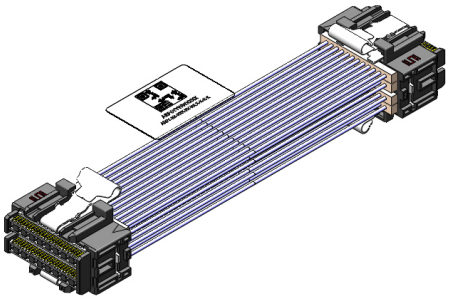
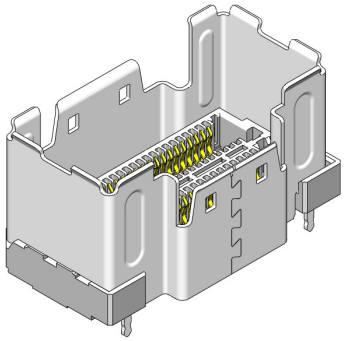
High Speed Characterization Report

ARP6-SE-025-04-XX.0-T-L-L



Mated with:

APF6-025-03.5-L-04-2-L-TR



Description:
AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

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Report Revision: 4/3/2024

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Cable Assembly Overview

The 0.635 mm (.025") ARP6 Cable Assembly is constructed using 34 AWG Eye Speed® ultra-low skew twinax cable (ARP6-DP), 34 AWG Eye Speed® ThinSE™ micro coax cable (ARP6-SE), or a combination of both cable types (ARP6-DS). The cable is terminated at both ends with connector that mates with the APF6-L or APF6-T socket.

The ARP6-SE series cable assemblies are available in 12 and 18 signals per row, 4 or 6 rows. The data in this report is applicable to the 4-row, 12 signals ARP6-SE with 250 mm, 500 mm, and 1000 mm cable lengths.

Each ARP6 cable assembly was tested by mating it to APF6 socket at both ends. One sample of each assembly was tested. The actual part numbers that were tested are shown in Table 1, which also identifies End 1 and End 2 of each assembly. A relative sample picture is shown in Figure1.

Length	Part Number	End 1	End 2
250 mm	ARP6-SE-025-04-10.0-T-L-L	L(Squeeze Latch)	L(Squeeze Latch)
500 mm	ARP6-SE-025-04-20.0-T-L-L	L(Squeeze Latch)	L(Squeeze Latch)
1000 mm	ARP6-SE-025-04-40.0-T-L-L	L(Squeeze Latch)	L(Squeeze Latch)

Table 1: Sample Description

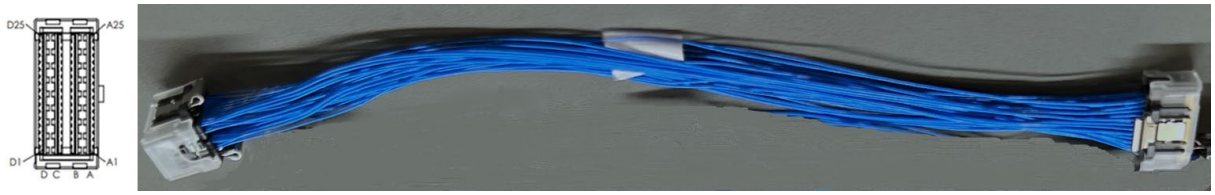

Figure 1: Test Sample

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Frequency Domain Data Summary

Bandwidth Figures – Single-ended Insertion Loss

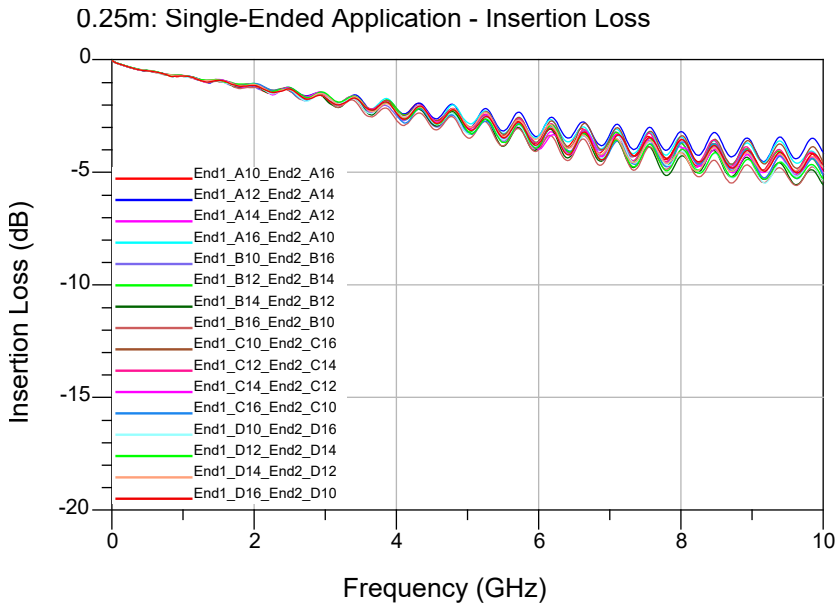

Figure 2

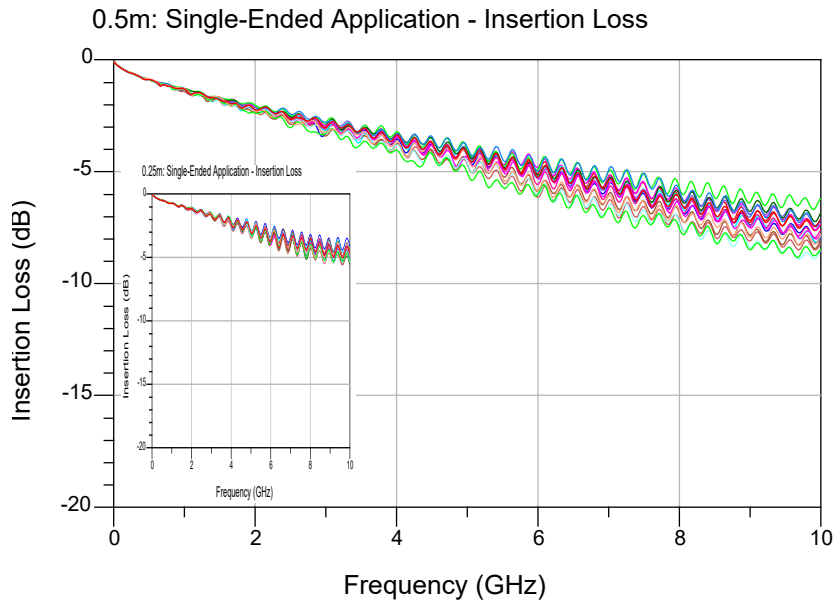

Figure 3

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Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

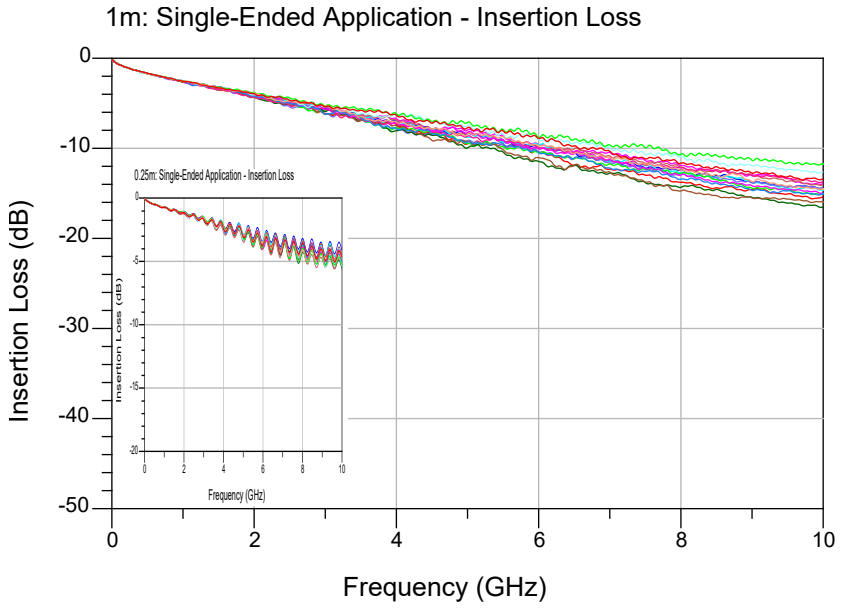

Figure 4

Time Domain Data Summary

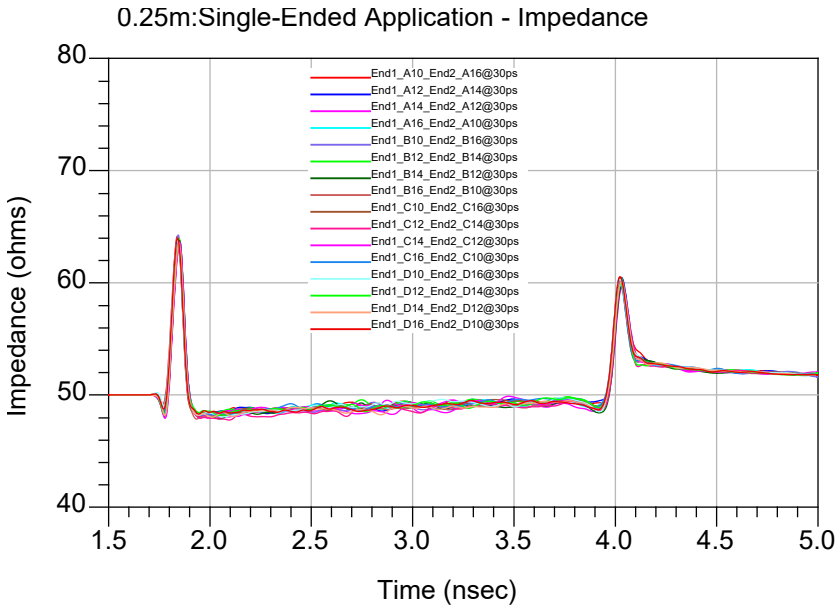

Figure 5

Because the same type of cable is used in cable assemblies with different lengths, only the impedance profile of 0.25 m cable assembly is reported.

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Table 2 - Propagation Delay (Cable Assembly)				
Driver	**Receiver**	**0.25 m**	**0.5 m**	**1 m**
End 1_A10	End 2_A16	1.187 ns	2.267 ns	4.435 ns
End 1_A12	End 2_A14	1.191 ns	2.271 ns	4.441 ns
End 1_A14	End 2_A12	1.193 ns	2.275 ns	4.435 ns
End 1_A16	End 2_A10	1.187 ns	2.267 ns	4.434 ns
End 1_B10	End 2_B16	1.186 ns	2.267 ns	4.439 ns
End 1_B12	End 2_B14	1.190 ns	2.275 ns	4.436 ns
End 1_B14	End 2_B12	1.192 ns	2.271 ns	4.437 ns
End 1_B16	End 2_B10	1.186 ns	2.267 ns	4.434 ns
End 1_C10	End 2_C16	1.186 ns	2.267 ns	4.435 ns
End 1_C12	End 2_C14	1.192 ns	2.274 ns	4.440 ns
End 1_C14	End 2_C12	1.191 ns	2.267 ns	4.436 ns
End 1_C16	End 2_C10	1.186 ns	2.267 ns	4.437 ns
End 1_D10	End 2_D16	1.185 ns	2.267 ns	4.435 ns
End 1_D12	End 2_D14	1.189 ns	2.274 ns	4.442 ns
End 1_D14	End 2_D12	1.191 ns	2.267 ns	4.437 ns
End 1_D16	End 2_D10	1.186 ns	2.268 ns	4.438 ns

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Characterization Details

This report presents data that characterizes the signal integrity response of a cable assembly in a controlled printed circuit board (PCB) environment. All efforts are made to reveal typical best-case responses inherent to the system under test (SUT).

In this report, the SUT includes the mating connectors, cable assembly, and footprint effects on a typical multi-layer PCB. PCB effects (trace loss) are de-embedded from test data. Board-related effects, such as pad-to-ground capacitance, are included in the data presented in this report.

Additionally, intermediate test signal connections can mask the cable assembly's true performance. Such connection effects are minimized by using high performance test cables and adapters. Where appropriate, calibration and de-embedding routines are also used to reduce residual effects.

Differential and Single-Ended Data

Most Samtec cable assemblies 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 "GSG" single-ended drive configuration only.

Cable assembly Signal to Ground Ratio

Samtec cable assemblies 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 cable assemblies, a ground plane or blade, or an outer shield, is used as the signal return, while in others, cable assembly 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 cable assembly. Therefore, care must be taken when choosing signal/ground ratios in cost or density-sensitive applications.

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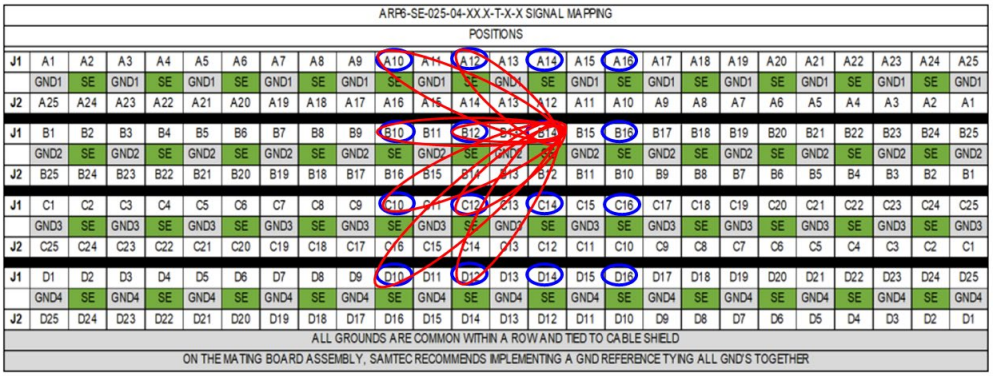
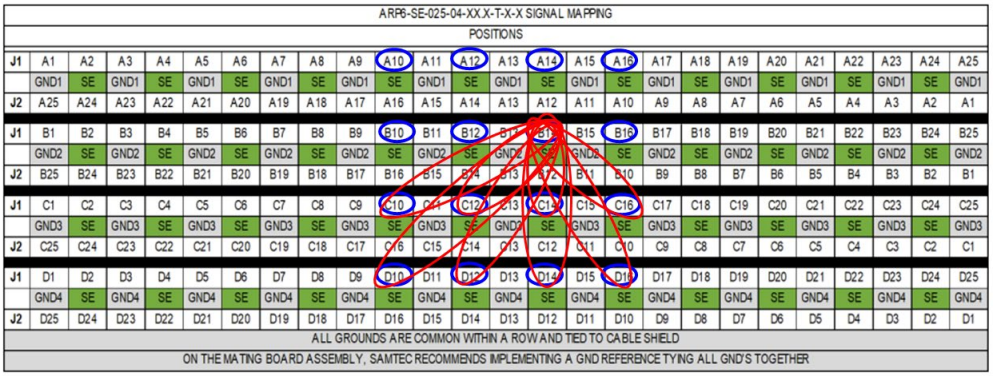
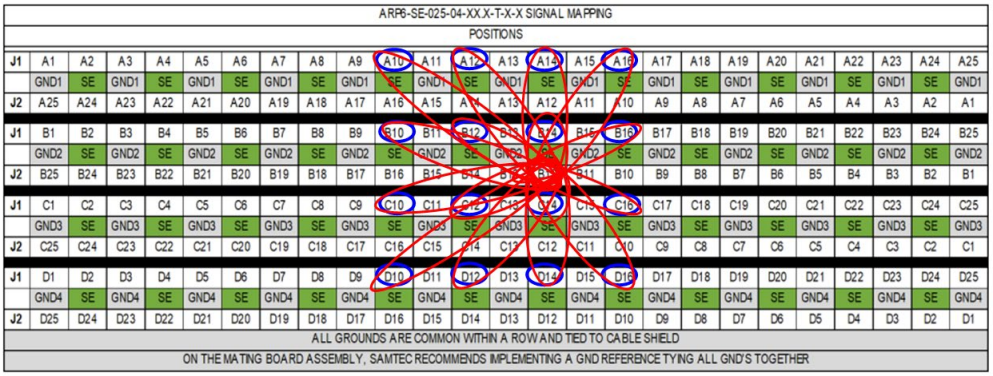
For this cable assembly, the following configurations are evaluated:





NEXT



FEXT

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Single-ended Impedance (denoted by blue circles)**:**

- GSG (Ground-Signal-Ground)

Single-ended Crosstalk (denoted by red circles)**:**

- NEXT (Near End Crosstalk)
- FEXT (Far End Crosstalk)

See Appendix C – Product and Test System Descriptions for details

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

Signal Edge Speed (Rise Time)
In pulse signaling applications, the perceived performance of the interconnect can vary significantly depending on the edge rate or rise time of the exciting signal. For this report, the fastest rise time used was 10 ps. Generally, this should demonstrate worst-case performance.

In many systems, the signal edge rate will be significantly slower at the cable assembly than at the driver launch point. To estimate interconnect performance at other edge rates, data is provided for several rise times between 10 ps and 30 ps.

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

Frequency Domain Data

Frequency Domain parameters are helpful in evaluating the cable assembly system’s signal loss and crosstalk characteristics across a range of sinusoidal frequencies. In this report, parameters presented in the Frequency Domain are Insertion Loss, Return Loss, Near-End and Far-End Crosstalk. 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.

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Time Domain Data

Time Domain parameters indicate Impedance mismatch versus length and signal propagation time. 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 cable assembly, mating connectors, and connector footprint. It also includes 2.43mm of PCB trace on each connector side. Delay is measured at 30 picoseconds signal rise-time. Delay is calculated as the difference in time measured between the 50% amplitude levels of the input and output pulses.

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

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Appendix A – Frequency Domain Responses

Single-ended Application – Insertion Loss

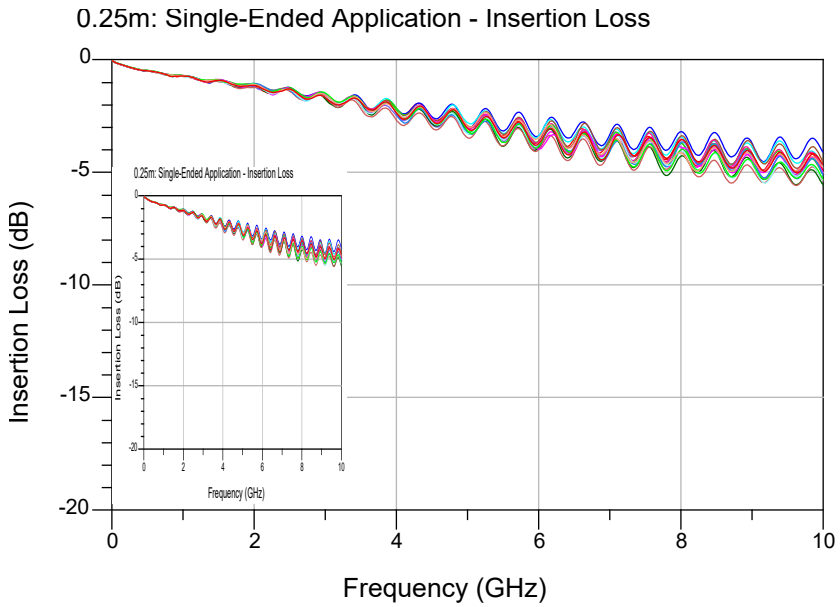

Figure 6

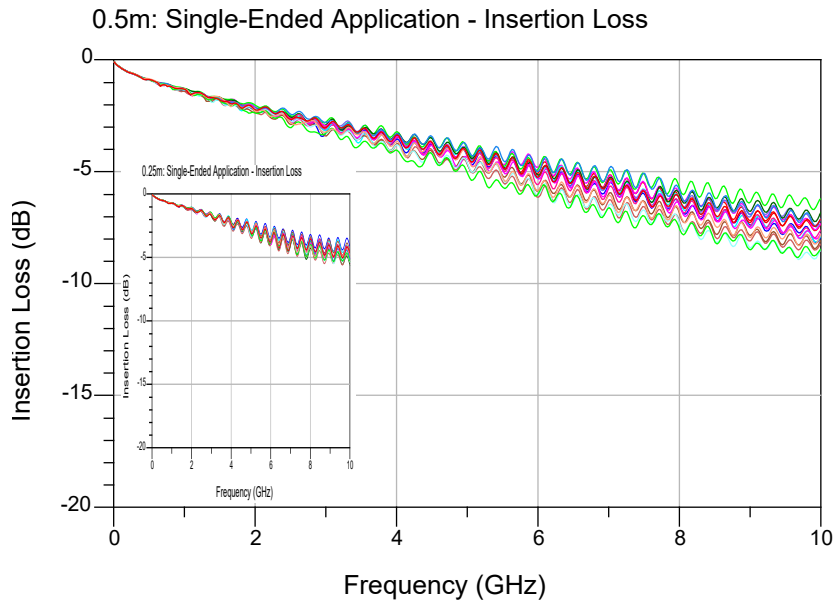

Figure 7

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

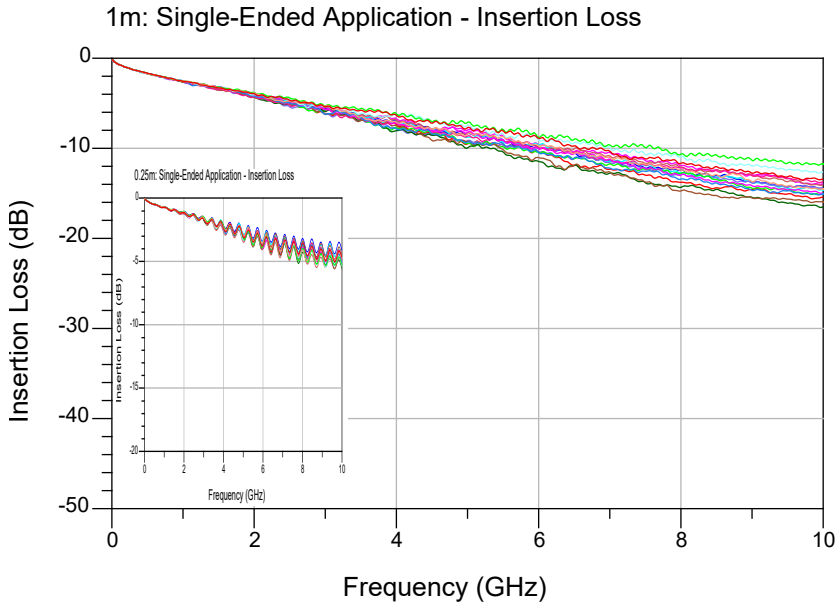

Figure 8

Single-ended Application – Return Loss

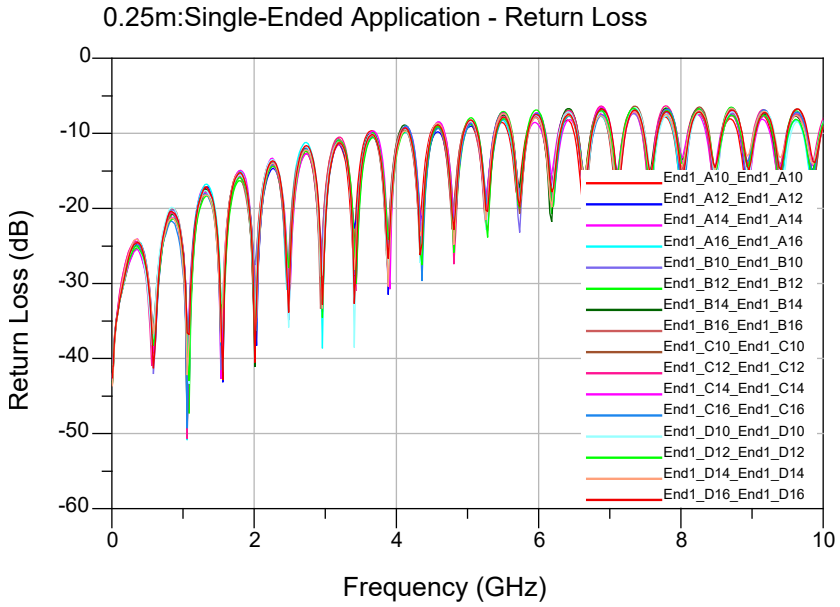

Figure 9

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

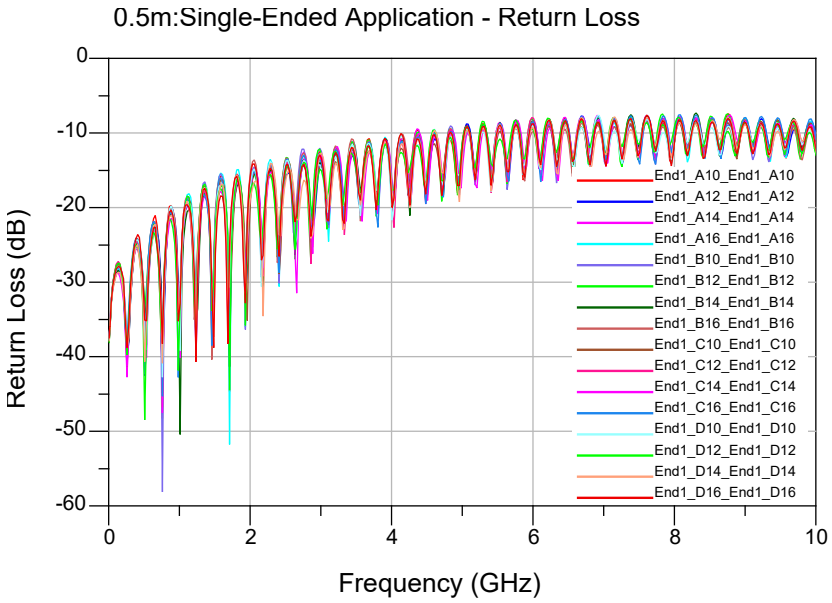

Figure 10

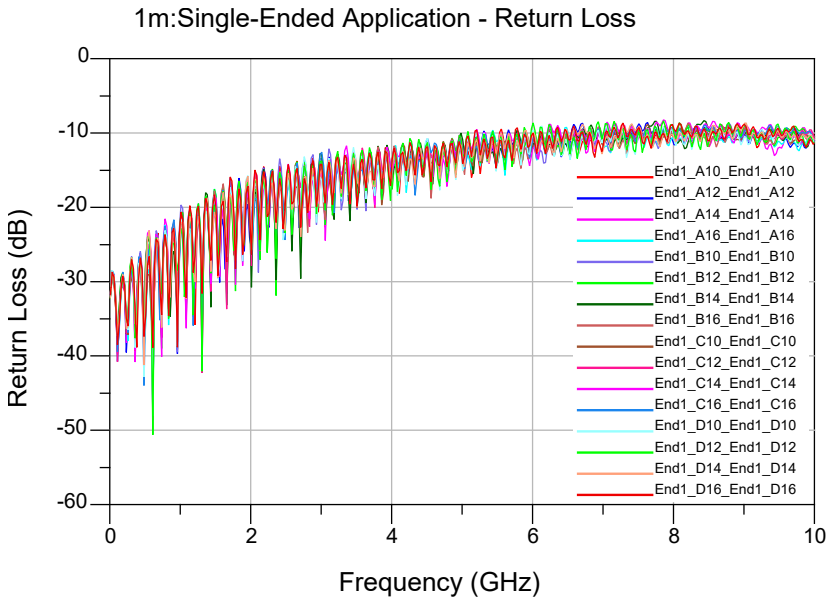

Figure 11

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

Single-ended Application – NEXT Configurations

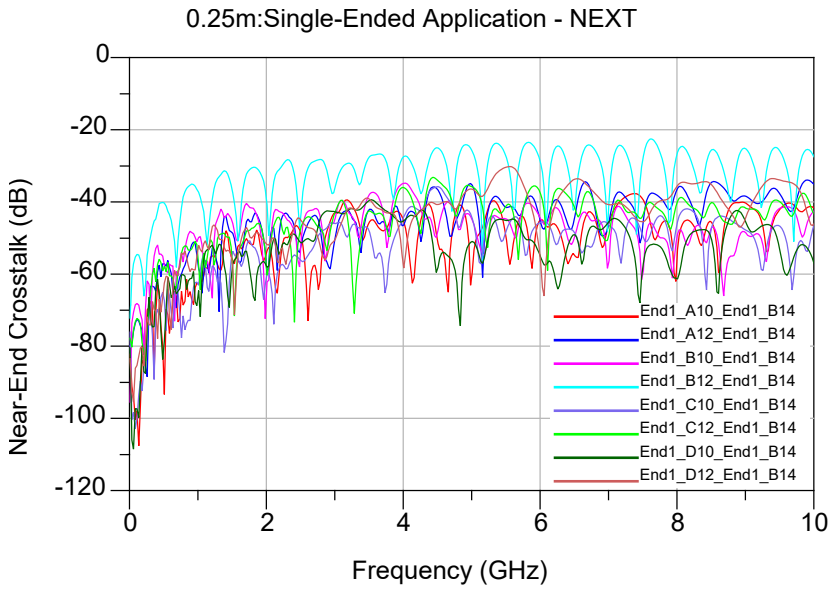

Figure 12

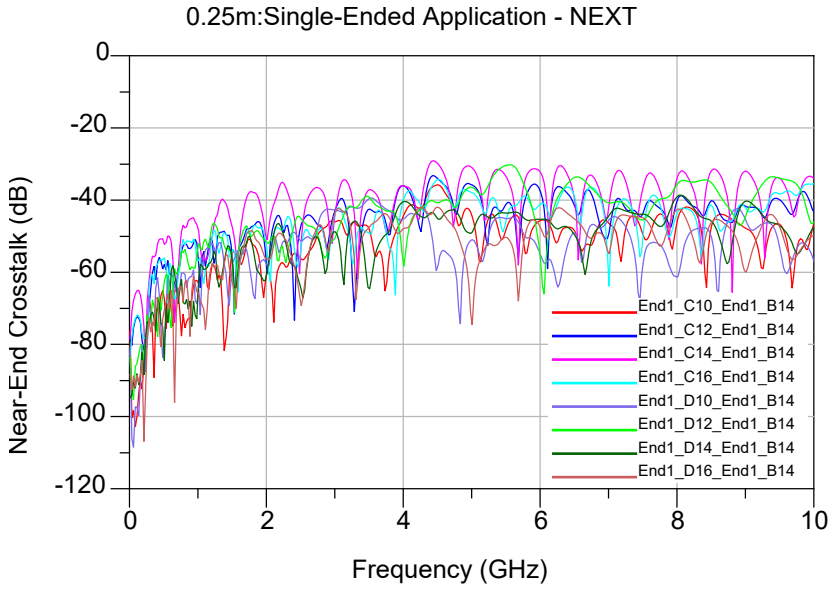

Figure 13

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

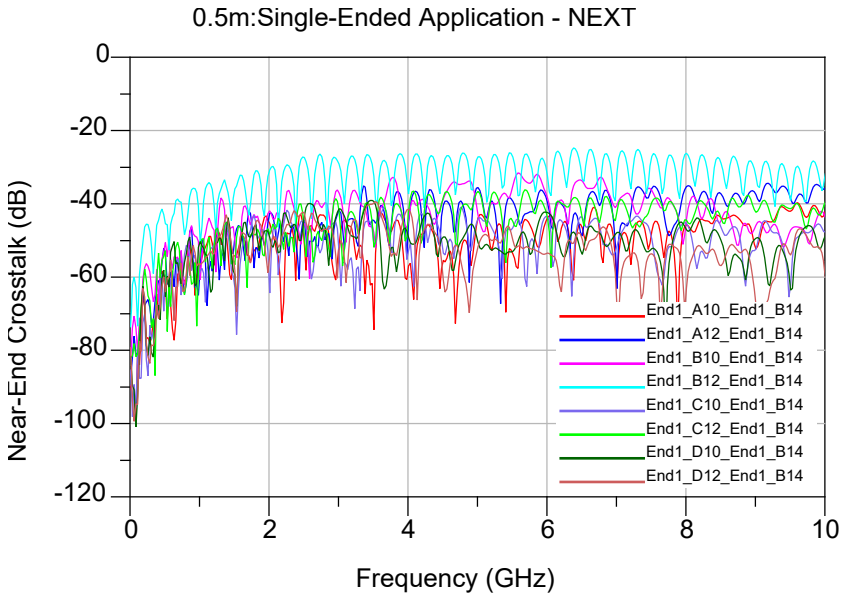

Figure 14

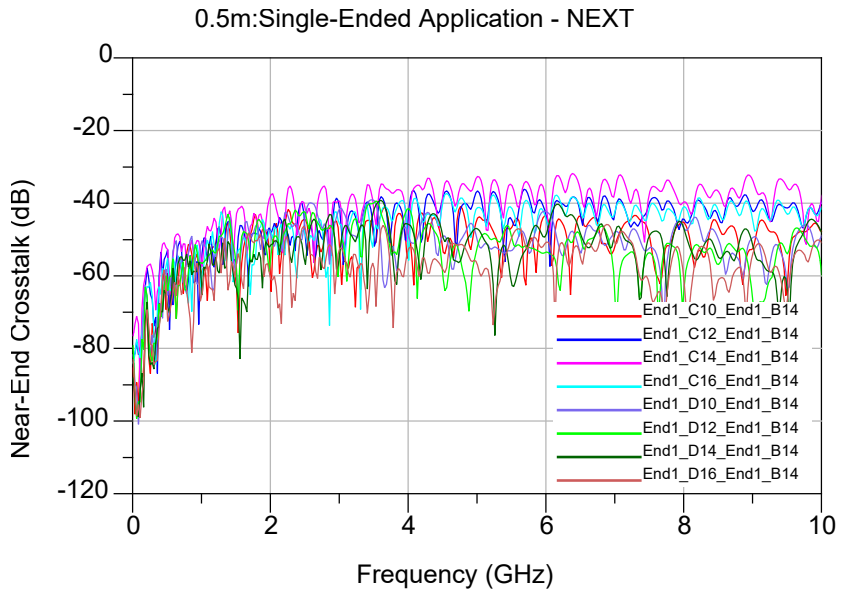

Figure 15

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

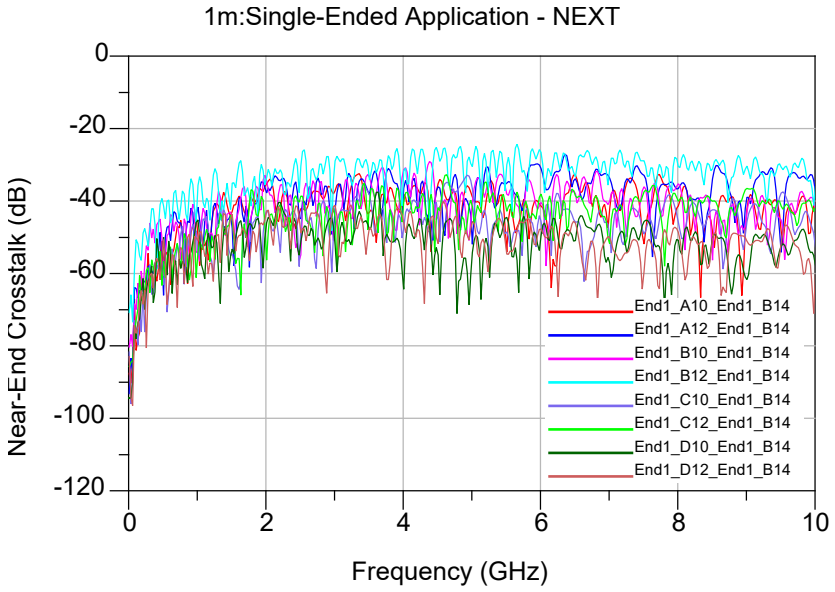

Figure 16

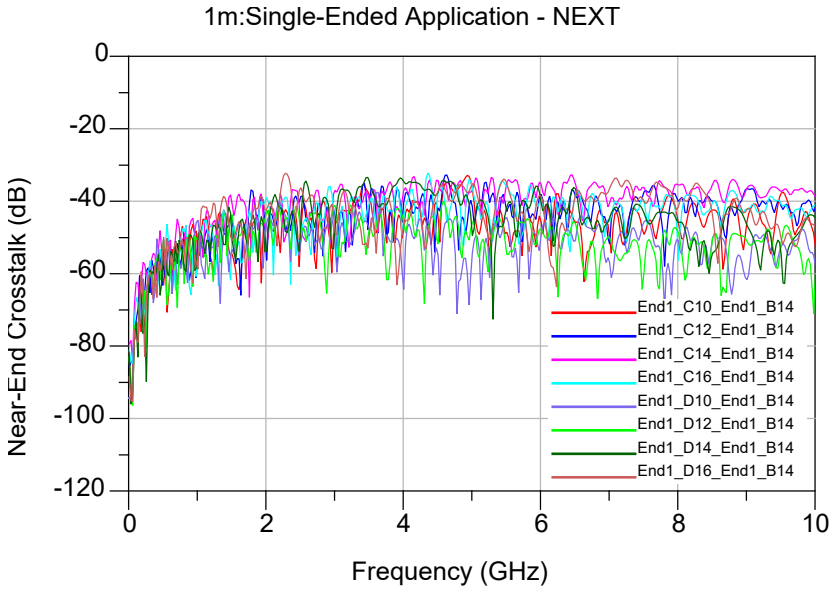

Figure 17

Series: ARP6-SE
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Single-ended Application – FEXT Configurations

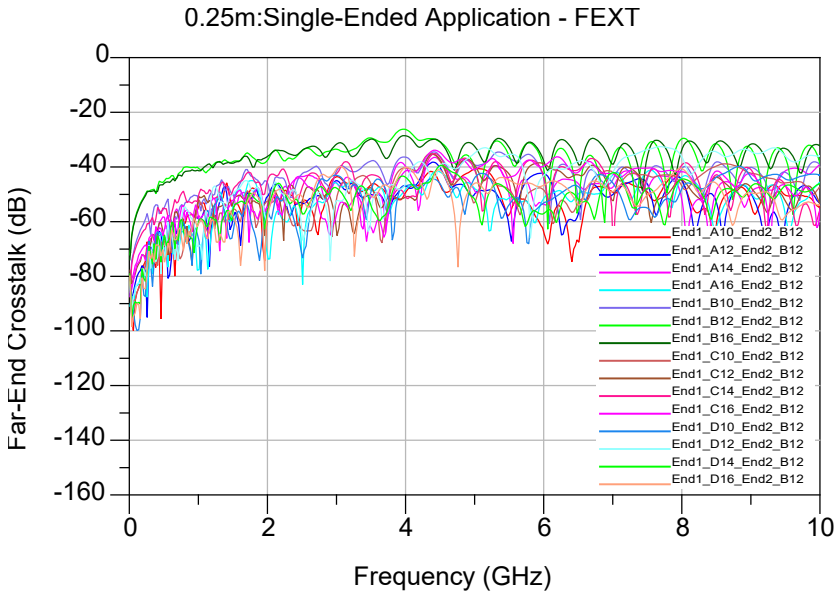

Figure 18

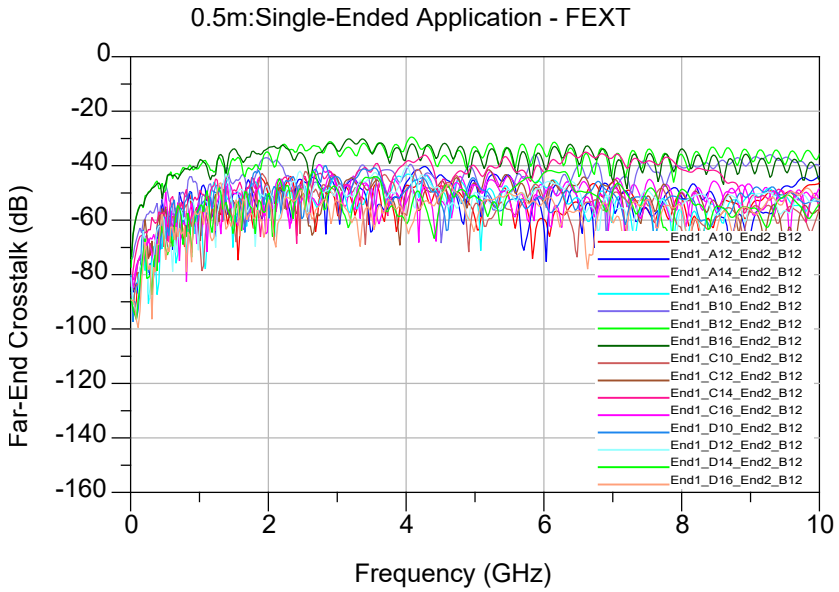

Figure 19

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

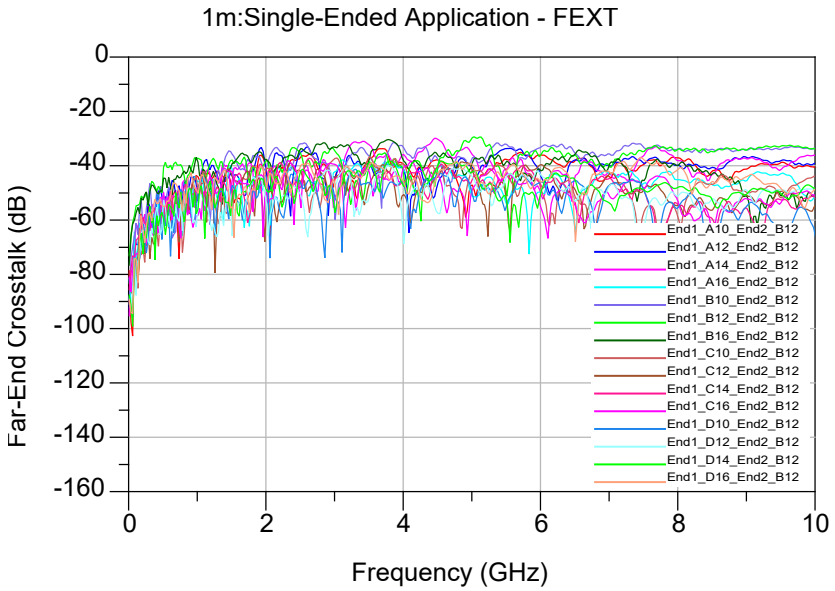

Figure 20

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

Appendix B – Time Domain Responses

Single-ended Application – Input Pulse

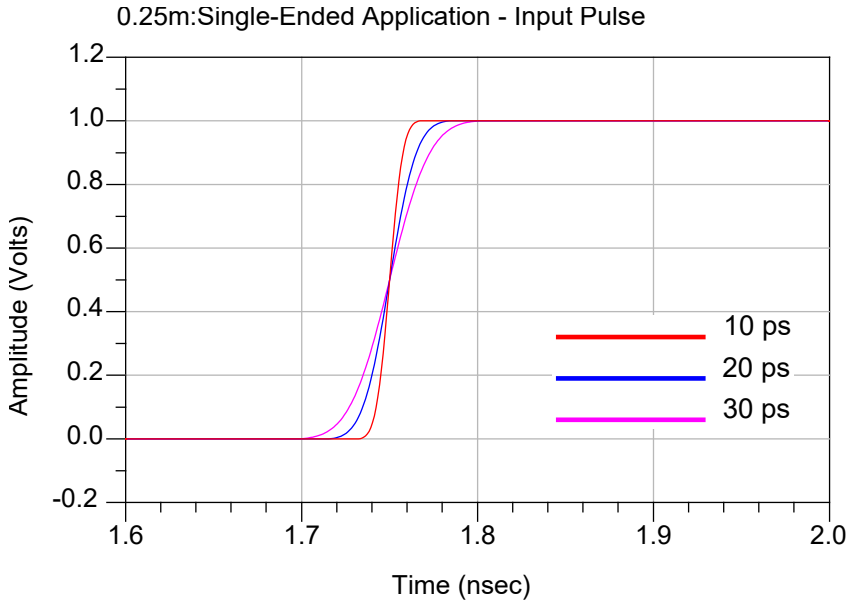

Figure 21

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

Single-ended Application – Cable assembly Impedance Summary

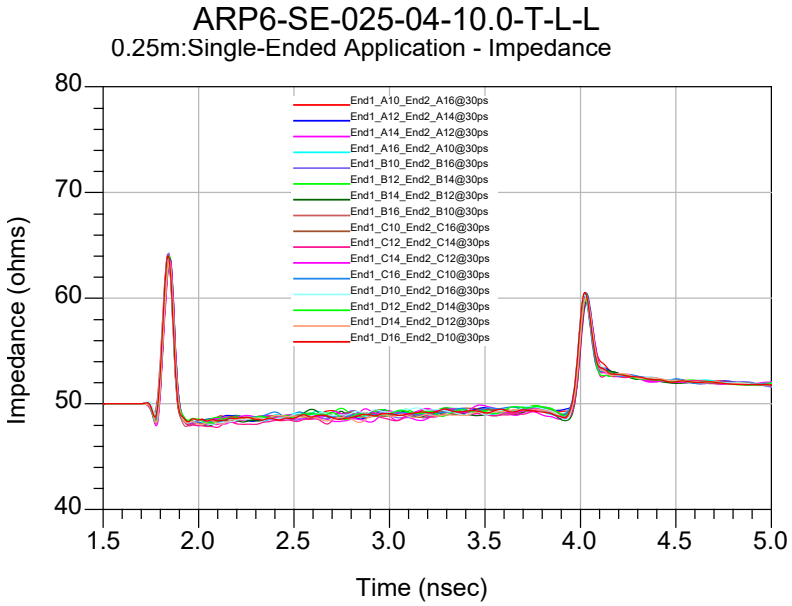

Figure 22

Single-ended Application – Cable assembly Impedance

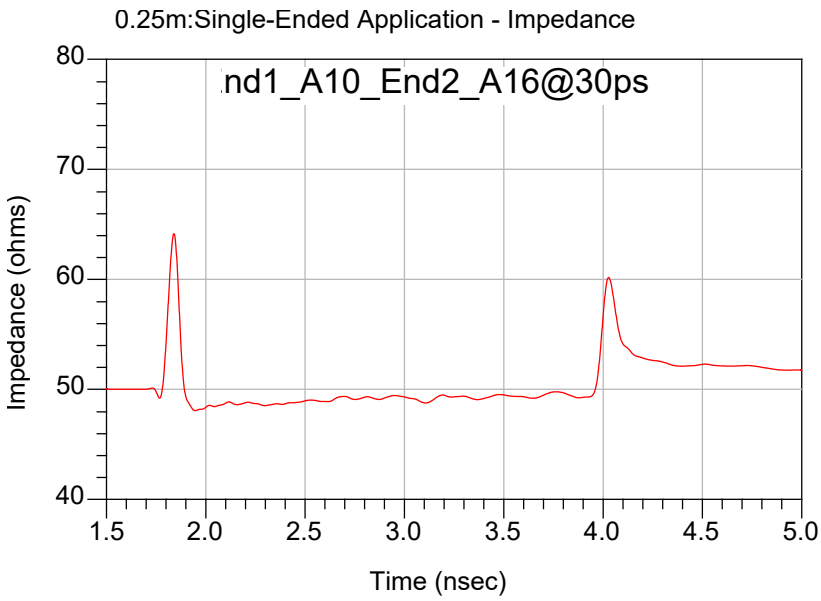

Figure 23

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

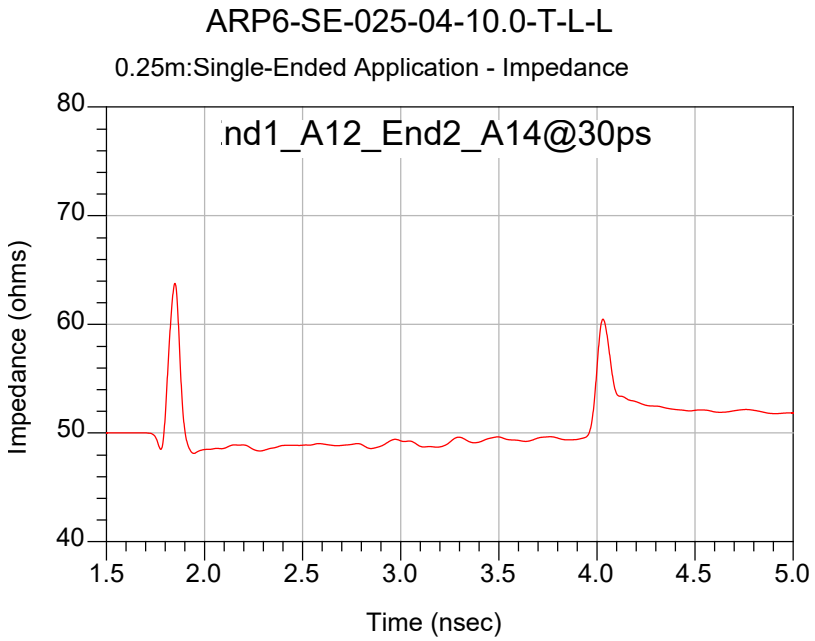

Figure 24

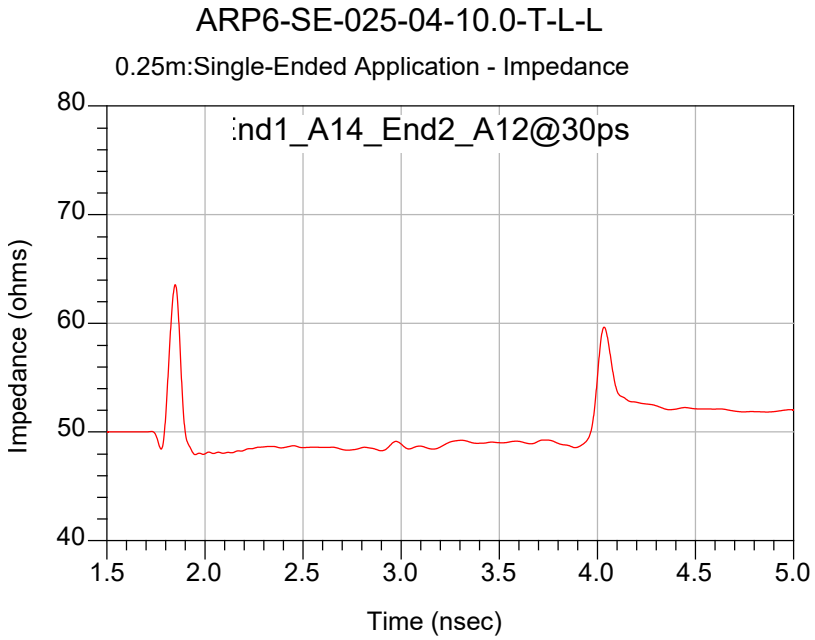

Figure 25

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

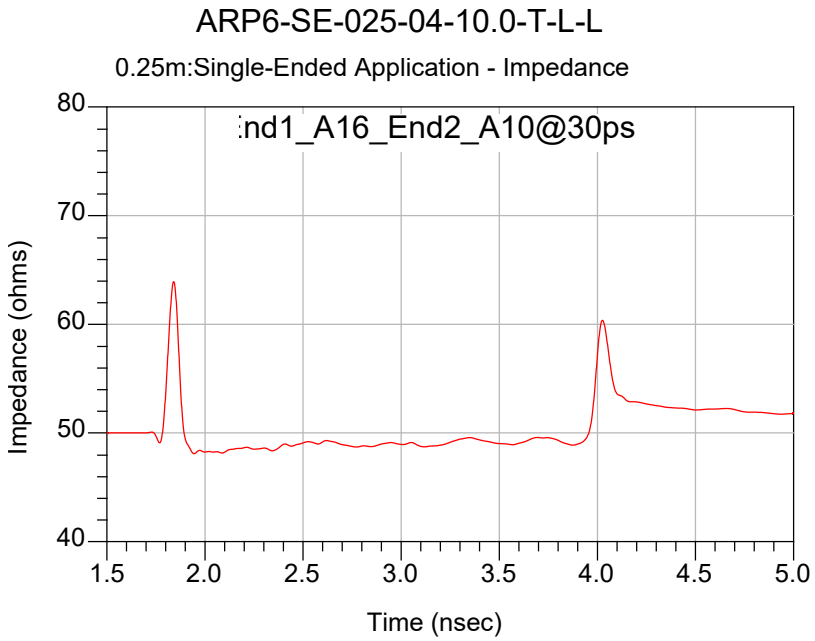

Figure 26

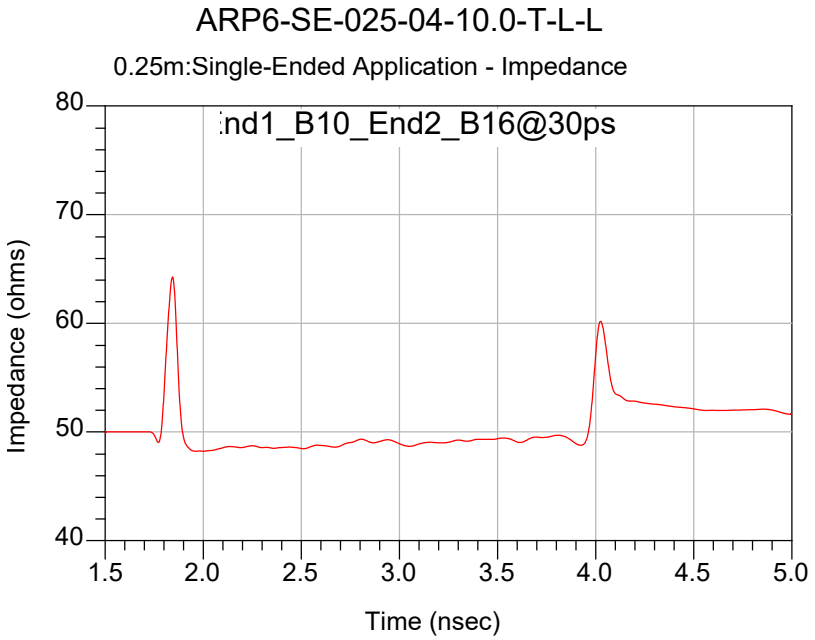

Figure 27

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Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

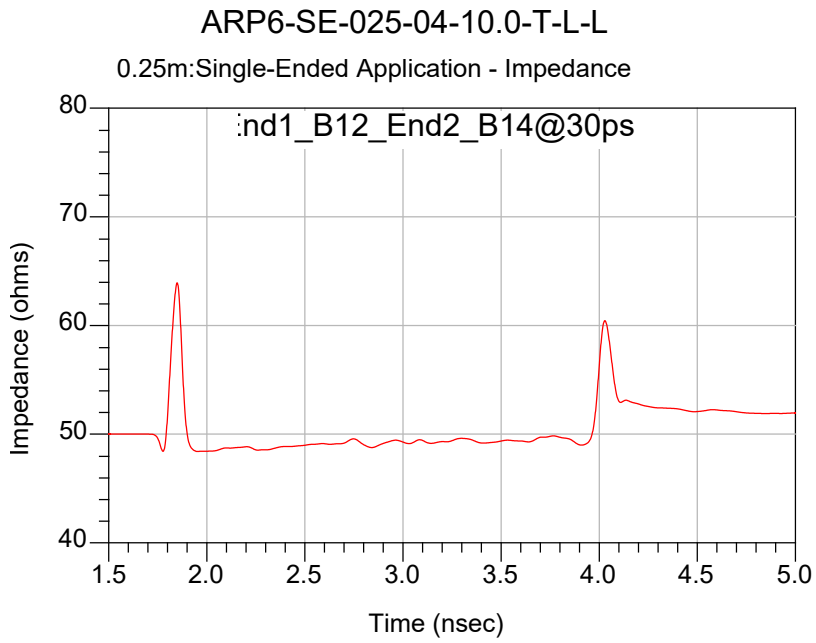

Figure 28

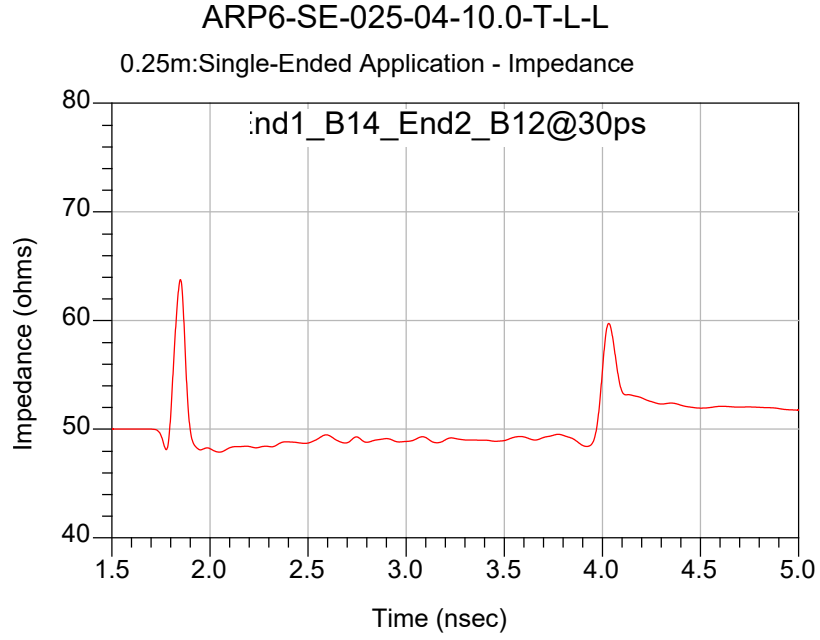

Figure 29

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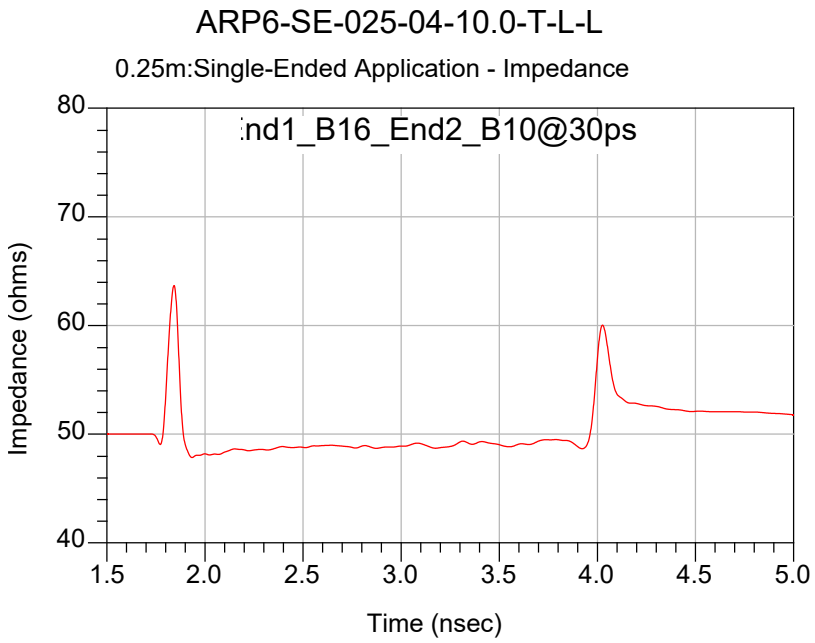

Figure 30

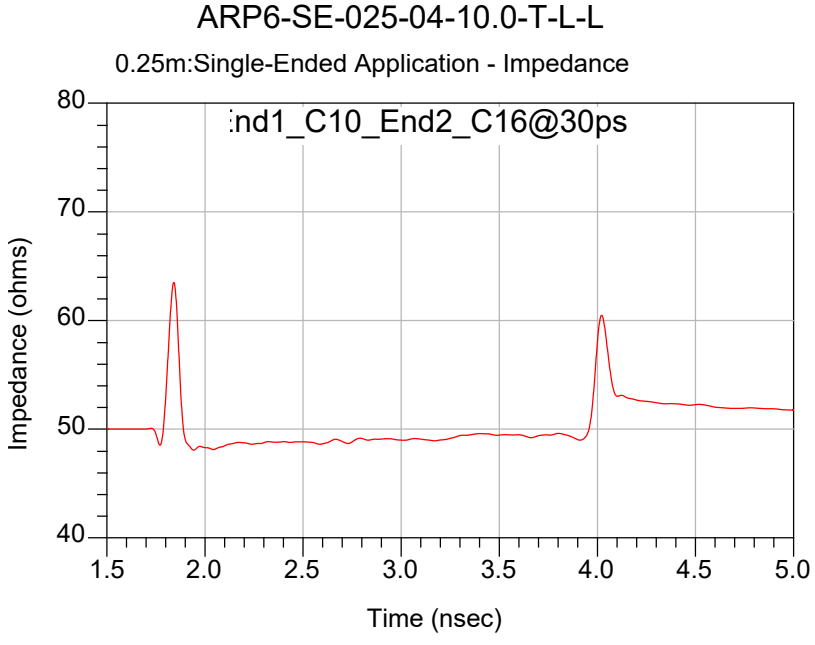

Figure 31

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

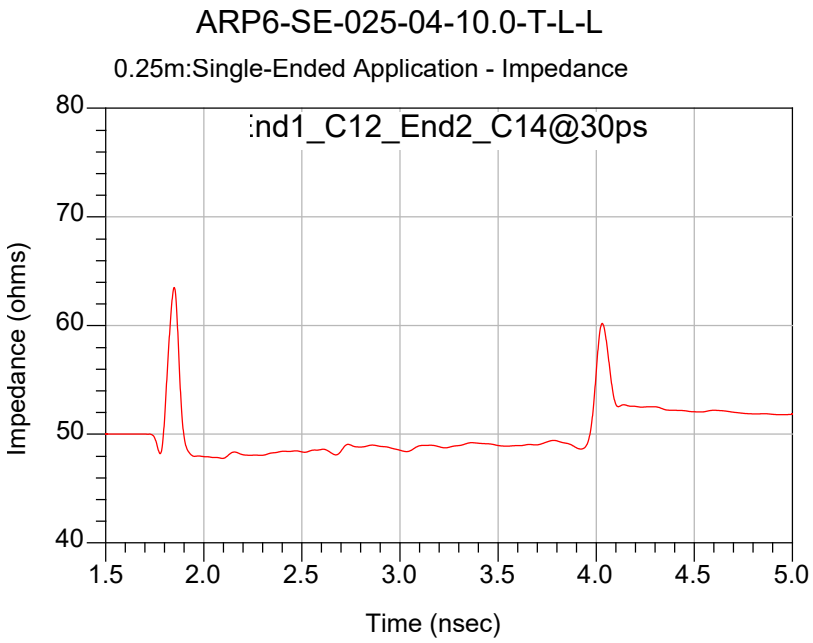

Figure 32

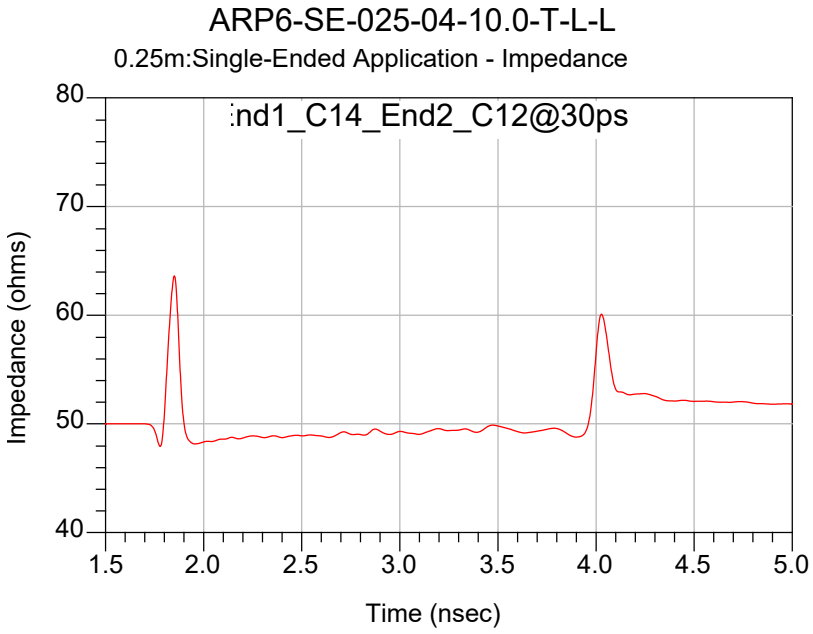

Figure 33

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

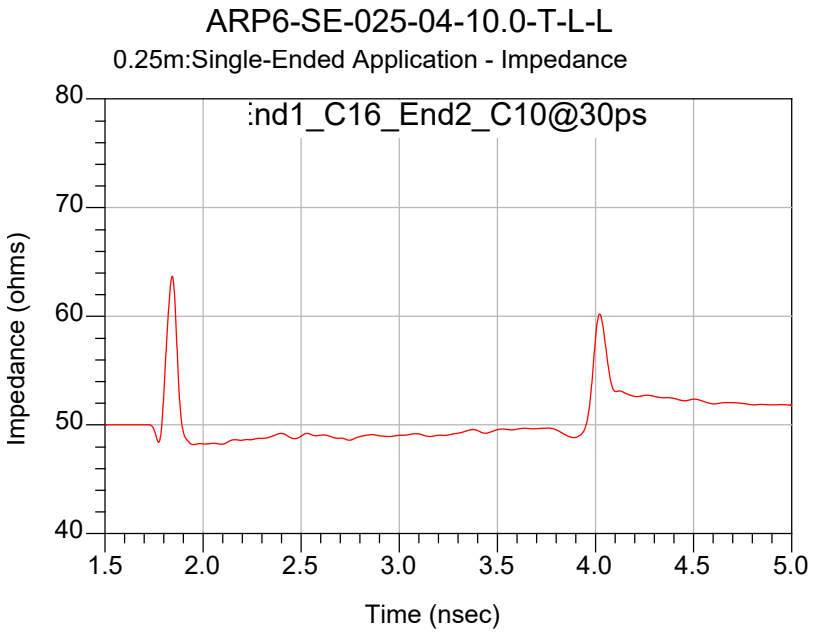

Figure 34

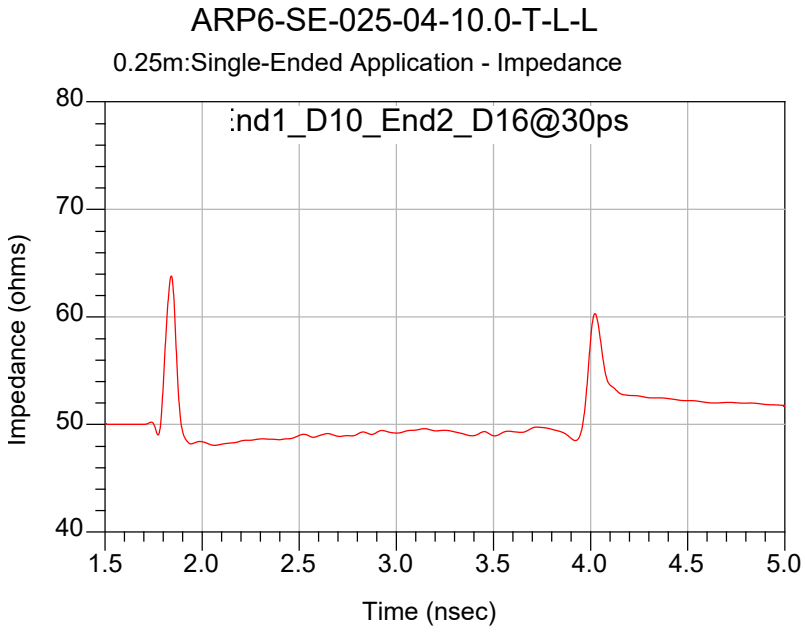

Figure 35

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

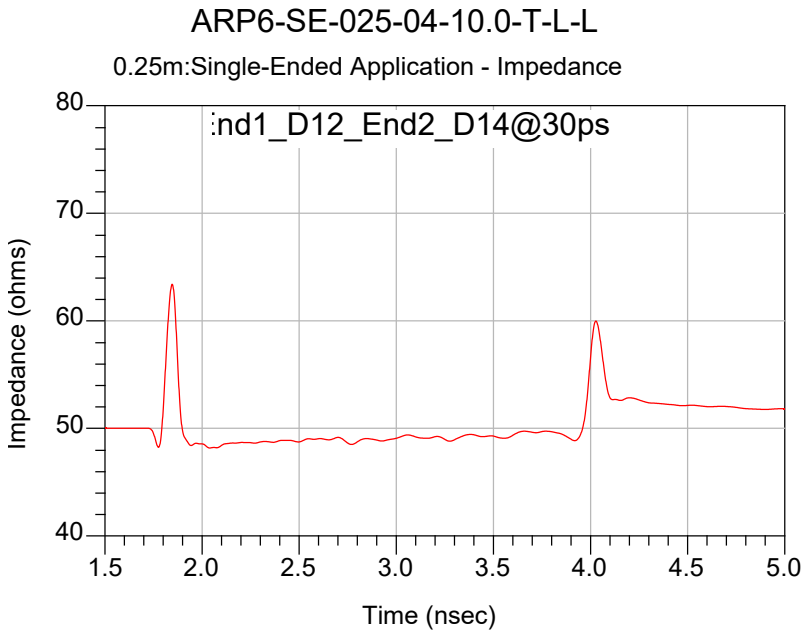

Figure 36

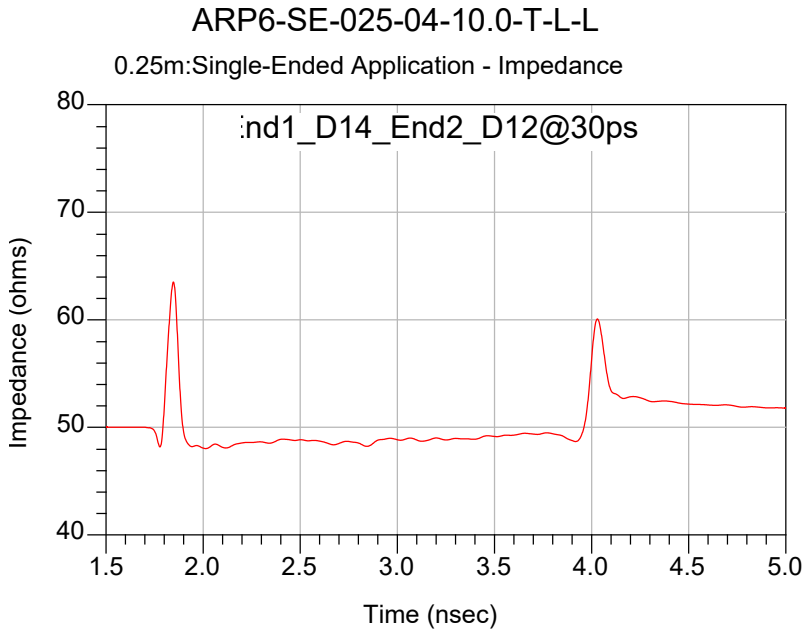

Figure 37

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

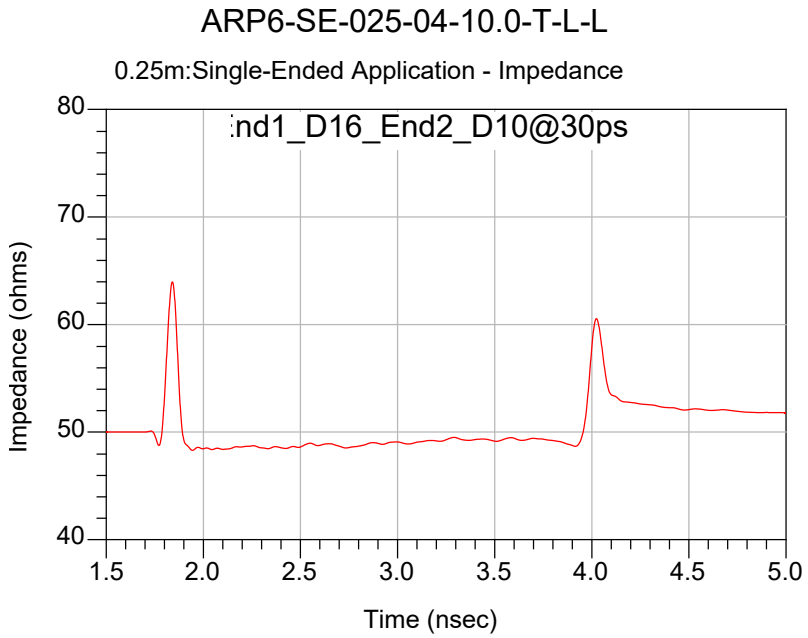

Figure 38

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

Single-ended Application – Propagation Delay

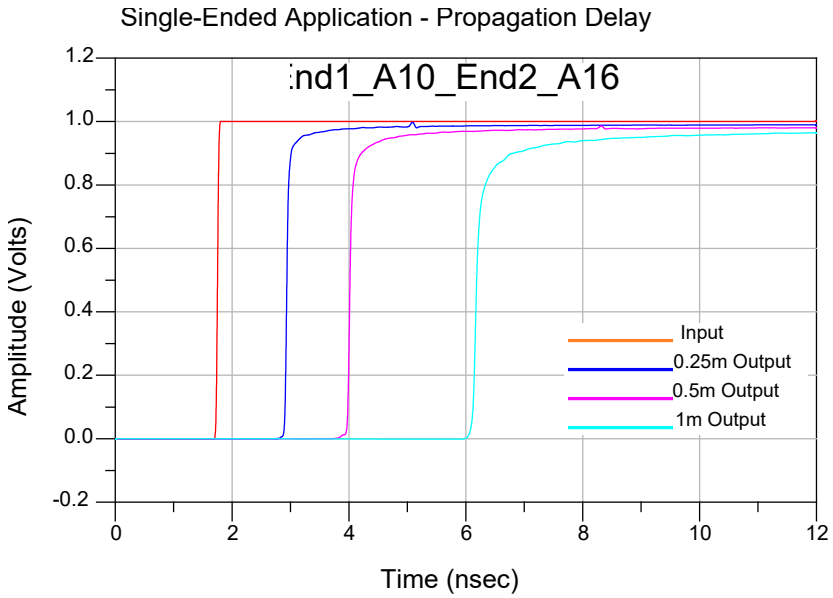

Figure 39

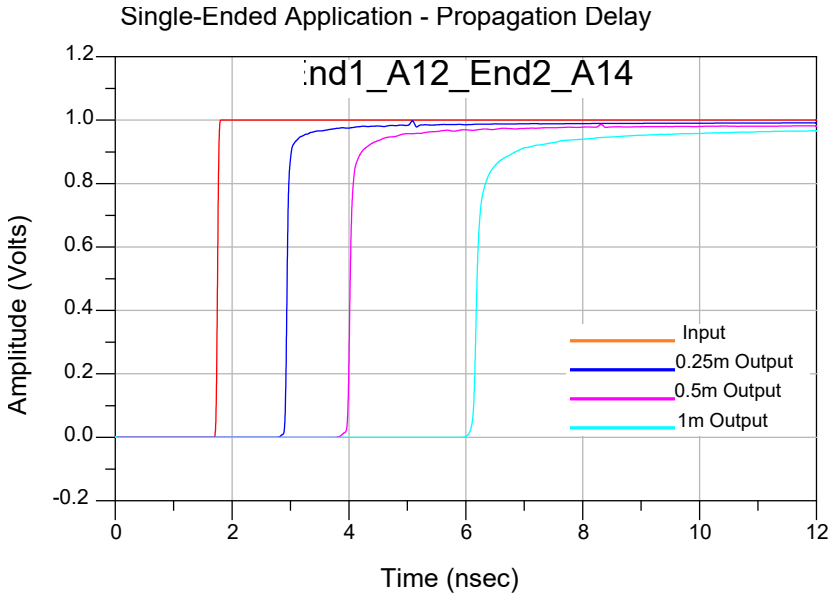

Figure 40

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

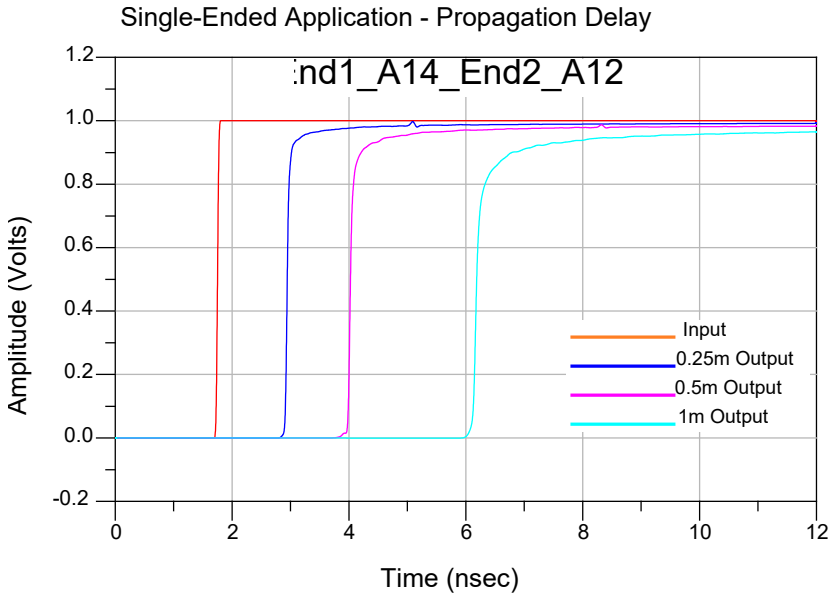

Figure 41

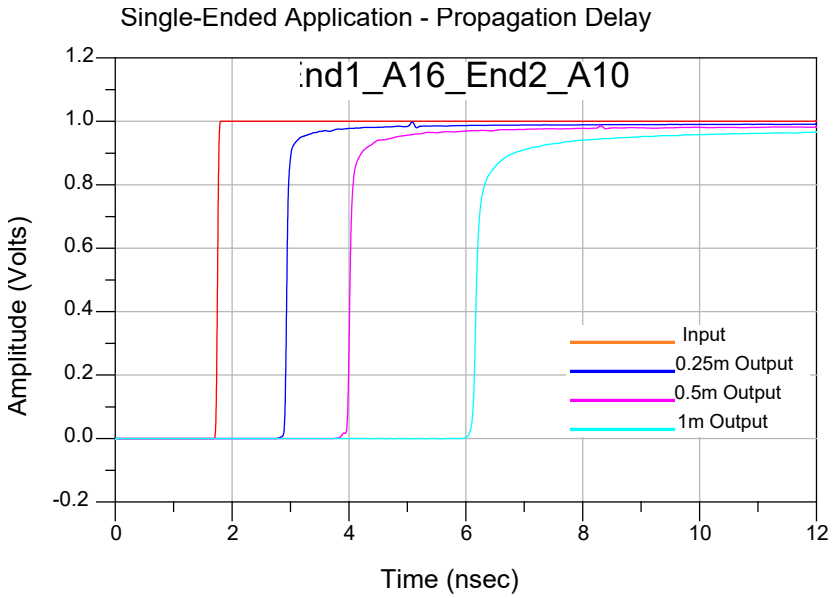

Figure 42

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

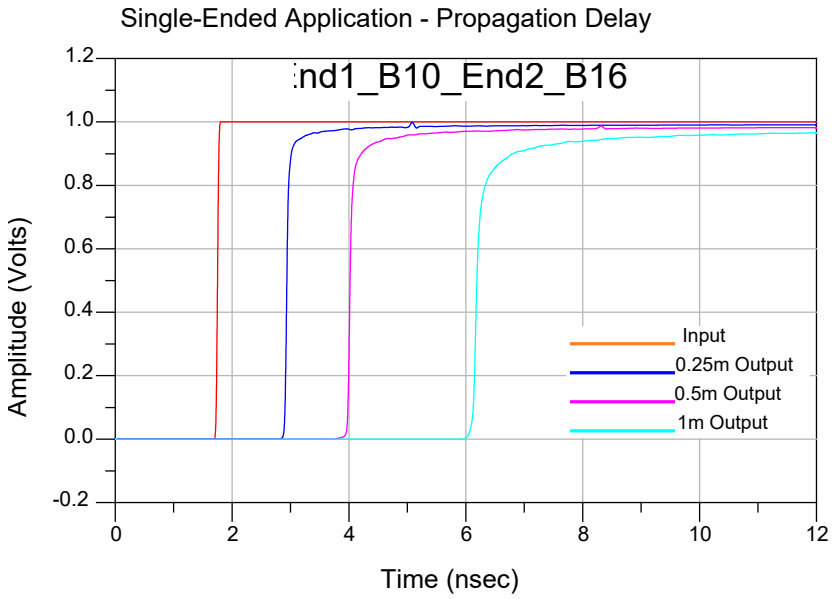

Figure 43

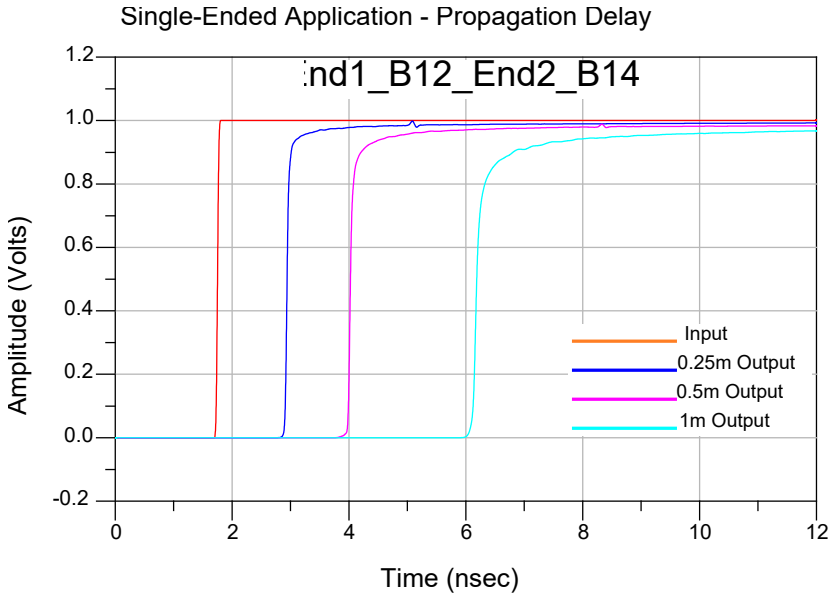

Figure 44

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

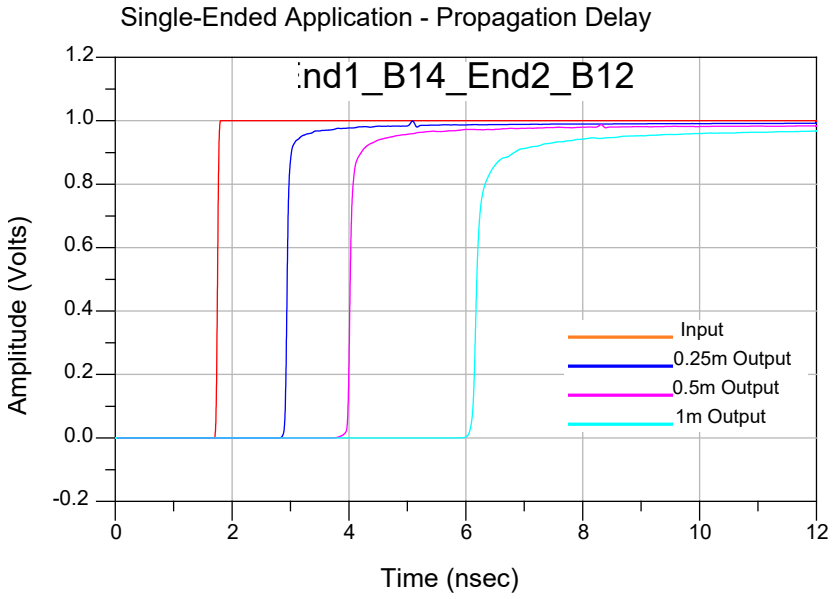

Figure 45

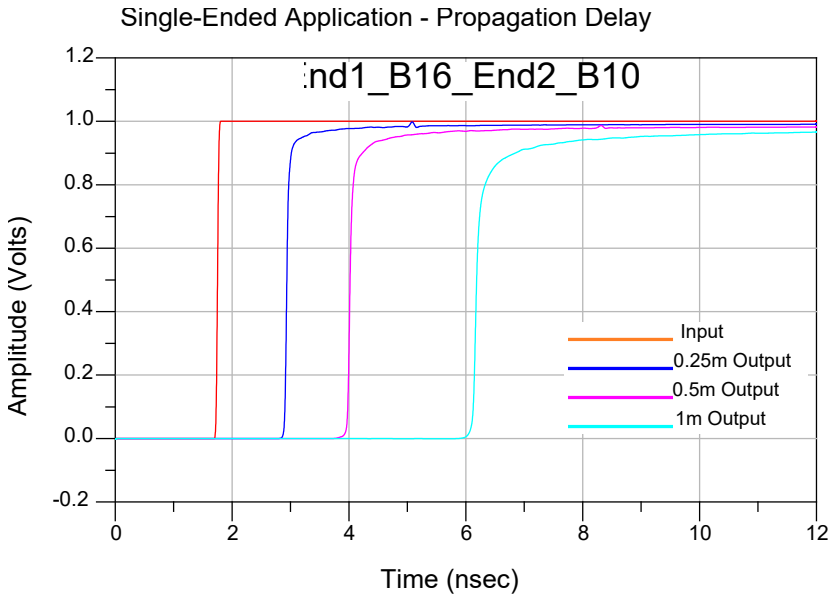

Figure 46

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

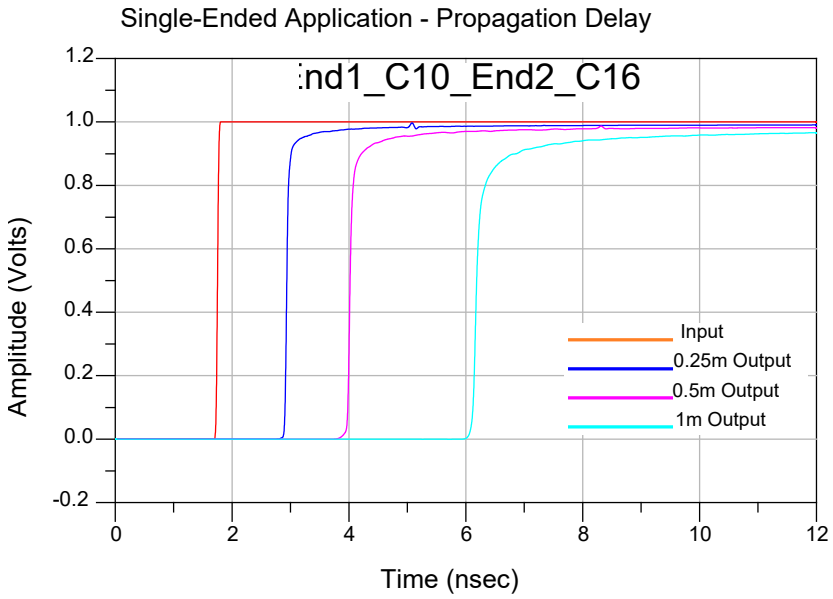

Figure 47

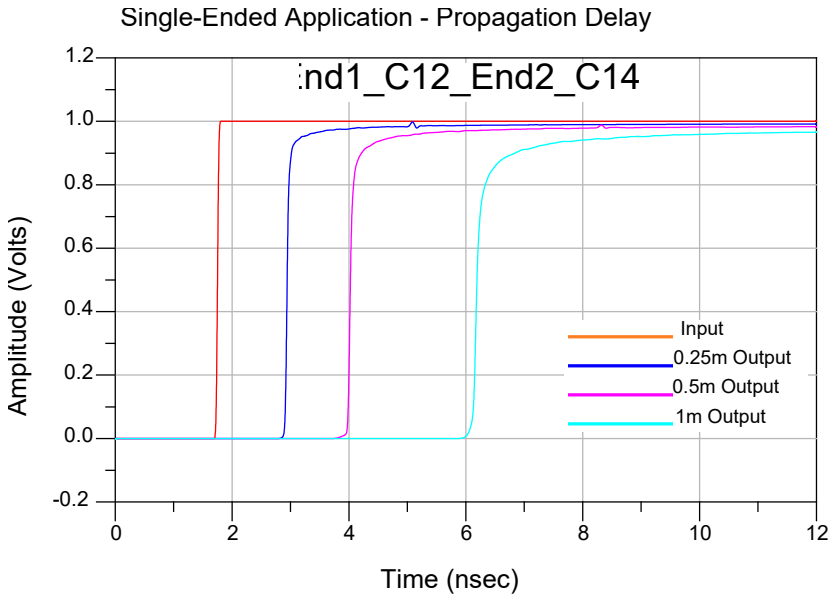

Figure 48

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

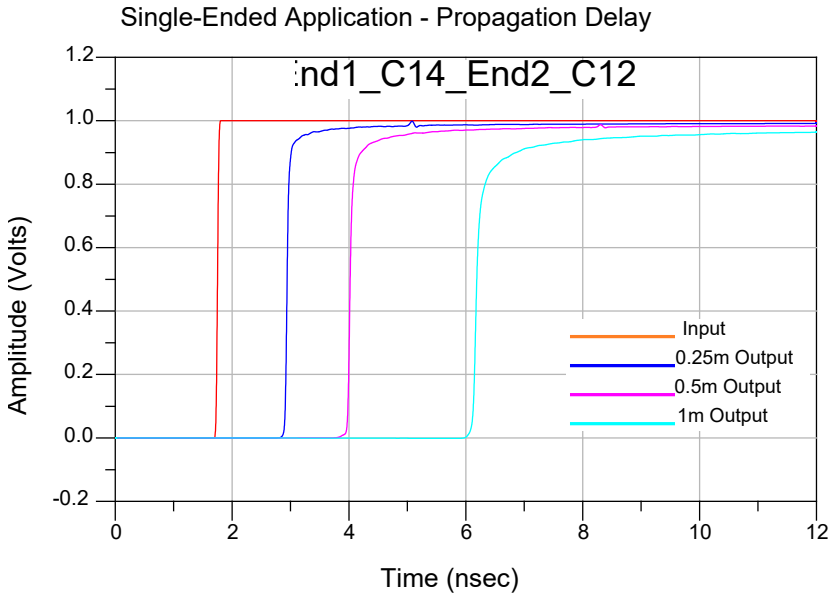

Figure 49

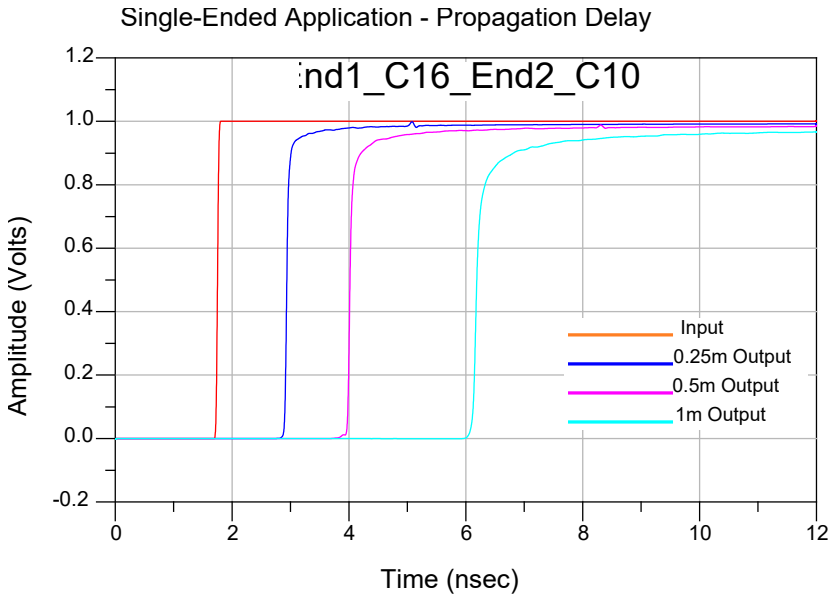

Figure 50

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

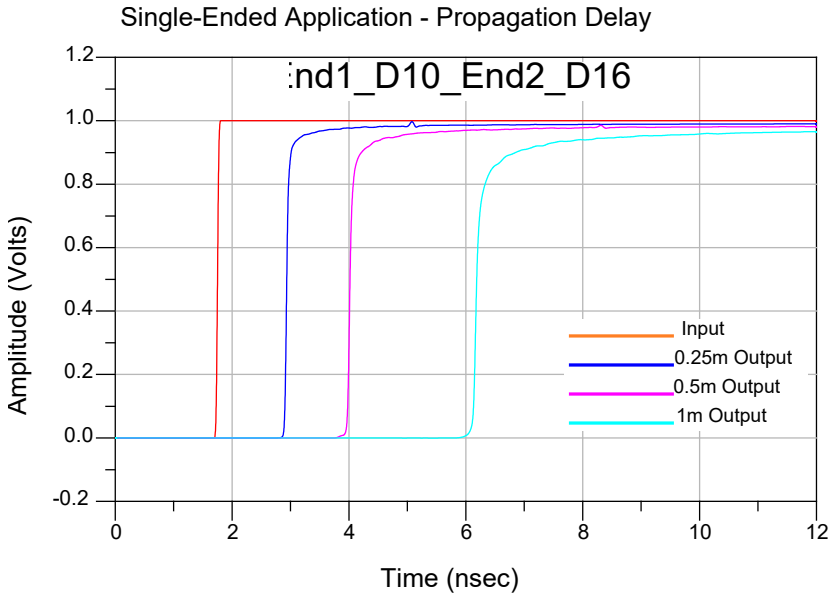

Figure 51

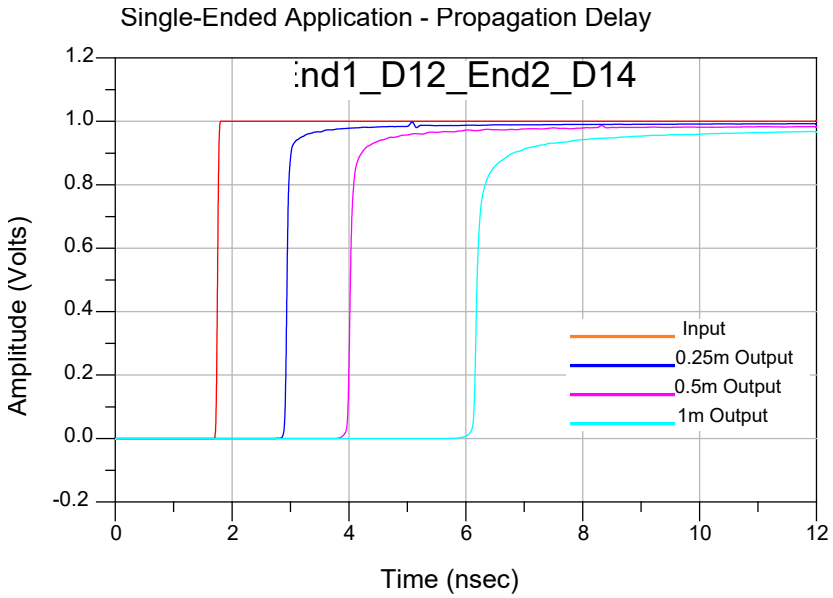

Figure 52

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

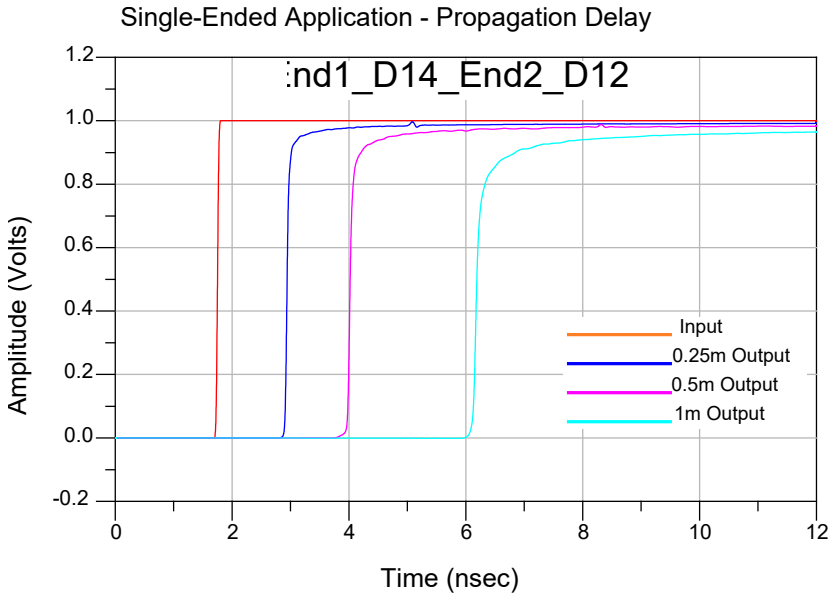

Figure 53

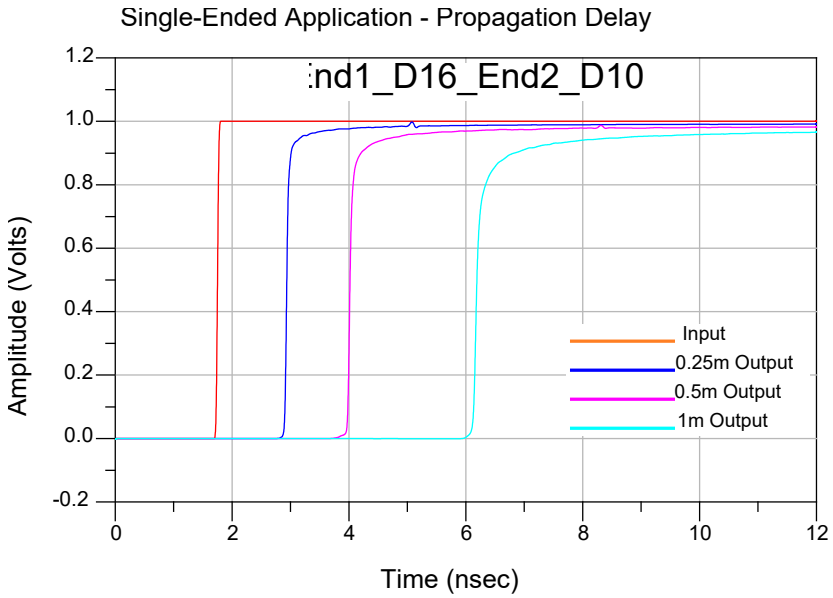

Figure 54

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

Appendix C – Product and Test System Descriptions

Product Description

Product test samples are 0.635 mm (.025") ARP6 Cable Assemblies. The part numbers are ARP6-SE-025-04-10.0-T-L-L, ARP6-SE-025-04-20.0-T-L-L and ARP6-SE-025-04-40.0-T-L-L. They mate with APF6-025-03.5-L-04-2-L-TR. A photo of the mated test article mounted to SI test boards is shown below.

The cable assembly terminations had a particular signal line configuration. There is a total of 12 signals per row, the signal line numbers are shown in Table 3.

ARP6-SE-025-04-XX.X-T-X-X SIGNAL MAPPING																									
POSITIONS																									
J1	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25
	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1	SE	GND1
J2	A25	A24	A23	A22	A21	A20	A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
J1	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25
	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2	SE	GND2
J2	B25	B24	B23	B22	B21	B20	B19	B18	B17	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
J1	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25
	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3	SE	GND3
J2	C25	C24	C23	C22	C21	C20	C19	C18	C17	C16	C15	C14	C13	C12	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1
J1	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25
	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4	SE	GND4
J2	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1
ALL GROUNDS ARE COMMON WITHIN A ROW AND TIED TO CABLE SHIELD																									
ON THE MATING BOARD ASSEMBLY, SAMTEC RECOMMENDS IMPLEMENTING A GND REFERENCE TYING ALL GND'S TOGETHER																									

Table 3：Signal line numbers

Test System Description

The test fixtures are composed of fourteen-layer Tachyon 100G material with 50Ω signal trace and pad configurations designed for the electrical characterization of Samtec high speed cable assembly 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 ARx6 series connector set and identified by part number PCB-112797-SIG-0.

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

PCB-112797-SIG-0 Test Fixtures

Figure 55

PCB Fixtures

The test fixtures used are as follows:

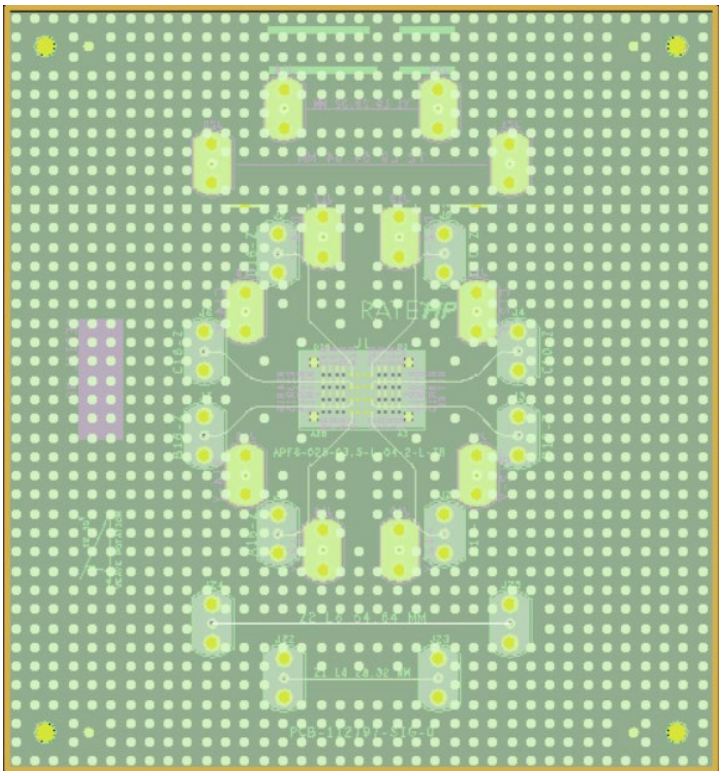

Figure 56

PCB-112797-SIG-0– ARP6 Cable Test Board

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

Appendix D – Test and Measurement Setup

For frequency domain measurements, the test instrument is the Agilent N5225B PNA-L network analyzer. Frequency domain data and graphs are extracted from the instrument by AFR application. The network analyzer is configured as follows:

Start Frequency – 10 MHz
Stop Frequency – 40 GHz
IFBW – 500 Hz

N5225B Measurement Setup

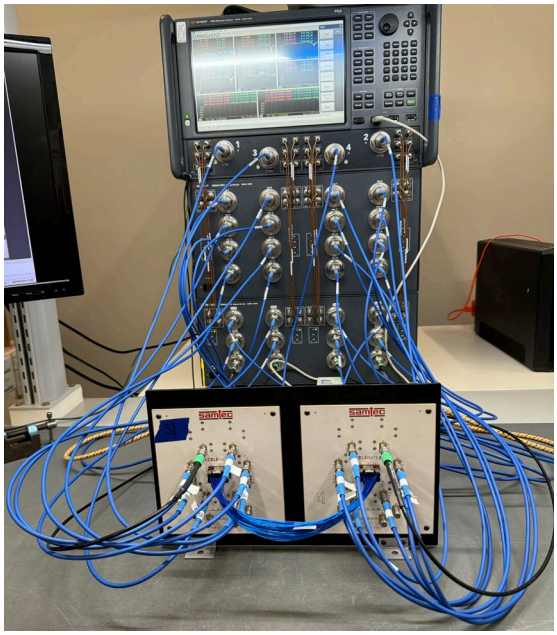

Figure 57

Test Instruments

QTY	Description
1	Agilent N5225B PNA-L Network Analyzer (10 MHz to 40 GHz)
1	Agilent N4694-60003 ECAL Module (10 MHz to 67 GHz)

Test Cables & Adapters

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

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

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

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

Time Domain Procedures

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

The Time Domain responses were generated using Keysight ADS 2023 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://suddendocs.samtec.com/notesandwhitepapers/tech-note_using-plts-for-time-domain-data_web.pdf

Propagation Delay (TDT)

The Propagation Delay is a measure of the Time Domain delay through the cable assembly and footprint. A step pulse is applied to the touchstone model of the cable assembly, and the transmitted voltage is monitored. The same pulse is also applied to a reference channel with zero loss, and the Time Domain pulses are plotted on the same figure.
The difference in time, measured at the 50% point of the step voltage, is the propagation delay.

Series: ARP6-SE
Description: AcceleRate® HP High-Density, High-Performance Cable System, 34 AWG Eye Speed® ThinSE™ Micro Coax, 4-Row

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.

Appendix F – Glossary of Terms

ADS – Keysight Advanced Design System
AFR – Automatic Fixture Removal
PCB – Printed Circuit Board
SUT – System Under Test
SOLT – acronym used to define Short, Open, Load & Thru Calibration Standards
TDR – Time Domain Reflectometry
TDT – Time Domain Transmission