



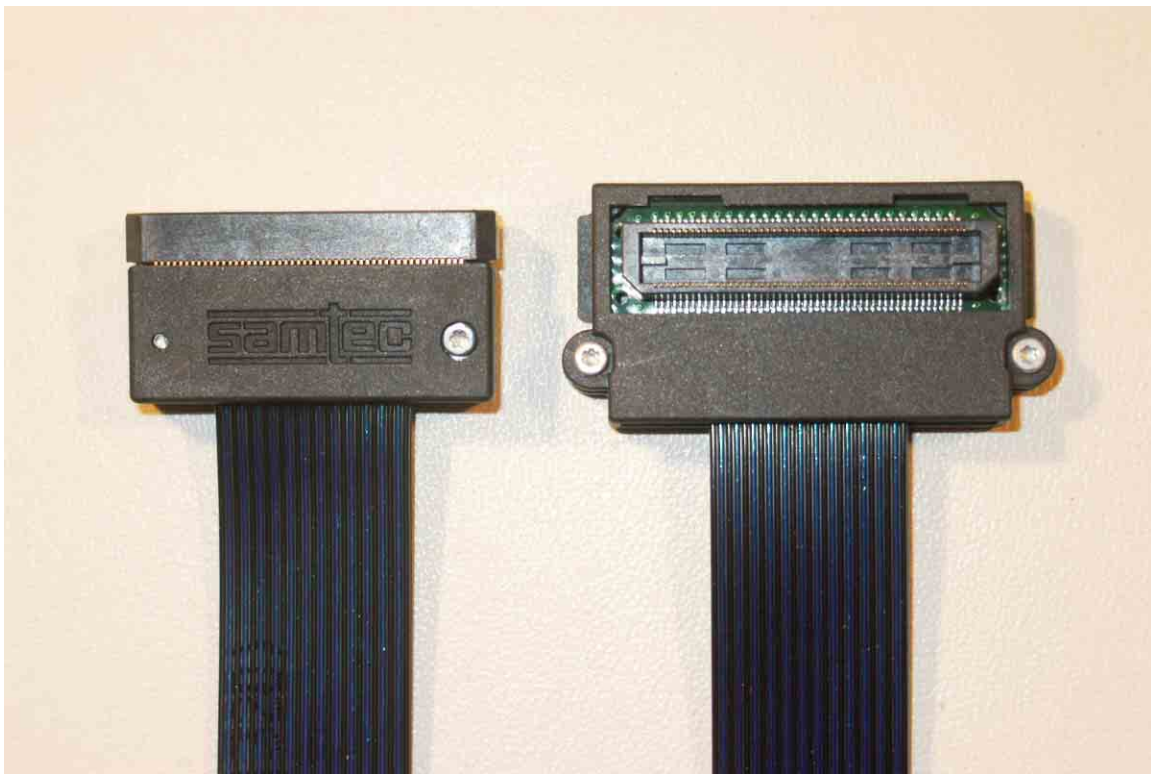
## High Speed Characterization Report

HBCD-050-39.37-TEU-TED-1

HBCD-050-39.37-TTR-TBL-1

HBCD-050-39.37-TTR-TED-1

(Mated with BSH-050-01-x-D-A)



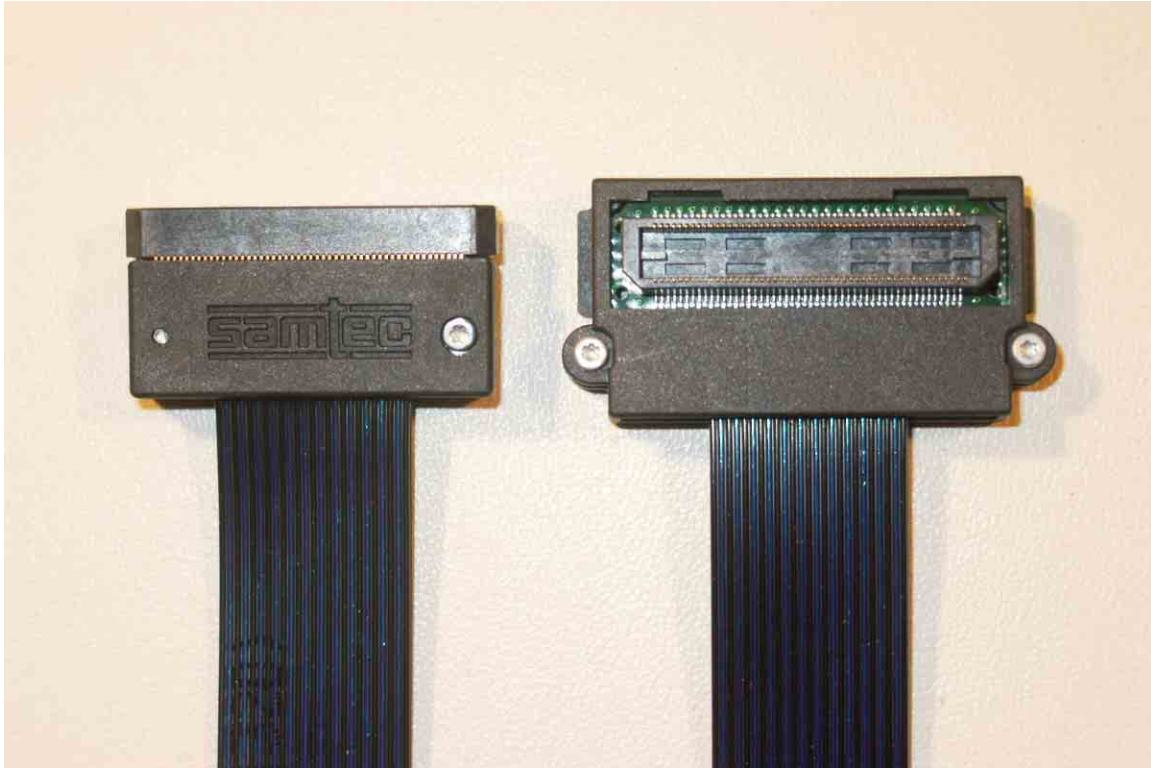
REVISION DATE: February 8, 2005

## TABLE OF CONTENTS

Introduction.....	1
Product Description .....	2
Results Summary .....	3
Time Domain Data.....	3
Impedance .....	3
NEXT .....	3
FEXT.....	4
Propagation Delay and Skew .....	4
Frequency Domain Data .....	5
Insertion Loss.....	5
Return Loss .....	8
Near End Crosstalk .....	11
Far End Crosstalk.....	14
Test Procedures.....	17
Fixturing.....	17
Time Domain Testing .....	19
Impedance .....	19
NEXT and FEXT .....	19
Frequency Domain Testing.....	20
Attenuation.....	20
Return Loss .....	20
Near and Far End Crosstalk .....	20
Equipment.....	21

## Introduction

This testing was performed to evaluate the electrical performance of the HBCD series of high-speed cable systems. Testing was performed in accordance to the High Performance Electrical Interconnect (HPEI) SFF-8416<sup>1</sup>, Level 1, testing standards when applicable.



**Figure 1: Samples tested**

Time domain and frequency domain measurements were made. In the time domain impedance, propagation delay, crosstalk and skew were measured. Frequency domain measurements were performed using TDA's IConnect software (Version 3.0) and include insertion loss (IL), return loss (RL), near end and far end crosstalk (NEXT and FEXT, respectively). All measurements were made utilizing test boards specifically designed for this project; referred to as "test board" in this report.

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<sup>1</sup> Measurement and Performance Requirements for HPEI Bulk Cable, Rev 10, March 25, 2004

## Product Description

The sample consists of two 39.37 inch (1m), 38 AWG micro-co-axial cables that contain 50 single lines. At each end of the cable there is a connector that is terminated to a small transition PCB. The respective connector is soldered to the PCB. All cable assemblies are terminated with a BTH micro header at both ends. There are two types of BTH connectors that can be terminated; edge-mount (EM) or vertical mount (DV). The cable connectors contain 50 pins per row.

The connectors are soldered to the transition PCBs. The transition boards are a straight through type that connects the outer connector row of one connector to the outer row of the opposite connector and the inner connector row is connected to the inner row on the other connector. The board/cable termination area is then covered with plastic caps.

Three samples, one of each type of termination configuration, were tested. The actual sample numbers tested are shown in Table 1 below. Two lines, the longest and the shortest electrical paths, from each sample were tested. Refer to Figure 1 on the preceding page for a picture of the sample.

The actual sample part numbers tested are shown in Table 1.

Length	Part Number	Termination
39.37in	HBCD-050-3937-TEU-TED-1	EM-EM
39.37in	HBCD-050-3937-TTR-TBL-1	DV-DV
39.37in	HBCD-050-3937-TTR-TED-1	DV-EM

**Table 1: HBCD Sample Descriptions**

## Results Summary

### Time Domain Data

#### Impedance

Impedance measurements were performed using a filtered risetime of 100ps. Note that all measurements were performed with the cable assembly mated to the respective connector/test board. Data was measured at the cable termination and 200ps into the cable.

Assembly	Path	End Option				Cable	
		End 1		End 2		End 1	End 2
		Z <sub>Min</sub> (Ω)	Z <sub>Max</sub> (Ω)	Z <sub>Min</sub> (Ω)	Z <sub>Max</sub> (Ω)	Z <sub>max</sub> (Ω)	Z <sub>max</sub> (Ω)
TEU-TED	Long	40.9	70.5	40.9	70.5	52.6	52.7
	Short	42.7	68.6	41.3	70.8	51.4	51.4
TTR-TBL	Long	41.4	63.1	38.6	63.8	51.2	51.9
	Short	38.3	65.1	38.2	63.0	50.7	50.8
TTR-TED	Long	41.5	63.6	40.1	70.6	51.4	54.2
	Short	38.8	66.6	43.0	70.7	49.9	50.6

Table 2: Impedance Measurements

#### NEXT

The near end Crosstalk was measured in the time domain and converted to a percentage and reported below in Table 3. The incident pulse amplitude from the TDR is 250 mV. The acquired data was post filtered with a 100-psec filter. The End 1 and End 2 headings in Table 4 represent the near-end cable assembly connector. All NEXT measurements were performed with the cable assembly mated to the respective connector/test board. Since most of the crosstalk occurs in the connectors the values in Table 3 represent the crosstalk that occurs in the near-end mated cable assembly and the test board connectors.

Assembly	Path	END1		END 2	
		NEXT (mV)	NEXT (%)	NEXT (mV)	NEXT (%)
TEU-TED	Long	13.7	5.5	22.2	8.9%
	Short	21.6	8.6	17.3	6.9%
TTR-TBL	Long	7.5	3.0	8.7	3.5%
	Short	5.9	2.4	9.7	3.9%
TTR-TED	Long	6.5	2.6	13.1	5.2%
	Short	8.5	3.4	13.1	5.2%

Table 3: NEXT Summary

## FEXT

The far end Crosstalk was measured in the time domain and converted to a percentage and reported below in Table 4. The incident pulse amplitude from the TDR is 250 mV. The acquired data was post filtered with a 100-psec filter. The End 1 and End 2 headings in Table 4 represent the near-end cable assembly connector. All NEXT measurements were performed with the cable assembly mated to the respective connector/test board. Since most of the crosstalk occurs in the connectors the values in Table 3 represent the crosstalk that occurs in the far-end mated cable assembly, the test board connectors and the cable itself.

Assembly	Path	END 1		END 2	
		FEXT (mV)	FEXT (%)	FEXT (mV)	FEXT (%)
TEU-TED	Long	15.7	6.3	15.5	6.2%
	Short	14.3	5.7	15.7	6.3%
TTR-TBL	Long	9.8	3.9	6.4	2.5%
	Short	6.7	2.7	12.5	5.0%
TTR-TED	Long	13.0	5.2	22.4	9.0%
	Short	14.4	5.8	22.4	9.0%

Table 4: FEXT Summary

## Propagation Delay and Skew

Skew was calculated as the difference between the propagation delay of the longest (outer row) and the shortest (inner Row) electrical paths.

The results are tabulated below.

Assembly	Path	Propagation Delay (nS)	Skew (nS)
TEU-TED	Long	2.495	0.005
	Short	2.490	
TTR-TBL	Long	2.520	0.038
	Short	2.480	
TTR-TED	Long	2.500	0.020
	Short	2.480	

Table 5: Propagation delay and skew

## Frequency Domain Data Insertion Loss

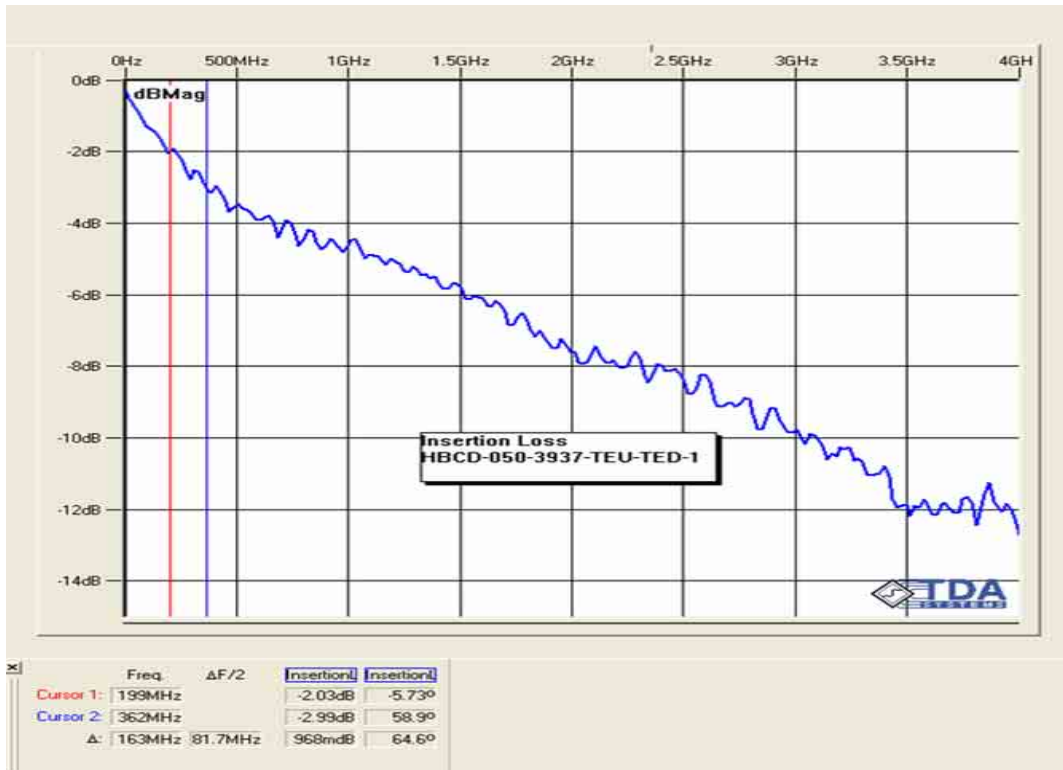


Figure 2: HBCD-050-3937-TEU-TED-1 Insertion Loss Short Path



Figure 3: HBCD-050-3937-TEU-TED-1 Insertion Loss Long Path

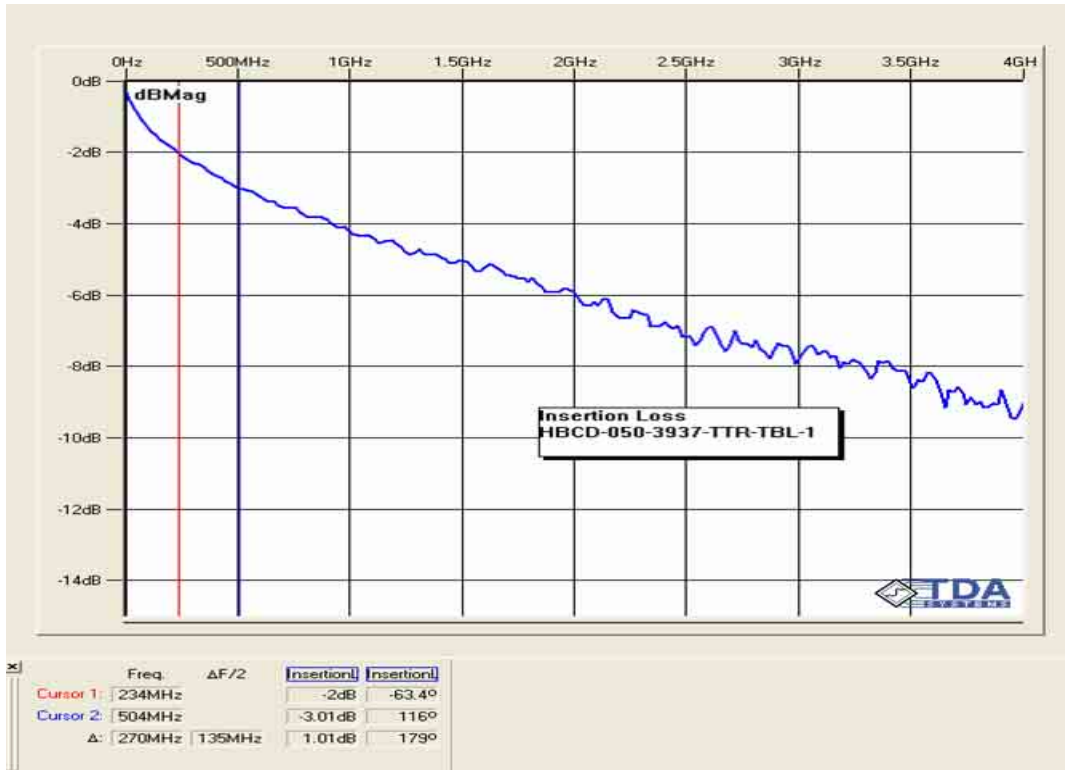


Figure 4: HBCD-050-3937-TTR-TBL-1 Insertion Loss Short Path

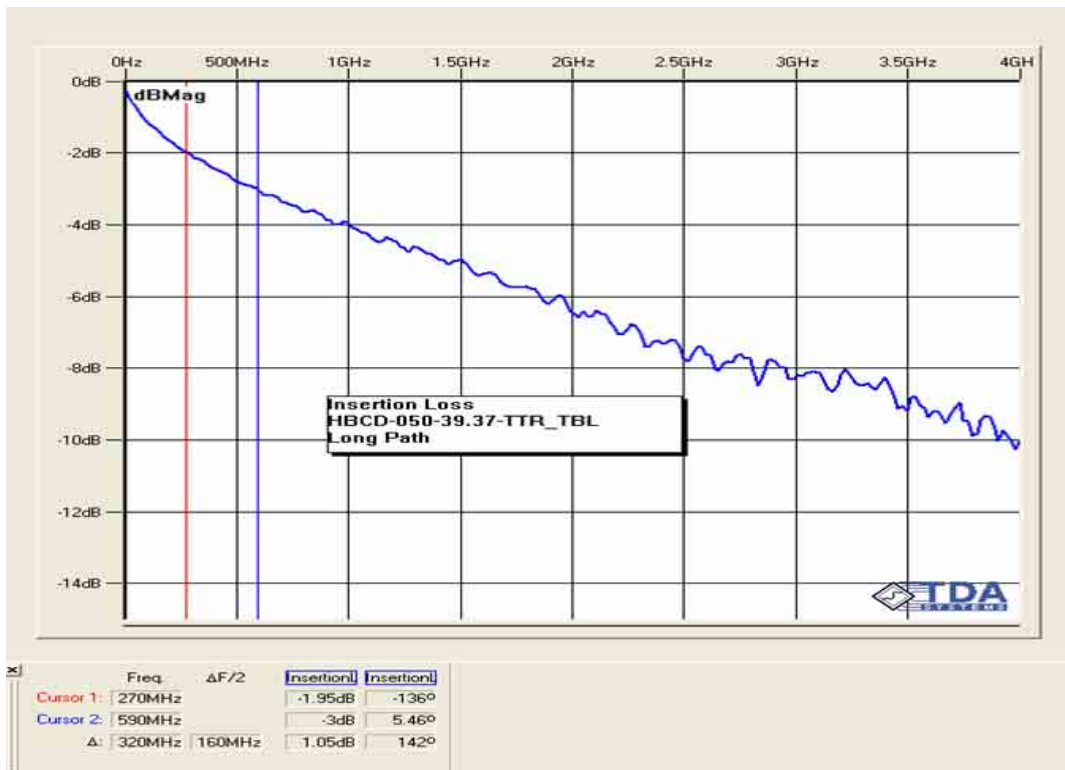


Figure 5: HBCD-050-3937-TTR-TBL-1 Insertion Loss Long Path

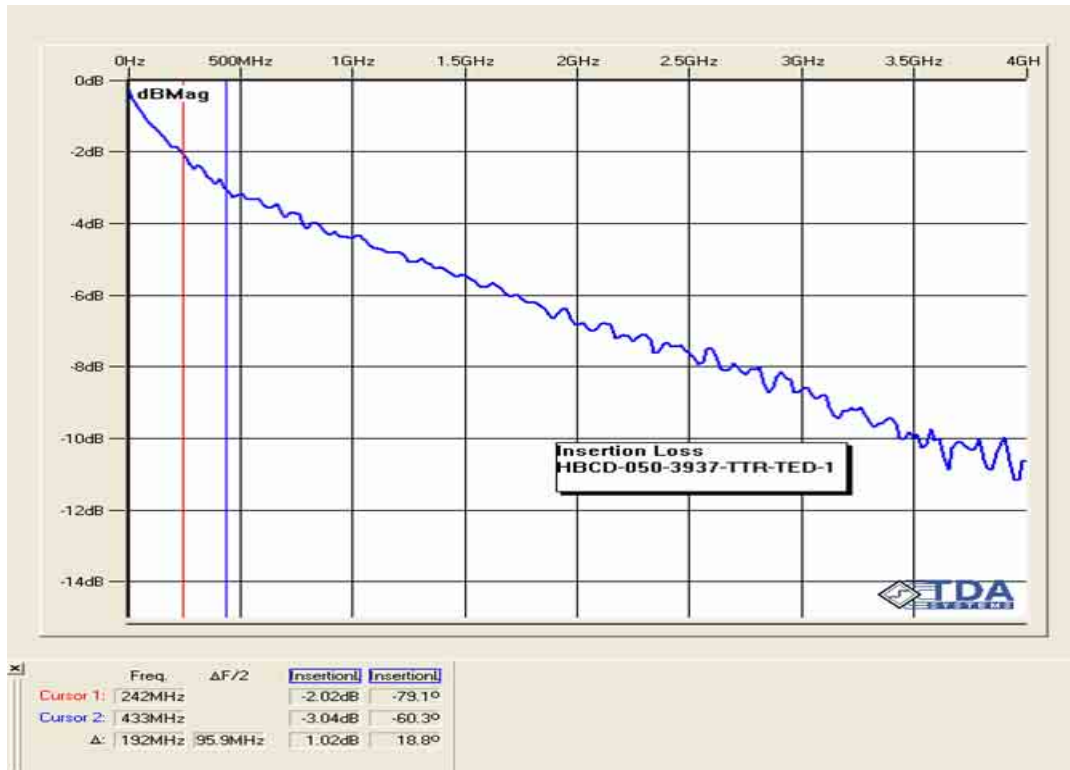


Figure 6: HBCD-050-3937-TTR-TED-1 Insertion Loss Short Path

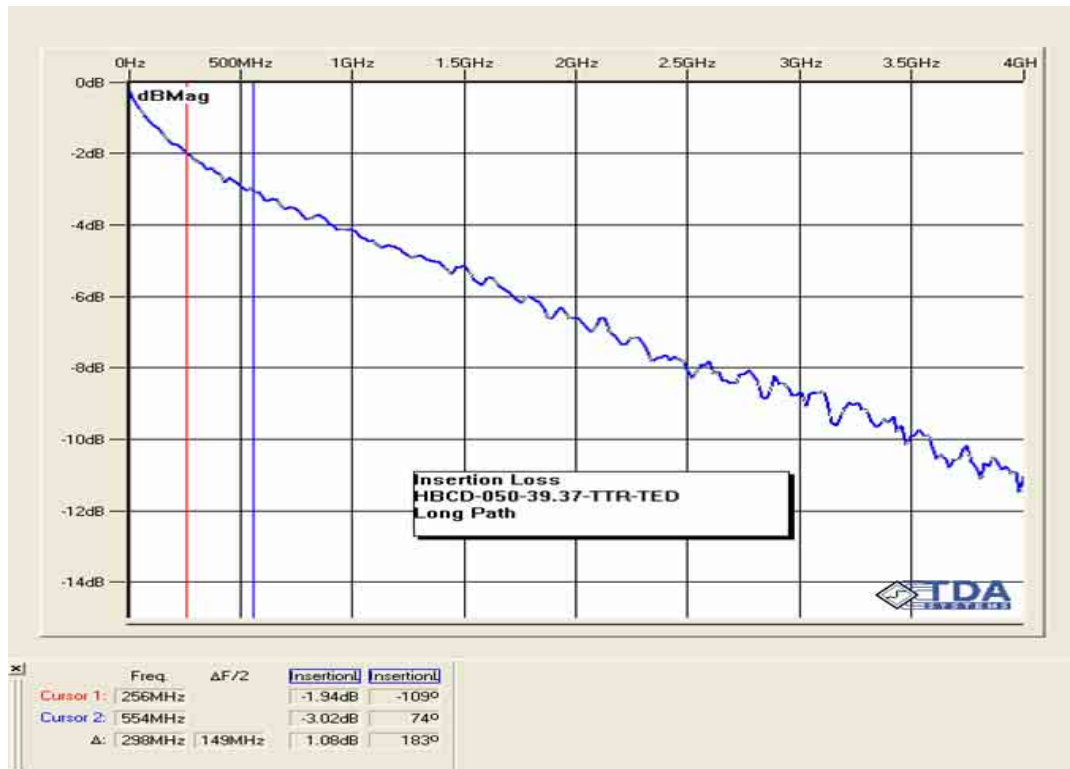


Figure 7: HBCD-050-3937-TTR-TED-1 Insertion Loss Long Path

### Return Loss

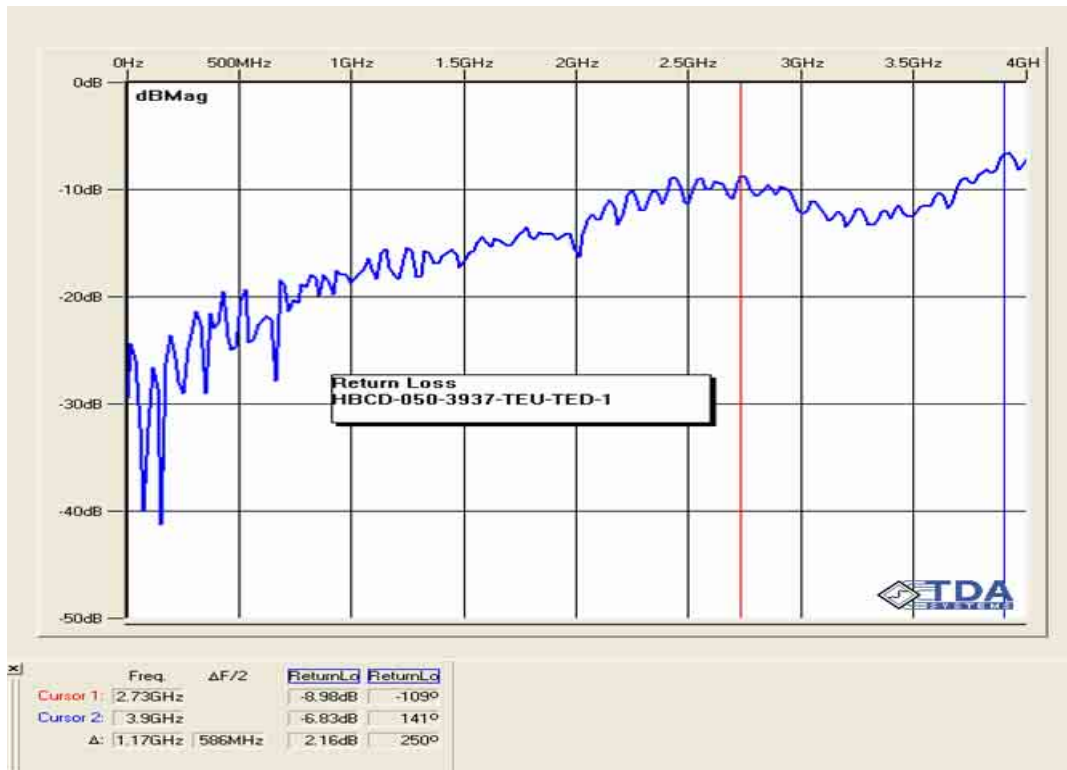


Figure 8: HBCD-050-3937-TEU-TED-1 Return Loss Short Path

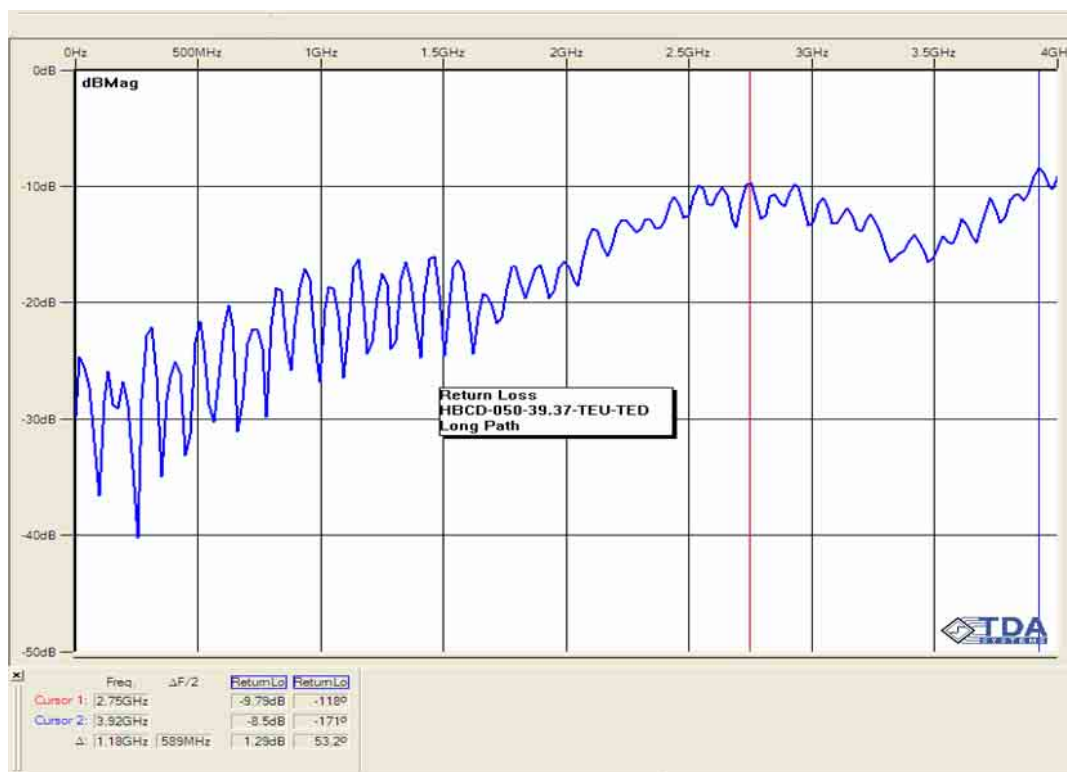


Figure 9: HBCD-050-3937-TEU-TED-1 Return Long Path

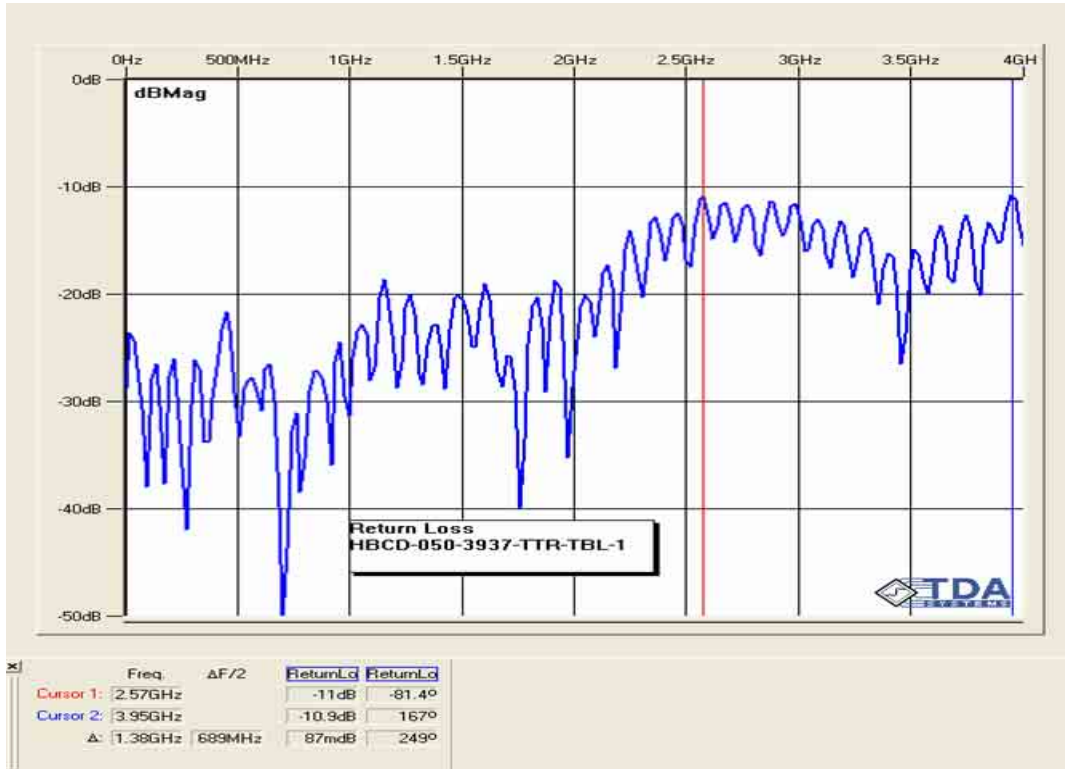


Figure 10: HBCD-050-3937-TTR-TBL-1 Return Loss Short Path

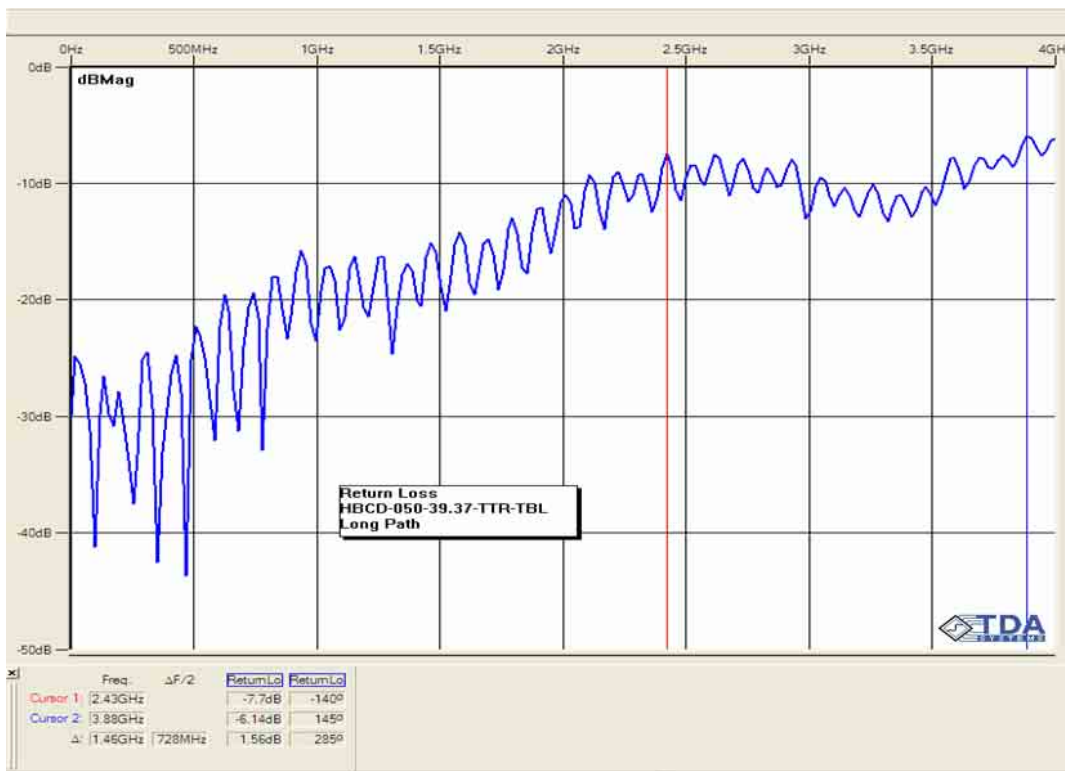


Figure 11: HBCD-050-3937-TTR-TBL-1 Return Loss long Path

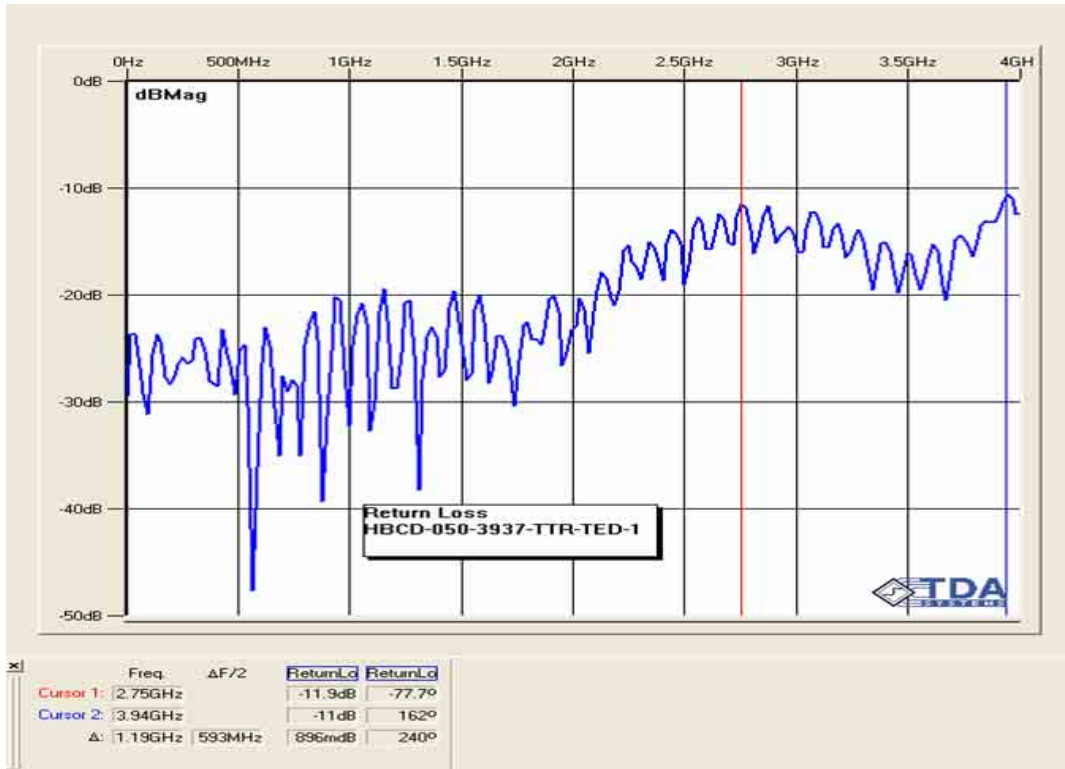


Figure 12: HBCD-050-3937-TTR-TED-1 Return Loss Short Path

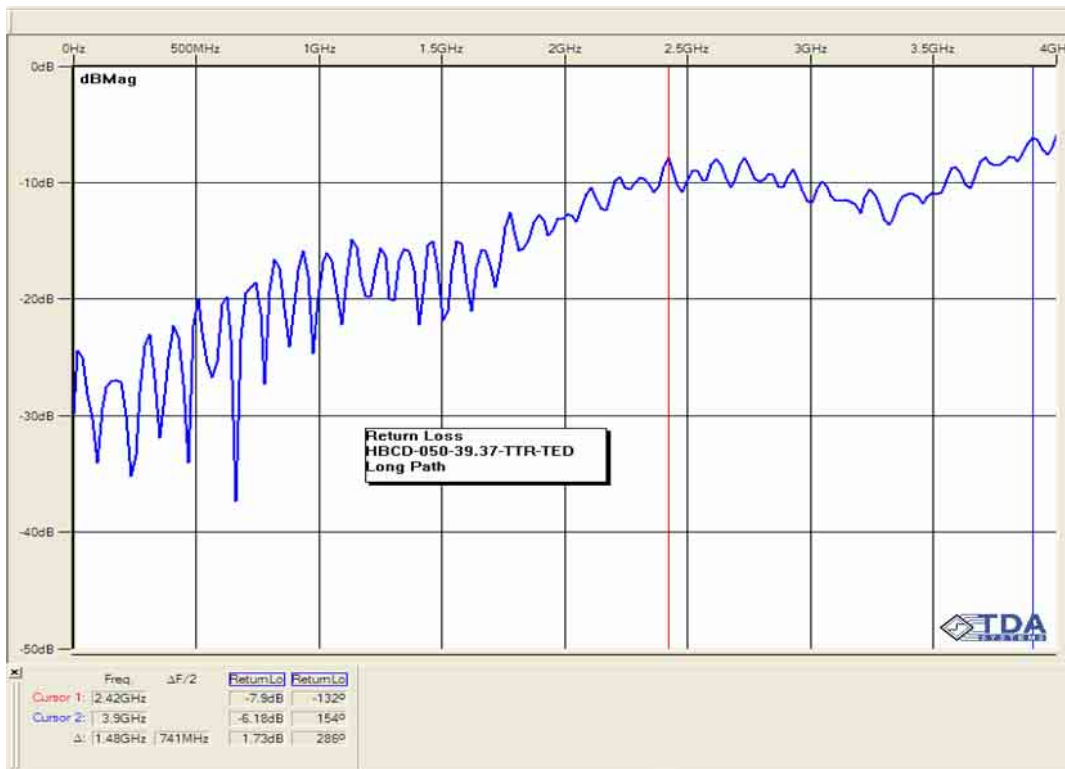


Figure 13: HBCD-050-3937-TTR-TED-1 Return Loss Long Path

### Near End Crosstalk

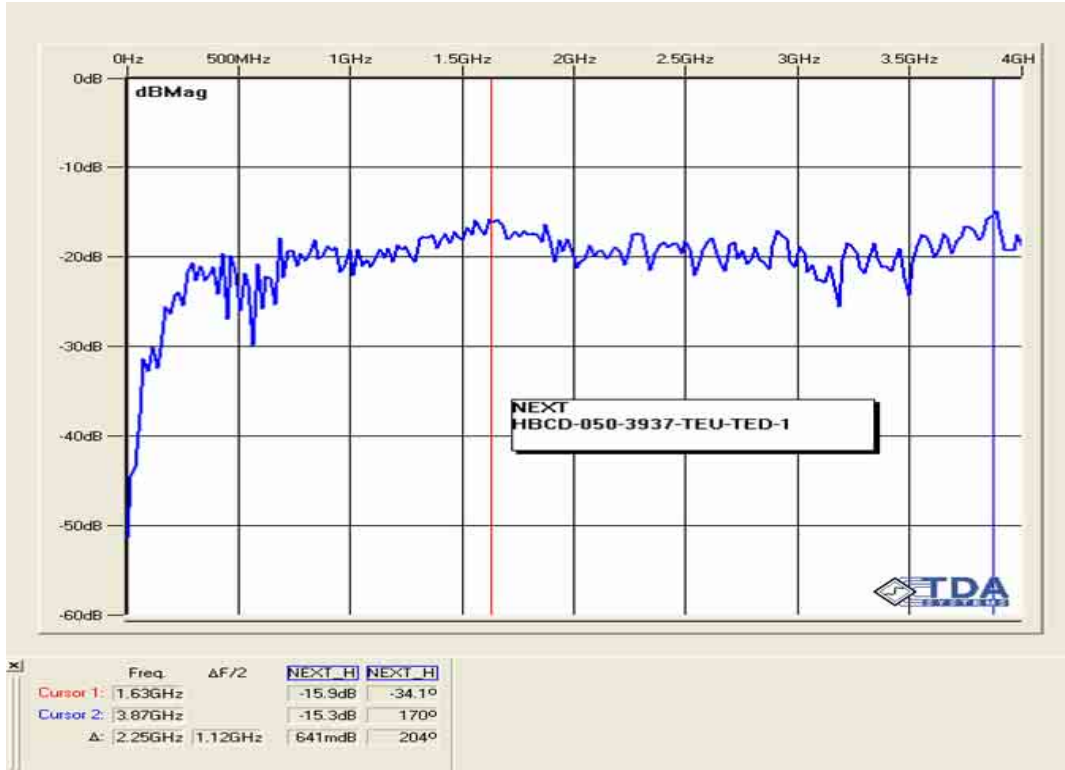


Figure 14: HBCD-050-3937-TEU-TED NEXT Short Path

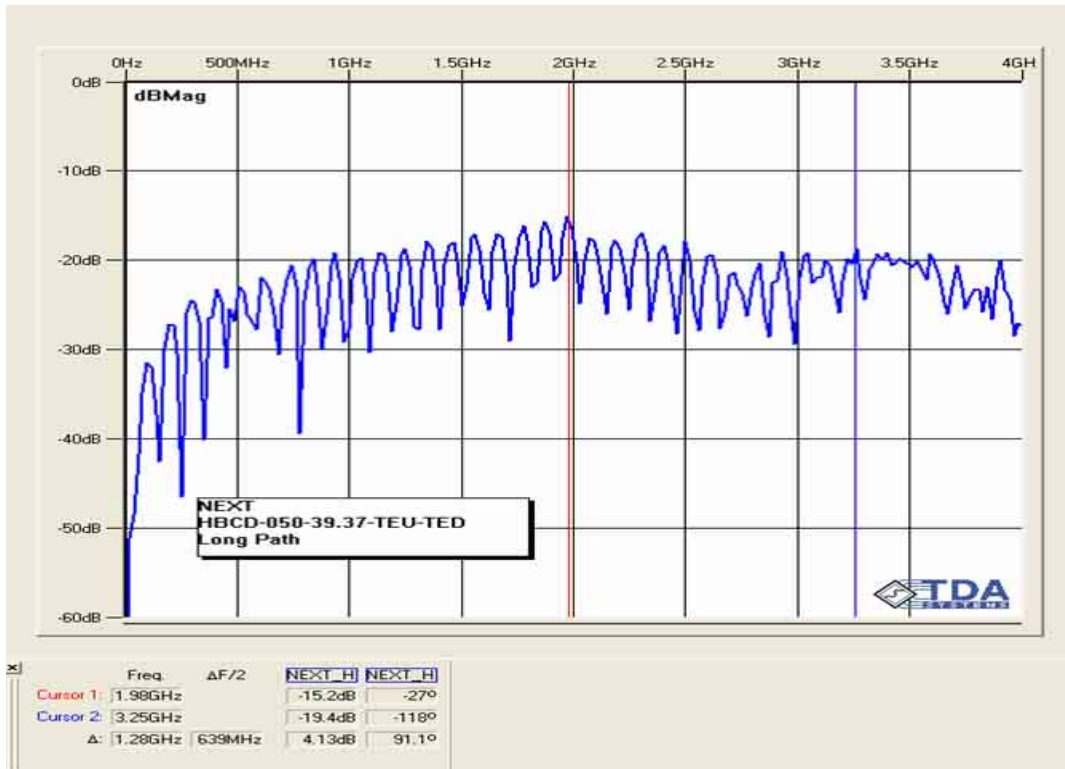


Figure 15: HBCD-050-3937-TEU-TED NEXT Long Path

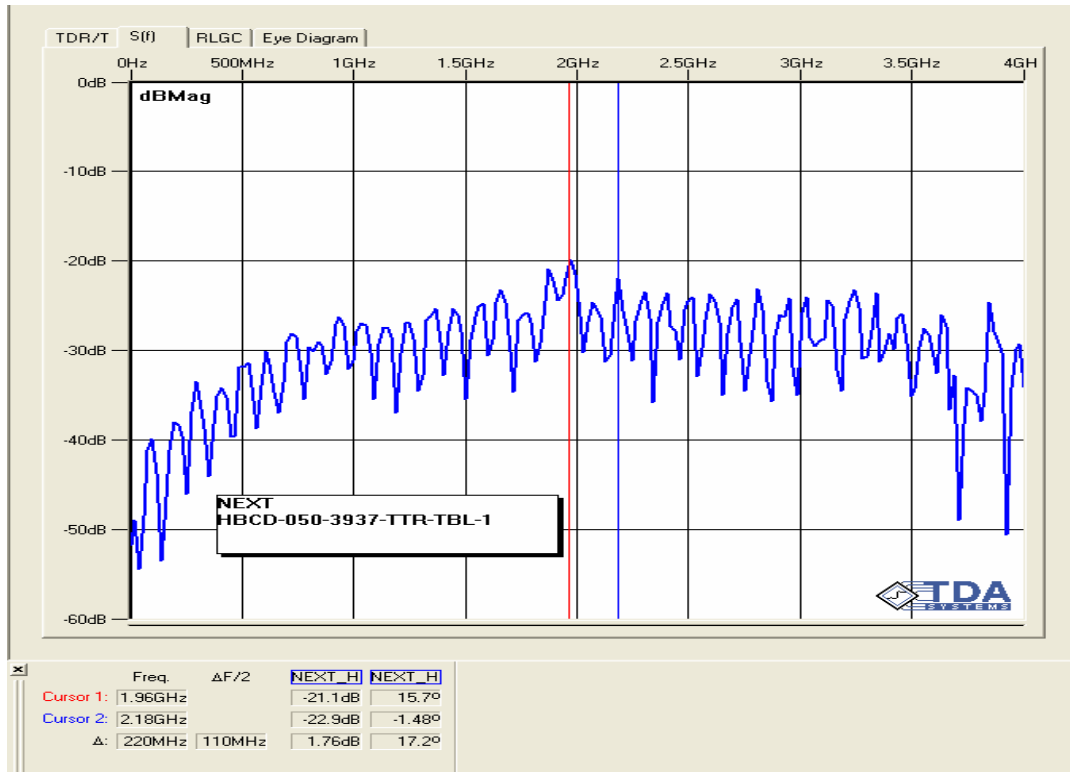


Figure 16: HBCD-050-3937-TTR-TBL-1 NEXT Short Path

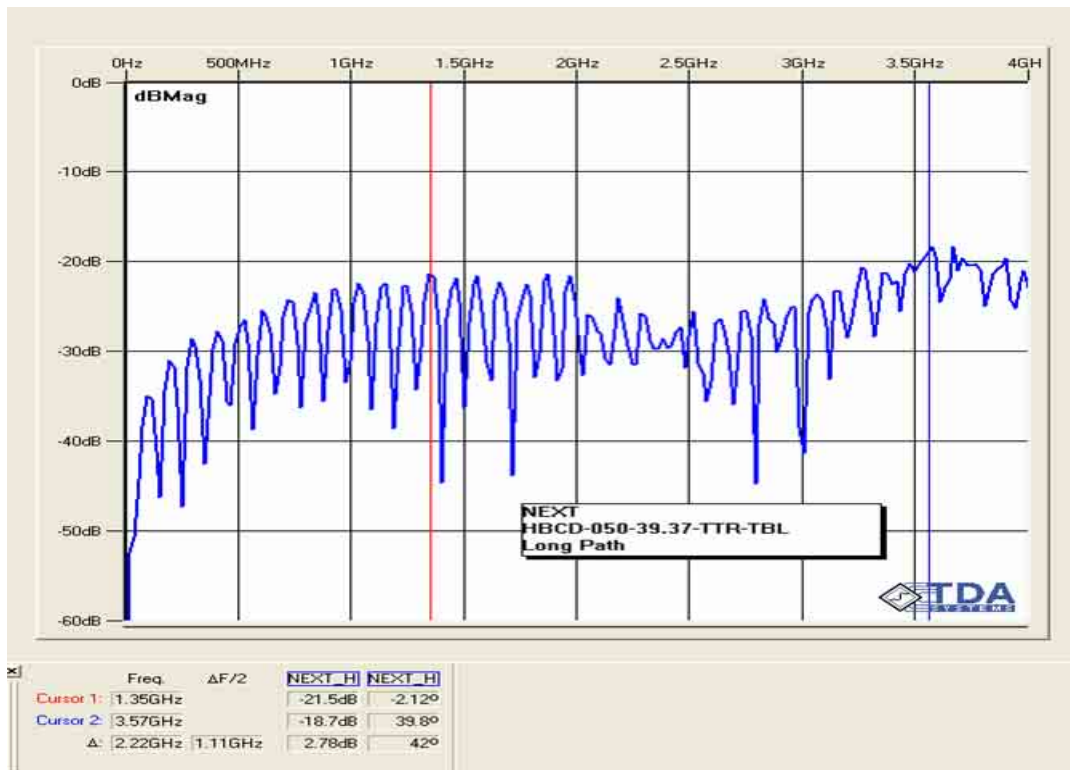


Figure 17: HBCD-050-3937-TTR-TBL-1 NEXT Long Path

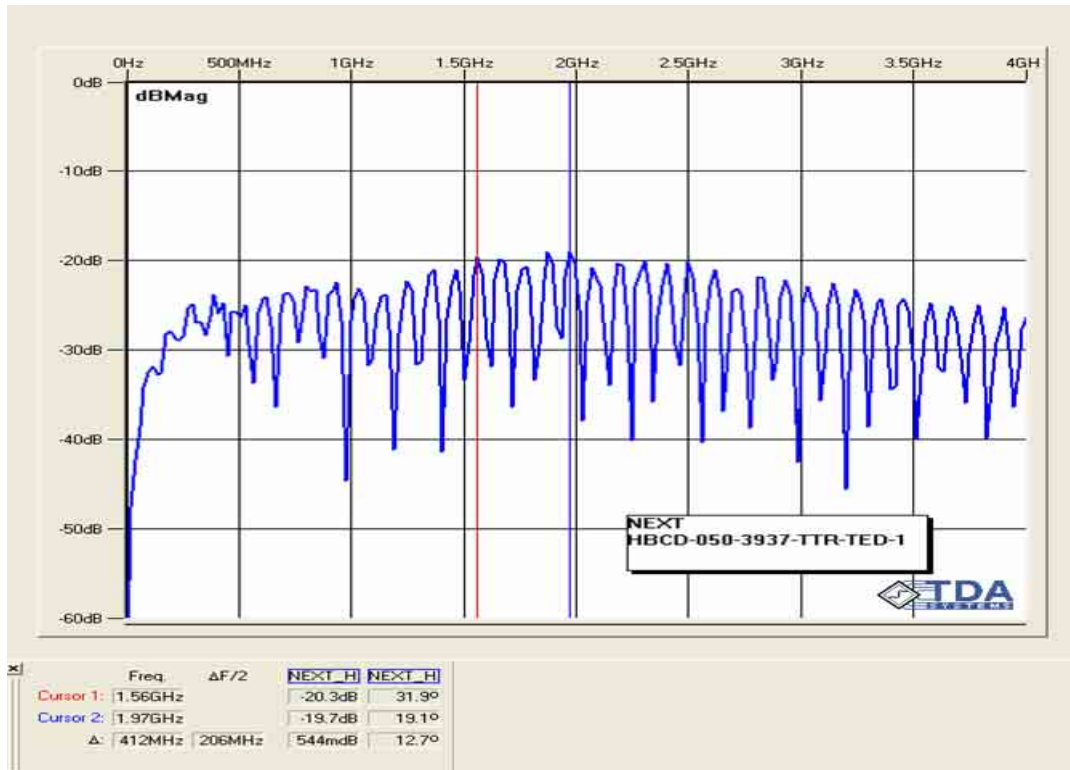


Figure 18: HBCD-050-3937-TTR-TED-1 NEXT Short Path

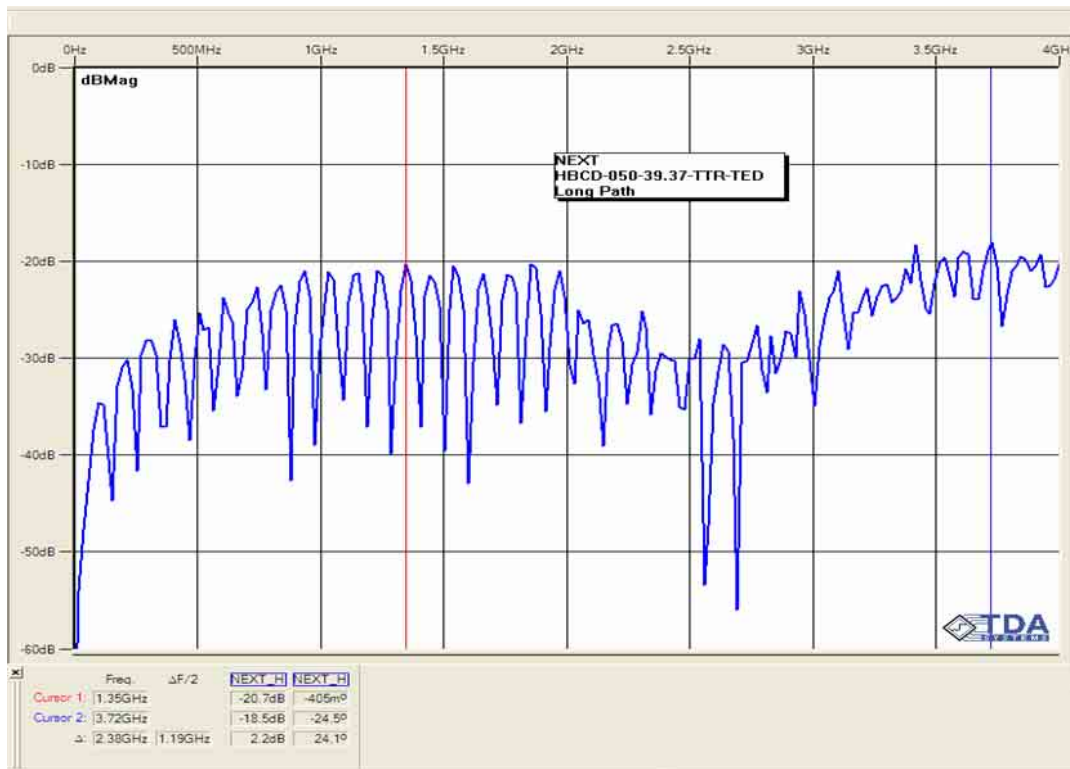


Figure 19: HBCD-050-3937-TTR-TED-1 NEXT Long Path

### Far End Crosstalk

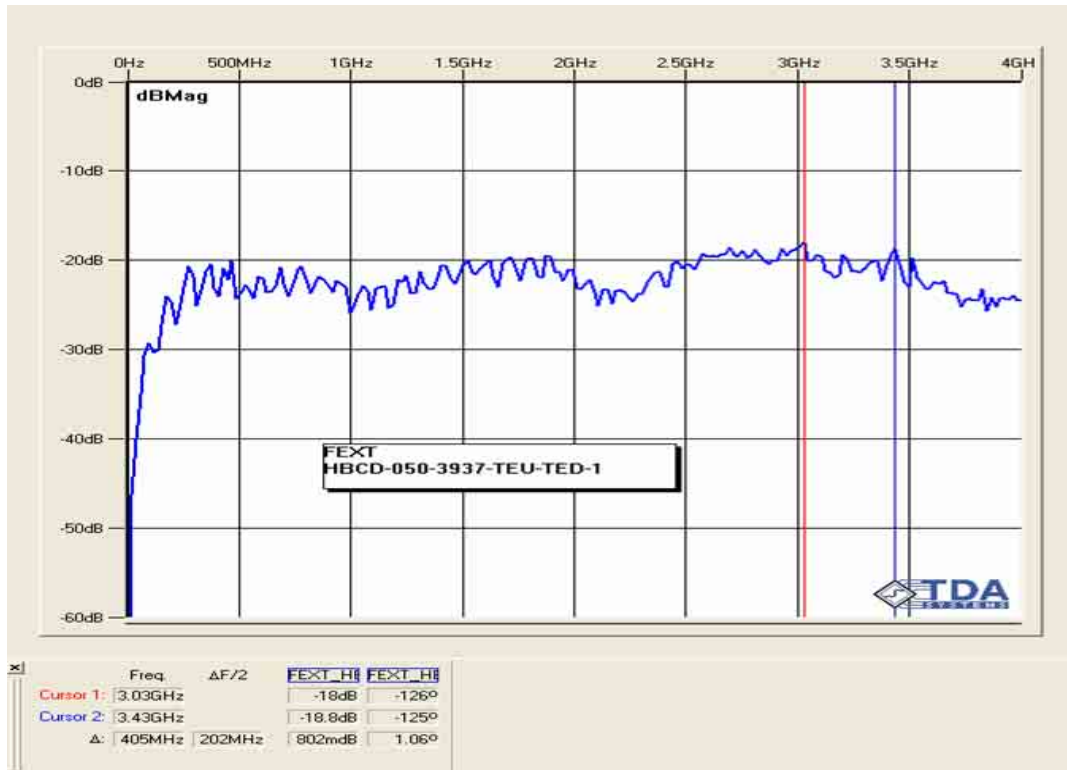


Figure 20: HBCD-050-3937-TEU-TED-1 FEXT Short Path

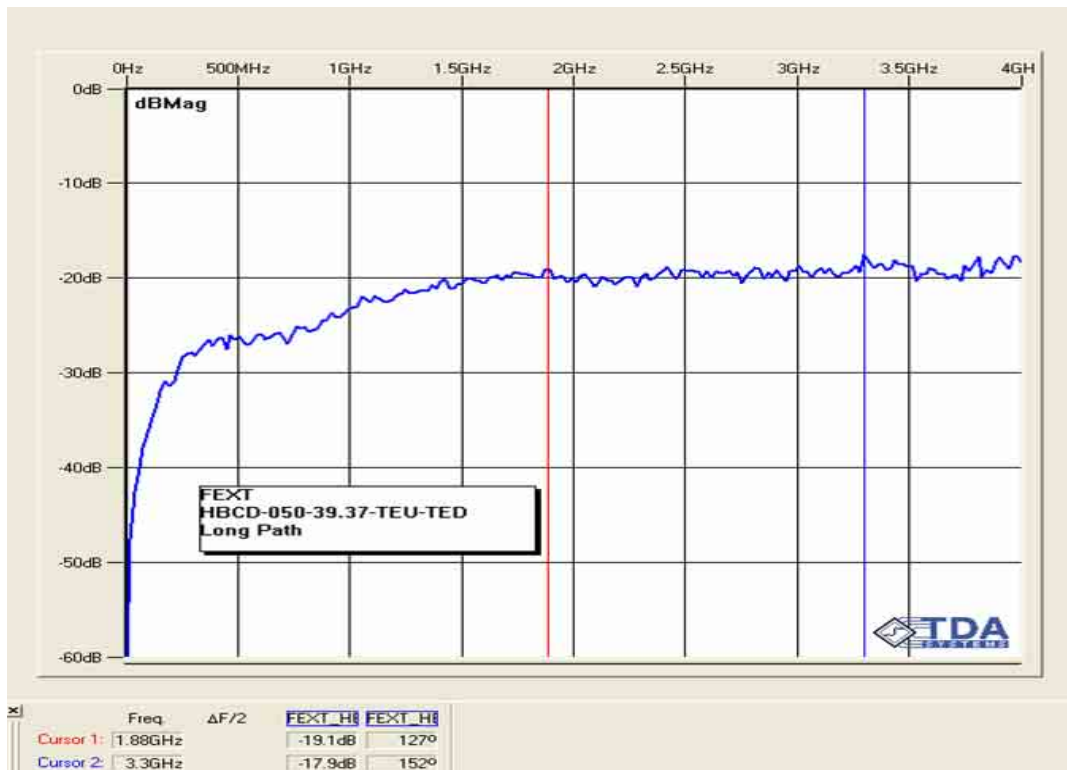


Figure 21: HBCD-050-3937-TEU-TED-1 FEXT Long Path

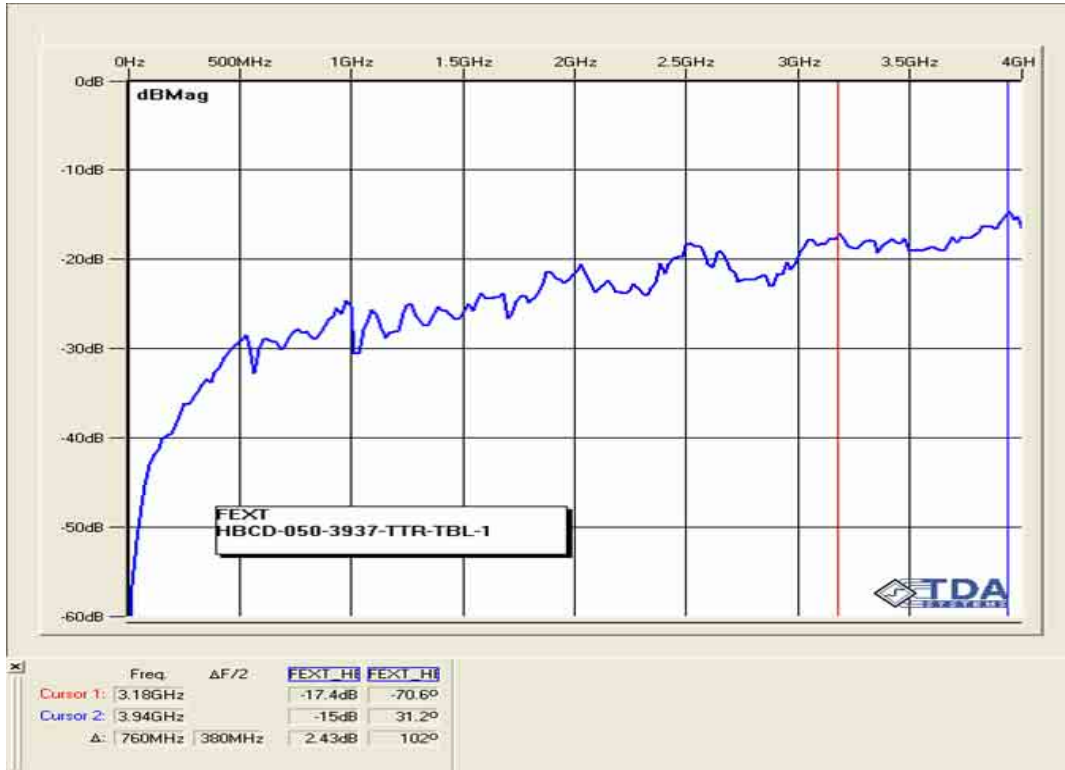


Figure 22: HBCD-050-3937-TTR-TBL-1 FEXT Short Path

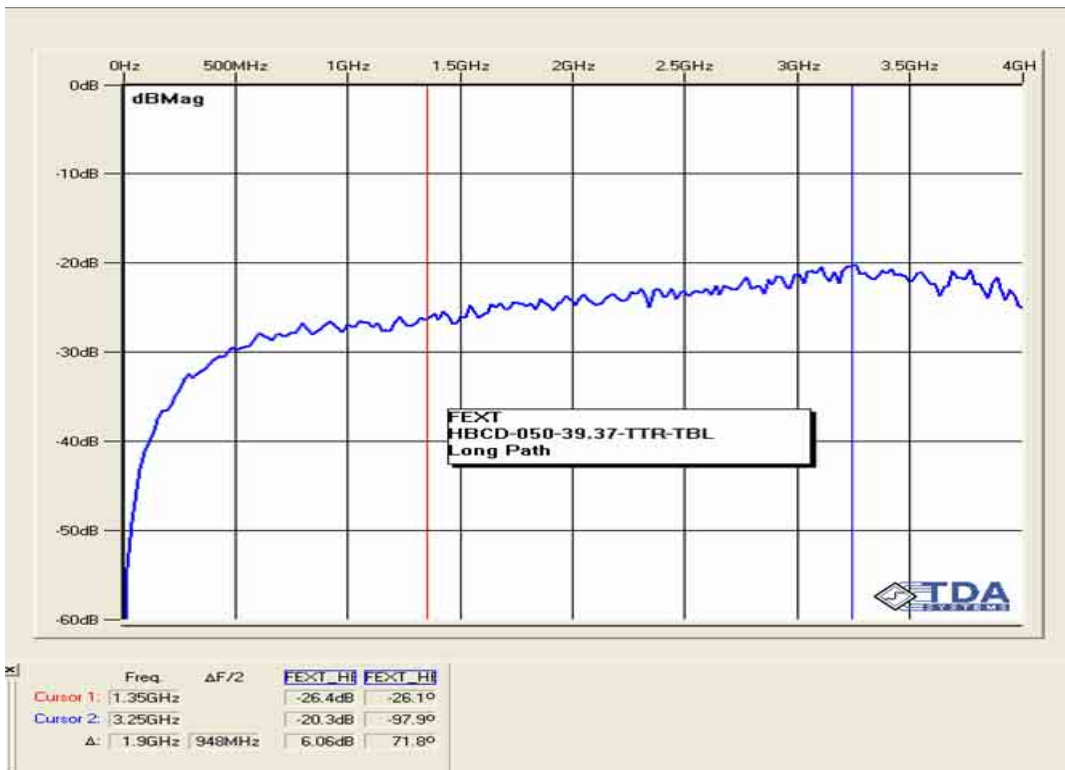


Figure 23: HBCD-050-3937-TTR-TBL-1 FEXT Long Path

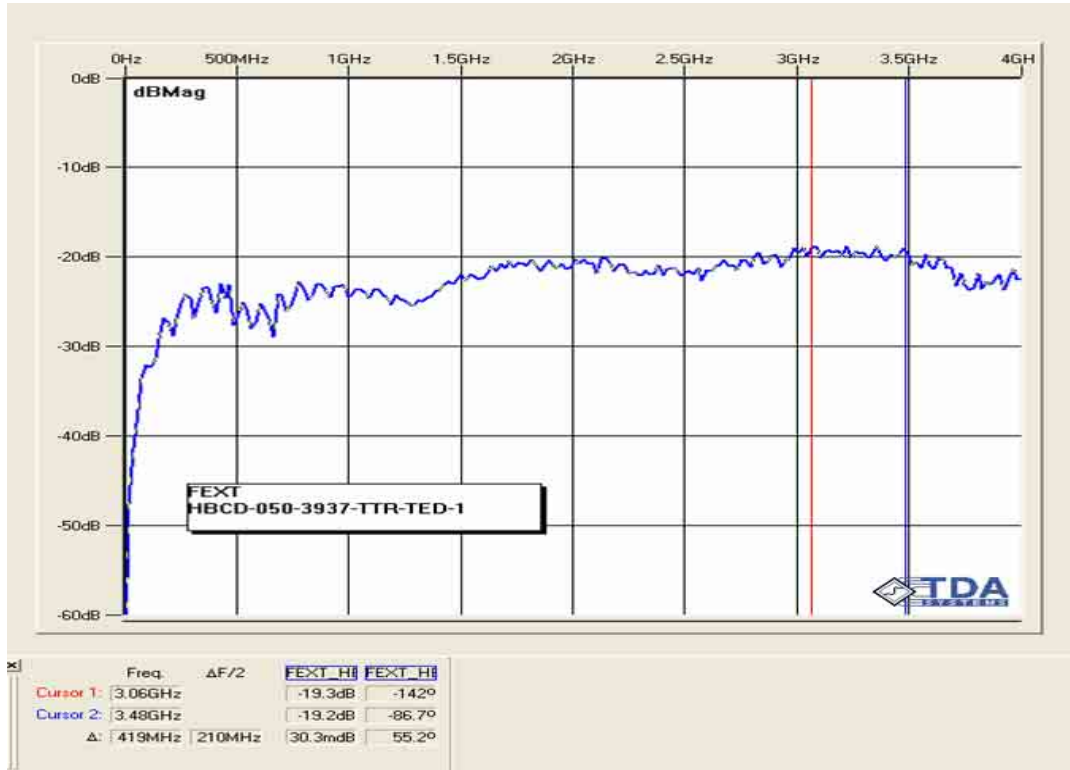


Figure 24: HBCD-050-3937-TTR-TED-1 FEXT Short Path

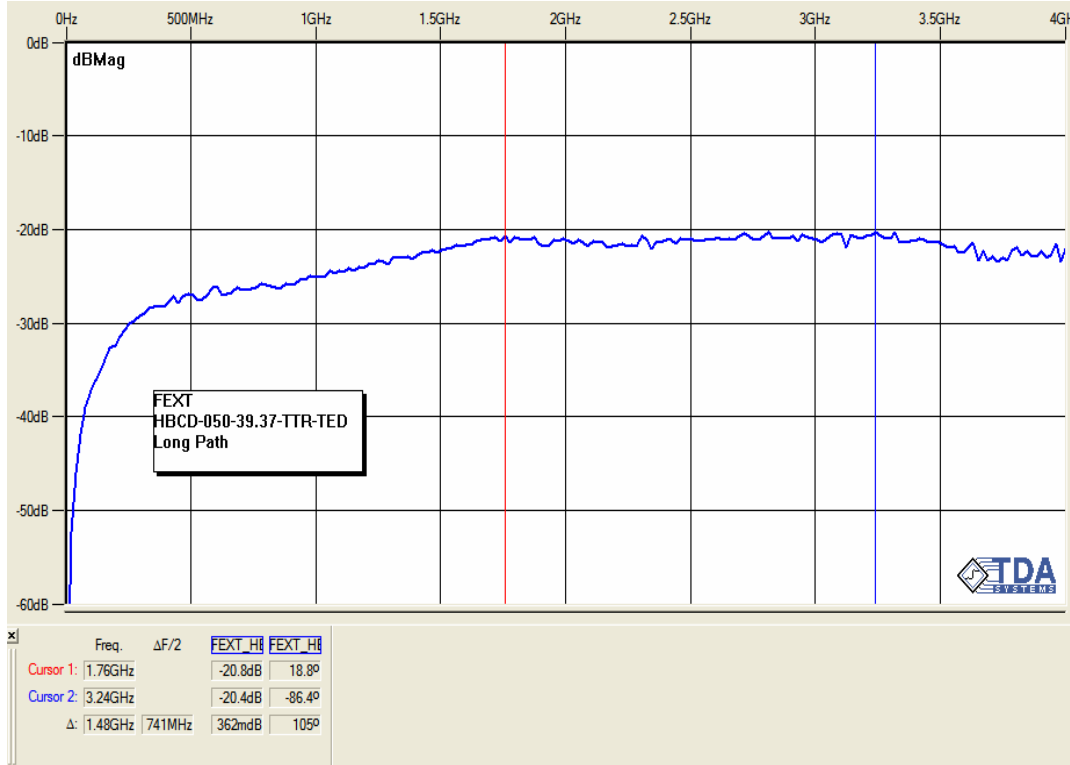
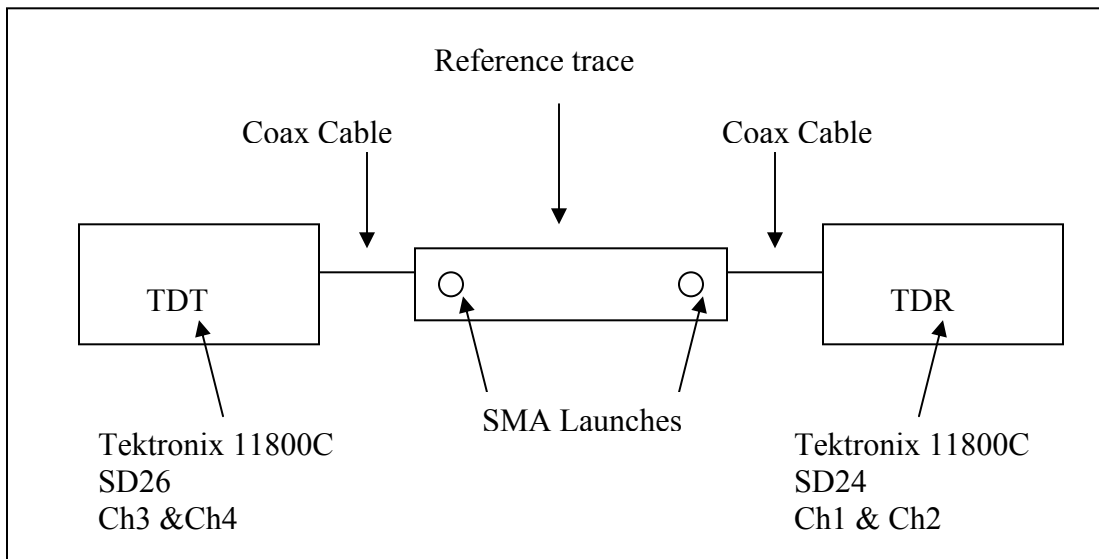


Figure 25: HBCD-050-3937-TTR-TED-1 FEXT Long Path

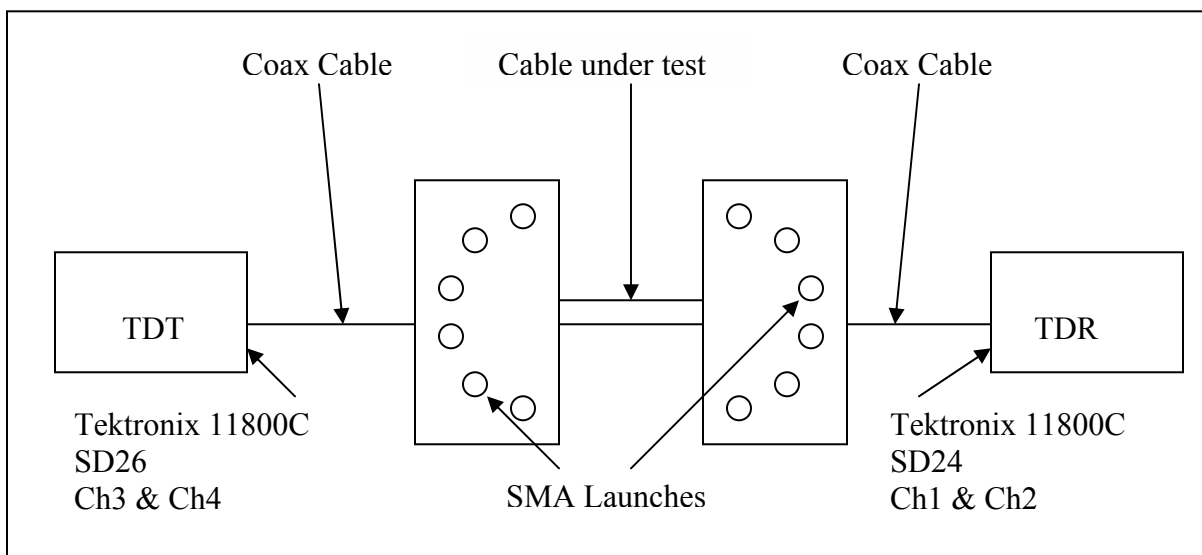
**Fixturing**

All measurements were performed using test boards specifically designed for this project (referred to in this report as “test board”). The test boards have a trace length of 2.60 inches and provides for the interconnection to the HBCD cable by use of replaceable SMA connectors. Each test board has a test trace for measurements that required reference measurements (referred to in this report as “reference board”) and was utilized as shown in Figure 26 below. The reference board was used to compensate for the losses due to the coaxial test cables, SMA launches, and the loss effects of the test board during the measurement process.



**Figure 26: Test setup for Insertion Reference acquisition**

Measurements were then performed using the test boards as shown in Figure 105. A picture of the test board and cable is shown in Figure 28 on the following page.



**Figure 27: Characterization test setup**

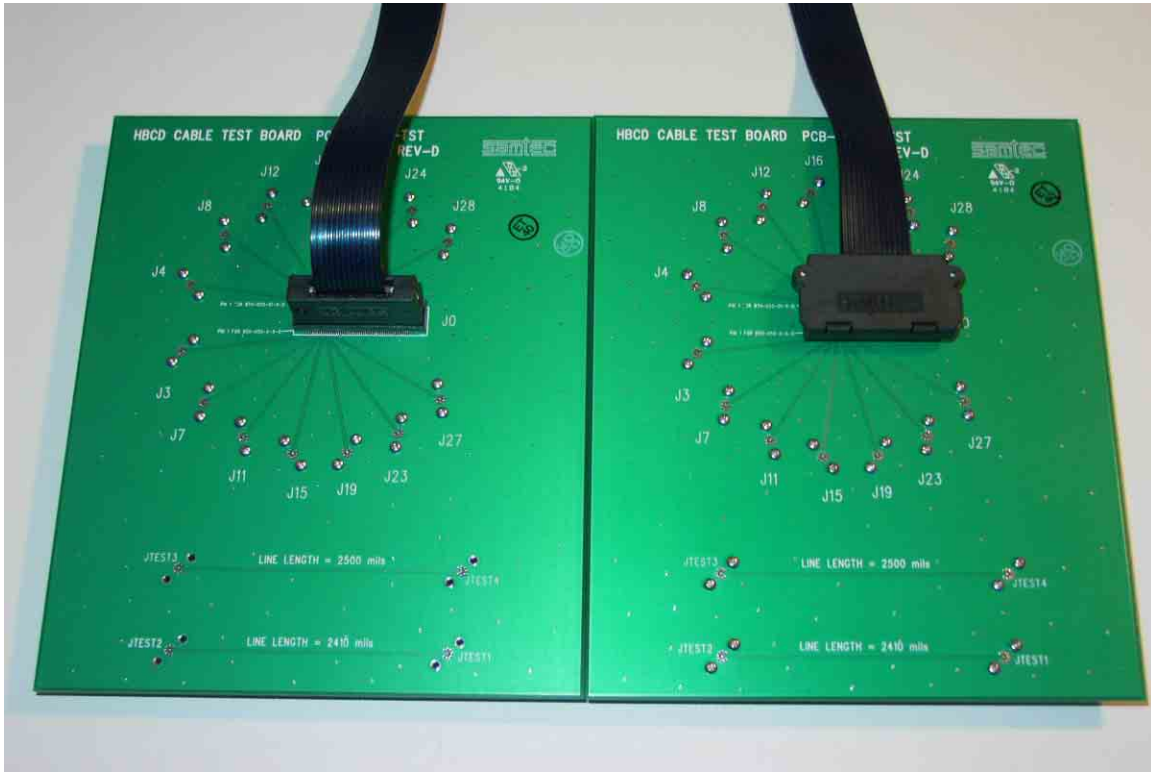


Figure 28: Test setup with Test PCBs and HBCD cable.

The cable termination uses a S, G, S, G configuration. The respective signal line numbers are shown in Table 6 below (first 25 positions shown; there are a total of 50 positions per row). All adjacent lines are terminated where applicable.

1	G	5	G	9	G	13	G	17	G	21	G	25	G	29	G	33	G	37	G	41	G	45	G	49
2	G	6	G	10	G	14	G	18	G	22	G	26	G	30	G	34	G	38	G	42	G	46	G	50

Table 6: Grounding schemes and respective signal line number

## **Time Domain Testing**

### **Impedance**

The Tektronix 11800C oscilloscope was set up in TDR (time domain reflectometry) mode using 128 averages and a 5000-point record length. The horizontal scale was set to 5ns/div to allow the near end connector and a portion of the cable to be displayed. The waveforms were acquired with the TDS Systems IConnect SW. A filtering function was set to 100ps. Measurements were made at the near end of each sample. The impedance measurements were made at the cable termination and 200ps into the cable.

### **Skew**

The skew was calculated by taking the difference of the propagation delay measurements. Calculations were performed between the shortest (minimum delay) and longest (maximum delay) electrical paths.

### **NEXT and FEXT**

Near end crosstalk (NEXT) and far end crosstalk (FEXT) measurements were made using the Tektronix 11800C oscilloscope. A thru reference of the coaxial test cables, SMAs, and reference board was performed to compensate for the test setup losses (see Figure 26, on page 29).

To acquire NEXT, a signal was driven using the oscilloscope. NEXT was measured on an adjacent signal at the near end (see Figure 29, on page 33). Acquiring FEXT, trace was driven with the oscilloscope. FEXT was measured on an adjacent trace at the far end (see Figure 30 on page 33). All adjacent lines were terminated, at both ends, with 50 $\Omega$  SMA loads; refer to Figures 29 and 30, on page 33.

## Frequency Domain Testing

### Attenuation

Insertion Loss measurements were made using the Tektronix 11800C oscilloscope. Testing was performed using a risetime of 35ps. The horizontal scale was set to 5ns/div, the record length was set to 5000 points and the number of averages was set to 128. These values were selected to ensure the ratio between the number of points and the window length was long enough to capture the highest frequencies and still yield a small enough frequency step to gain adequate resolution. Test setup losses were compensated for by acquiring a thru measurement (reference output pulse) of the coaxial test cables, SMAs, and the reference board (see Figure 29 on page 29).

A thru measurement was taken and then post processed by using TDA Systems' IConnect software (Version 3.0). The result is the insertion loss of the cable assembly.

### Return Loss

Return Loss measurements were made using the Tektronix 11800C oscilloscope. The horizontal scale was set to 5ns/div, the record length was set to 5000 points and the number of averages was set to 128. These values were selected to ensure the ratio between the number of points and the window length was long enough to capture the highest frequencies and still yield a small enough frequency step to gain adequate resolution. An open circuit reference measurement was taken at the connector that is mounted on the test board.

A matched reflection waveform of the cable assembly was acquired and then post processed by using TDA Systems' IConnect software (Version 3.0). The result is the return loss of the cable assembly.

### Near and Far End Crosstalk

NEXT and FEXT were measured initially in the time domain using the Tektronix 11800C oscilloscope.

To acquire the NEXT, an open circuit reference measurement was taken at the connector that is mounted on the test board. Then a trace was driven using the oscilloscope. NEXT was measured, in the time domain, on an adjacent trace (see Figure 103, on the next page). NEXT was then post processed by using TDA Systems' IConnect software (Version 3.0). The result is the NEXT of the cable assembly in the frequency domain.

Acquiring FEXT, a thru reference of the coaxial test cables, SMAs, and reference board was performed to compensate for the test setup losses (see Figure 26, on page 29). FEXT was measured, in the time domain, on an adjacent trace at the far end (see Figure 30, on the next page). FEXT was then post processed by using TDA Systems' IConnect software (Version 3.0). The result is the FEXT of the cable assembly in the frequency domain. All adjacent lines were terminated, at both ends, with 50 $\Omega$  SMA loads; refer to Figures 29 and 30 on the next page.

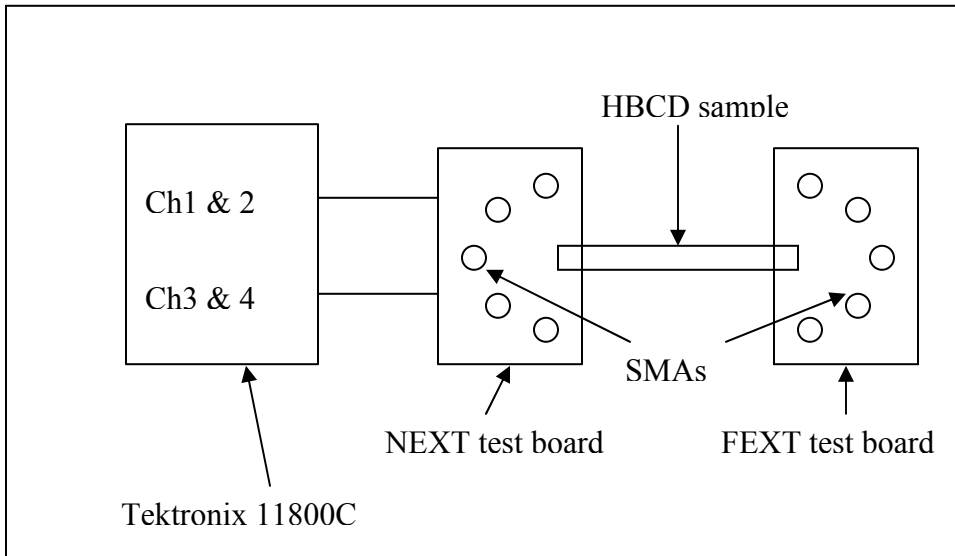


Figure 29: NEXT Measurement Setup

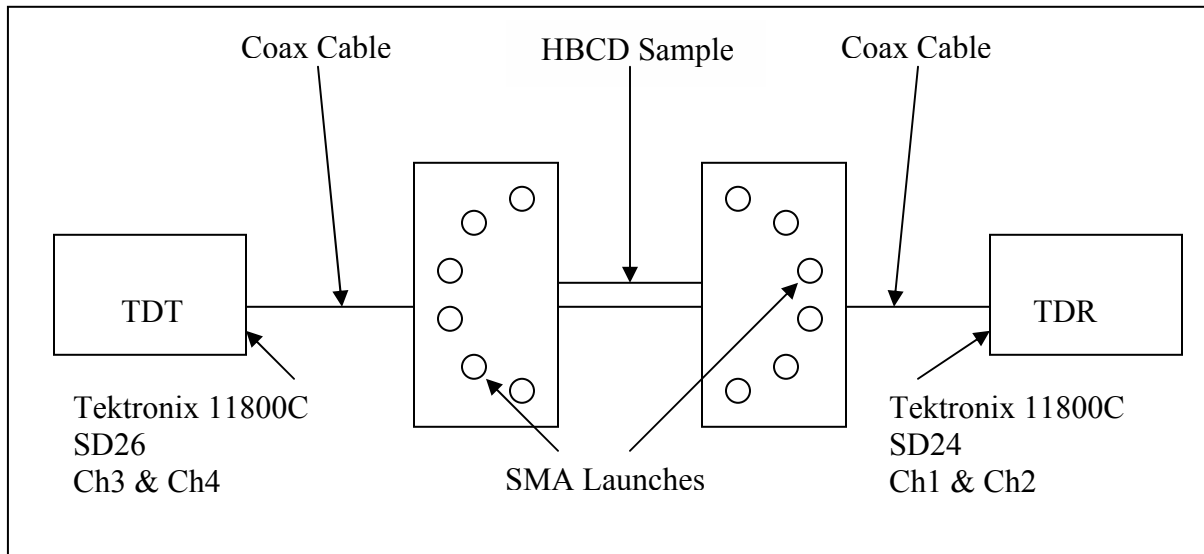


Figure 30: FEXT Measurement Setup

## Equipment

### Time Domain Testing

Tektronix 11800C Oscilloscope  
 Tektronix SD26 Sampling Head  
 Tektronix SD24 TDR/Sampling Head