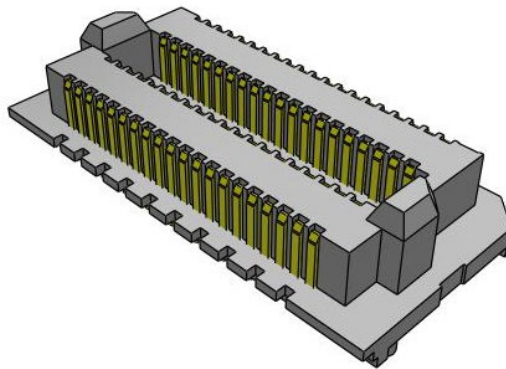


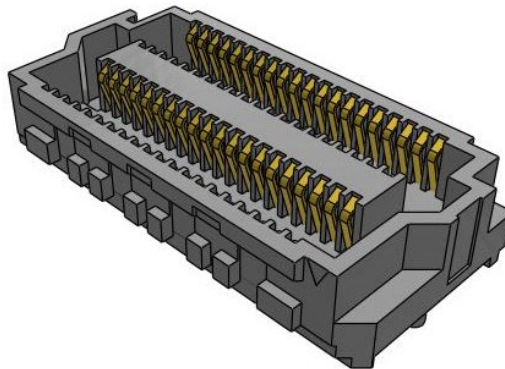


High Speed Characterization Report

APM6-XXX-01.5-XXX-04-0-A



APF6-XXX-03.5-XXX-04-0-A



Description:

**0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height**

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

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Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Connector Overview

The APx6 series is 0.635 mm AcceleRate® HP High-Performance Array Interconnect., featuring extreme performance to 112 Gbps PAM4 and an open-pin-field design for grounding and routing flexibility. This cost-optimized solution features up to 800 total pins (roadmap to 1,000+) in a low 5 mm stack height (and up to 10mm), with data rate compatibility to PCIe® 6.0/CXL® 3.2 and 100 GbE. The data presented in this report is for the 5mm mated stack height with Solder Column termination.

Frequency Domain Data Summary

Bandwidth Chart – Differential Insertion Loss

APx6 Connector Series

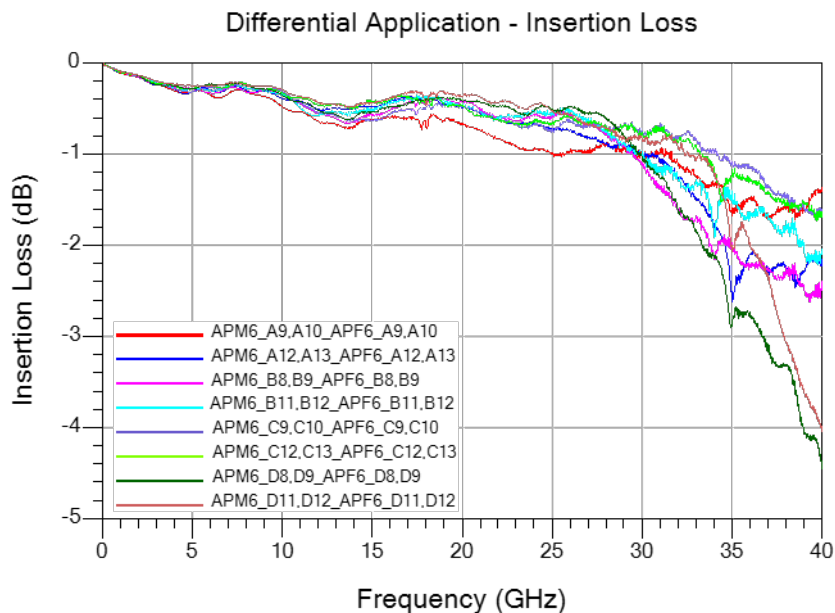


Figure 1

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Time Domain Data Summary

Table 1 - Differential Impedance (Ω)				
Driver	Signal Rise-time	30ps	50ps	100ps
APM6_A9,A10	Maximum Impedance	105.0	104.6	104.0
	Minimum Impedance	88.6	89.7	90.0
APM6_A12,A13	Maximum Impedance	105.0	105.0	104.8
	Minimum Impedance	90.6	90.8	90.9
APM6_B8,B9	Maximum Impedance	105.0	104.7	101.3
	Minimum Impedance	90.2	90.6	91.0
APM6_B11,B12	Maximum Impedance	104.9	104.6	104.0
	Minimum Impedance	89.8	90.1	90.7
APM6_C9,C10	Maximum Impedance	105.1	104.7	104.2
	Minimum Impedance	89.8	90.1	90.7
APM6_C12,C13	Maximum Impedance	105.4	105.1	105.0
	Minimum Impedance	90.2	90.4	90.9
APM6_D8,D9	Maximum Impedance	105.7	105.2	104.7
	Minimum Impedance	88.4	90.2	91.3
APM6_D11,D12	Maximum Impedance	105.4	105.0	104.1
	Minimum Impedance	90.0	90.4	91.0

Table 2 - Differential Crosstalk (%)					
Input(tr)	Driver	Receiver	30ps	50ps	100ps
NEXT	APM6_A9,A10	APM6_B11,B12	<0.1	<0.1	<0.1
	APM6_A12,A13	APM6_B11,B12	<0.1	<0.1	<0.1
	APM6_B8,B9	APM6_B11,B12	0.35	0.26	0.13
	APM6_C9,C10	APM6_B11,B12	<0.1	<0.1	<0.1
	APM6_C12,C13	APM6_B11,B12	<0.1	<0.1	<0.1
	APM6_D8,D9	APM6_B11,B12	<0.1	<0.1	<0.1
	APM6_D11,D12	APM6_B11,B12	<0.1	<0.1	<0.1
	APM6_A9,A10	APM6_D8,D9	<0.1	<0.1	<0.1
	APM6_A12,A13	APM6_D8,D9	<0.1	<0.1	<0.1
	APM6_B8,B9	APM6_D8,D9	<0.1	<0.1	<0.1
	APM6_B11,B12	APM6_D8,D9	<0.1	<0.1	<0.1
	APM6_C9,C10	APM6_D8,D9	<0.1	<0.1	<0.1
	APM6_C12,C13	APM6_D8,D9	<0.1	<0.1	<0.1
	APM6_D11,D12	APM6_D8,D9	0.33	0.24	0.14

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Differential Crosstalk (%)					
FEXT	APF6_A9,A10	APM6_B11,B12	<0.1	<0.1	<0.1
	APF6_A12,A13	APM6_B11,B12	<0.1	<0.1	<0.1
	APF6_B8,B9	APM6_B11,B12	<0.1	<0.1	<0.1
	APF6_C9,C10	APM6_B11,B12	<0.1	<0.1	<0.1
	APF6_C12,C13	APM6_B11,B12	<0.1	<0.1	<0.1
	APF6_D8,D9	APM6_B11,B12	<0.1	<0.1	<0.1
	APF6_D11,D12	APM6_B11,B12	<0.1	<0.1	<0.1
	APF6_A9,A10	APM6_D8,D9	<0.1	<0.1	<0.1
	APF6_A12,A13	APM6_D8,D9	<0.1	<0.1	<0.1
	APF6_B8,B9	APM6_D8,D9	<0.1	<0.1	<0.1
	APF6_B11,B12	APM6_D8,D9	<0.1	<0.1	<0.1
	APF6_C9,C10	APM6_D8,D9	<0.1	<0.1	<0.1
	APF6_C12,C13	APM6_D8,D9	<0.1	<0.1	<0.1
	APF6_D11,D12	APM6_D8,D9	<0.1	<0.1	<0.1

Table 3 - Propagation Delay (Mated Connector)	
APM6_A9,A10 APF6_A9,A10	56 ps
APM6_A12,A13 APF6_A12,A13	56 ps
APM6_B8,B9 APF6_B8,B9	55 ps
APM6_B11,B12 APF6_B11,B12	57 ps
APM6_C9,C10 APF6_C9,C10	55 ps
APM6_C12,C13 APF6_C12,C13	56 ps
APM6_D8,D9 APF6_D8,D9	55 ps
APM6_D11,D12 APF6_D11,D12	57 ps

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated 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 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: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

For this test report, the following configurations were evaluated:

A	B	C	D
A20	B20	C20	D20
A19	B19	C19	D19
A18	B18	C18	D18
A17	B17	C17	D17
A16	B16	C16	D16
A15	B15	C15	D15
A14	B14	C14	D14
A13	B13	C13	D13
A12	B12	C12	D12
A11	B11	C11	D11
A10	B10	C10	D10
A9	B9	C9	D9
A8	B8	C8	D8
A7	B7	C7	D7
A6	B6	C6	D6
A5	B5	C5	D5
A4	B4	C4	D4
A3	B3	C3	D3
A2	B2	C2	D2
A1	B1	C1	D1

A	B	C	D
A20	B20	C20	D20
A19	B19	C19	D19
A18	B18	C18	D18
A17	B17	C17	D17
A16	B16	C16	D16
A15	B15	C15	D15
A14	B14	C14	D14
A13	B13	C13	D13
A12	B12	C12	D12
A11	B11	C11	D11
A10	B10	C10	D10
A9	B9	C9	D9
A8	B8	C8	D8
A7	B7	C7	D7
A6	B6	C6	D6
A5	B5	C5	D5
A4	B4	C4	D4
A3	B3	C3	D3
A2	B2	C2	D2
A1	B1	C1	D1

Differential Impedance (denoted by blue circles):

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

Differential Crosstalk (denoted by red circles):

- In row: from the terminals to the other terminals on the same row.
- Across row: from one row of terminals to the other row of terminals.

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 30 ps and 100 ps.

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

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

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 1.82 mm of PCB trace on both the APM6 and APF6 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. 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 in the appendices of this report. Further information may be obtained by contacting our Signal Integrity Group at sig@samtec.com.

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Appendix A – Frequency Domain Responses

Differential Application – Insertion Loss

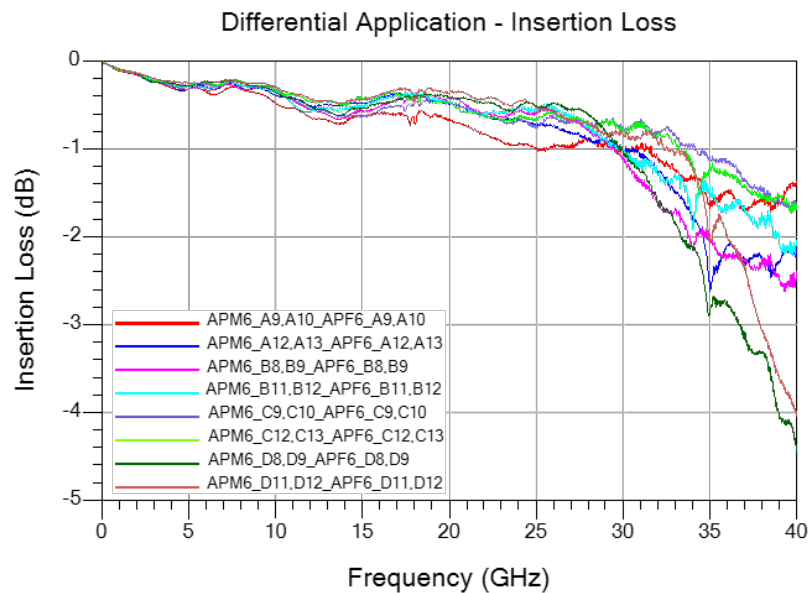


Figure 2

Differential Application – Return Loss

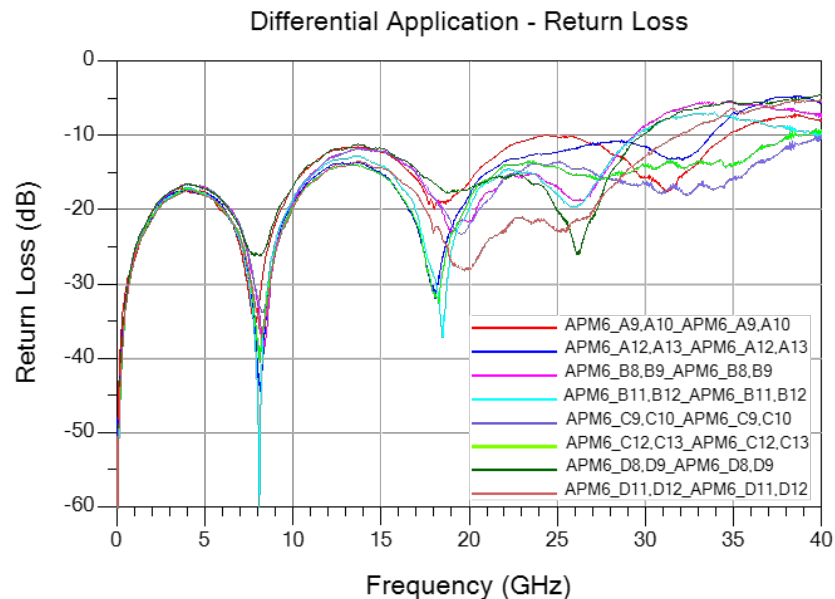


Figure 3

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Differential Application – NEXT Configurations

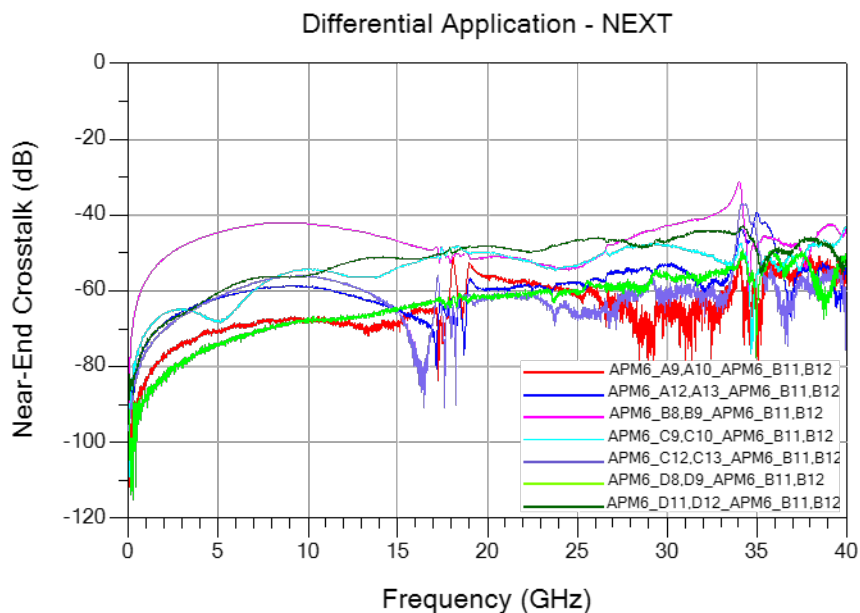


Figure 4

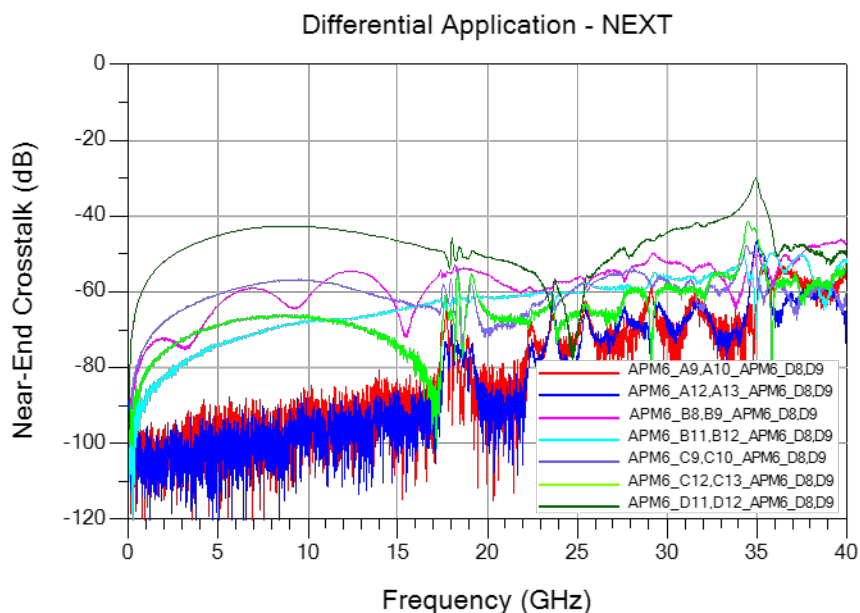


Figure 5

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Differential Application – FEXT Configurations

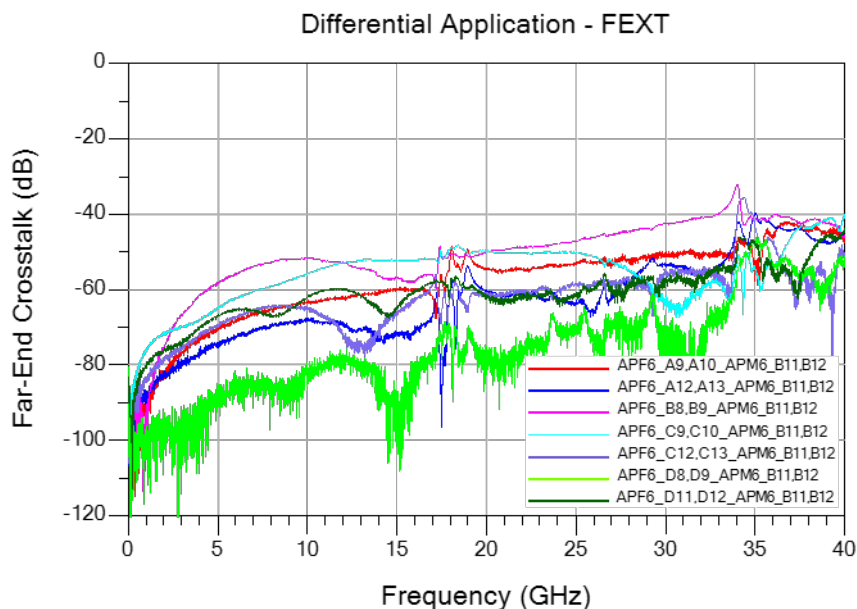


Figure 6

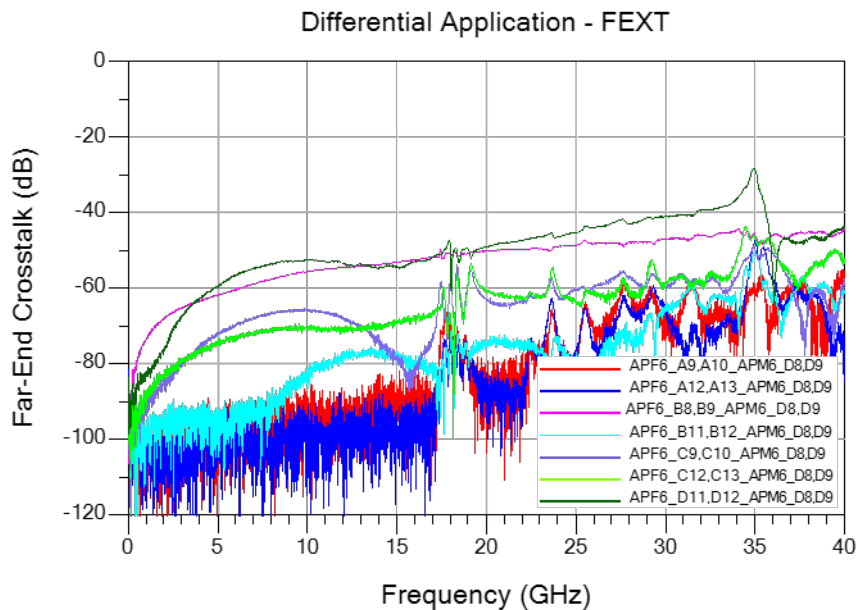


Figure 7

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Appendix B – Time Domain Responses

Differential Application – Impedance

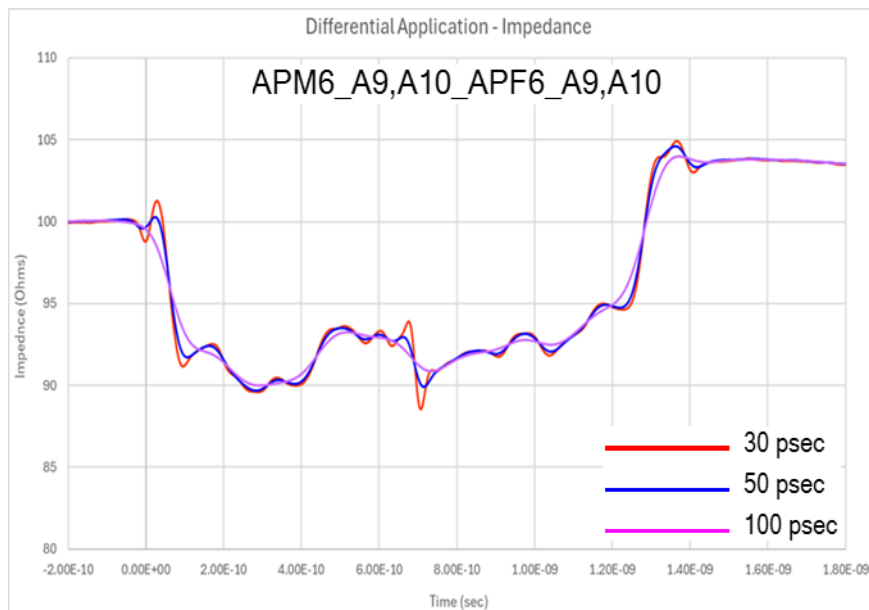


Figure 8

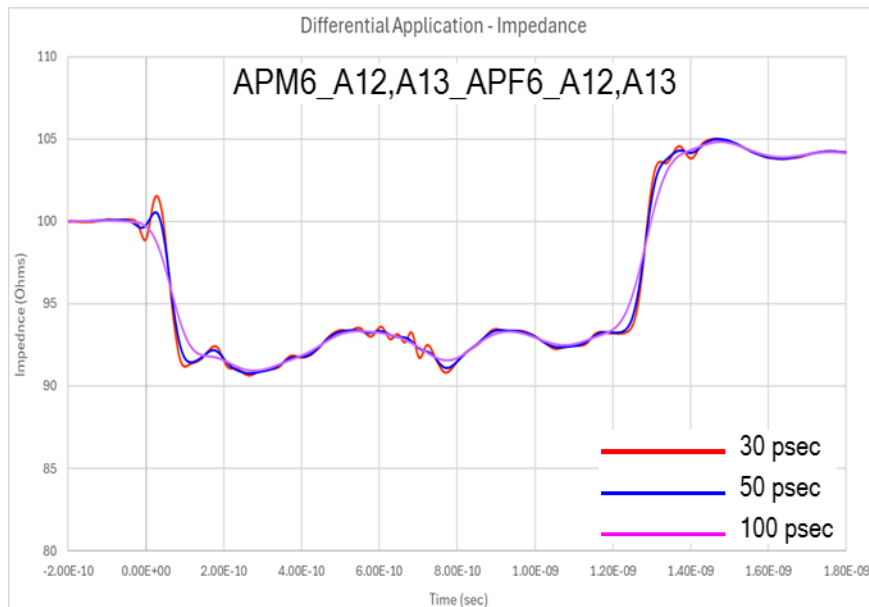
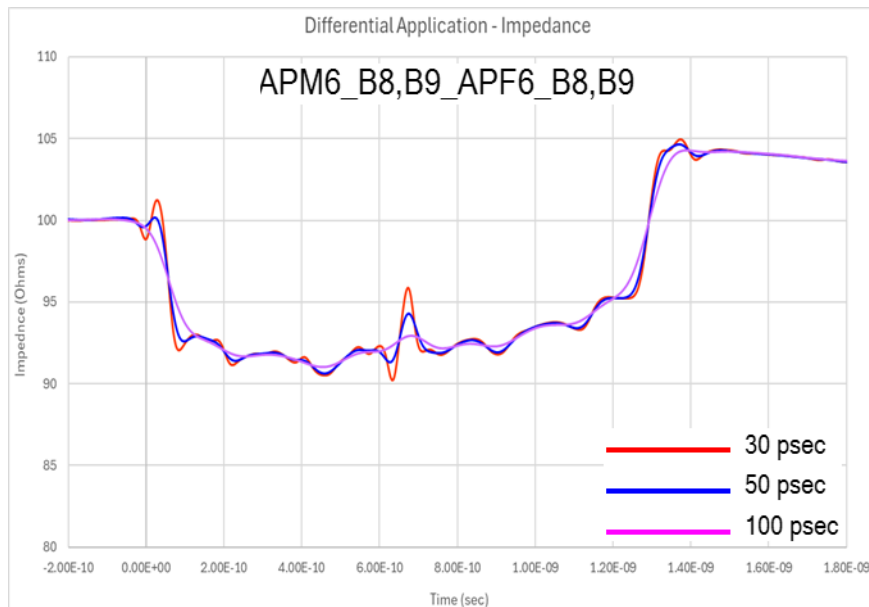
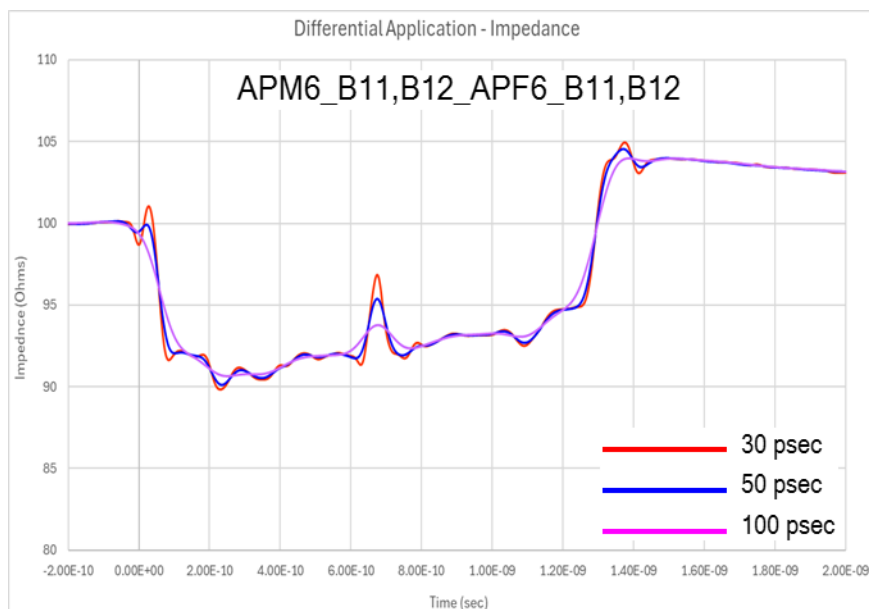


Figure 9

Series: APM6 / APF6**Description:** 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height**Figure 10****Figure 11**

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

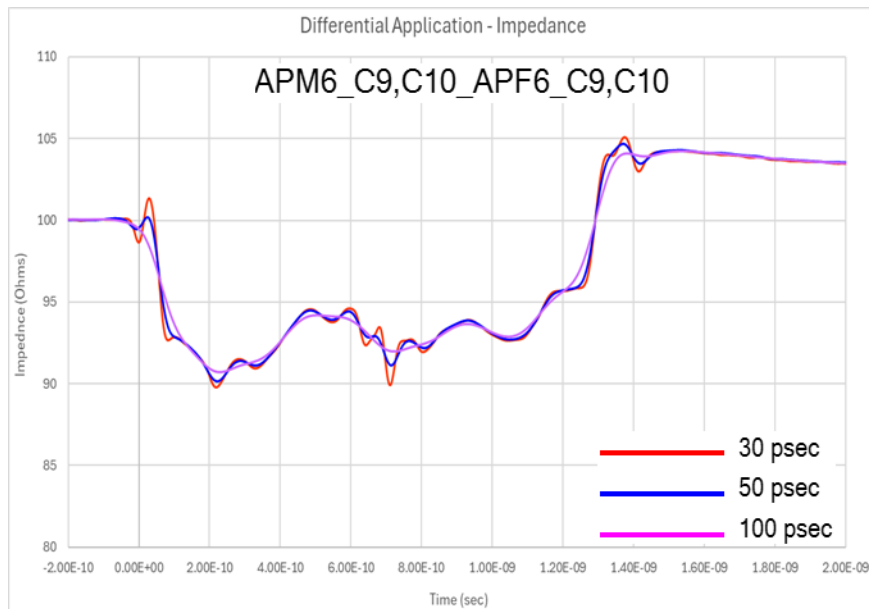


Figure 12

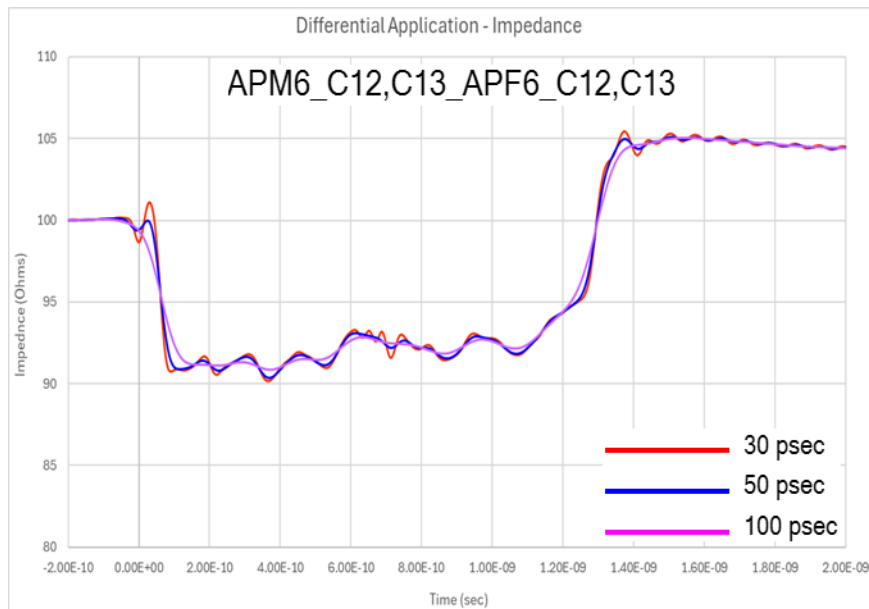
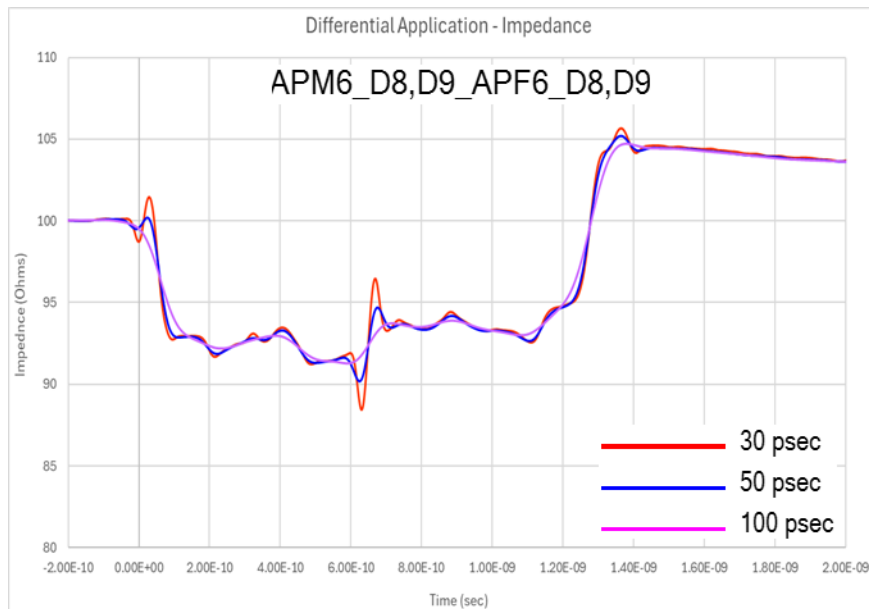
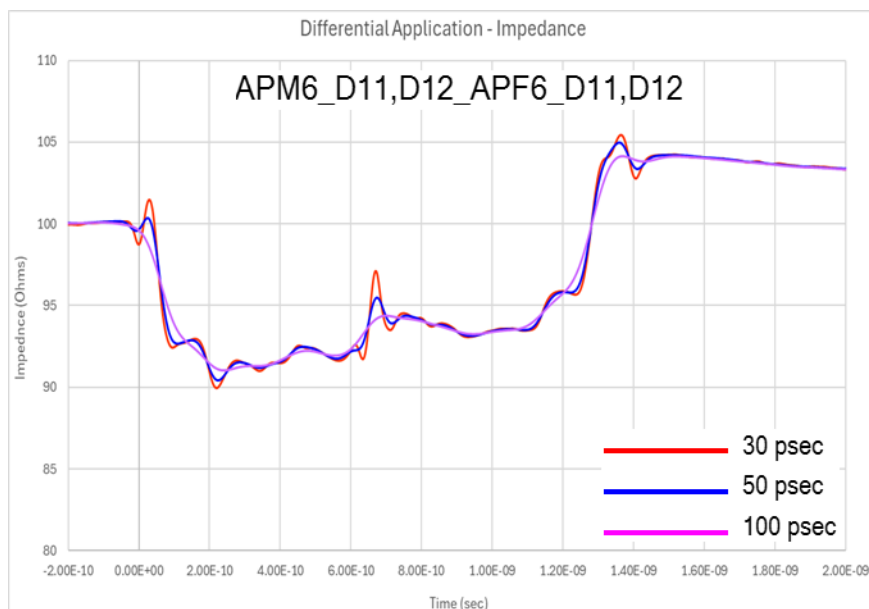


Figure 13

Series: APM6 / APF6**Description:** 0.635 mm Pitch AcceRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height**Figure 14****Figure 15**

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Differential Application – Propagation Delay

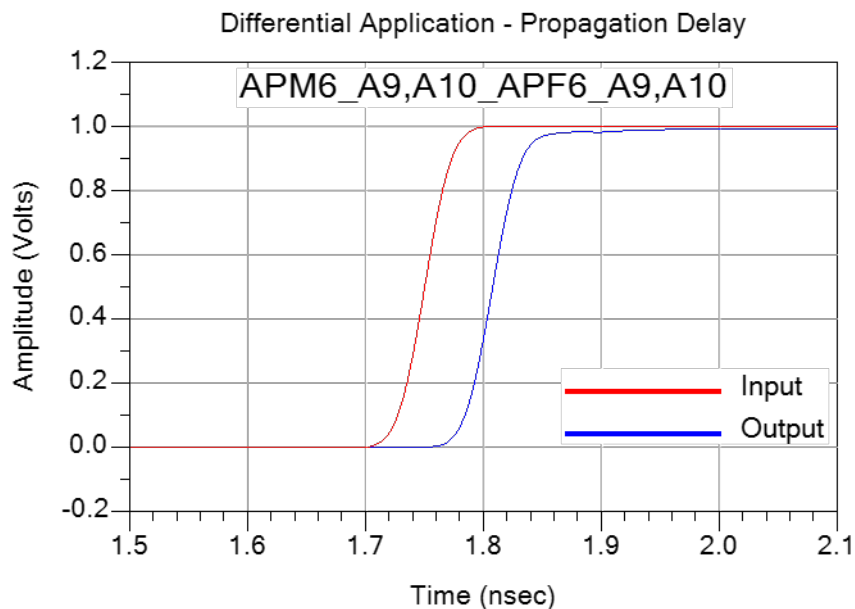


Figure 16

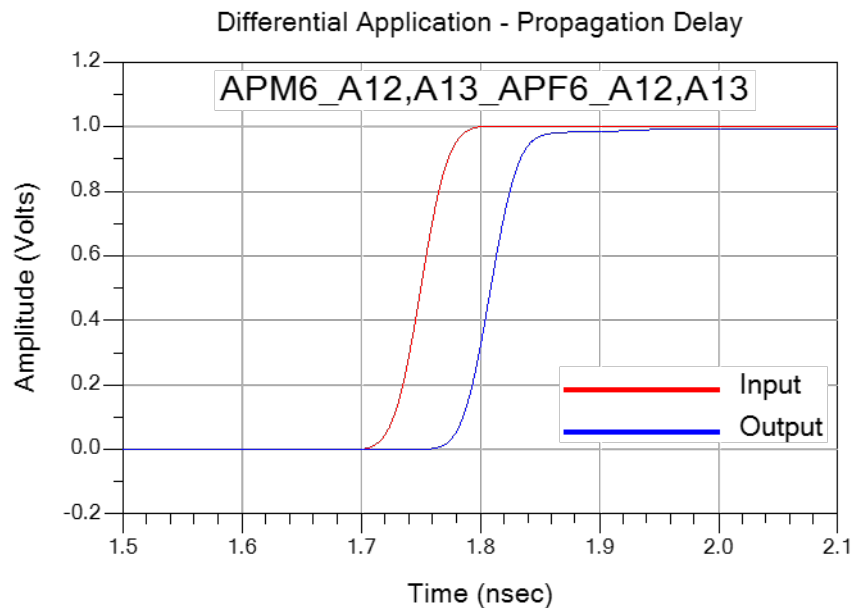
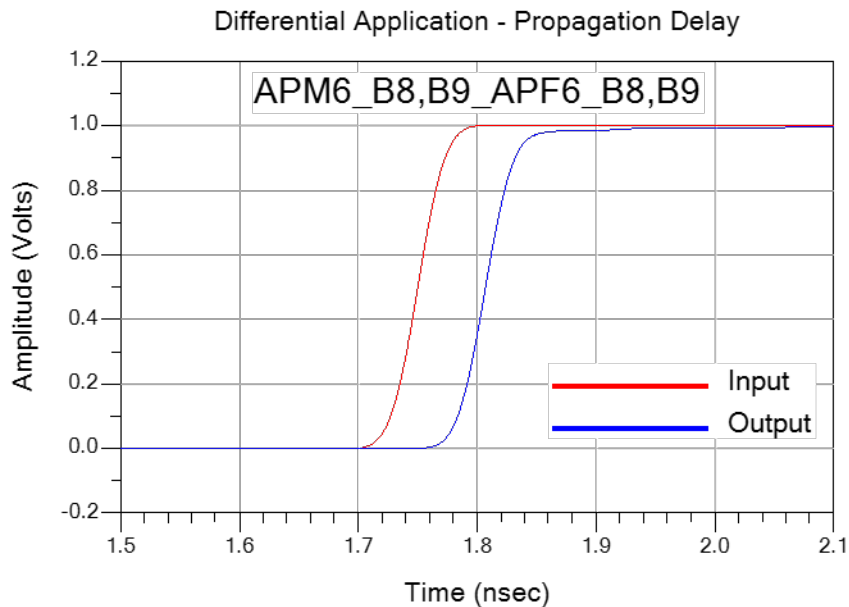
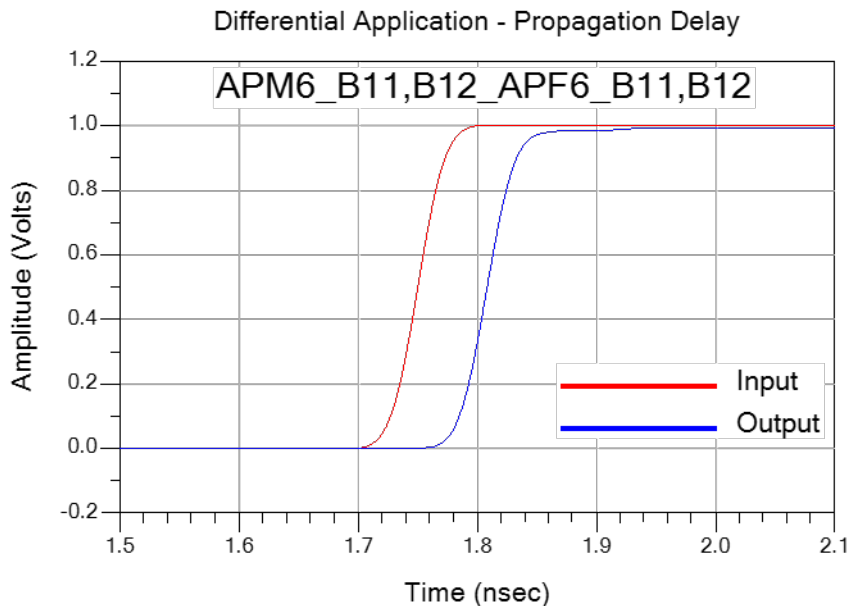
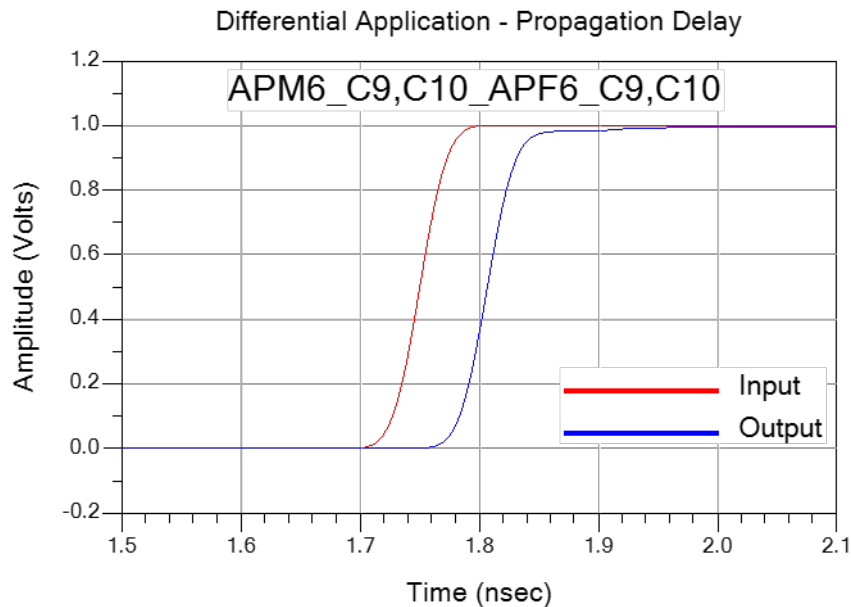
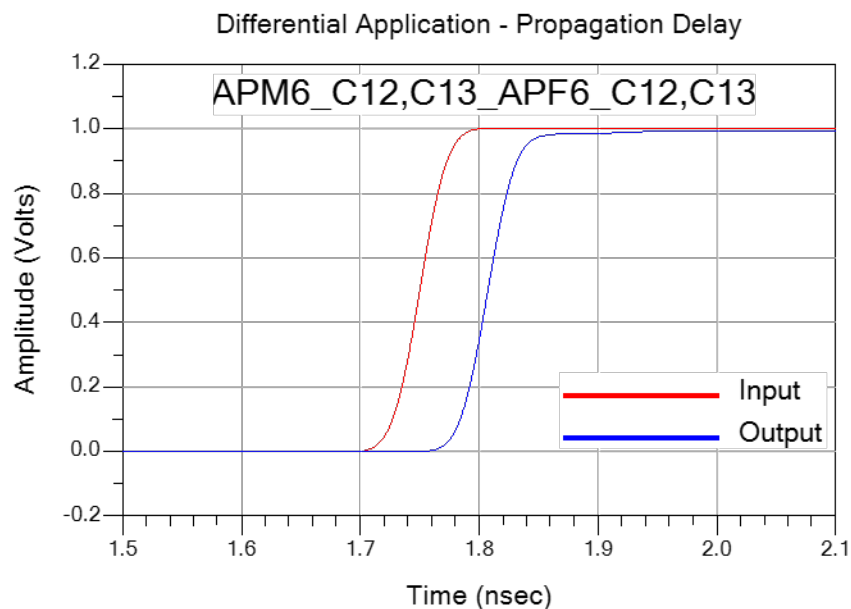
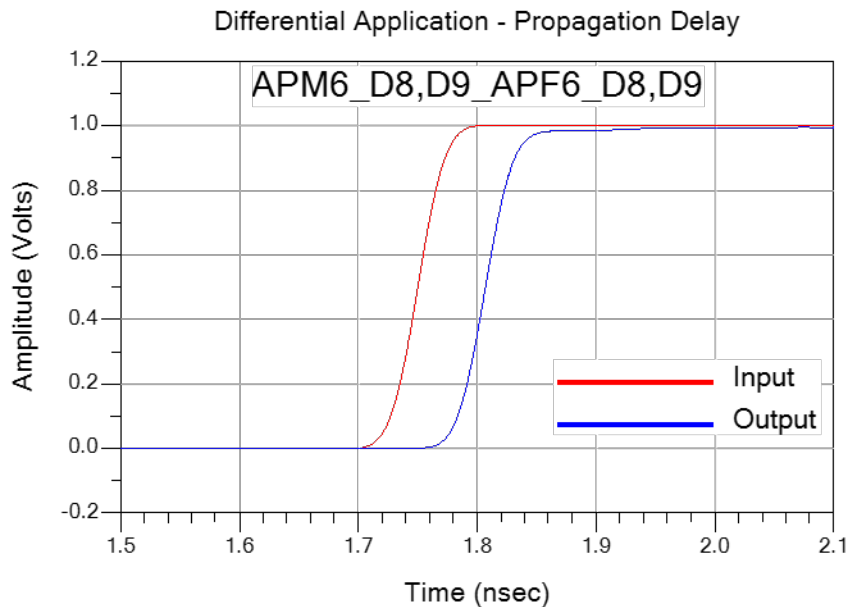
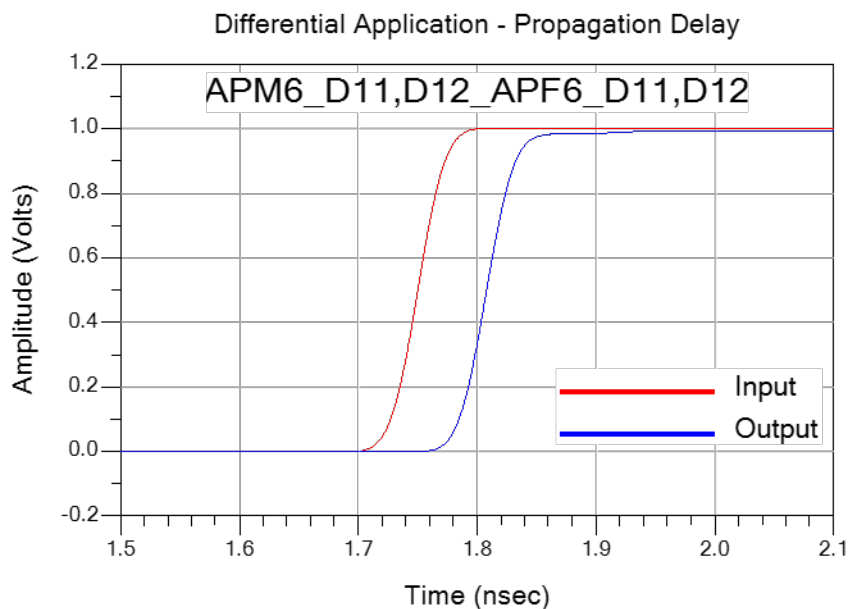


Figure 17

Series: APM6 / APF6**Description:** 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height**Figure 18****Figure 19**

Series: APM6 / APF6**Description:** 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height**Figure 20****Figure 21**

Series: APM6 / APF6**Description:** 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height**Figure 22****Figure 23**

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

Appendix C – Product and Test System Descriptions

Product Description

Product test samples are High-Performance APx6 Series connectors. The part number is APM6-020-01.5-XXX-04-0-A and APF6-020-03.5-XXX-04-0-A. A photo of the test articles mounted to SI test boards is shown below.

Test System Description

The test fixtures are composed of twelve-layer TACHYON 100G 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 APx6 series connector set and identified by part number PCB-APx6HD-110323-SIG-1.

PCB-APx6HD-110323-SIG-1 Test Fixtures

Shown below is a photograph of the test board sets.



Figure 24

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

PCB Fixtures

The test fixtures used are as follows:

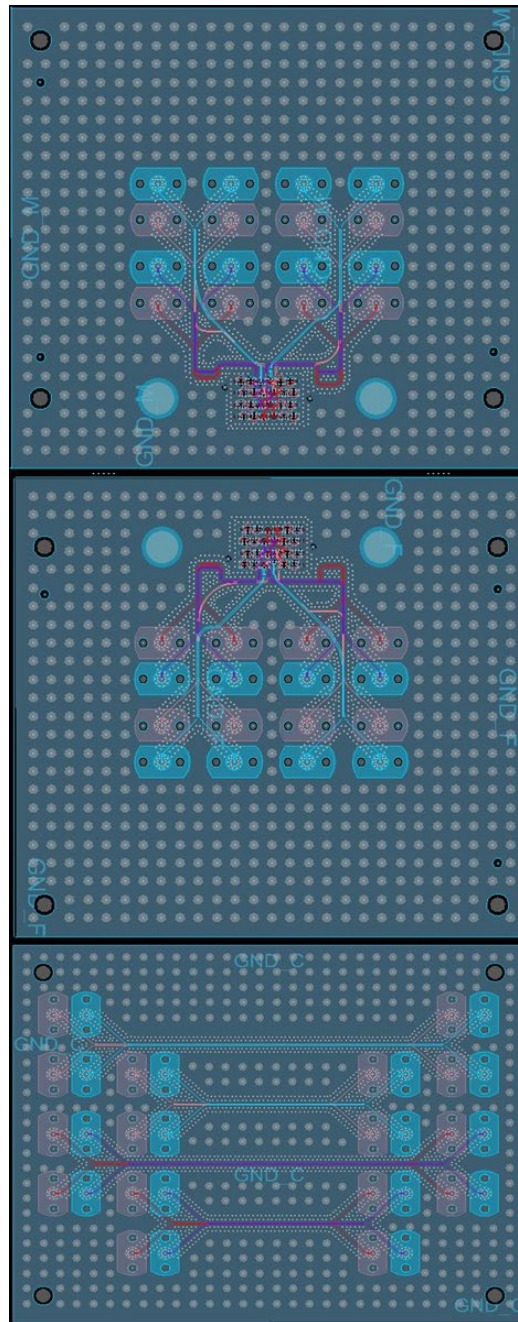


Figure 25

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

All traces on the test boards are length matched to 46.82 mm measured from the edge of the pad to the 2.4mm connector. The AFR calibration effectively removes 45 mm of test board trace effects. This means that 1.82 mm of test board trace length effects are included in both sides of test boards in the measurement. The S-Parameter measurement includes:

- A- The APx6 Series connector set
- B- Test board vias, pads (footprint effects) for the APM6 connector side.
- C- 1.82 mm of 0.127 mm wide microstrip trace.
- D- Test board vias, pads (footprint effects) for the APF6 side.
- E- 1.82 mm of 0.127 mm wide microstrip trace.

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

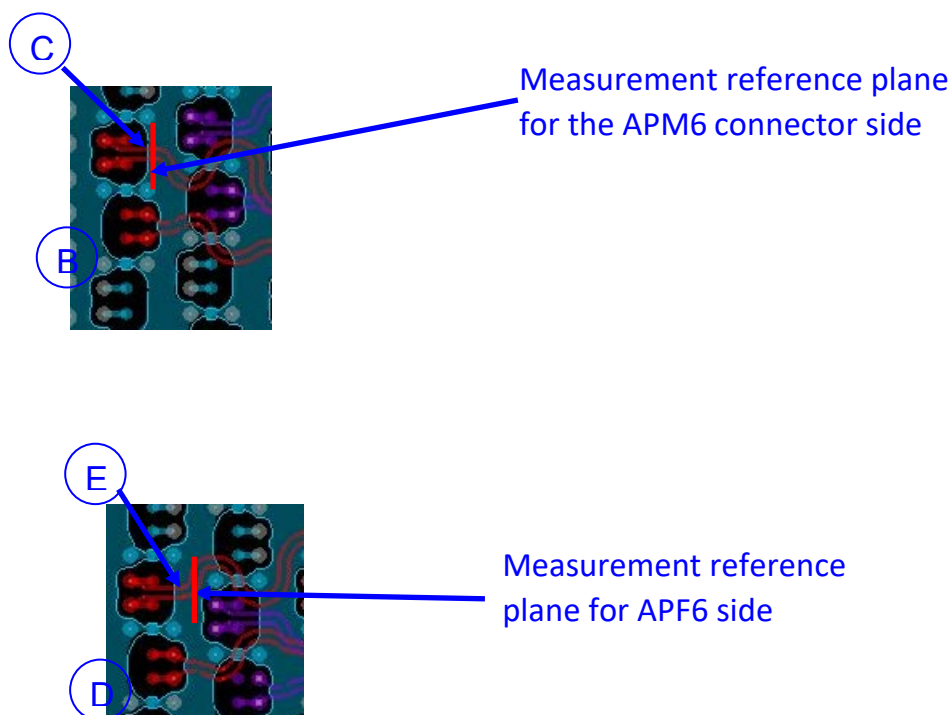


Figure 26

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

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

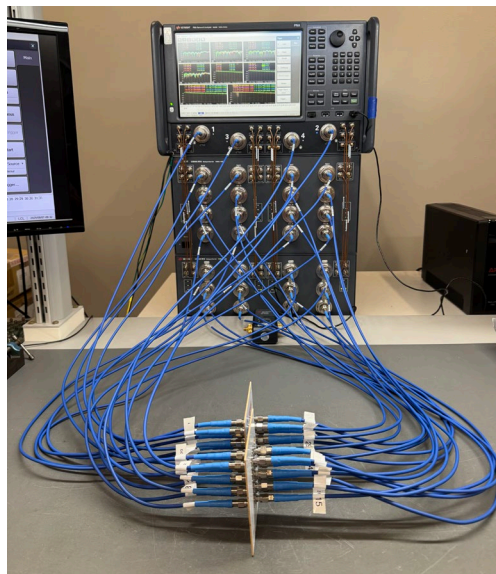


Figure 27

Test Instruments

<u>QTY</u>	<u>Description</u>
1	Keysight N5225B PNA-L Network Analyzer (10 MHz to 40 GHz)
1	Keysight N4694-60003 ECAL Module (10 MHz to 40 GHz)

Test Cables & Adapters

<u>QTY</u>	<u>Description</u>
32	Junkosha 2.4mm male to female cables

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

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

Vertical Scale: 5 ohm / Div

Horizontal Resolution: 200ps

Averages: 128

DCA-X86100D Measurement Setup

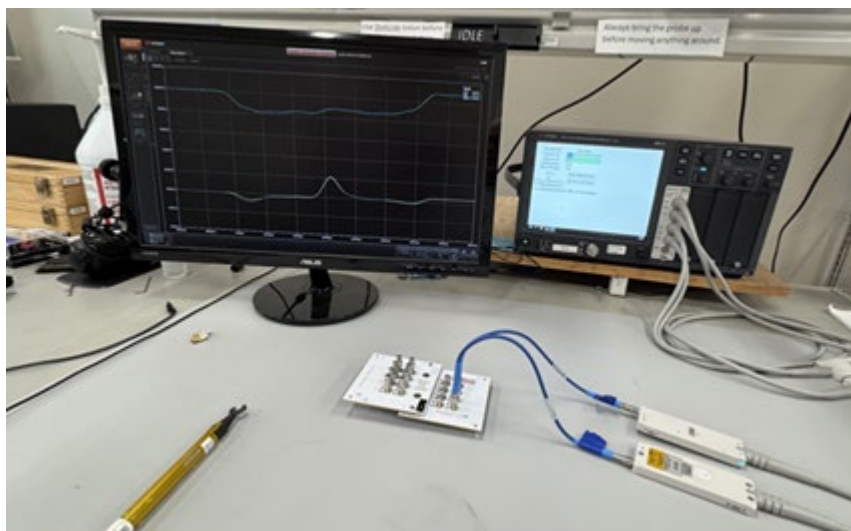


Figure 28

Test Instruments

<u>QTY</u>	<u>Description</u>
1	Keysight DCA-X86100D Wide-Bandwidth Oscilloscope Mainframe

Test Cables & Adapters

<u>QTY</u>	<u>Description</u>
2	Junkosha J12J103834-00

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated 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 through calibration standards, the SI test boards, and the selection of the PCB vendor.

A coaxial SOLT calibration is performed using a N4694-60003 ECAL module. Then DUT measurements are performed under SOLT calibration. The measurements include the effect of test fixture. The measurements of the 2X THRU line standards are required to remove the test fixture effect.

Time Domain Procedures

Mathematically, Frequency Domain data can be transformed to obtain a Time Domain response. Perfect transformation requires Frequency Domain data from DC to infinity Hz. Fortunately, a very accurate Time Domain response can be obtained with bandwidth-limited data, such as measured with modern network analyzer.

Time Domain responses were generated using Keysight ADS 2025. 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)

Measurements involving digital pulses are performed using either Time Domain Reflectometer (TDR) or Time Domain Transmission (TDT) methods. The TDR method is used for impedance measurements in this report.

The signal line(s) of the SUT's is energized with a TDR pulse and the far-end of the energized signal line is terminated in the test systems characteristic impedance (e.g.; 50Ω or 100Ω terminations). By terminating the adjacent signal lines in the test systems characteristic impedance, the effects on the resultant impedance shape of the waveform are limited.

Series: APM6 / APF6

Description: 0.635 mm Pitch AcceleRate® HP High-Performance Array,
Column Termination, 5mm Mated Stack Height

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.

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)