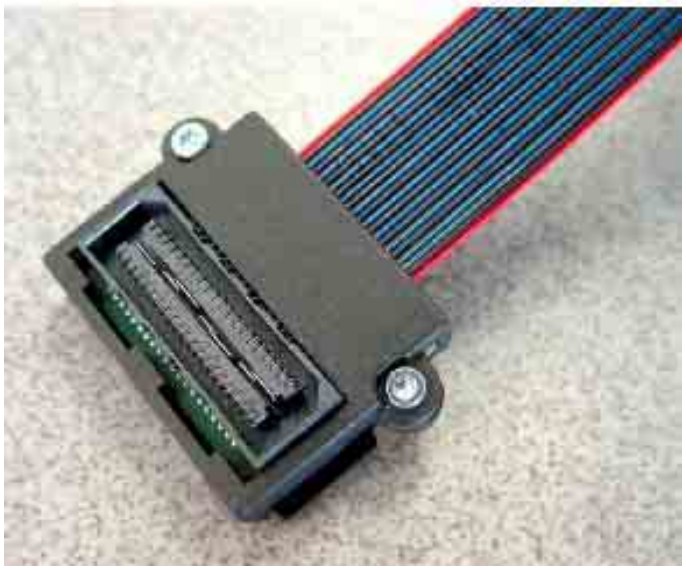
# SPICE Model Validation Report

## EQCD (DV to DV) Cable Assembly



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

## Description:
## Cable Assembly, High Data Rate, 0.8mm Pitch

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Report Revision: 7/11/2005

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## INTRODUCTION

An EQCD DV-DV electrical model was created to allow customers to simulate the electrical performance of the cable assembly. This report presents the comparison of simulated data from the model to measured data from a sample.

## MODEL DESCRIPTION

The HSPICE model is specific to EQCD DV-DV cable assemblies where the outer connector rows are connected together as are the inner connector rows. Specifically, part numbers:

| | |
|---|---|
| EQCD-XX-XX.XX-TTR-STR-X-X | EQCD-XX-XX.XX-TBR-SBR-X-X |
| EQCD-XX-XX.XX-TTR-STL-X-X | EQCD-XX-XX.XX-TBR-SBL-X-X |
| EQCD-XX-XX.XX-TTL-STR-X-X | EQCD-XX-XX.XX-TBL-SBR-X-X |
| EQCD-XX-XX.XX-TTL-STR-X-X | EQCD-XX-XX.XX-TBL-SBL-X-X |
| EQCD-XX-XX.XX-STR-TTR-X-X | EQCD-XX-XX.XX-SBR-TBR-X-X |
| EQCD-XX-XX.XX-STR-TTL-X-X | EQCD-XX-XX.XX-SBR-TBL-X-X |
| EQCD-XX-XX.XX-STL-TTR-X-X | EQCD-XX-XX.XX-SBL-TBR-X-X |
| EQCD-XX-XX.XX-STL-TTL-X-X | EQCD-XX-XX.XX-SBL-TBL-X-X |

The cable portion of model utilizes the 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 10” model.

## PROCEDURES OVERVIEW

All measurement procedures used in this document are the same as those followed in the EQCD Characterization Report. QTE/QSE Final Inch® Test and Evaluation Kit boards were used in the testing. Please see the Test Procedures section at the end of this document.

Time domain simulation stimulus was achieved by measuring the input at the point of launch into the sample. The measured pulse was then converted to a piece-wise-linear HSPICE source. This source was used for the time domain simulations.

Test PCB breakout areas were included in the simulations. These were obtained from HSPICE models of the QTE/QSE Final Inch® Test and Evaluation Kit.

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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 | 38.5 | 58.8 | 49.5 | 30.0 | 16.6 | 1.367 |
| Simulated | 39.0 | 60.7 | 50.0 | 30.5 | 14.0 | 1.365 |

Long Path

| | Z Test Board Pad/Connector (Ω) | Z Connector (Ω) | Z Cable (Ω) | NEXT (mV) | FEXT (mV) | PD (ns) |
|---|---|---|---|---|---|---|
| Measured | 45.4 | 57.7 | 49.7 | 36.5 | 23.5 | 1.444 |
| Simulated | 38.5 | 60.8 | 50.0 | 30.5 | 15.9 | 1.448 |

### *Frequency Domain Data Tables*

RL Short Path

| | Frequency (GHz ) | | | | |
|---|---|---|---|---|---|
| | 0.3 | 1 | 2 | 3 | 4 |
| Measured | -27.0 dB | -24.4 dB | -14.2 dB | -9.4 dB | -8.5 dB |
| Simulated | -31.5 dB | -31.6 dB | -14.0 dB | -11.9 dB | -12.0 dB |

RL Long Path

| | Frequency (GHz ) | | | | |
|---|---|---|---|---|---|
| | 0.5 | 1.15 | 2 | 3 | 4 |
| Measured | -36.0 dB | -19.3 dB | -14.8 dB | -18.9 dB | -15.8 dB |
| Simulated | -41.5 dB | -22.6 dB | -28.4 dB | -12.8 dB | -5.6 dB |

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IL Short Path

| | Frequency (GHz ) | | | | | f @ -3dB pt |
|---|---|---|---|---|---|---|
| | 0.5 | 1 | 2 | 3 | 4 | |
| Measured | -0.88 | -2.09 | -2.80 | -2.53 | -3.80 | 2.27GHz |
| Simulated | -0.83 | -1.33 | -2.59 | -3.72 | -3.88 | 2.26GHz |

IL Long Path

| | Frequency (GHz ) | | | | | f @ -3dB pt |
|---|---|---|---|---|---|---|
| | 0.5 | 1 | 2 | 3 | 4 | |
| Measured | -0.96 | -1.70 | -2.95 | -4.34 | -5.03 | 2.14GHz |
| Simulated | -0.85 | -1.61 | -2.40 | -3.32 | -5.89 | 2.01GHz |

NEXT Short Path

| | Frequency (GHz ) | | | | |
|---|---|---|---|---|---|
| | 0.5 | 1 | 2 | 3 | 4 |
| Measured | -25.4 | -17.3 | -10.6 | -13.3 | -12.8 |
| Simulated | -25.2 | -23.1 | -12.9 | -12.1 | -13.8 |

NEXT Long Path

| | Frequency (GHz ) | | | | |
|---|---|---|---|---|---|
| | 0.5 | 1 | 2 | 3 | 4 |
| Measured | -33.8 | -17.6 | -19.2 | -10.4 | -11.4 |
| Simulated | -27.5 | -17.9 | -22.1 | -14.1 | -12.1 |

FEXT Short Path

| | Frequency (GHz ) | | | | |
|---|---|---|---|---|---|
| | 0.5 | 1 | 2 | 3 | 4 |
| Measured | -27.0 | -20.0 | -18.8 | -19.6 | -17.8 |
| Simulated | -32.6 | -24.7 | -23.1 | -19.2 | -21.5 |

FEXT Long Path

| | Frequency (GHz ) | | | | |
|---|---|---|---|---|---|
| | 0.5 | 1 | 2 | 3 | 4 |
| Measured | -23.4 | -24.9 | -18.2 | -16.3 | -15.0 |
| Simulated | -28.9 | -22.2 | -20.0 | -22.7 | -20.3 |

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## *Time Domain Plots*

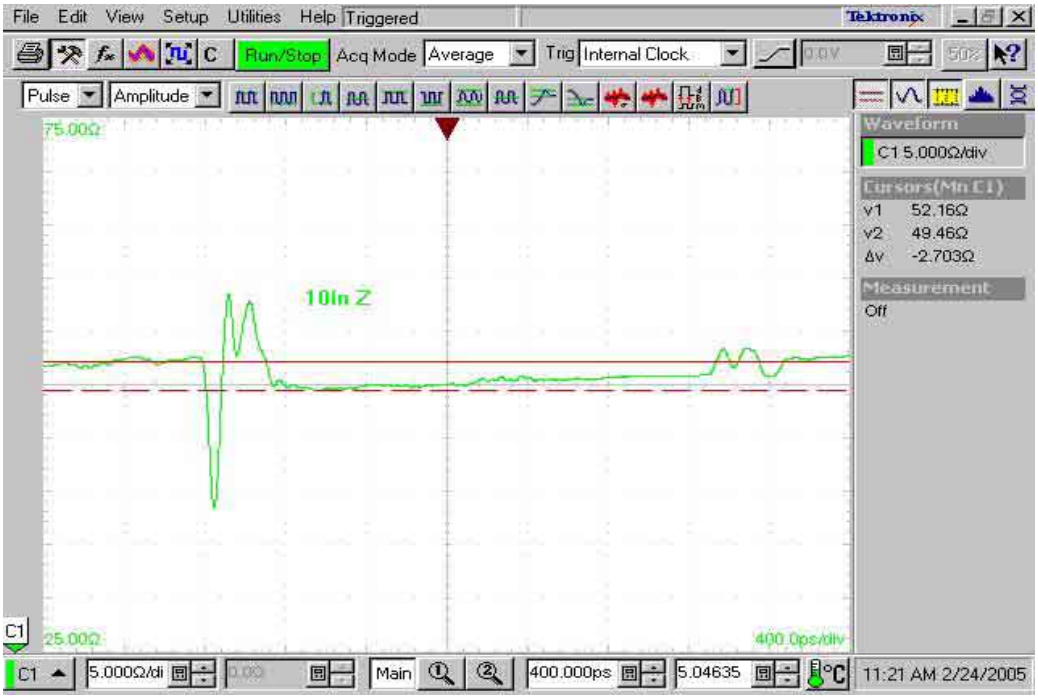


**Figure 1: Measured Z(t) Short Path.**

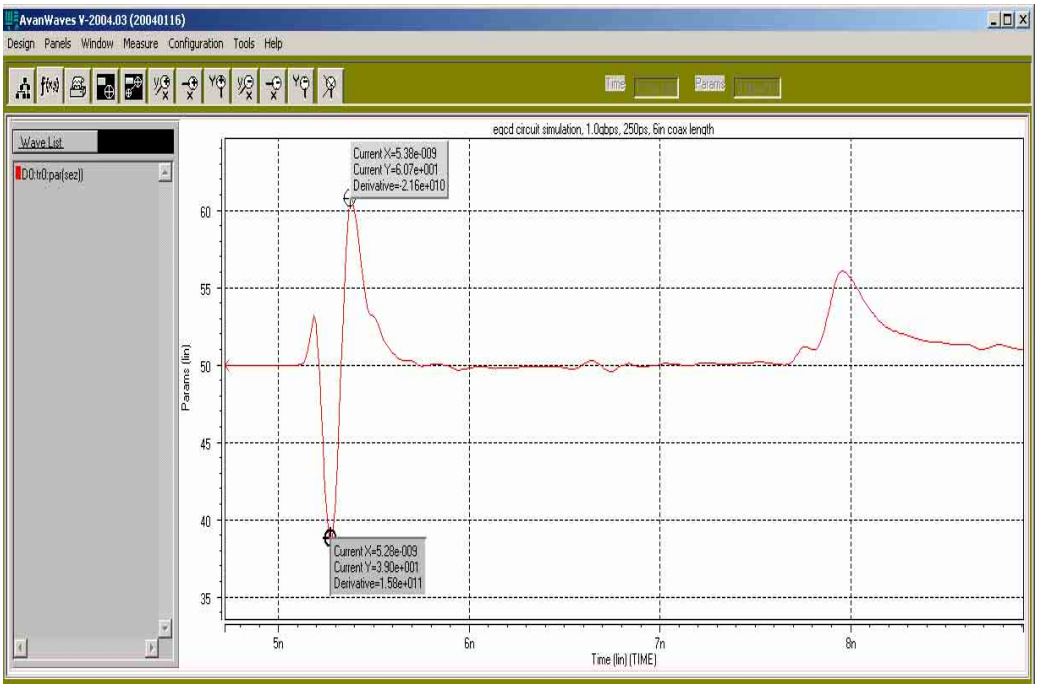


**Figure 2: Simulated Z(t) Short Path.**

**Series:** EQCD Mated with QTE and QSE
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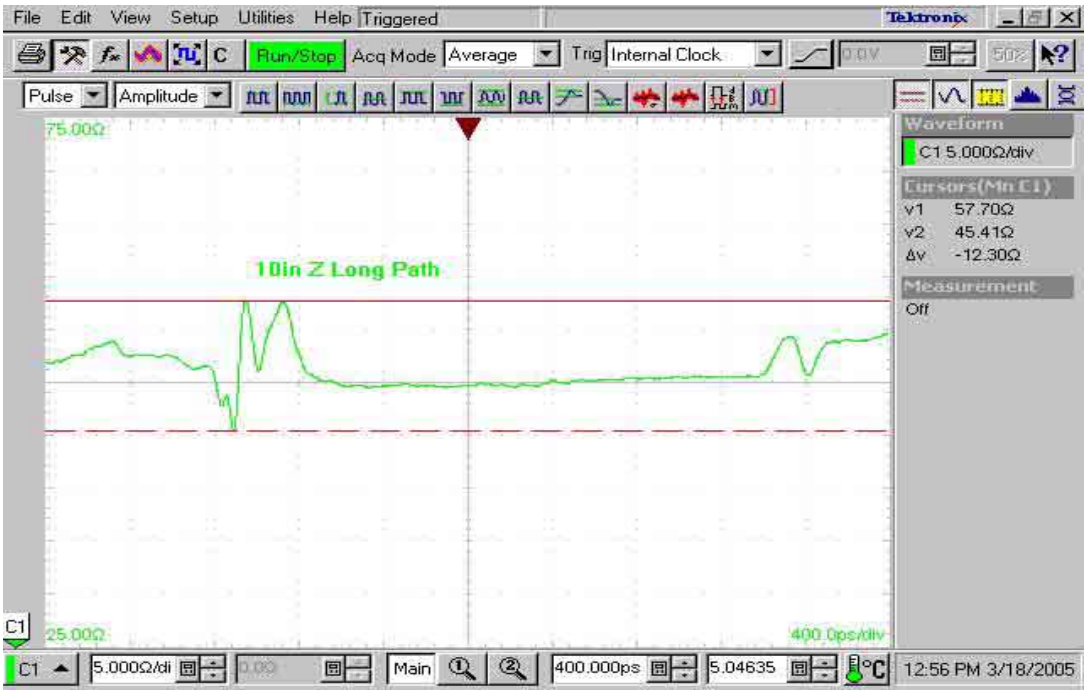


**Figure 3: Measured Z(t) Long Path.**

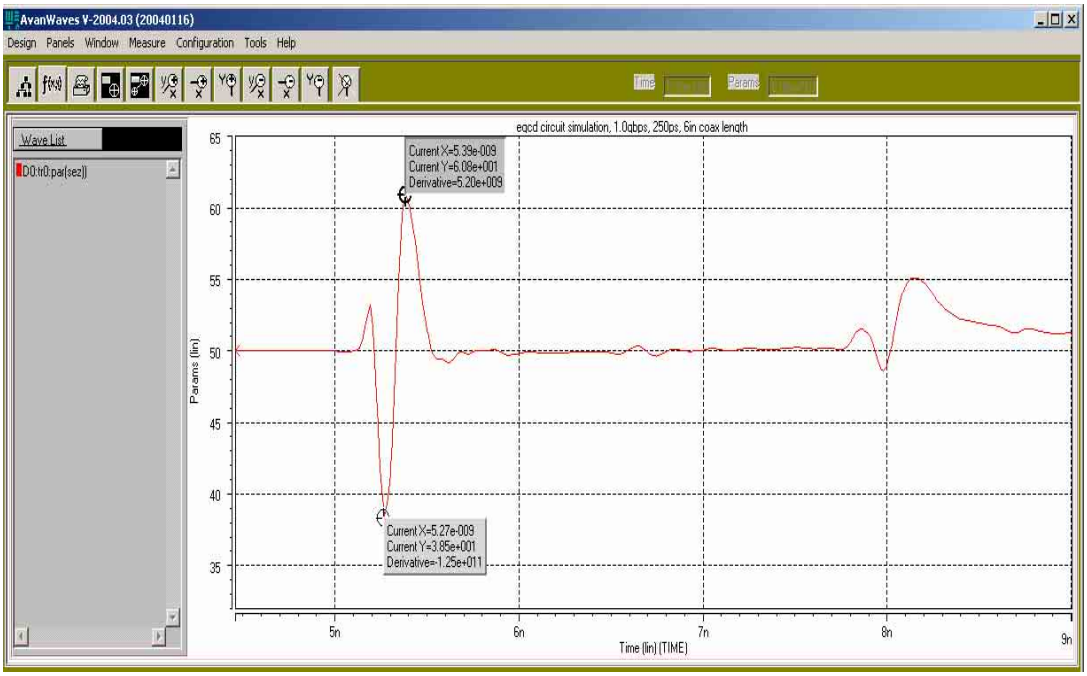


**Figure 4: Simulated Z(t) Long Path.**

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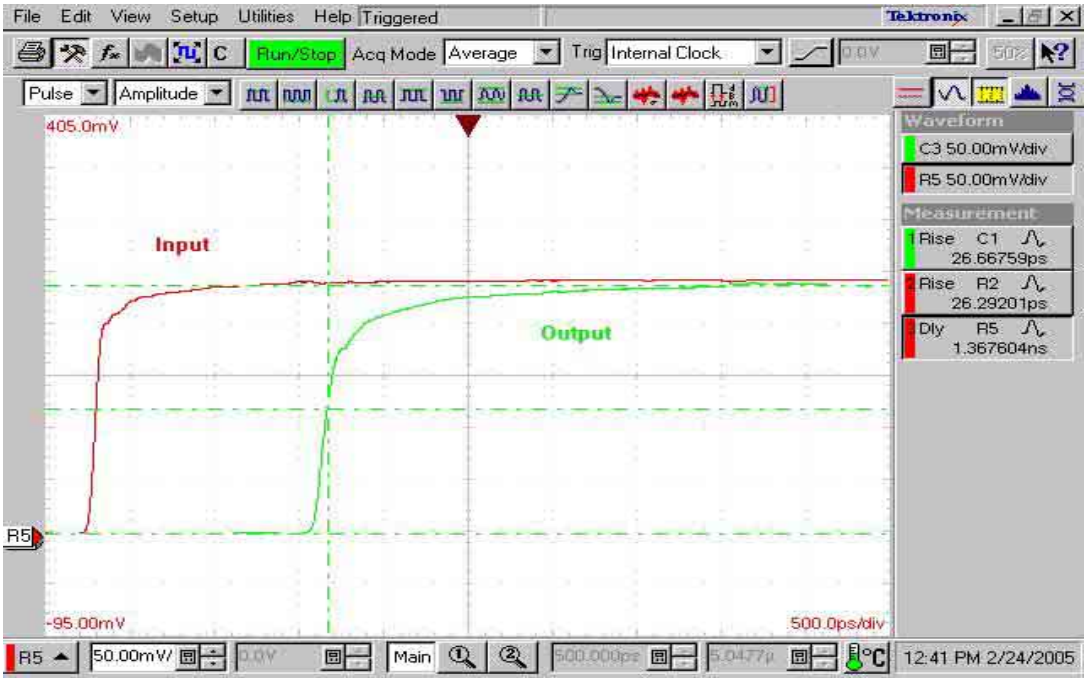


**Figure 5: Measured Propagation Delay Short Path. PD = 1.367ns.**

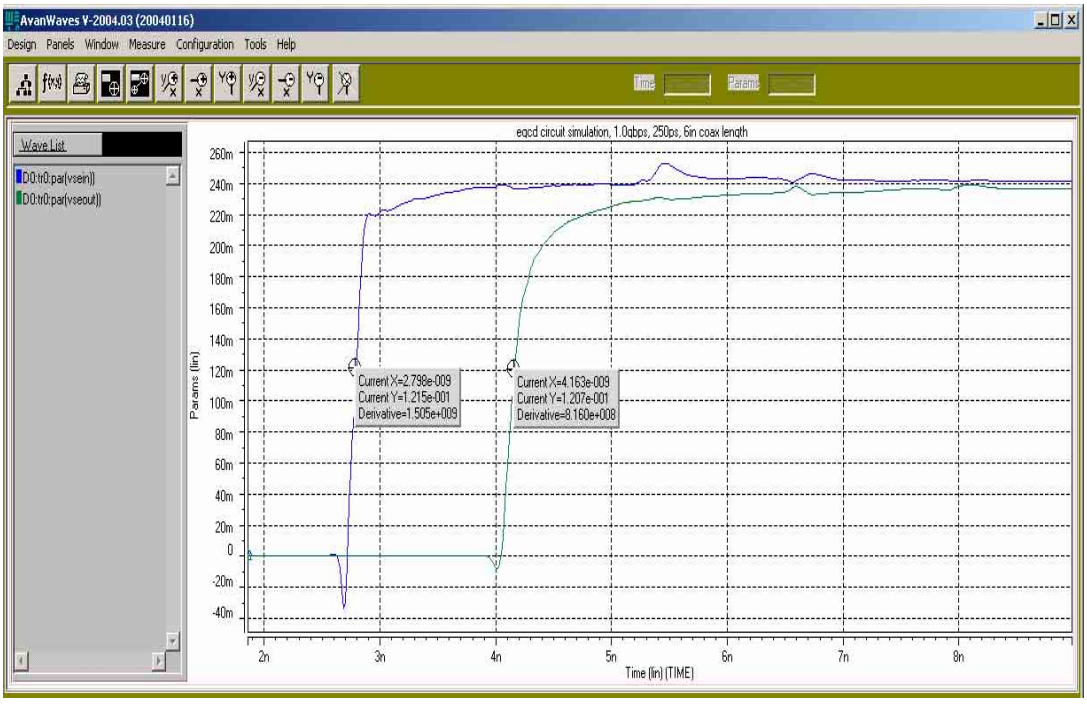


**Figure 6: Simulated Propagation Delay Short Path. PD = 1.365ns.**

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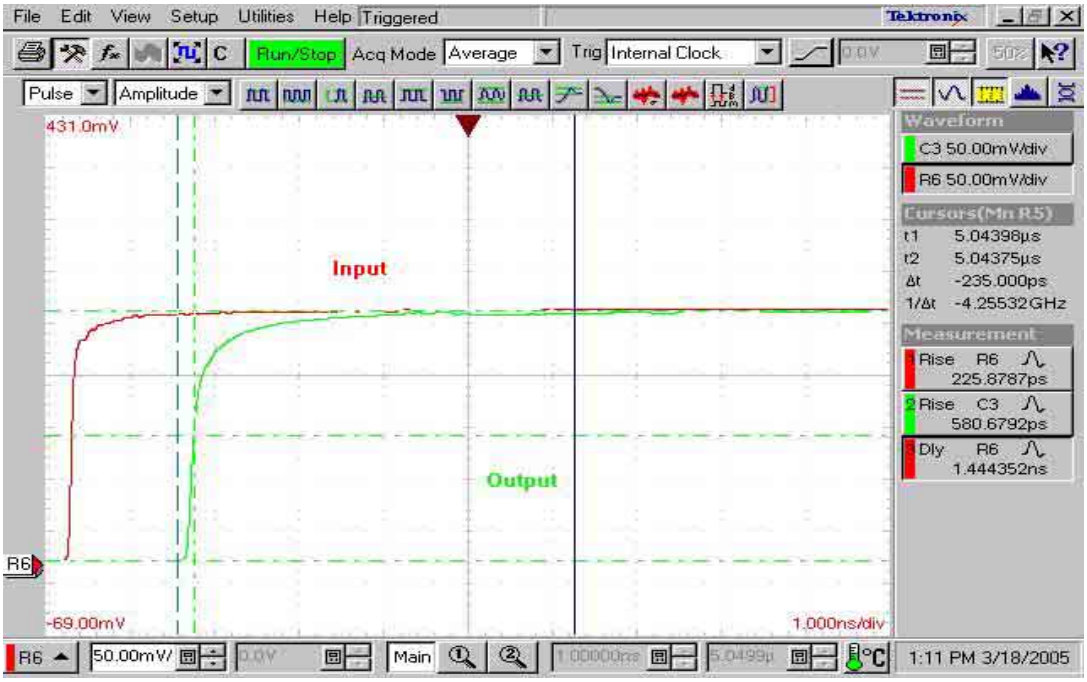


**Figure 7: Measured Propagation Delay Long Path. PD = 1.444ns.**

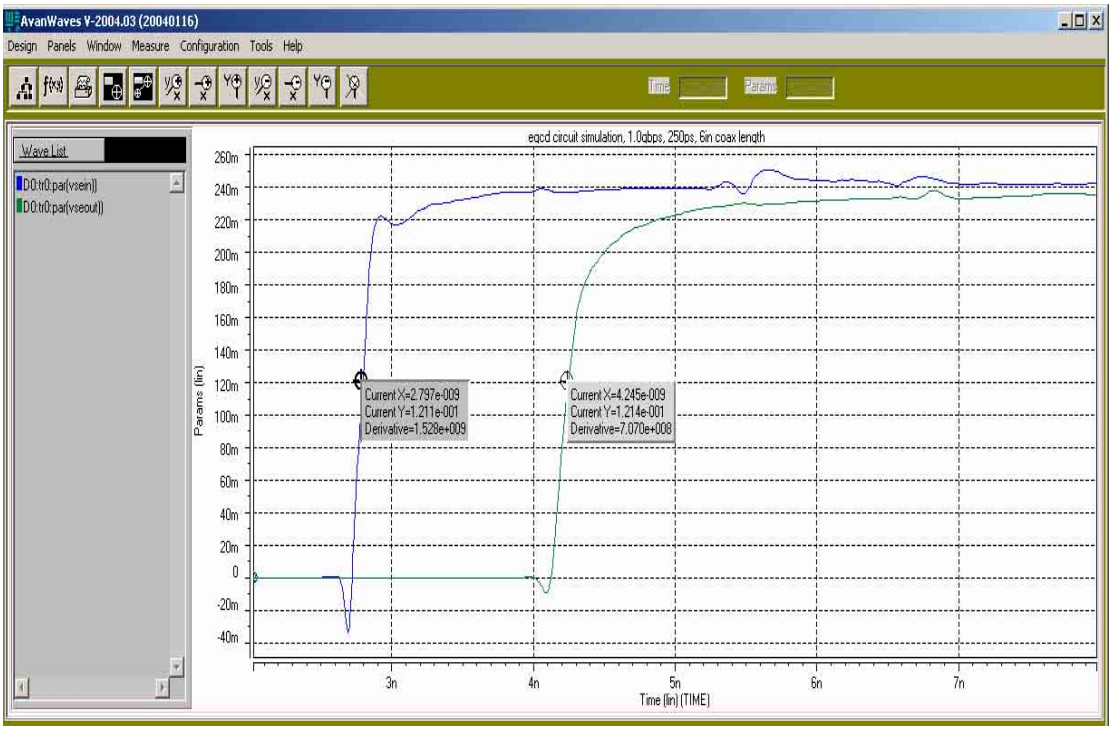


**Figure 8: Simulated Propagation Delay Long Path. PD = 1.448ns.**

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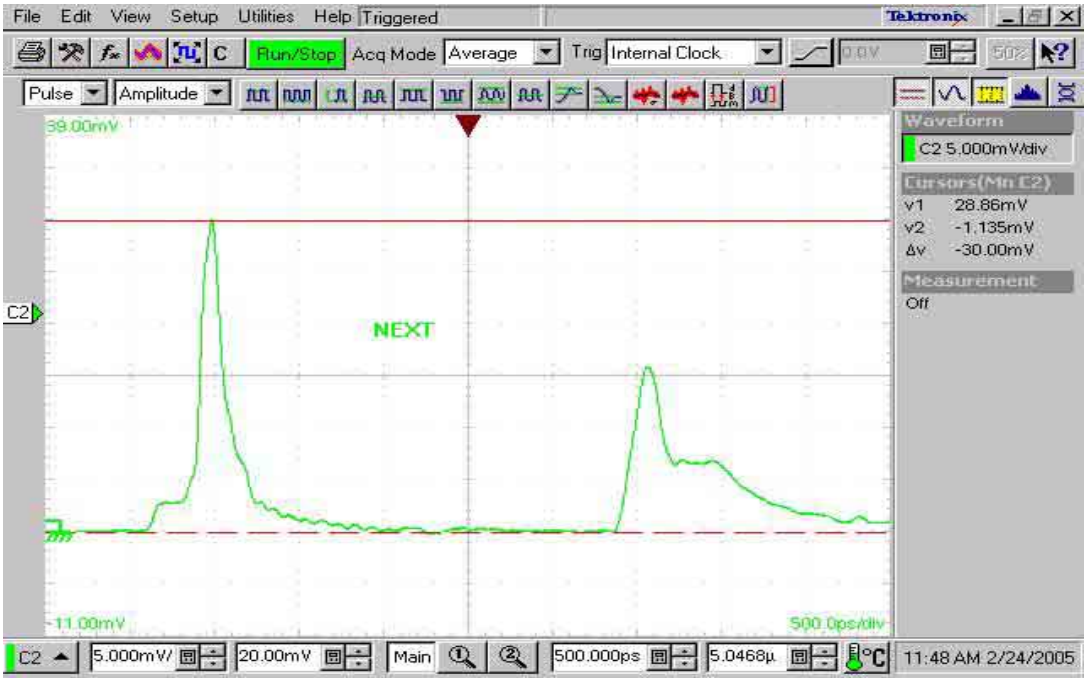


**Figure 9: Measured Near End Crosstalk Short Path. Connector NEXT = 30.0mV.**

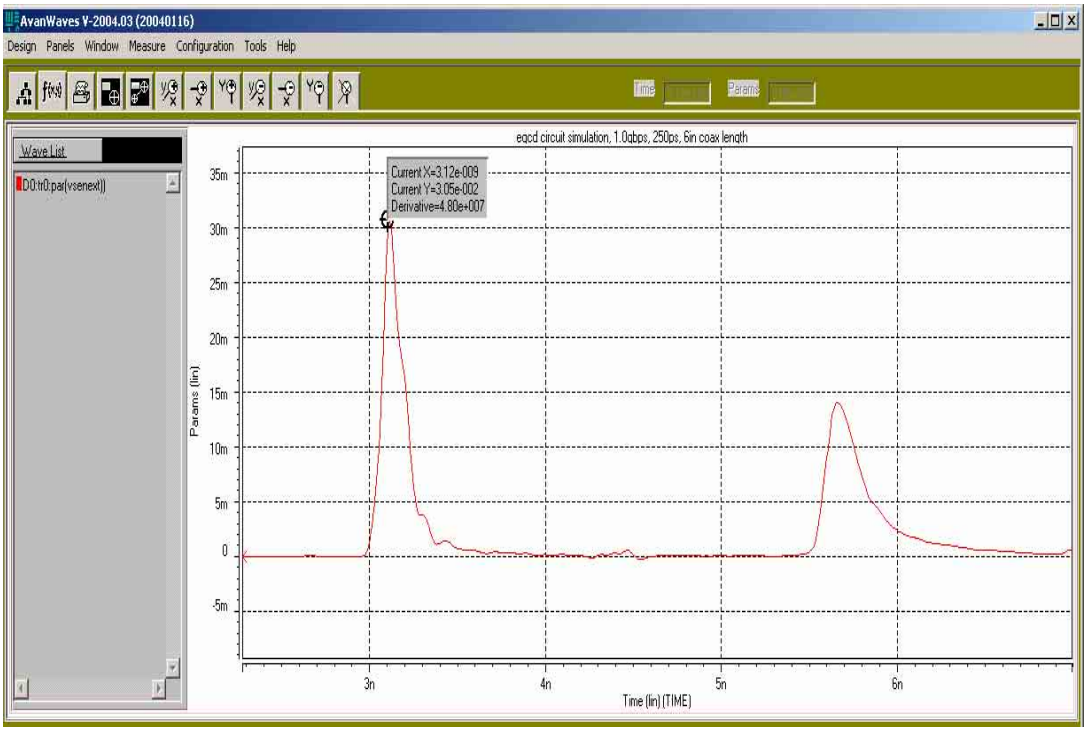


**Figure 10: Simulated Near End Crosstalk Short Path. Connector Next = 30.5mV.**

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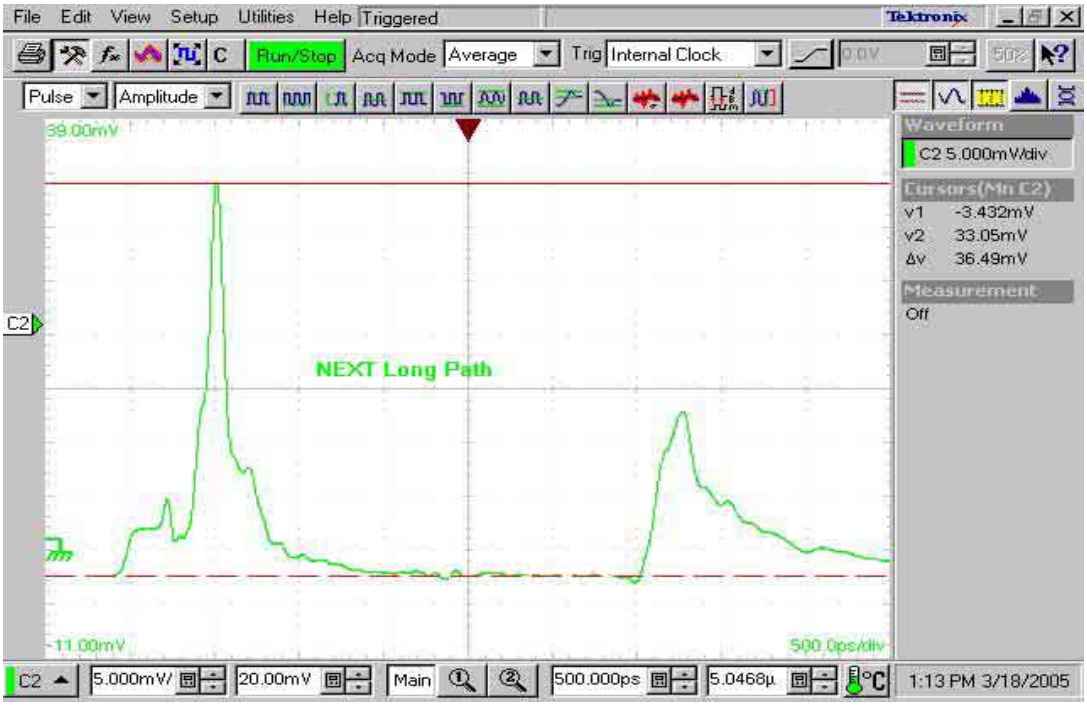


**Figure 11: Measured Near End Crosstalk Long Path. Connector NEXT =36.5mV**

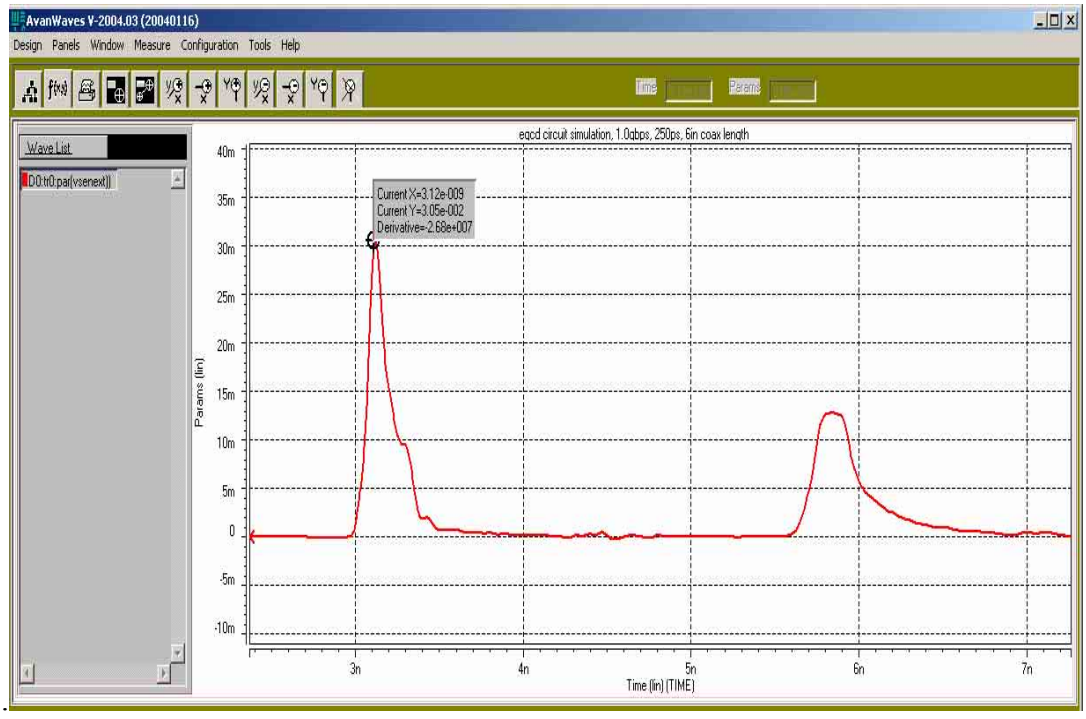


**Figure 12: Simulated Near End Crosstalk Long Path. Connector NEXT = 30.5mV.**

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**Description:** Cable Assembly, High Data Rate, 0.8mm Pitch

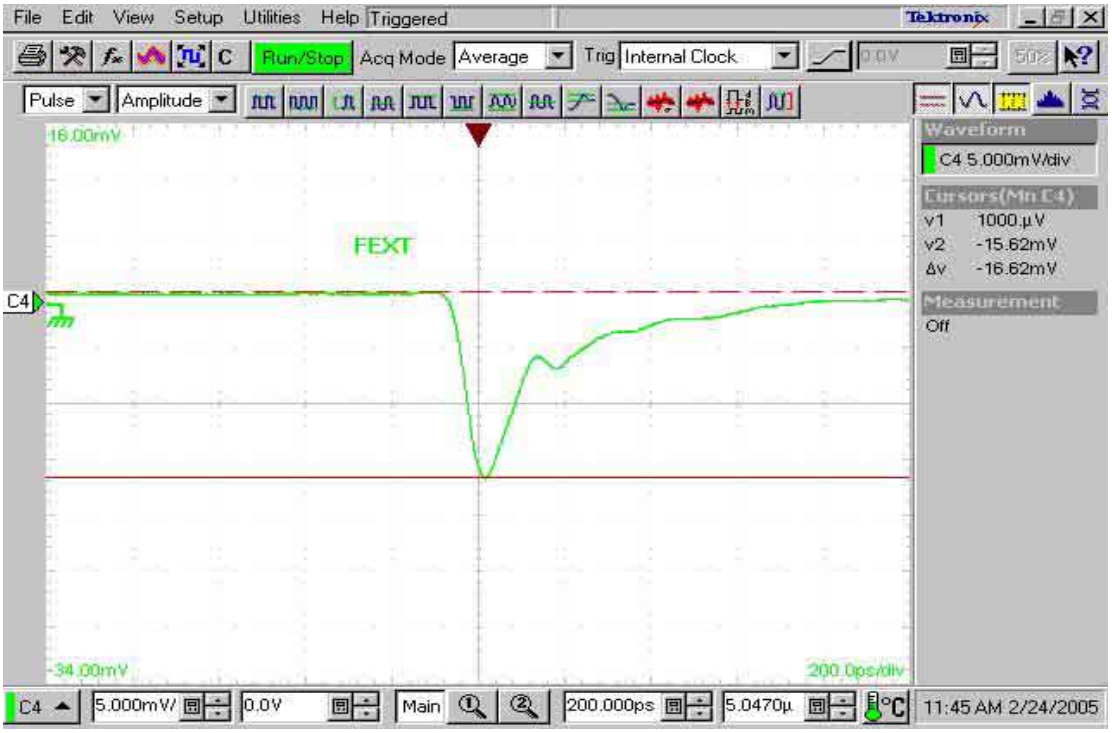


**Figure 13: Measured Far End Crosstalk Short Path. Cumulative FEXT = 16.6mV.**

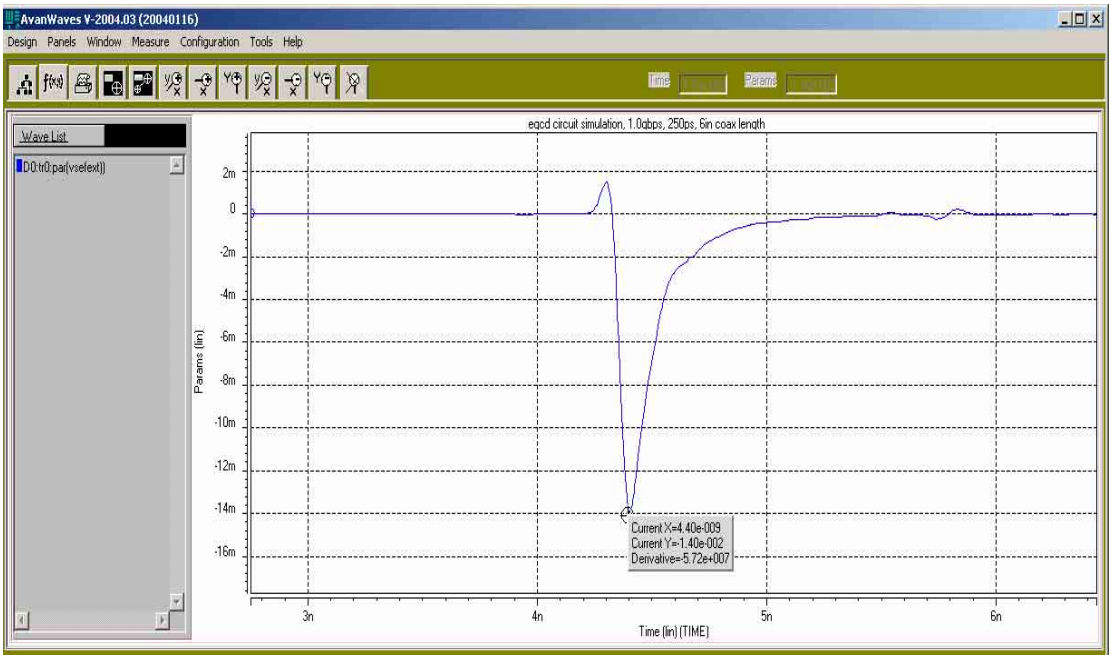


**Figure 14: Simulated Far End Crosstalk Short Path. Cumulative FEXT = 14.0mV.**

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**Figure 15: Measured Far End Crosstalk Long Path. Cumulative FEXT = 23.5mV.**

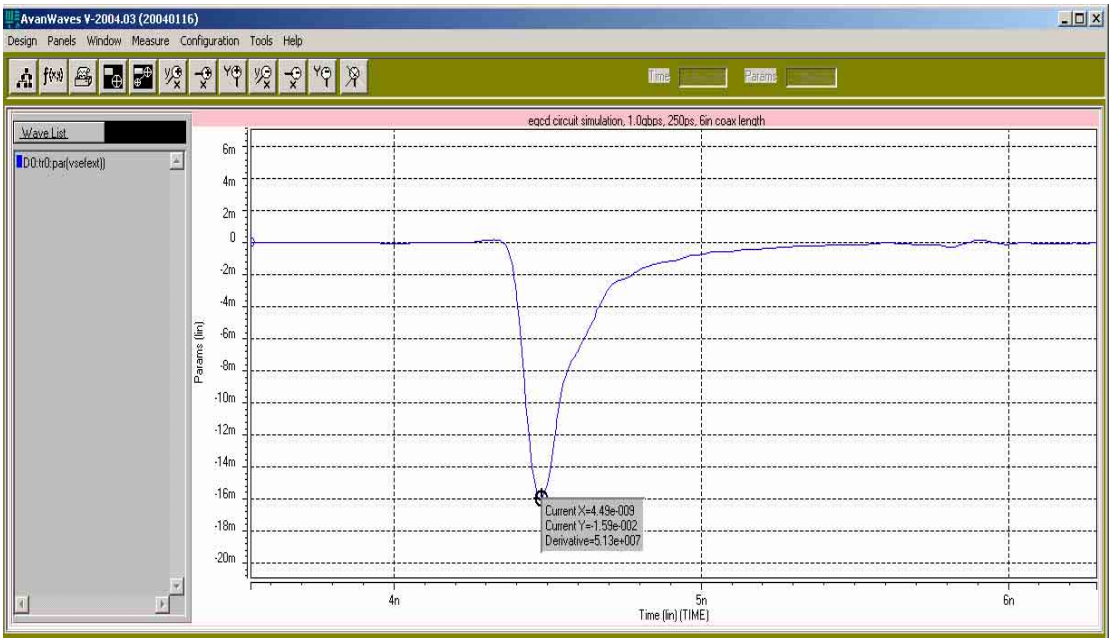


**Figure 16: Simulated Far End Crosstalk Long Path. Cumulative FEXT = 15.9mV.**

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## *Frequency Domain Plots*

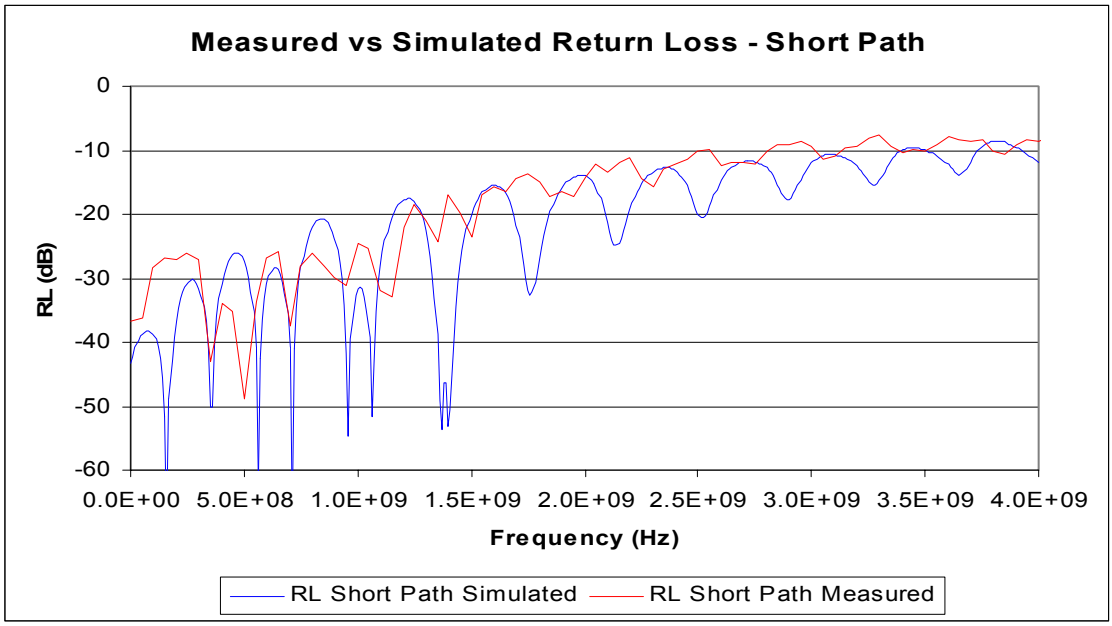


**Figure 17: Measured and Simulated RL-Short Path.**

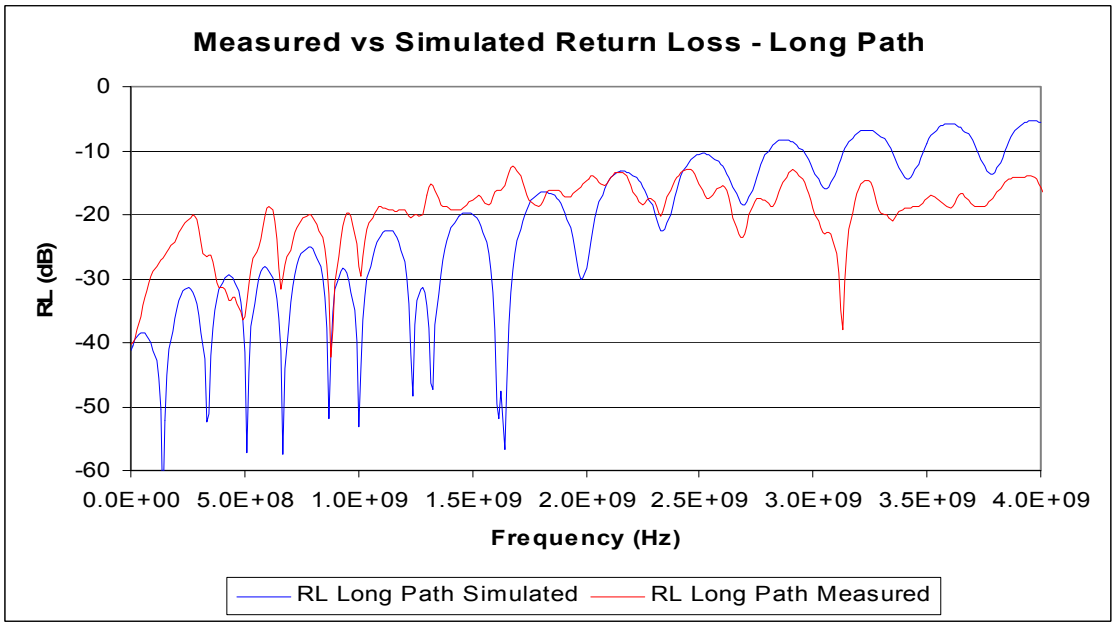


**Figure 18: Measured and Simulated RL-Long Path.**

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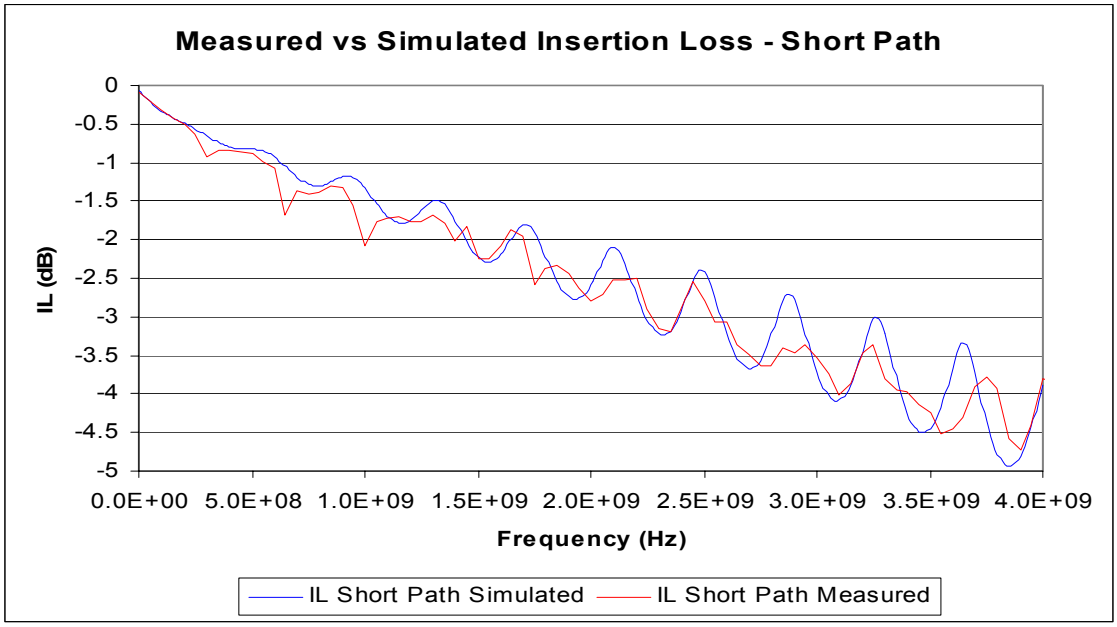


**Figure 19: Measured and Simulated IL-Short Path.**

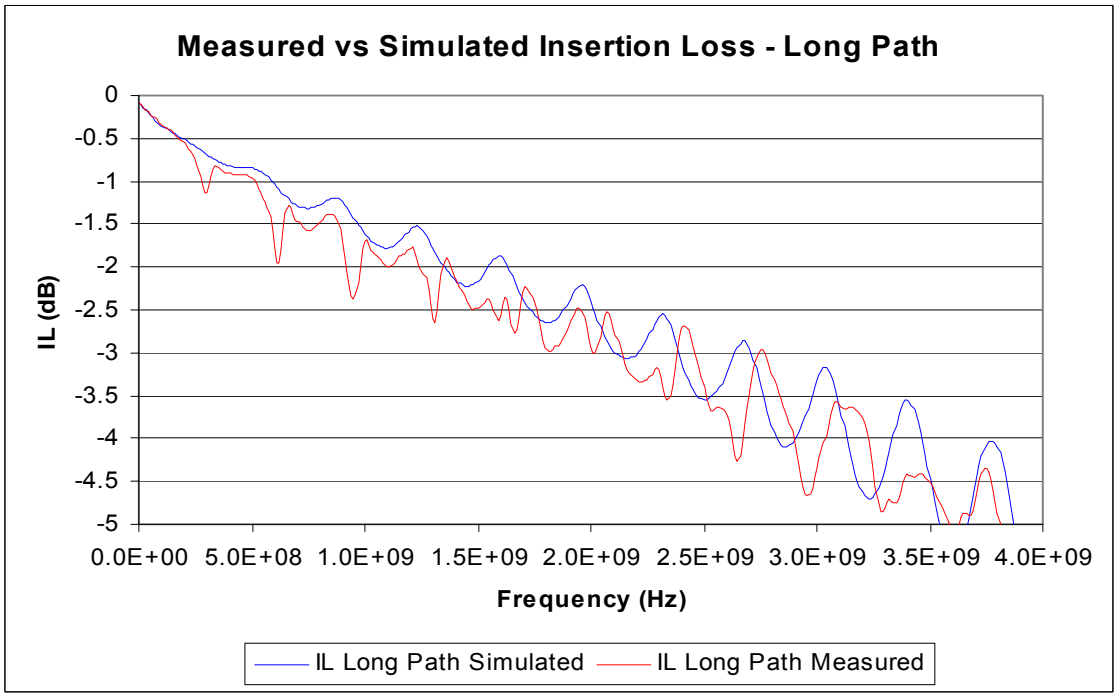


**Figure 20: Measured and Simulated IL-Long Path.**

**Series:** EQCD Mated with QTE and QSE
**Description:** Cable Assembly, High Data Rate, 0.8mm Pitch

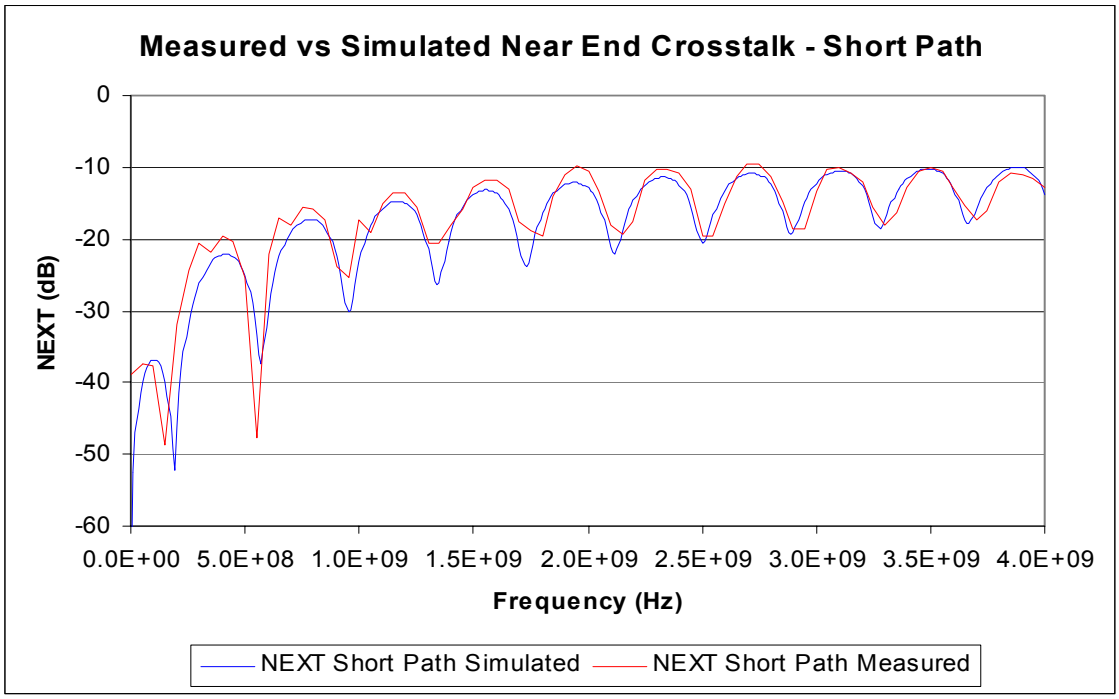


**Figure 21: Measured and Simulated NEXT-Short Path.**

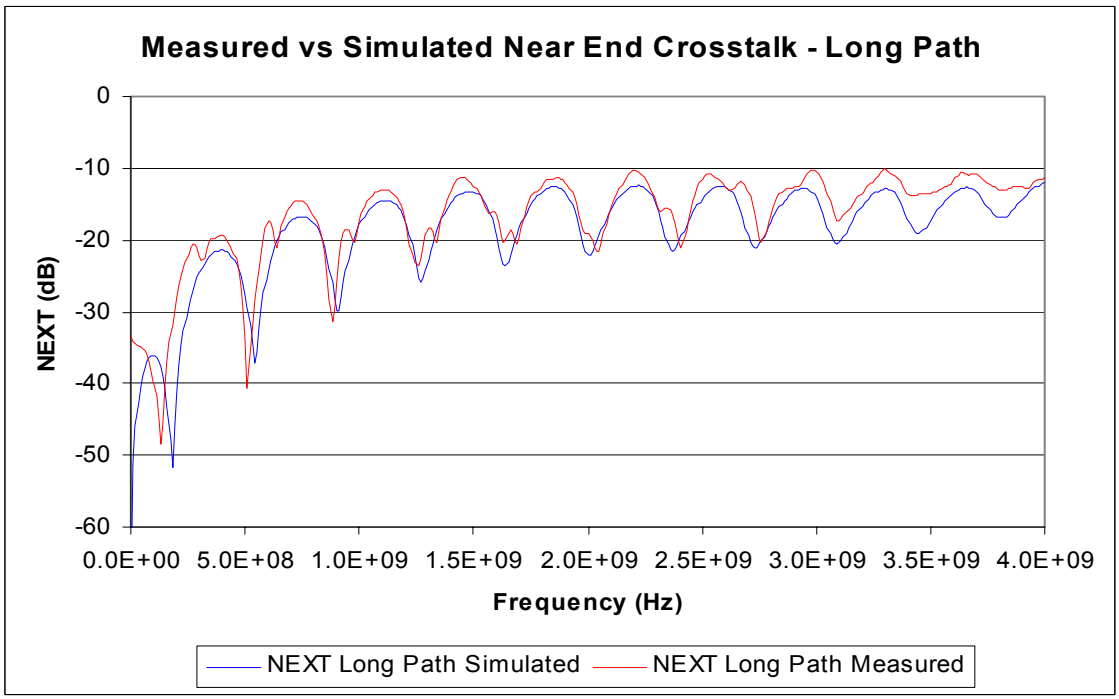


**Figure 22: Measured and Simulated NEXT-Long Path.**

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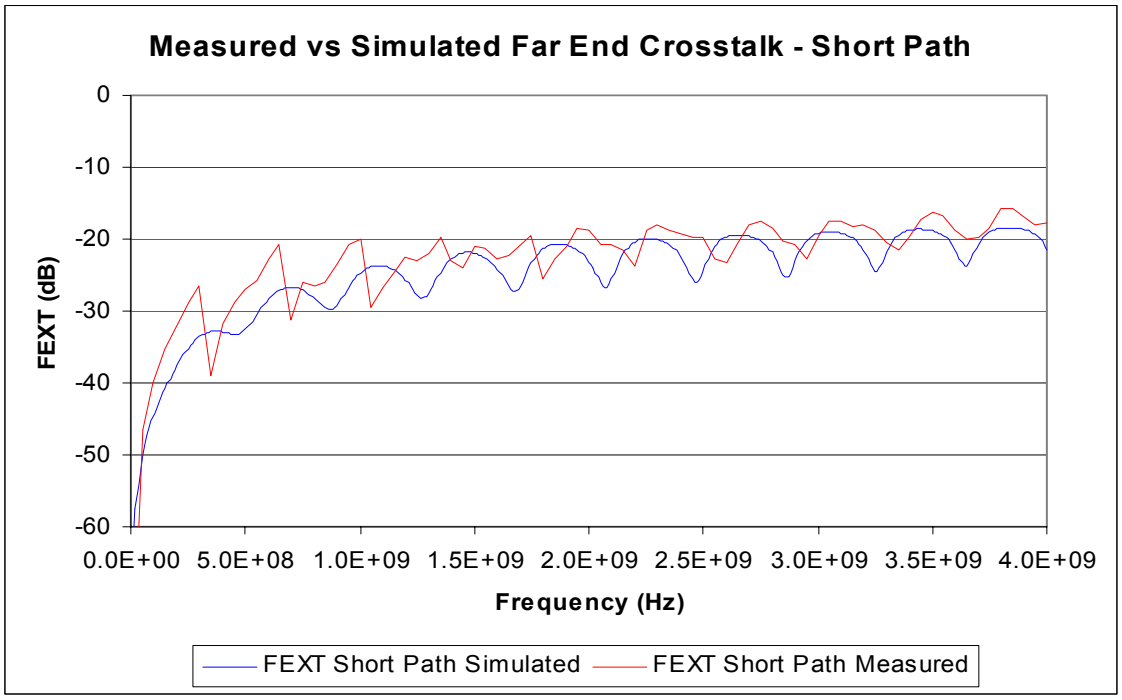


**Figure 23: Measured and Simulated FEXT-Short Path.**

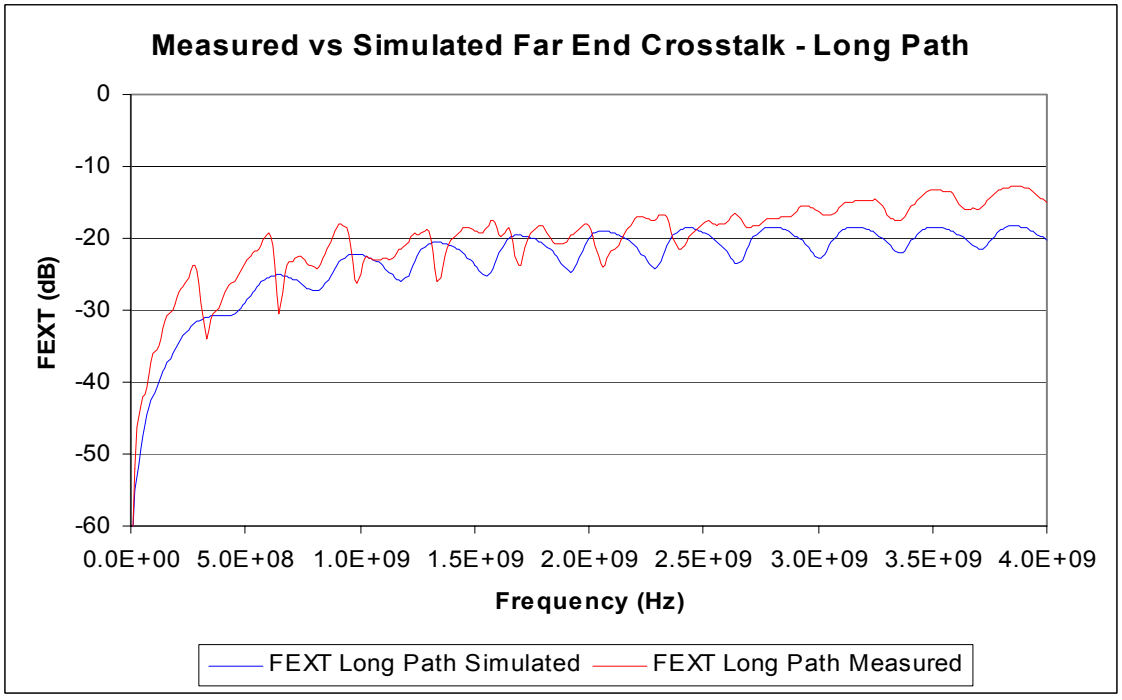


**Figure 24: Measured and Simulated FEXT-Long Path.**

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## TEST PROCEDURES

### *Time Domain Testing*

#### Impedance:

The Tektronix CSA 8000 oscilloscope was set up in TDR (Time Domain Reflectometry) mode using 128 averages and a 500-point record length. The horizontal scale was set to 500ps/div to allow the near end connector and a portion of the cable to be displayed. Measurements were made at the near end of each sample. Impedance measurements were made at the mated connector and 200ps into the cable. A full bandwidth risetime was used.

#### Propagation Delay:

The Time Domain Transmission (TDT) capabilities of the oscilloscope were used to measure the propagation delay. The delay of the test cables, SMA connectors, and a reference PCB were measured collectively and stored as an input reference.

The sample and the test PCBs replaced the reference PCB, and the pulse at the output of the sample was measured. The propagation delay was determined by using the propagation delay measurement function of the oscilloscope. This function measures the difference in time, at 50% the level, between the output pulse and the input pulse.

#### NEXT and FEXT:

Near-end Crosstalk (NEXT) and Far-End Crosstalk (FEXT) measurements were made using the Tektronix CSA 8000 oscilloscope. A thru reference of the coaxial test cables, SMAs, and reference board was performed to compensate for the test setup losses.

To acquire the NEXT, a near end line was driven using the oscilloscope. NEXT was measured on an adjacent line, using a full bandwidth risetime, at the near end as matched reflection waveform. Acquiring FEXT, a near end line was driven with the oscilloscope. FEXT was measured on an adjacent line at the far end. All adjacent lines were terminated, at both ends, with 50Ω SMA loads. Refer to Figures 25 and 26.

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## *Frequency Domain Testing*

### Attenuation:

Insertion Loss measurements were made using the Tektronix CSA 8000 oscilloscope. The horizontal scale was set to 20ns/div, the record length was set to 5120 points, and the number of averages was set to 128. These values are used to ensure the ratio between the number of points and the window length is long enough to capture the highest frequencies. Test setup losses were compensated for by acquiring a thru measurement (reference output pulse) of the coaxial test cables, SMAs, and reference board.

The reference board was then replaced with the test PCBs and the sample (see Figure 11). A thru measurement was taken and then post processed by using TDA Systems', IConnect software (Version 3.1).

### Return Loss:

Return Loss measurements were made using the Tektronix CSA 8000 oscilloscope. The horizontal scale was set to 20ns/div, the record length was set to 5120 points, and the number of averages was set to 128. These values are used to ensure that the ratio between the number of points and the window length is long enough to capture the highest frequencies. An open circuit reference measurement was taken right at the start of the near end connector.

A matched reflection waveform of the cable assembly was acquired and then post processed by using TDA Systems', IConnect software (Version 3.1).

### Near and Far End Crosstalk:

Near-End Crosstalk (NEXT) and Far-End Crosstalk (FEXT) measurements were made using the Tektronix CSA 8000 oscilloscope. A thru reference of the coaxial test cables, SMAs, and reference board was performed to compensate for the test setup losses (see Figure 10), and an open circuit measurement was taken right at the start of the near end connector.

To acquire the NEXT, a near end line was driven using the oscilloscope. NEXT was measured on an adjacent line at the near end as matched reflection waveform then post processed by using TDA Systems', IConnect software (Version 3.1). The result is the NEXT of the cable assembly post processed to 350 MHz. Acquiring FEXT, a near end line was driven with the oscilloscope. FEXT was measured on an adjacent line at the far end then post processed by using TDA Systems',

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IConnect software (Version 3.1). The result is the FEXT of the cable assembly post processed to 350 MHz. All adjacent lines were terminated, at both ends, with 50Ω SMA loads; Refer to Figures 25 and 26.

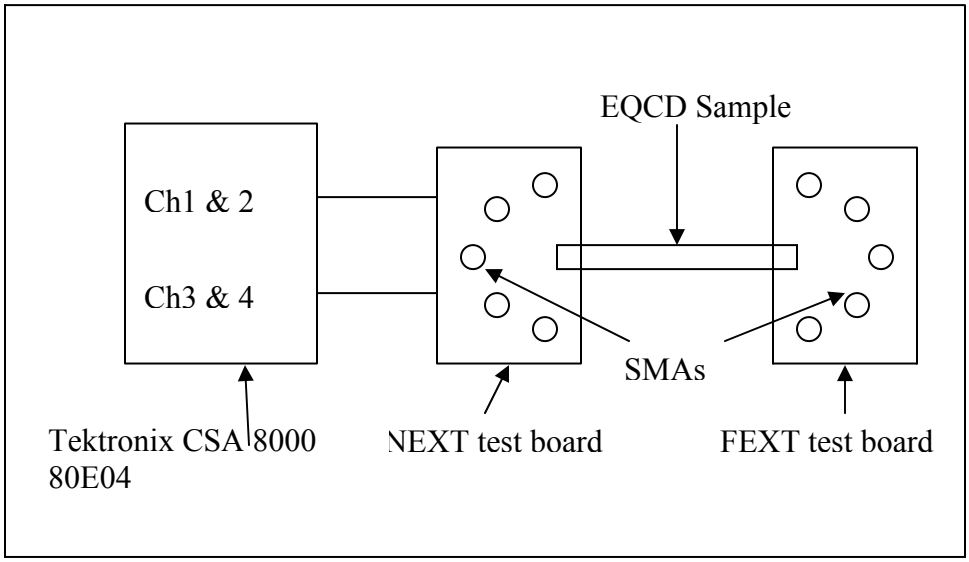


**Figure 25: NEXT Measurement Setup.**

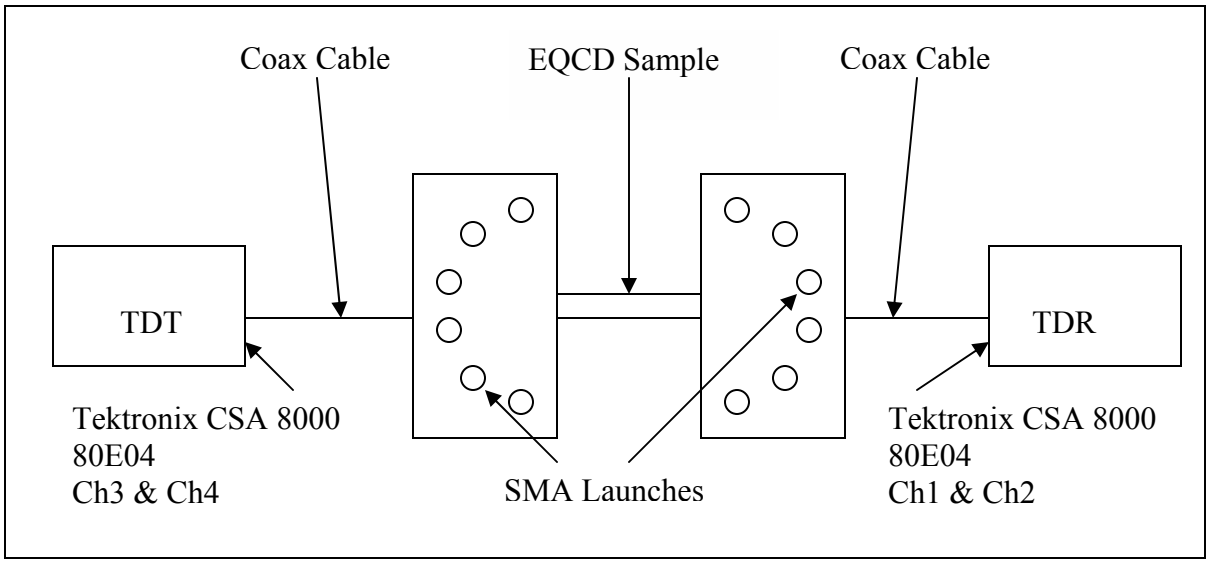


**Figure 26: FEXT Measurement Setup.**

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## EQUIPMENT

Tektronix CSA 8000 Oscilloscope
Tektronix 80E04 TDR/Sampling Head
TDA IConnect Version 3.1.0 MX