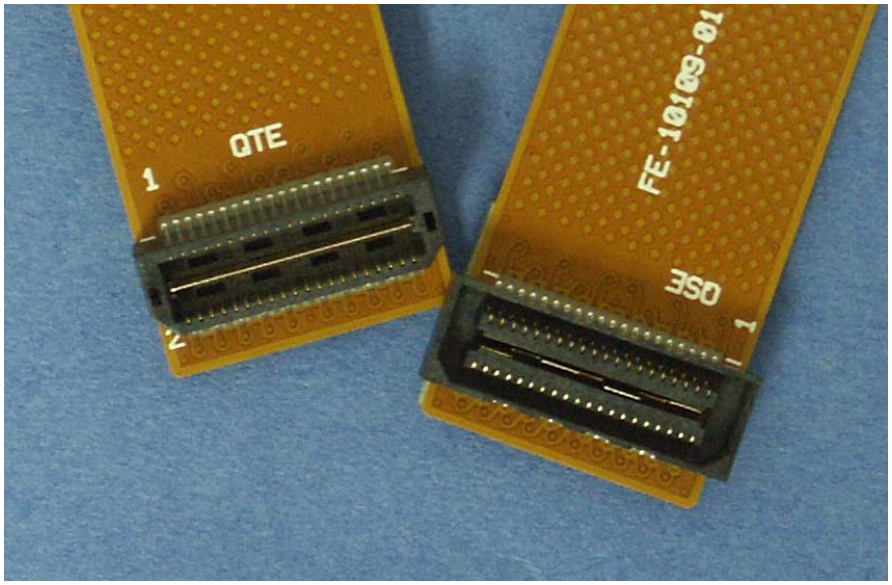
SPICE Model Validation Report

HFEM-SE High Speed Flex Data Link



Mated with:
QTE-xxx-01-x-D-A
QSE-xxx-01-x-D-A

Description:
Flex Data Link, High Speed, 0.8mm Pitch

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Report Revision: 9/13/2007

Series: HFEM-SE Mated with QTE and QSE
Description: Flex Data Link, High Speed, 0.8mm Pitch

TABLE OF CONTENTS

Series: HFEM-SE Mated with QTE and QSE
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INTRODUCTION

An electrical model of the HFEM-SE series high speed flex data link was created to allow customers to simulate the signal integrity performance. This report presents the comparison of simulated model data to empirical sample data.

Measurements were performed in the frequency domain using Agilent Physical Layer Test System (PLTS), version 4.003. Swept frequency simulations were performed in HSPICE from which a four port Touchstone file was generated. The Touchstone file was imported into PLTS and compared to the measured data. Using PLTS for measurement and post processing purposes eliminates issues regarding disparages between the simulation and measurement stimuli.

MODEL DESCRIPTION

The model is specific to HFEM-SE high speed flex data link assemblies where the outer connector rows are connected together as are the inner connector rows. Specifically, part number:

HFEM-020-T-10.00-SE

The cable portion of the model utilizes an HSPICE W-Element where the cable length is a variable set by the simulator. Thus any cable length can be achieved by adjusting this parameter. In this report a 10” sample was used in the empirical measurements and compared to simulations using a model of a 10” assembly.

Series: HFEM-SE Mated with QTE and QSE
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CORRELATION RESULTS SUMMARY

Time Domain Data Tables

Short Path

	Z Test Board Pad/Connector (Ω)	Z Connector (Ω)	Z Cable (Ω)	NEXT (mV)	FEXT (mV)	PD (ns)
Measured	38.3	61.1	49.2	25.3	10.1	2.823
Simulated	38.5	62.3	51.4	24.9	8.5	2.907

Long Path

	Z Test Board Pad/Connector (Ω)	Z Connector (Ω)	Z Cable (Ω)	NEXT (mV)	FEXT (mV)	PD (ns)
Measured	47.1	65.1	48.9	25.3	8.6	2.913
Simulated	47.4	69.4	51.6	28.5	7.6	3.042

Frequency Domain Data Tables

RL Short Path

	Frequency (GHz)				
	0.3	1	2	3	4
Measured	-33.5 dB	-27.6 dB	-16.5 dB	-12.6 dB	-11.6 dB
Simulated	-39.8 dB	-25.4 dB	-14.6 dB	-12.1 dB	-13.6 dB

RL Long Path

	Frequency (GHz)				
	0.5	1.15	2	3	4
Measured	-19.9 dB	-17.5 dB	-13.4 dB	-17.1 dB	-16.2 dB
Simulated	-26.7 dB	-15.7 dB	-15.4 dB	-18.2 dB	-14.5 dB

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IL Short Path

	Frequency (GHz)					f @ -3dB pt
	0.5	1	2	3	4	
Measured	-2.1 dB	-3.5 dB	-6.3 dB	-8.9 dB	-11.2 dB	792MHz
Simulated	-1.9 dB	-3.4 dB	-6.2 dB	-9.0 dB	-11.8 dB	878MHz

IL Long Path

	Frequency (GHz)					f @ -3dB pt
	0.5	1	2	3	4	
Measured	-2.3 dB	-3.5 dB	-6.0 dB	-7.7 dB	-10.3 dB	770MHz
Simulated	-1.9 dB	-3.4 dB	-6.0 dB	-8.7 dB	-11.9 dB	860MHz

NEXT Short Path

	Frequency (GHz)				
	0.5	1	2	3	4
Measured	-25.6 dB	-16.7 dB	-13.9 dB	-14.9 dB	-16.1 dB
Simulated	-35.0 dB	-18.0 dB	-16.0 dB	-16.5 dB	-16.8 dB

NEXT Long Path

	Frequency (GHz)				
	0.5	1	2	3	4
Measured	-20.6 dB	-21.1 dB	-22.8 dB	-17.0 dB	-14.5 dB
Simulated	-28.2 dB	-20.7 dB	-21.6 dB	-15.0 dB	-13.5 dB

FEXT Short Path

	Frequency (GHz)				
	0.5	1	2	3	4
Measured	-26.0 dB	-27.6 dB	-24.3 dB	-25.3 dB	-24.9 dB
Simulated	-32.7 dB	-28.9 dB	-26.8 dB	-26.9 dB	-27.1 dB

FEXT Long Path

	Frequency (GHz)				
	0.5	1	2	3	4
Measured	-25.1 dB	-30.0 dB	-28.3 dB	-31.0 dB	-26.2 dB
Simulated	-31.4 dB	-29.4 dB	-29.6 dB	-28.1 dB	-26.5 dB

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Description: Flex Data Link, High Speed, 0.8mm Pitch

Time Domain Plots

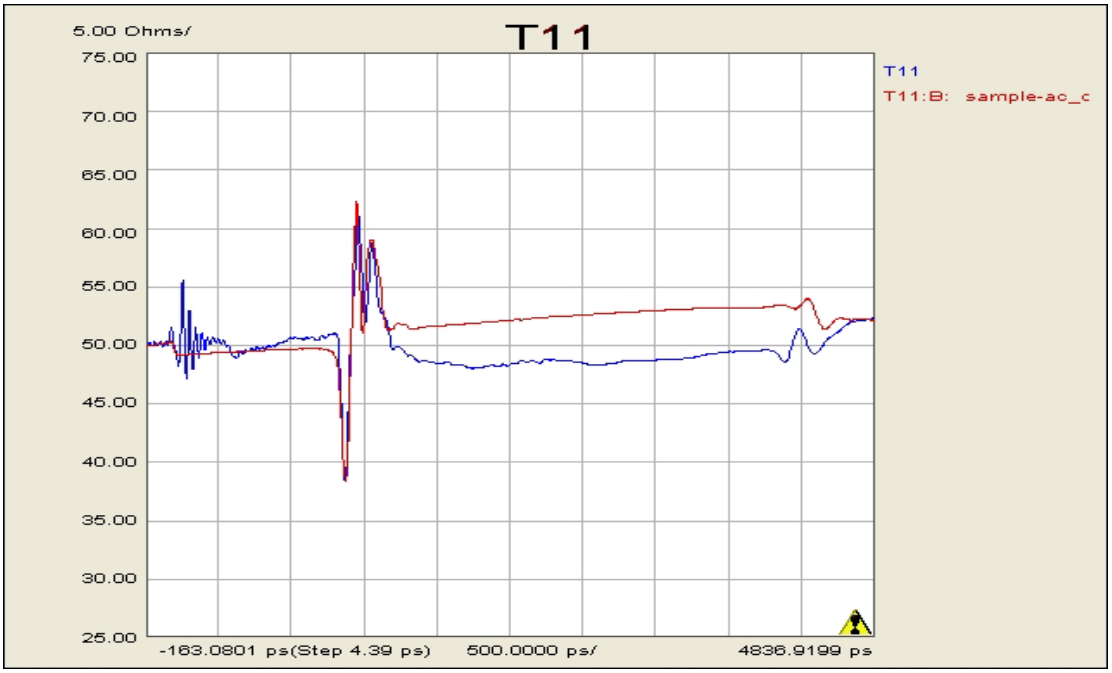

Figure 1: Measured and Simulated Z(t) Short Path.

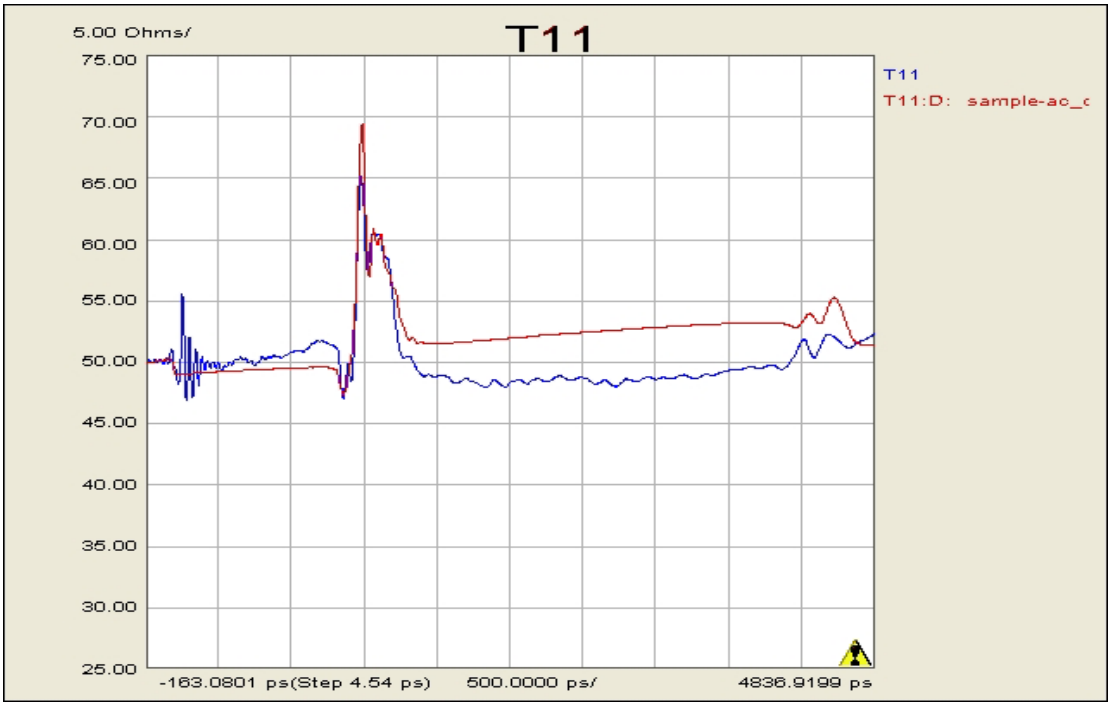

Figure 2: Measured and Simulated Z(t) - Long Path.

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Description: Flex Data Link, High Speed, 0.8mm Pitch

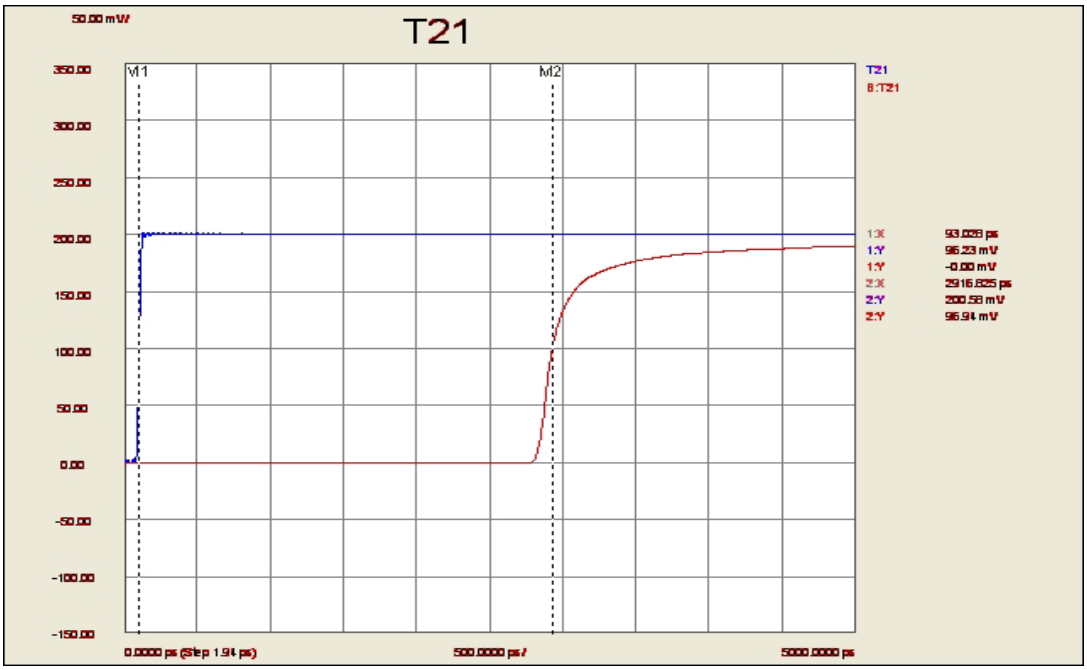

Figure 3: Measured Propagation Delay Short Path.

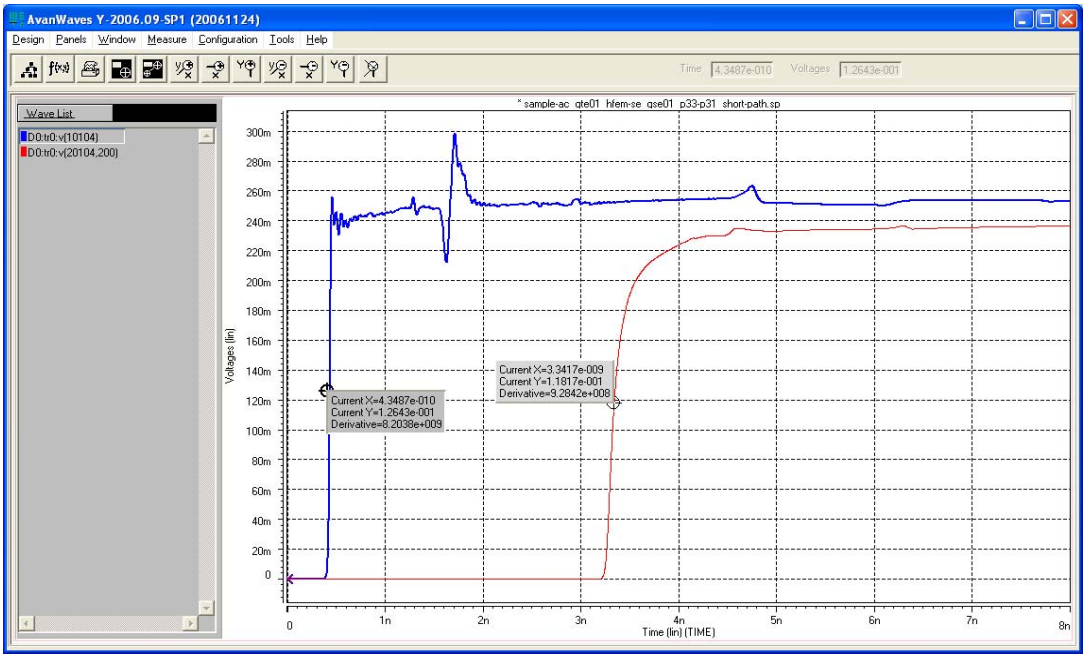

Figure 4: Simulated Propagation Delay Short Path.

Series: HFEM-SE Mated with QTE and QSE
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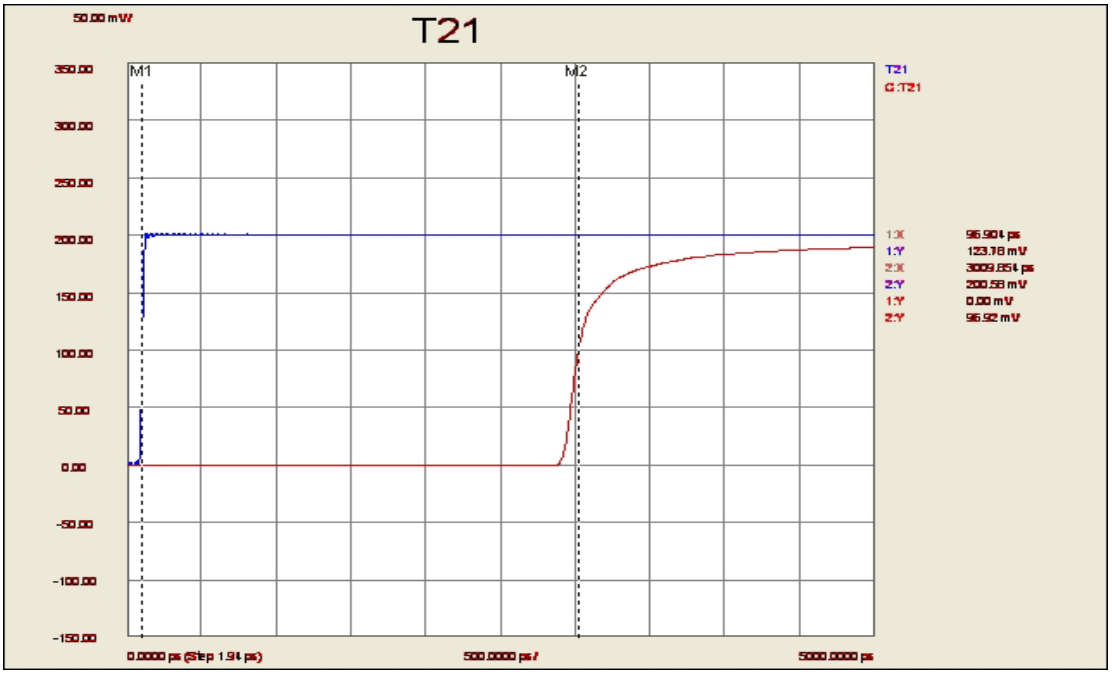

Figure 5: Measured Propagation Delay Long Path.

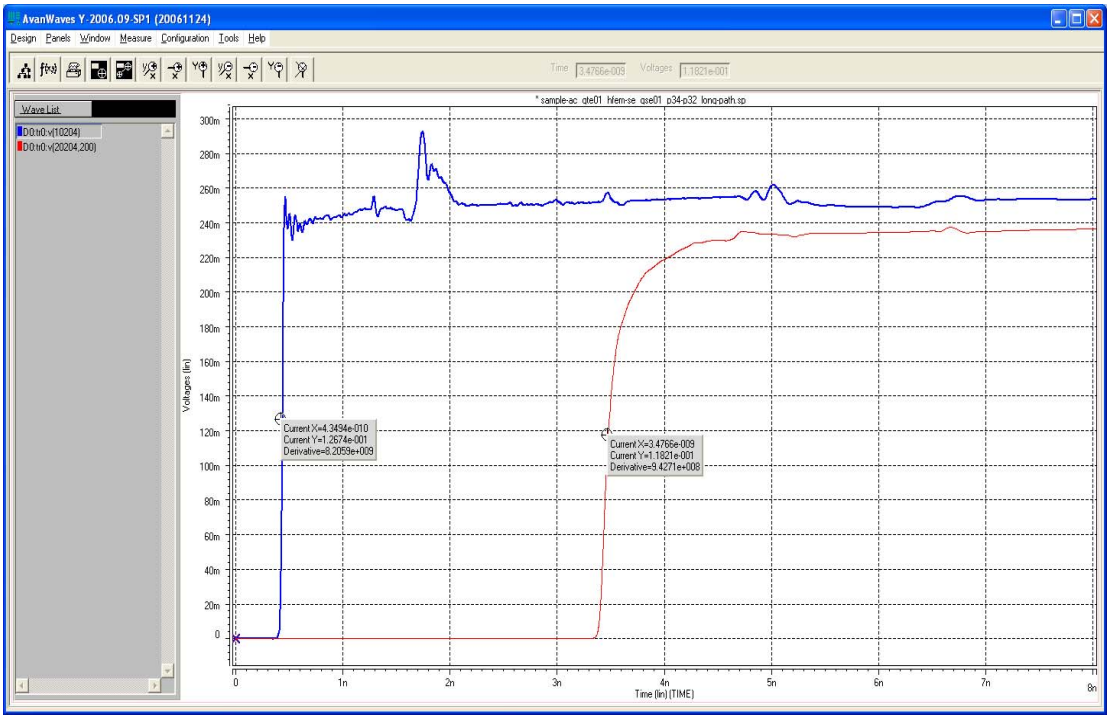

Figure 6: Simulated Propagation Delay Long Path.

Series: HFEM-SE Mated with QTE and QSE
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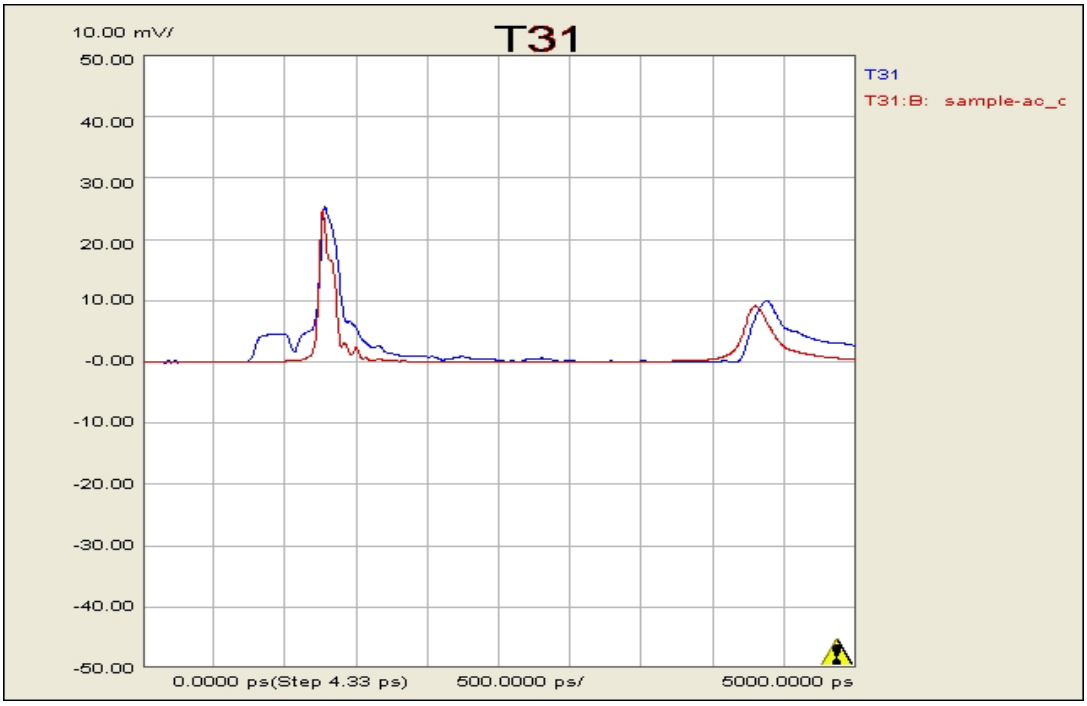

Figure 7: Measured and Simulated Near End Crosstalk - Short Path.

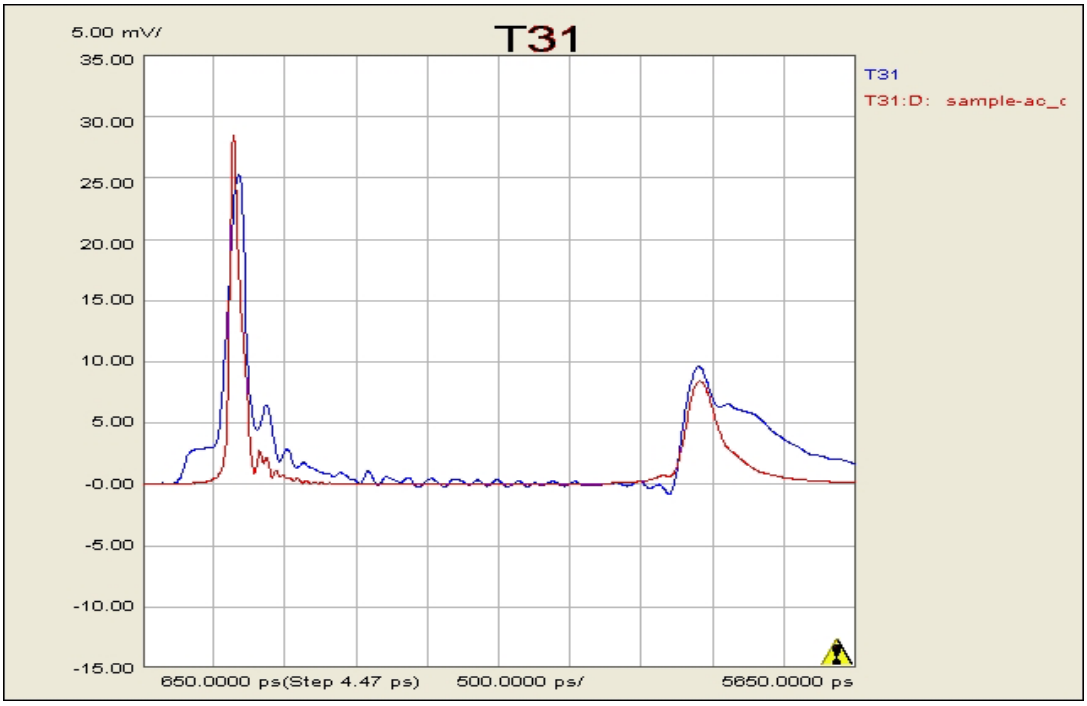

Figure 8: Measured and Simulated Near End Crosstalk - Long Path.

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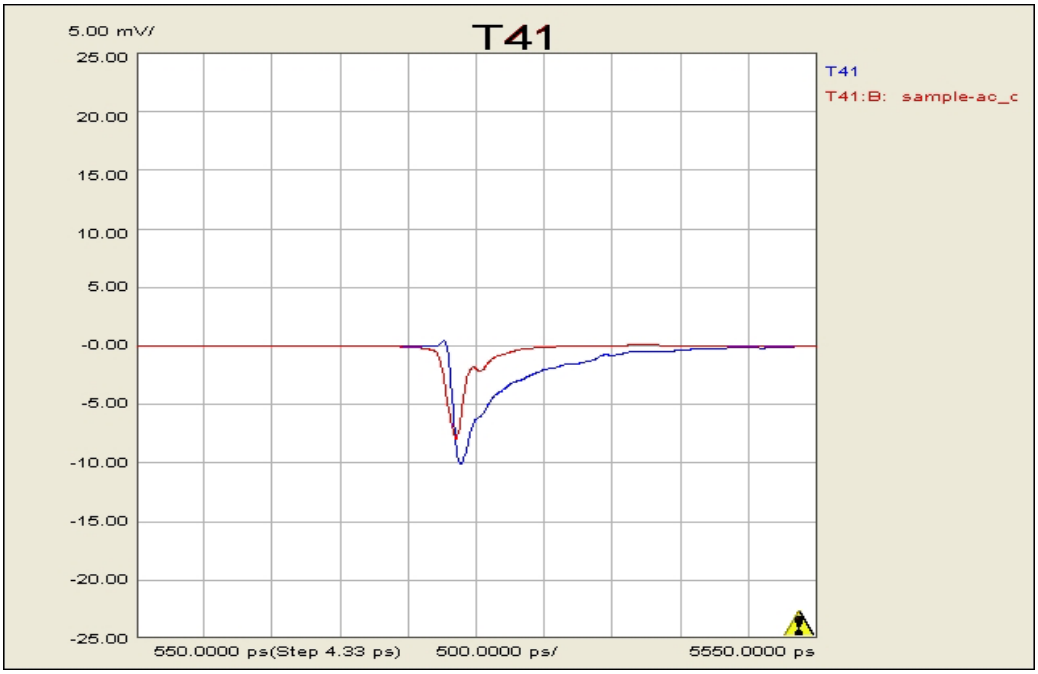

Figure 9: Measured and Simulated Far End Crosstalk - Short Path

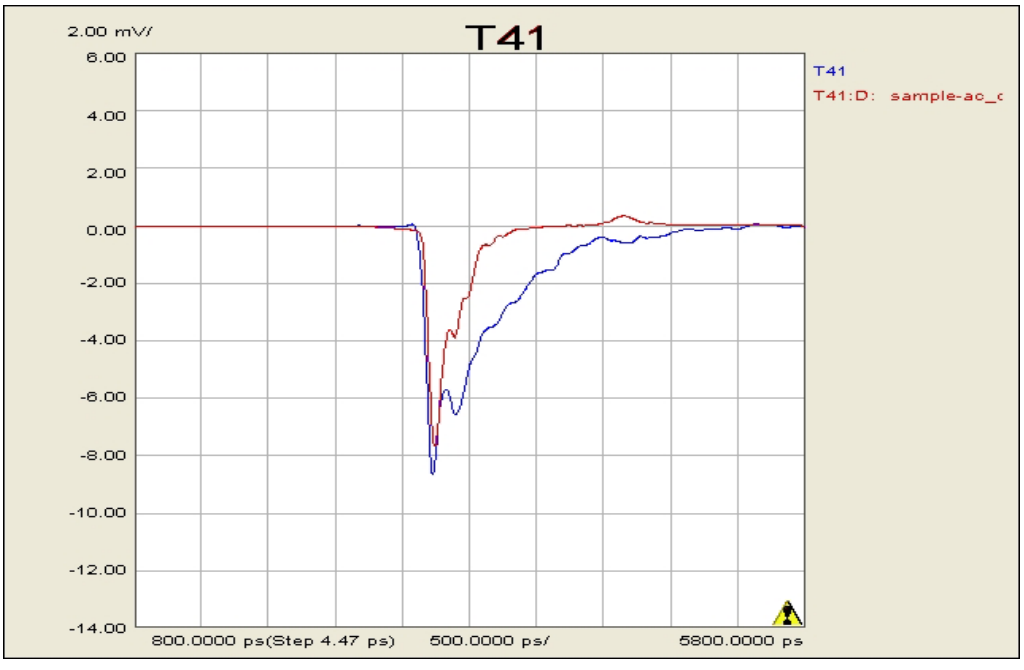

Figure 10: Measured and Simulated Far End Crosstalk - Long Path.

Series: HFEM-SE Mated with QTE and QSE
Description: Flex Data Link, High Speed, 0.8mm Pitch

Frequency Domain Plots

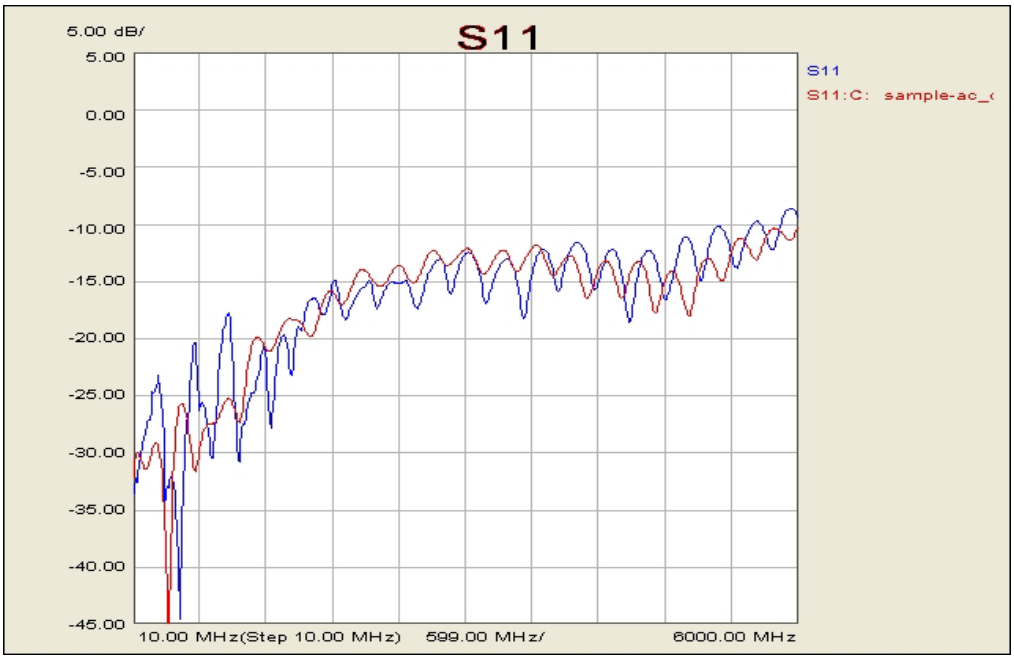

Figure 11: Measured and Simulated RL-Short Path.

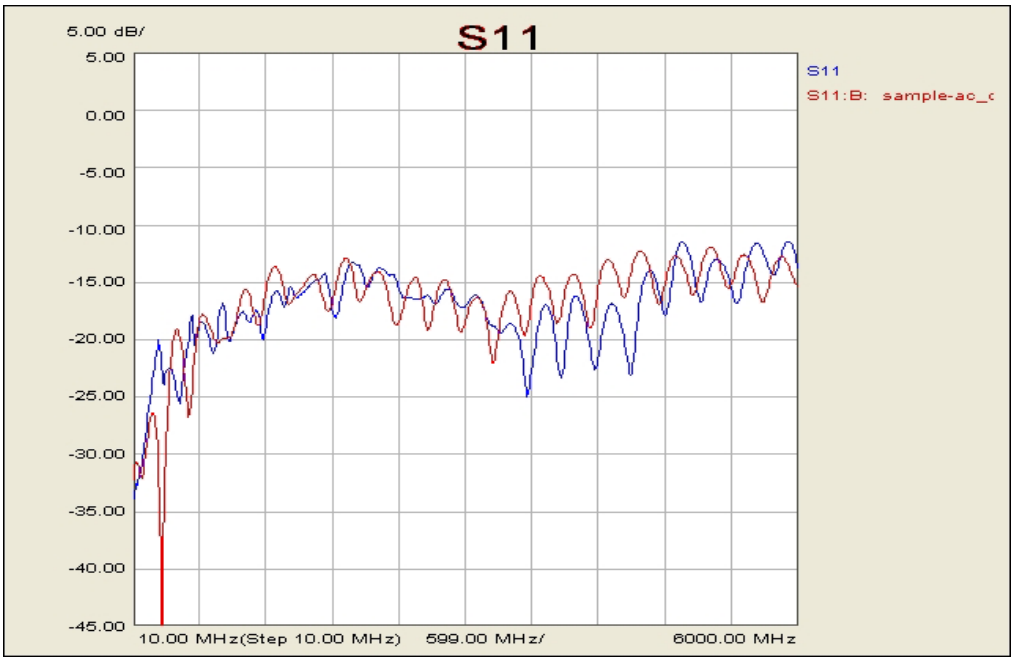

Figure 12: Measured and Simulated RL-Long Path.

Series: HFEM-SE Mated with QTE and QSE
Description: Flex Data Link, High Speed, 0.8mm Pitch

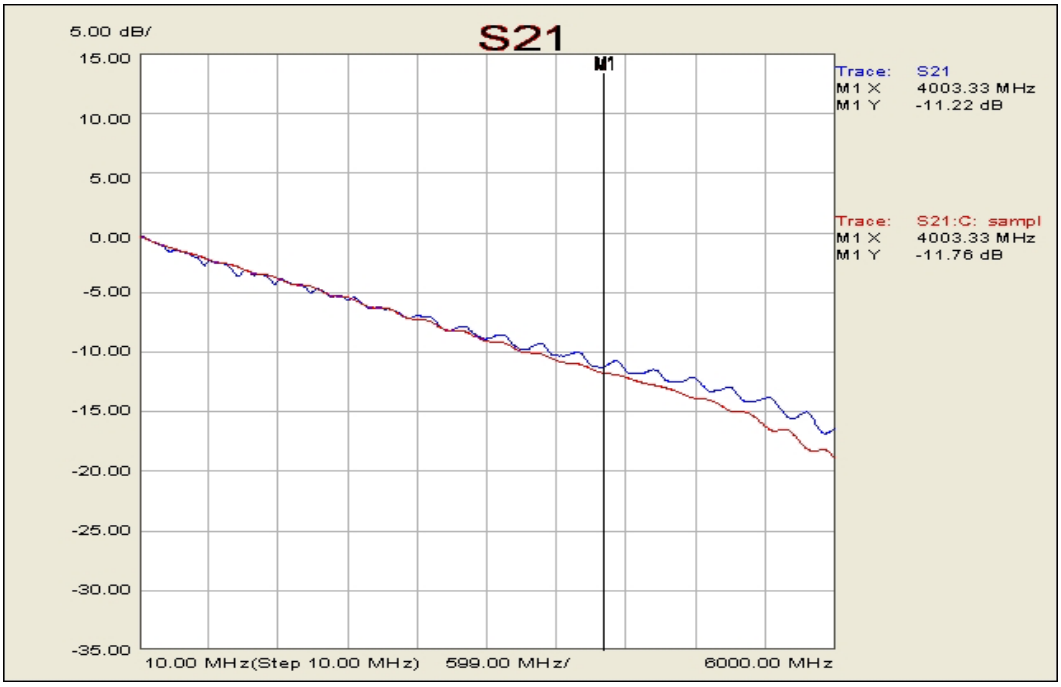

Figure 13: Measured and Simulated IL-Short Path.

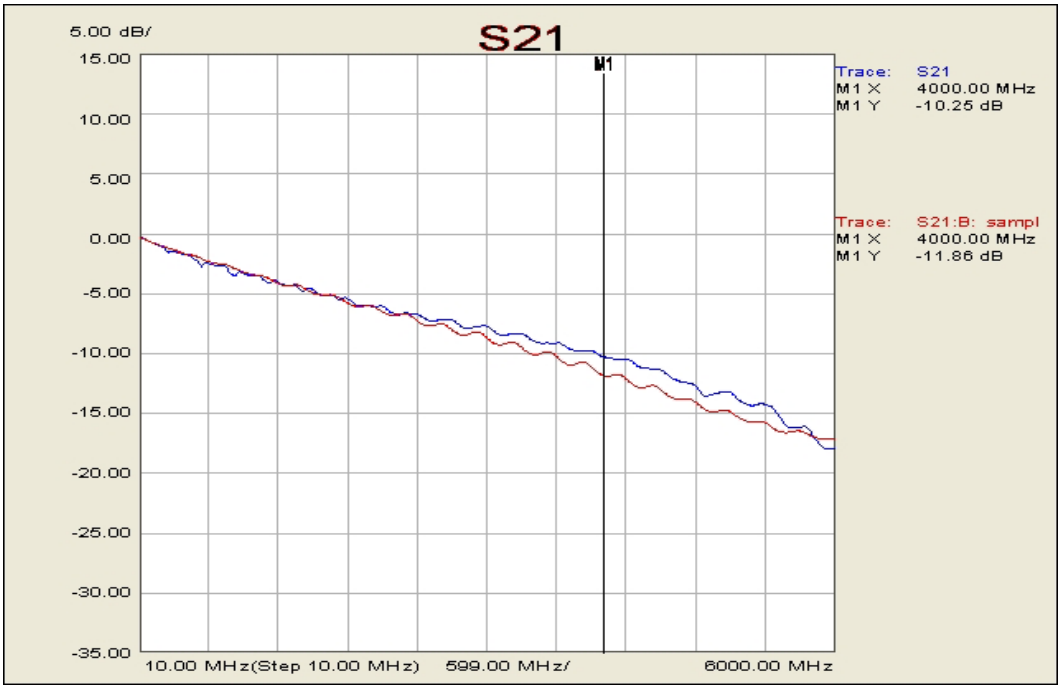

Figure 14: Measured and Simulated IL-Long Path.

Series: HFEM-SE Mated with QTE and QSE
Description: Flex Data Link, High Speed, 0.8mm Pitch

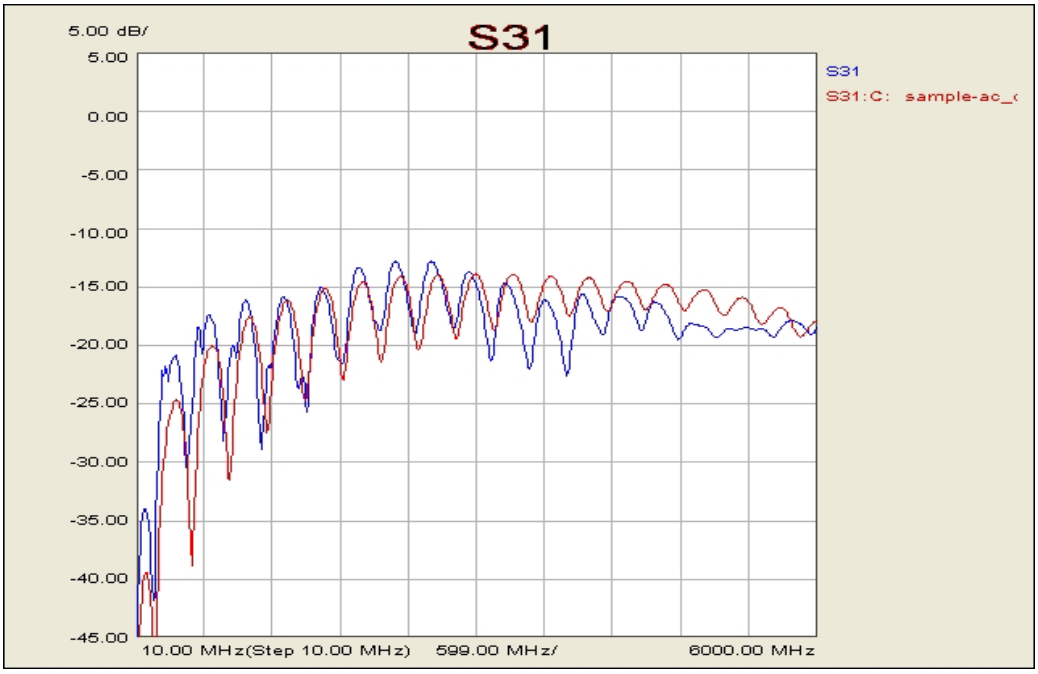

Figure 15: Measured and Simulated NEXT-Short Path.

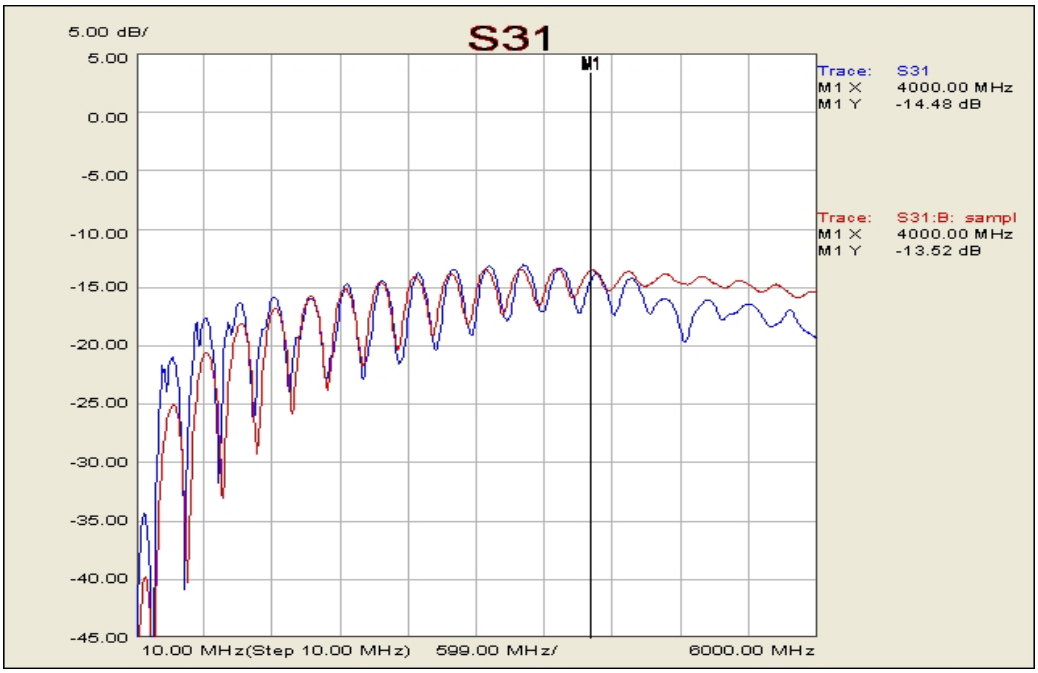

Figure 16: Measured and Simulated NEXT-Long Path.

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Description: Flex Data Link, High Speed, 0.8mm Pitch

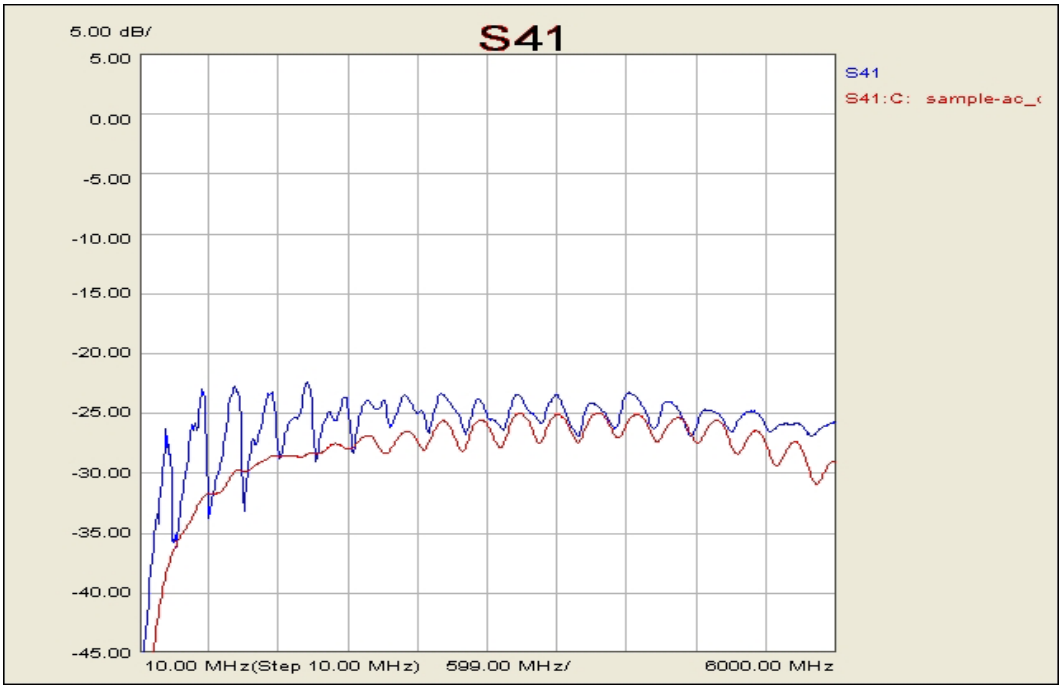

Figure 17: Measured and Simulated FEXT-Short Path.

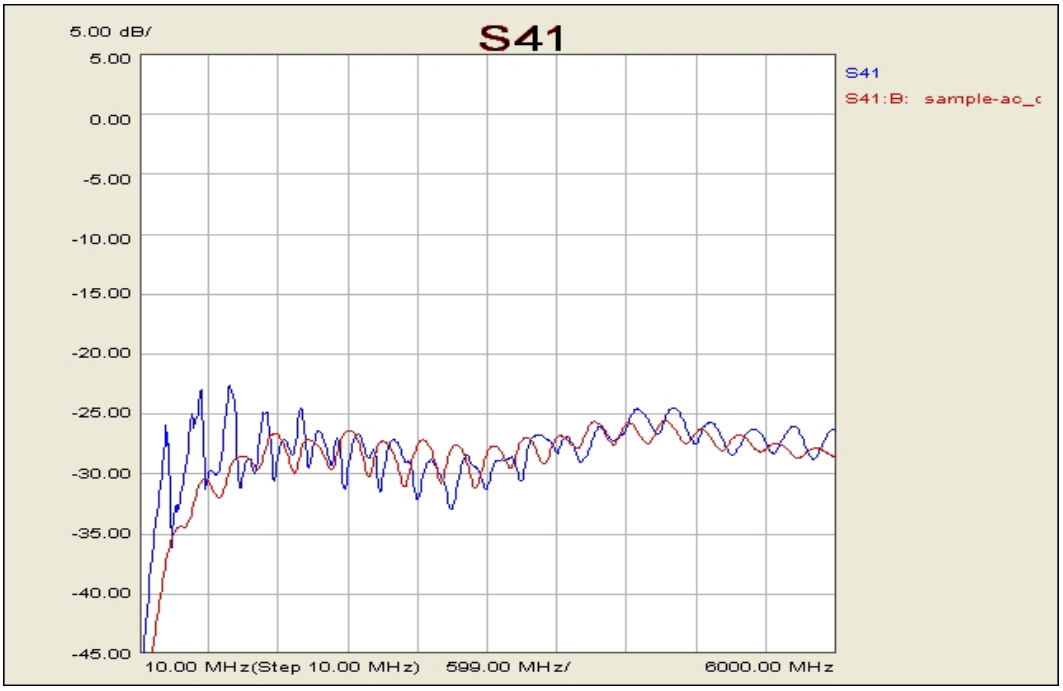

Figure 18: Measured and Simulated FEXT-Long Path.

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TEST PROCEDURES

Measurements were made in the frequency domain using the Agilent PLTS. Time domain data was generated in PLTS by virtue of its Fourier Transform capability.

The PLTS was set with the following settings:

Fstart = 10MHz
Fstop = 26.5GHz
IF BW = 1kHz
Averages = 1
Number of points = 2650

A full (12 term error correction) 4 port 3.5mm calibration was performed on the PLTS at the end of the coax test cables (refer to Figure 18 on next page). QTE/QSE Final Inch™ test boards were utilized for fixturing. A reference measurement was performed to determine the propagation delay thru the coax test cables. Thus the DUT consists of a near end Final Inch board, the EQCD-SE cable assembly, and a far end Final Inch™ test board as in Figure 17.

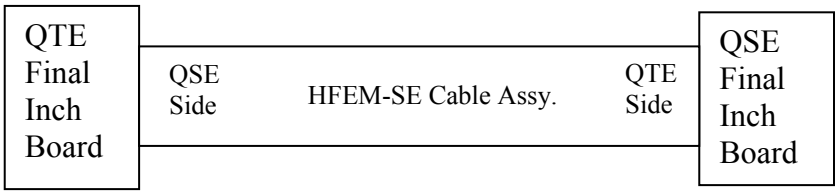

Figure 19: DUT.

The short signal path was measured on Final Inch® SMA J33 and J31. On the QTE Final Inch™ board J33 was attached to port 1 and J31 was attached to port 3 of the PLTS. On the QSE Final Inch™ board J33 was attached to port 2 and J31 was attached to port 4 of the PLTS.

The long signal path was measured on Final Inch™ SMA J34 and J32. On the QTE Final Inch™ board J34 was attached to port 1 and J32 was attached to port 3 of the PLTS. On the QSE Final Inch™ board J34 was attached to port 2 and J32 was attached to port 4 of the PLTS. Using the aforementioned Final Inch™ board connections allowed for four port measurements in a GSSG configuration.

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Swept frequency model simulations were performed with HSPICE which generated a 4-port Touchstone file. The following HSPICE sweep control statement was used:

.AC LIN 2600 10E6 26.5e9

The Touchstone file was imported into PLTS where time domain data was generated and comparative plots were generated with the measured data.

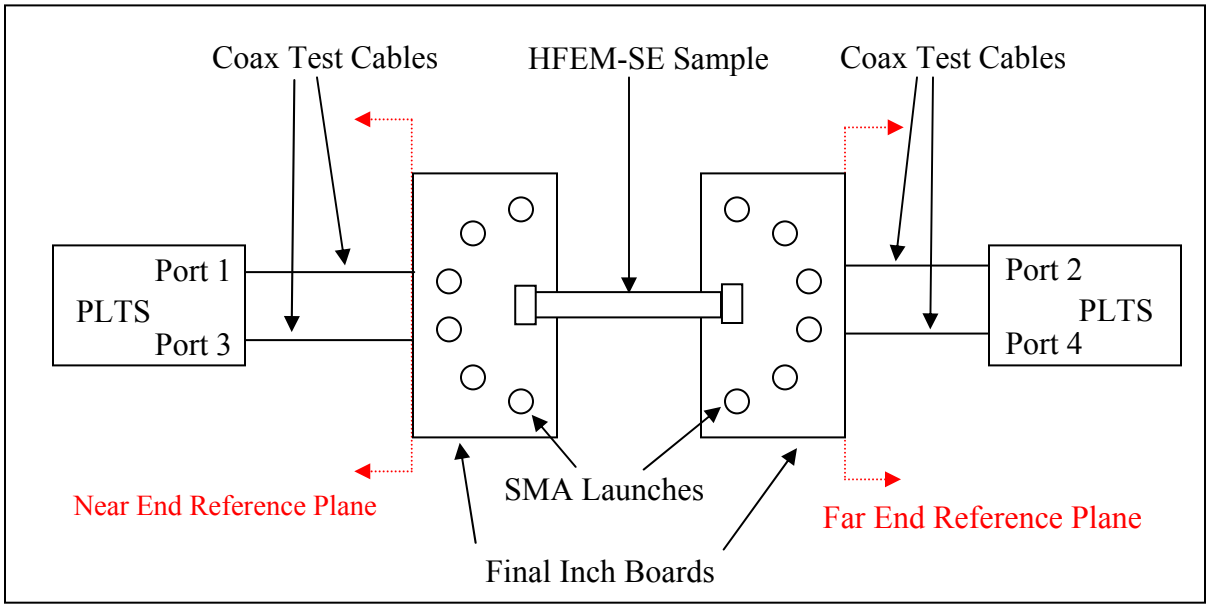

Figure 20: Measurement Setup.

EQUIPMENT

Agilent N1900 Series Physical Layer Test System:
- Agilent E8364B Network Analyzer
- Agilent N4421B S-Parameter Test Set
- PLTS Software Version 4.003

Agilent 85052D 3.5mm Calibration Kit
Synopsys HSPICE Version 2006.9 SP1
Samtec QTE/QSE Final Inch™ Test Boards (FIK-QXE-02-01)