, 5mm Stack Height

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)