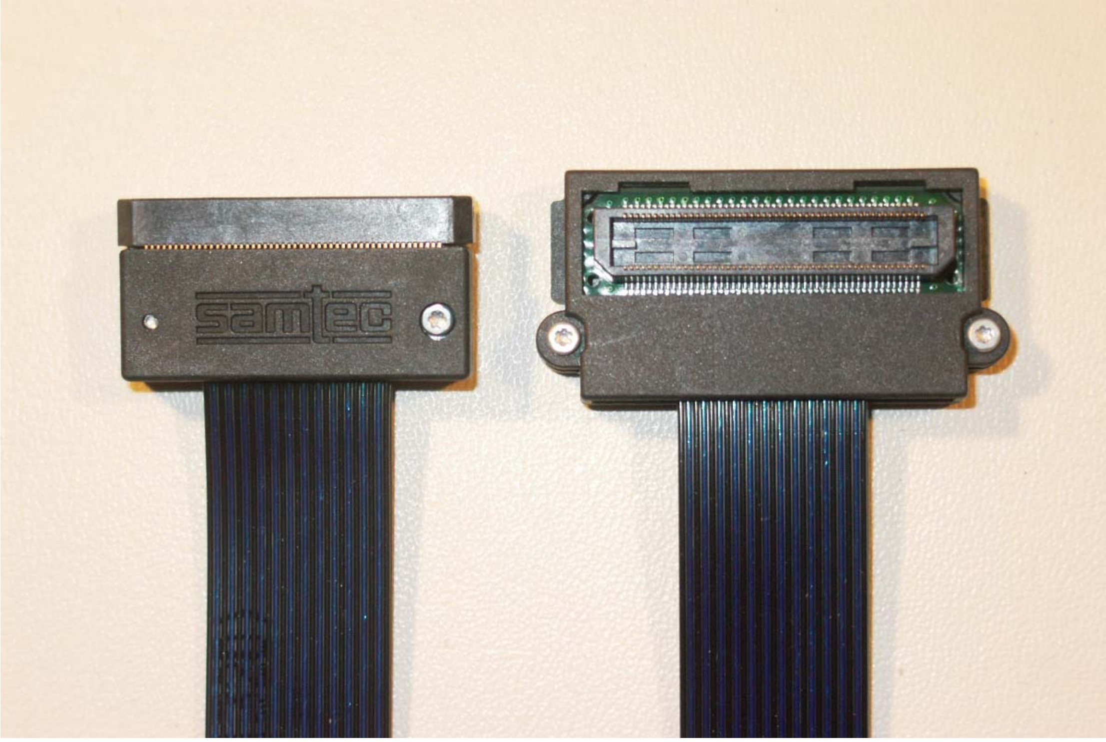
High Data Rate Characterization Report

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

Description:
Cable Assembly, High Data Rate, 0.5mm Pitch

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Report Revision: 4/24/2006

Series: HBCD
Description: Cable Assembly, High Data Rate, 0.5mm Pitch

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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[1], Level 1, testing standards when applicable.

Time domain and frequency domain measurements were made. Time domain measurements included impedance, propagation delay, crosstalk and skew. Frequency domain measurements were preformed using TDA's IConnect software (Version 3.0) and included insertion loss (IL), return loss (RL), near end crosstalk (NEXT) and far end crosstalk (FEXT). All measurements were made utilizing test boards specifically designed for this project and are referred to as "test board" in this report. The test boards were identified as "HBCD CABLE TEST BOARD PCB-100178-TEST REV-E".

Product Description

Each 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 green 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 red transition boards are crossover type boards and are used to connect the inner connector row to the out connector row and visa versa. The crossover boards are used here to achieve a position 1 to position 1 mapping, because the second end terminations are turned down for the edge mount and turned left for the vertical mount. Figure 1 on the preceding page is a picture of a termination configuration of one of the test samples. The board/cable termination areas are covered with plastic caps

Three samples, one of each type of termination configuration, were tested. The actual sample part numbers tested are shown in below in Table 1, which also identifies End 1 and

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[1] Measurement and Performance Requirements for HPEI Bulk Cable**,** Rev 14, March 25, 2004

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End 2 of each assembly. Two lines, the longest and the shortest electrical paths, from each sample were tested

Length	Part Number	Termination	End 1	End 2
39.37in	HBCD-050-39.37-TEU-TED-1	EM-EM	TEU	TED
39.37in	HBCD-050-39.37-TTR-TBL-1	DV-DV	TTR	TBL
39.37in	HBCD-050-39.37-TTR-TED-1	DV-EM	TTR	TED

Table 1: Sample Descriptions

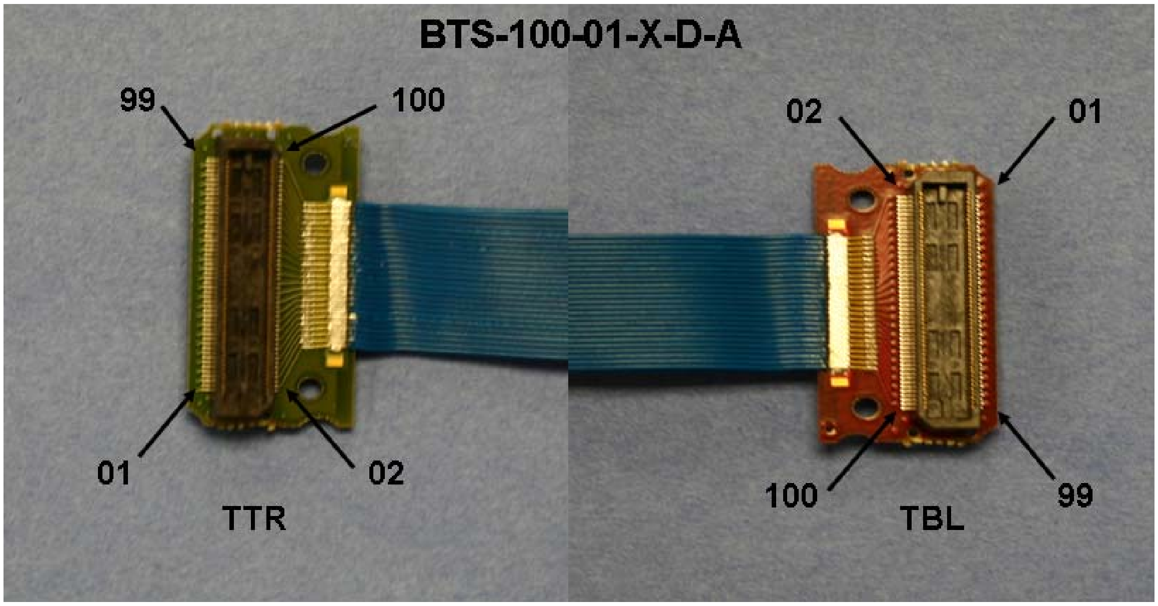


Figure 1: Test Sample Configuration, Part #: HBCD-39.37-TTR-TBL-1

Results Summary

Time Domain Data

Impedance

Impedance measurements were performed using a filtered risetime of 100 pS.
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 200 pS into the cable.

Assembly	Path	End Option				Cable	
		End 1		End 2		End 1	End 2
		Z_{Min} (Ω)	Z_{Max} (Ω)	Z_{Min} (Ω)	Z_{Max} (Ω)	Z_{max} (Ω)	Z_{max} (Ω)
TEU-TED	Long	46.5	58.9	46.7	61.0	49.5	50.0
	Short	46.7	61.5	45.7	63.1	49.9	51.8
TTR-TBL	Long	46.2	64.2	45.8	64.4	48.9	49.2
	Short	47.0	58.6	46.0	59.7	49.4	49.2
TTR-TED	Long	46.4	64.1	46.6	60.8	49.1	49.2
	Short	46.7	58.2	45.5	64.0	49.3	51.1

Table 2: Impedance Measurements

Timing Measurements

Skew was calculated as the difference between the propagation delay of the longest (outer row) and the shortest (inner Row) electrical paths. End 1 of each assembly was the source end for these measurements. The results are tabulated below.

Assembly	Path	Propagation Delay (nS)	Skew (nS)
TEU-TED	Long	5.044	0.009
	Short	5.053	
TTR-TBL	Long	5.121	0.006
	Short	5.015	
TTR-TED	Long	5.088	0.055
	Short	5.033	

Table 3: Timing 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 was 244 mV. The acquired data was measured using a filtered rise time of 100 pS. The End 1 and End 2 headings in Table 4 represent the near-end cable assembly connector, i.e. the source end. 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	12.4	5.1	16.0	6.6
	Short	14.0	5.7	21.6	8.9
TTR-TBL	Long	7.2	3.0	10.8	4.4
	Short	5.8	2.4	8.2	3.4
TTR-TED	Long	7.2	3.0	16.2	6.6
	Short	5.4	2.2	21.0	8.6

Table 4: % NEXT

FEXT

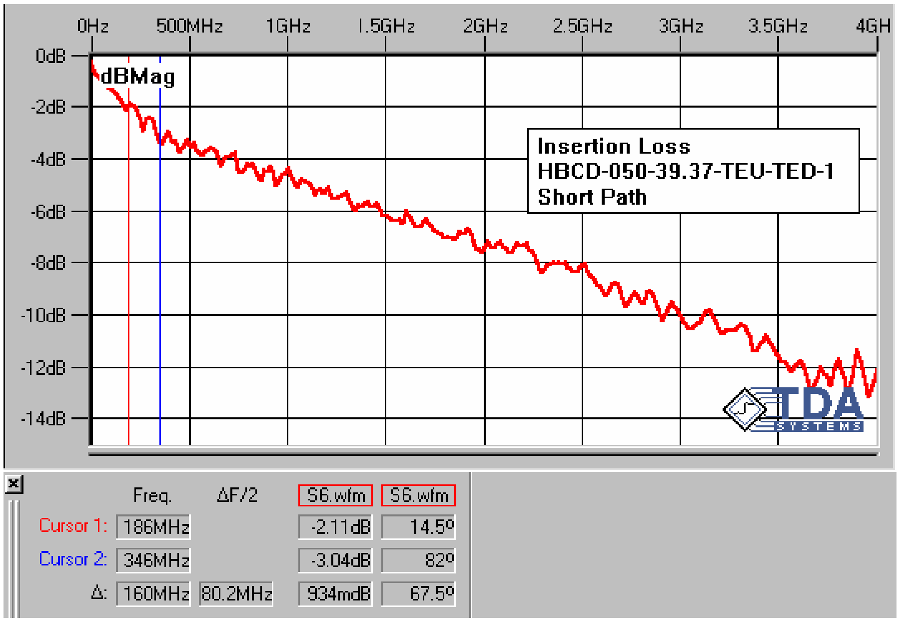
The far end crosstalk was measured in the time domain and converted to a percentage and reported below in Table 4. The incident pulse amplitude from the TDR was 244 mV. The acquired data was measured using a filtered rise time of 100 pS. The End 1 and End 2 headings in Table 4 represent the near-end cable assembly connector, i.e. the source end. All FEXT measurements were performed with the cable assembly mated to the respective connector/test board. The values in Table 4 represent the crosstalk measured at the far end of the assembly.

Assembly	Path	END 1		END 2	
		FEXT (mV)	FEXT (%)	FEXT (mV)	FEXT (%)
TEU-TED	Long	18.8	7.7	18.8	7.7
	Short	18.4	7.5	18.4	7.5
TTR-TBL	Long	11.6	4.8	11.6	4.8
	Short	9.2	3.8	9.2	3.8
TTR-TED	Long	16.4	6.7	16.0	6.6
	Short	16.4	6.7	16.8	6.9

Table 5: % FEXT

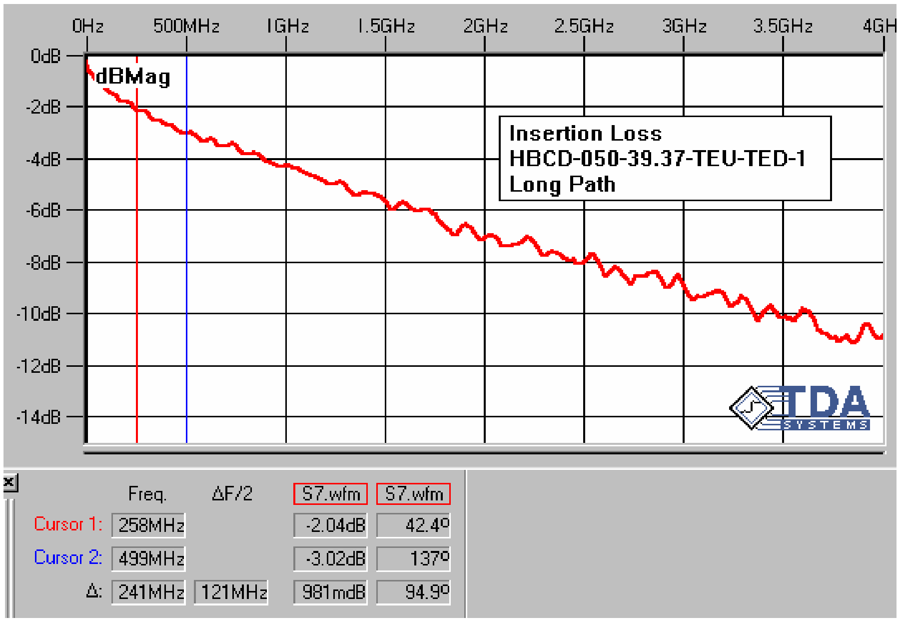
Frequency Domain Data

Insertion Loss



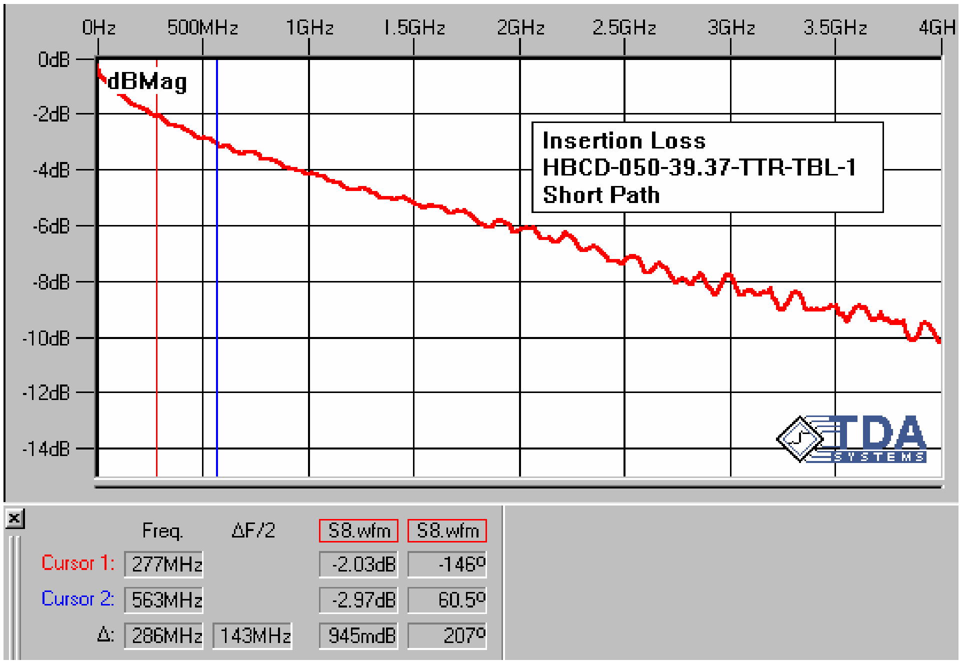
	Freq.	ΔF/2	S6.wfm	S6.wfm
Cursor 1:	186MHz		-2.11dB	14.5°
Cursor 2:	346MHz		-3.04dB	82°
Δ:	160MHz	80.2MHz	934mdB	67.5°

Figure 2: HBCD-050-39.37-TEU-TED-1 Insertion Loss Short Path



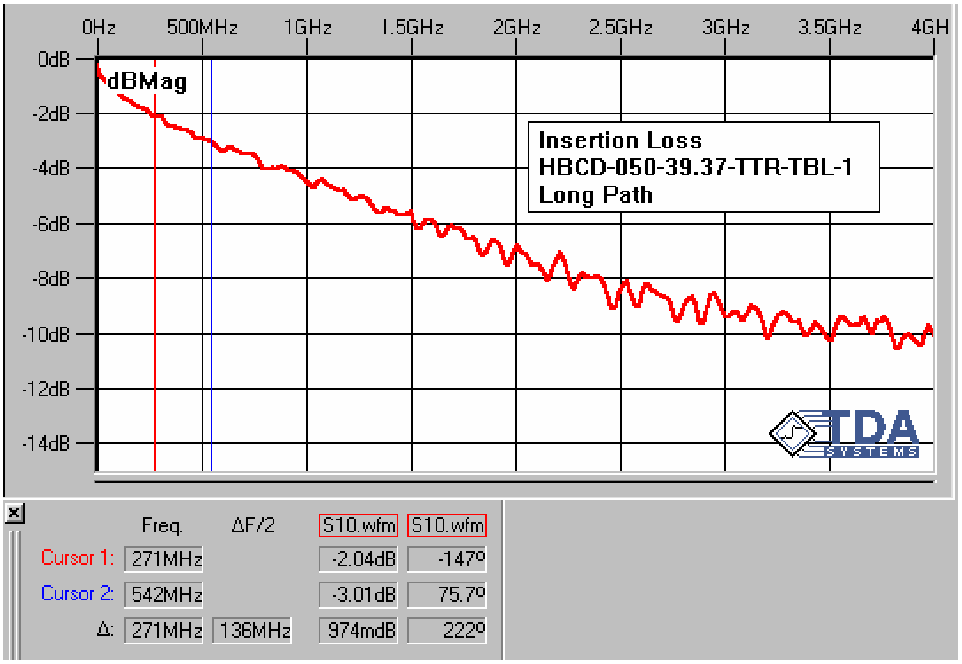
	Freq.	ΔF/2	S7.wfm	S7.wfm
Cursor 1:	258MHz		-2.04dB	42.4°
Cursor 2:	499MHz		-3.02dB	137°
Δ:	241MHz	121MHz	981mdB	94.9°

Figure 3: HBCD-050-39.37-TEU-TED-1 Insertion Loss Long Path



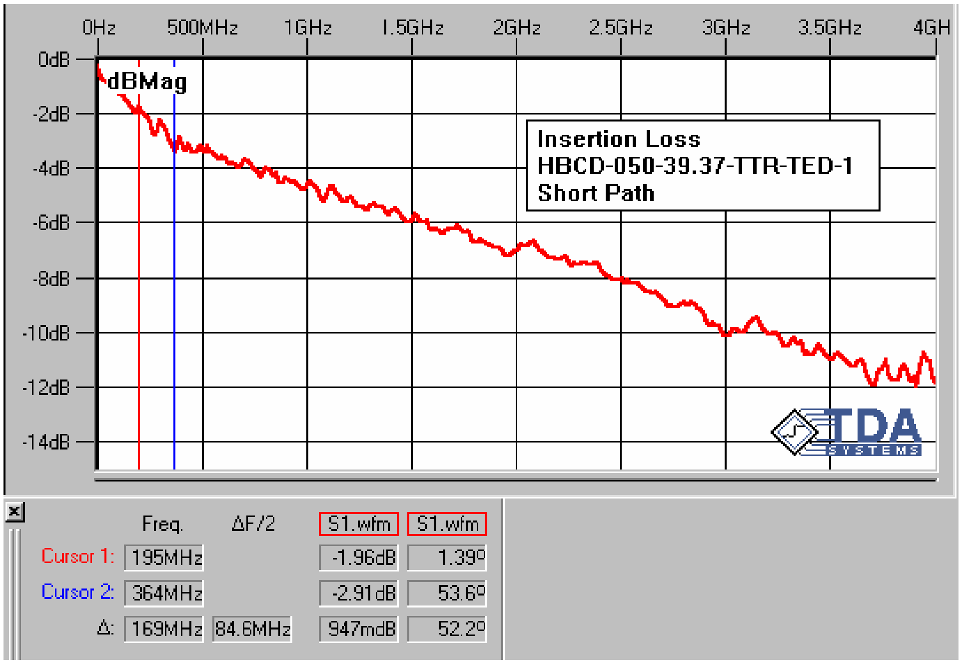
	Freq.	ΔF/2	S8.wfm	S8.wfm
Cursor 1:	277MHz		-2.03dB	-146º
Cursor 2:	563MHz		-2.97dB	60.5º
Δ:	286MHz	143MHz	945mdB	207º

Figure 4: HBCD-050-39.37-TTR-TBL-1 Insertion Loss Short Path



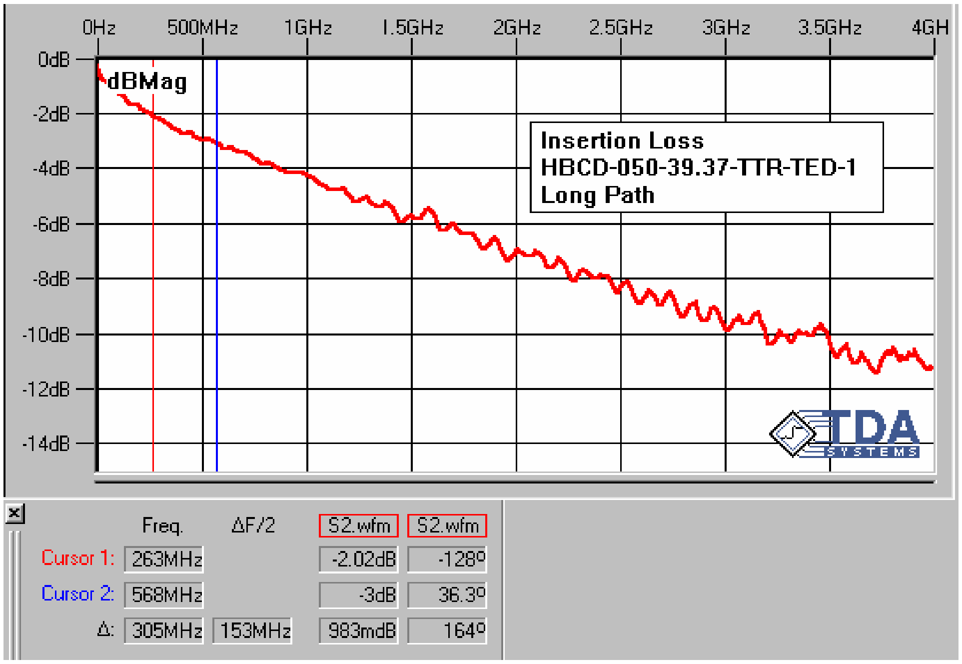
	Freq.	ΔF/2	S10.wfm	S10.wfm
Cursor 1:	271MHz		-2.04dB	-147º
Cursor 2:	542MHz		-3.01dB	75.7º
Δ:	271MHz	136MHz	974mdB	222º

Figure 5: HBCD-050-39.37-TTR-TBL-1 Insertion Loss Long Path



	Freq.	ΔF/2	S1.wfm	S1.wfm
Cursor 1:	195MHz		-1.96dB	1.39°
Cursor 2:	364MHz		-2.91dB	53.6°
Δ:	169MHz	84.6MHz	947mdB	52.2°

Figure 6: HBCD-050-39.37-TTR-TED-1 Insertion Loss Short Path

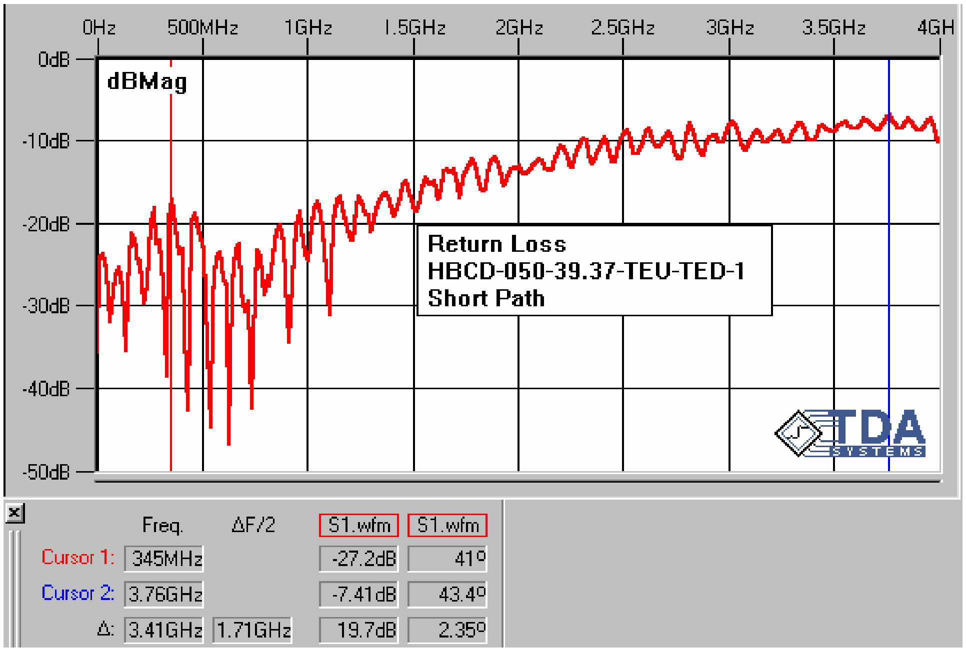


	Freq.	ΔF/2	S2.wfm	S2.wfm
Cursor 1:	263MHz		-2.02dB	-128°
Cursor 2:	568MHz		-3dB	36.3°
Δ:	305MHz	153MHz	983mdB	164°

Figure 7: HBCD-050-39.37-TTR-TED-1 Insertion Loss Long Path

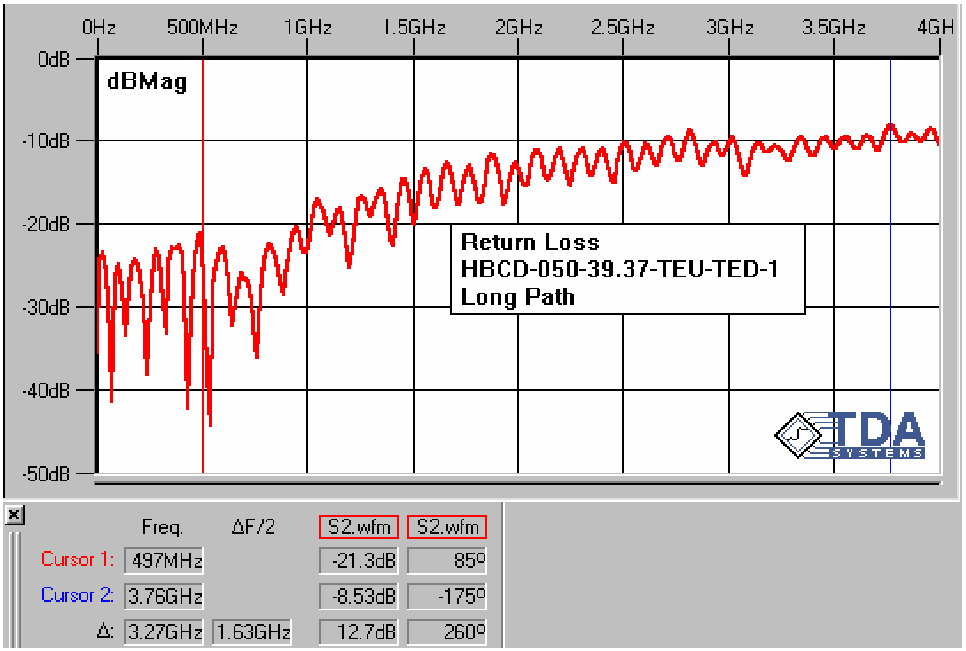
Series: HBCD
Description: Cable Assembly, High Data Rate, 0.5mm Pitch

Return Loss



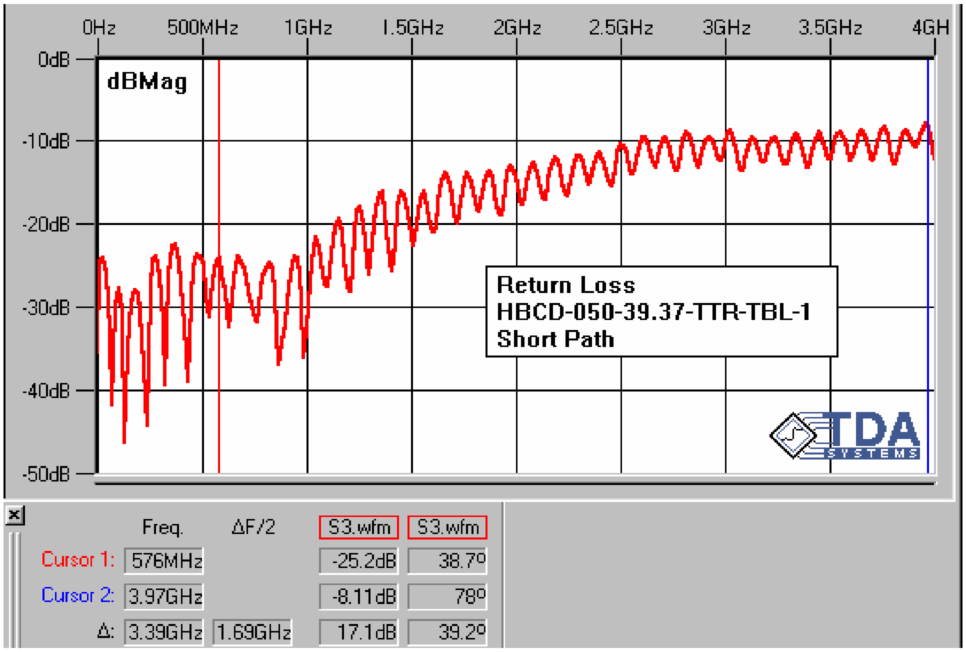
	Freq.	ΔF/2	S1.wfm	S1.wfm
Cursor 1:	345MHz		-27.2dB	41º
Cursor 2:	3.76GHz		-7.41dB	43.4º
Δ:	3.41GHz	1.71GHz	19.7dB	2.35º

Figure 8: HBCD-050-39.37-TEU-TED-1 Return Loss Short Path



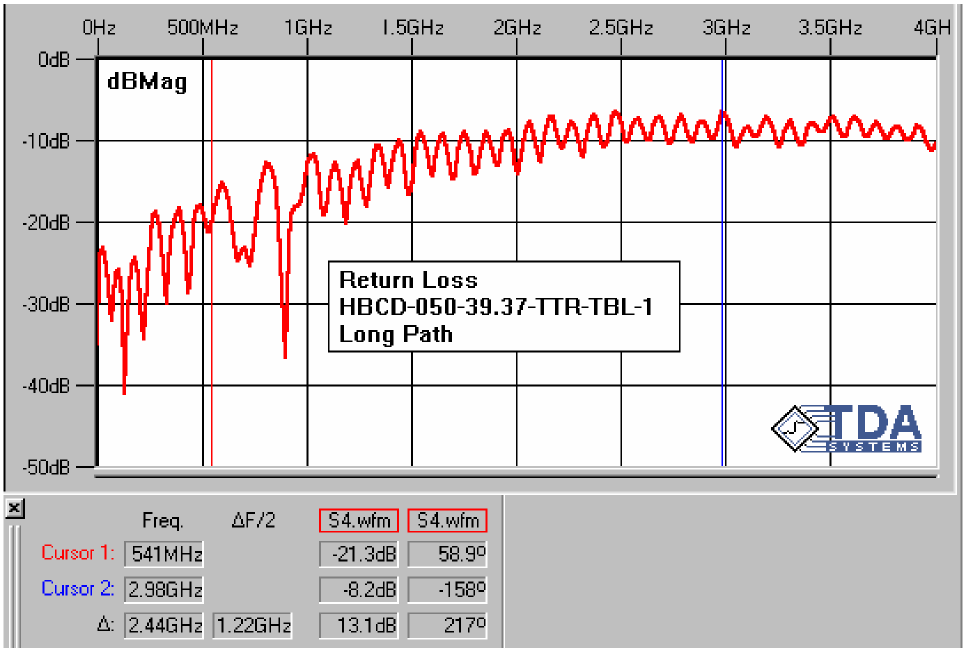
	Freq.	ΔF/2	S2.wfm	S2.wfm
Cursor 1:	497MHz		-21.3dB	85º
Cursor 2:	3.76GHz		-8.53dB	-175º
Δ:	3.27GHz	1.63GHz	12.7dB	260º

Figure 9: HBCD-050-39.37-TEU-TED-1 Return Loss Long Path



	Freq.	ΔF/2	S3.wfm	S3.wfm
Cursor 1:	576MHz		-25.2dB	38.7°
Cursor 2:	3.97GHz		-8.11dB	78°
Δ:	3.39GHz	1.69GHz	17.1dB	39.2°

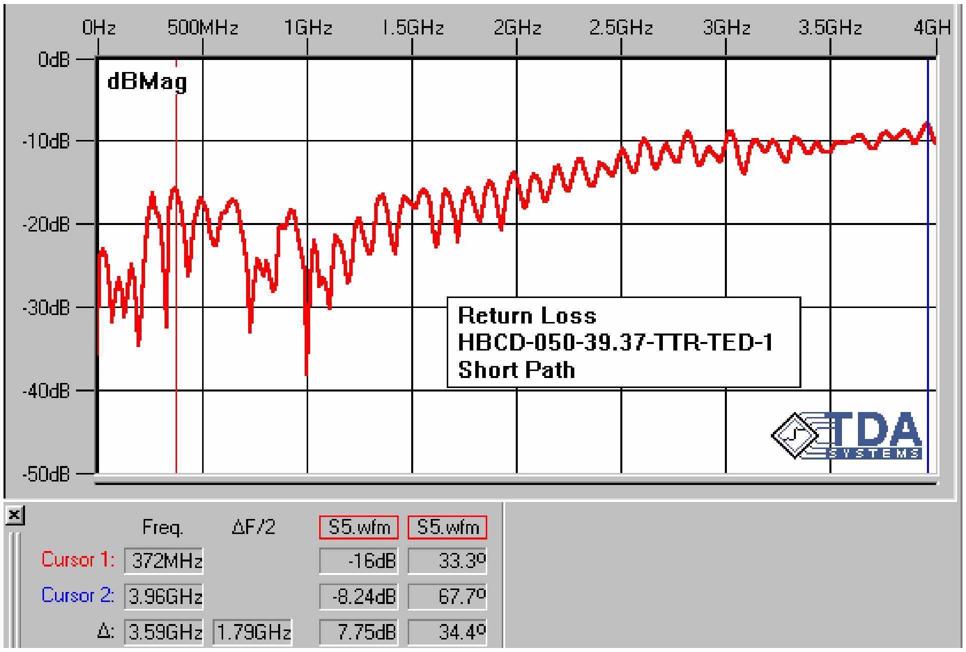
Figure 10: HBCD-050-39.37-TTR-TBL-1 Return Loss Short Path



	Freq.	ΔF/2	S4.wfm	S4.wfm
Cursor 1:	541MHz		-21.3dB	58.9°
Cursor 2:	2.98GHz		-8.2dB	-158°
Δ:	2.44GHz	1.22GHz	13.1dB	217°

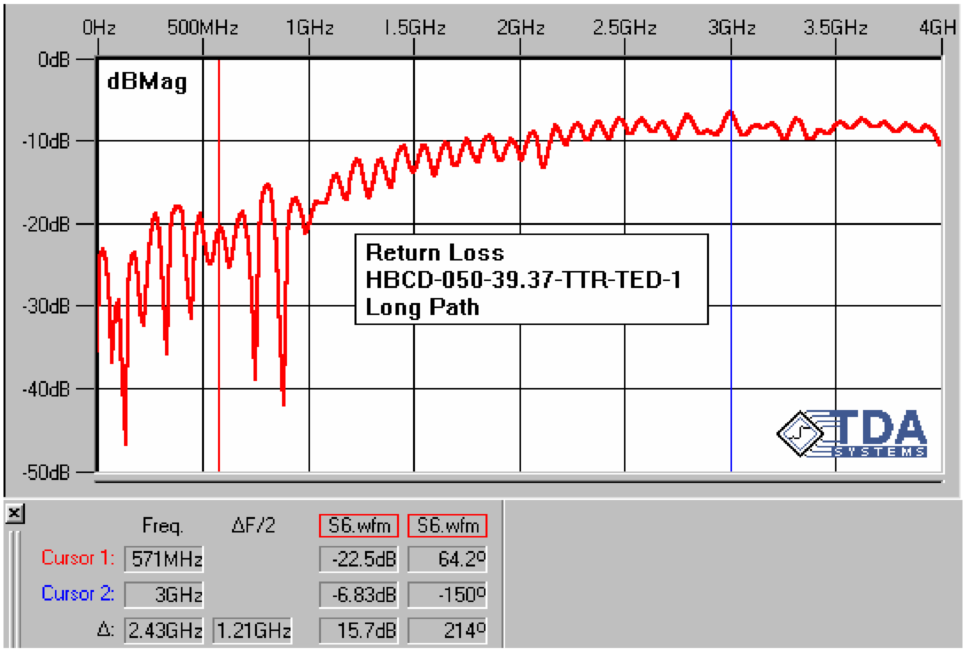
Figure 11: HBCD-050-39.37-TTR-TBL-1 Return Loss Long Path

Series: HBCD
Description: Cable Assembly, High Data Rate, 0.5mm Pitch



	Freq.	ΔF/2	S5.wfm	S5.wfm
Cursor 1:	372MHz		-16dB	33.3º
Cursor 2:	3.96GHz		-8.24dB	67.7º
Δ:	3.59GHz	1.79GHz	7.75dB	34.4º

Figure 12: HBCD-050-39.37-TTR-TED-1 Return Loss Short Path

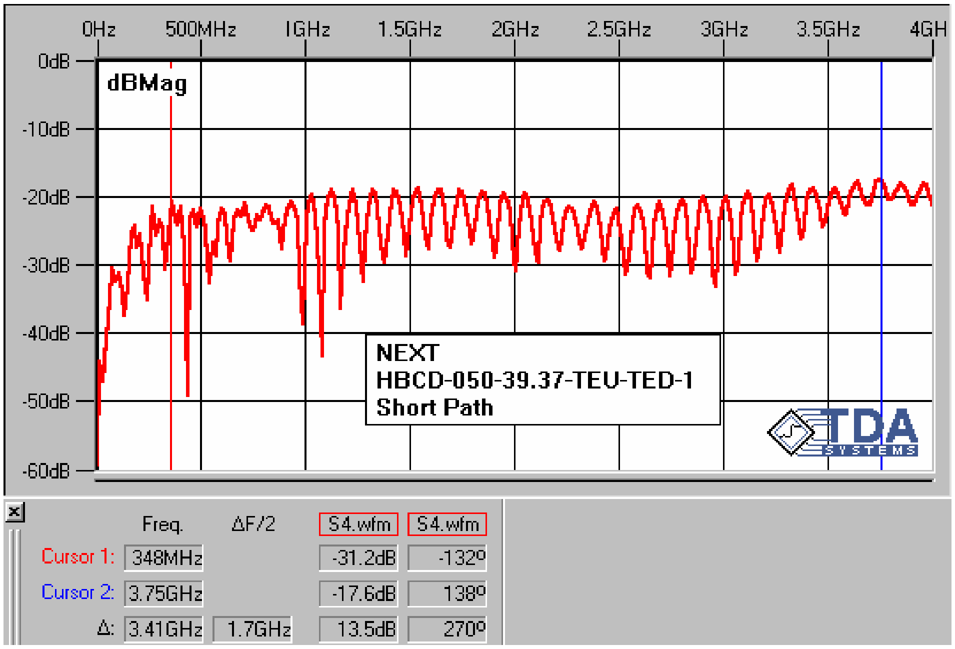


	Freq.	ΔF/2	S6.wfm	S6.wfm
Cursor 1:	571MHz		-22.5dB	64.2º
Cursor 2:	3GHz		-6.83dB	-150º
Δ:	2.43GHz	1.21GHz	15.7dB	214º

Figure 13: HBCD-050-39.37-TTR-TED-1 Return Loss Long Path

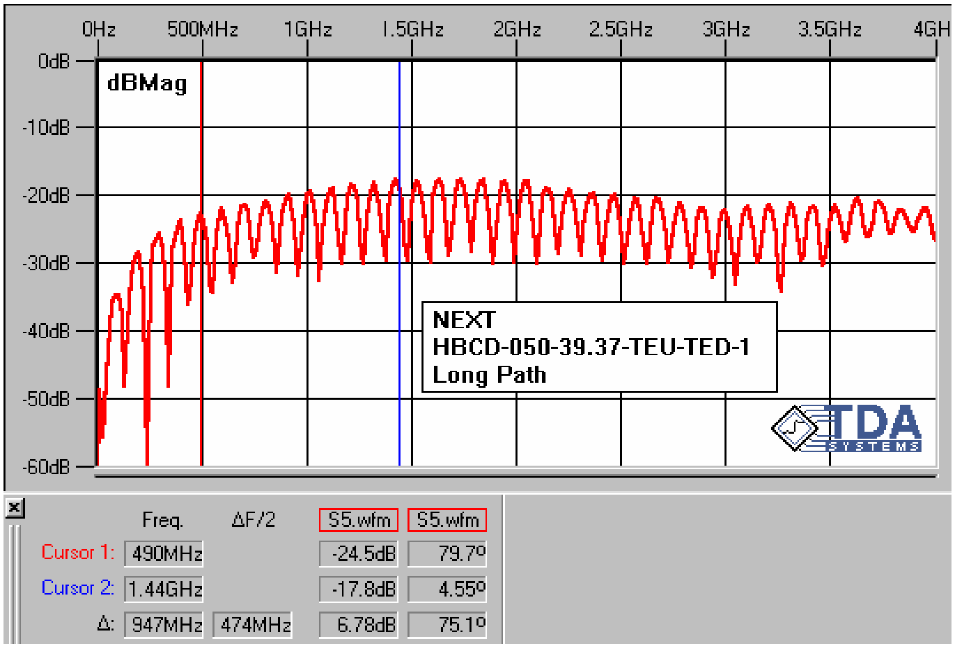
Series: HBCD
Description: Cable Assembly, High Data Rate, 0.5mm Pitch

Near End Crosstalk



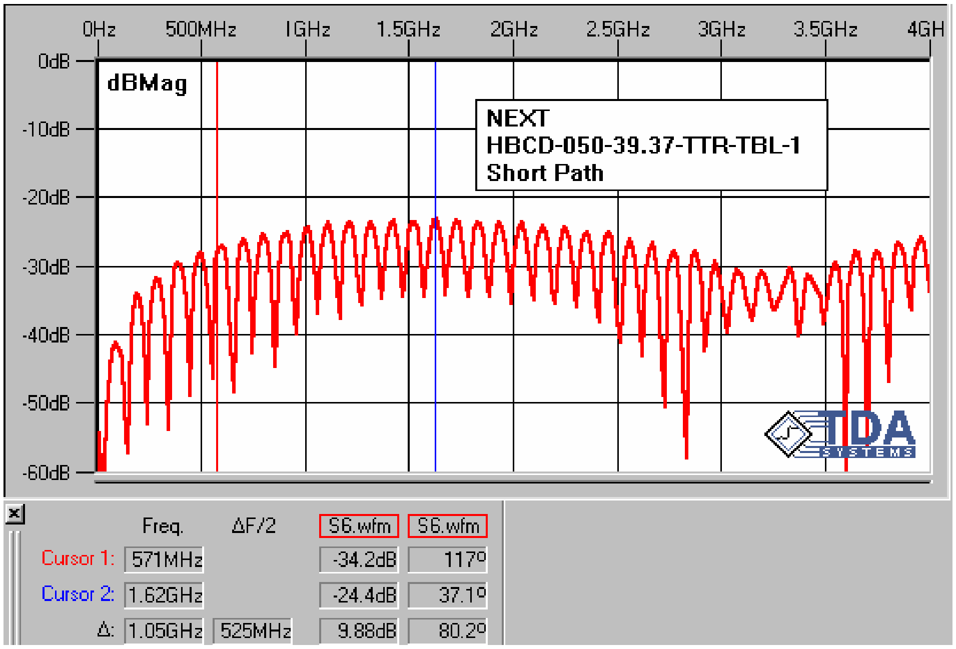
	Freq.	ΔF/2	S4.wfm	S4.wfm
Cursor 1:	348MHz		-31.2dB	-132º
Cursor 2:	3.75GHz		-17.6dB	138º
Δ:	3.41GHz	1.7GHz	13.5dB	270º

Figure 14: HBCD-050-39.37-TEU-TED-1 NEXT Short Path



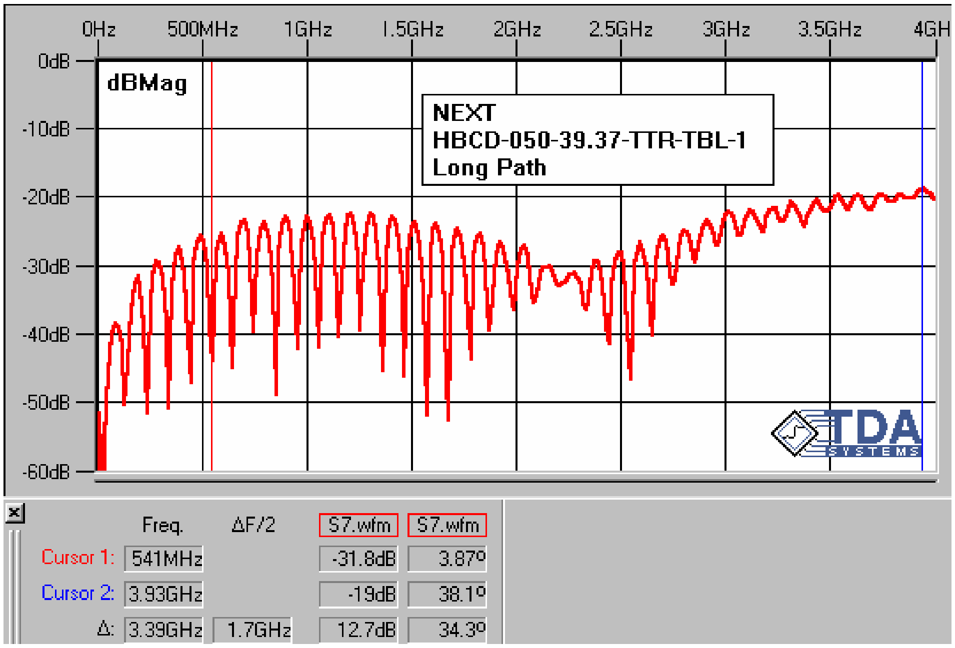
	Freq.	ΔF/2	S5.wfm	S5.wfm
Cursor 1:	490MHz		-24.5dB	79.7º
Cursor 2:	1.44GHz		-17.8dB	4.55º
Δ:	947MHz	474MHz	6.78dB	75.1º

Figure 15: HBCD-050-39.37-TEU-TED-1 NEXT Long Path



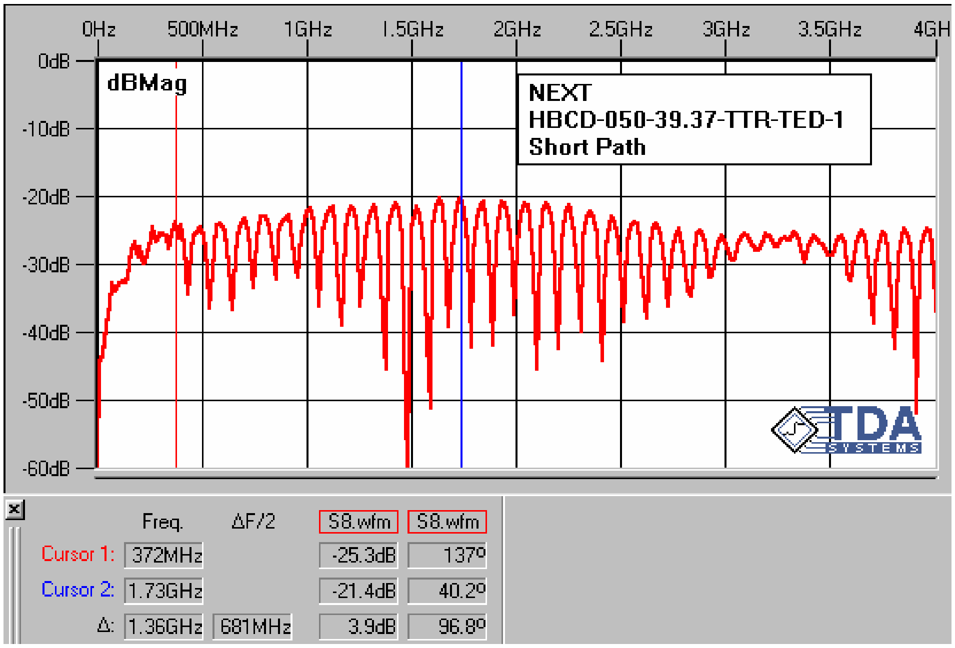
	Freq.	ΔF/2	S6.wfm	S6.wfm
Cursor 1:	571MHz		-34.2dB	117°
Cursor 2:	1.62GHz		-24.4dB	37.1°
Δ:	1.05GHz	525MHz	9.88dB	80.2°

Figure 16: HBCD-050-39.37-TTR-TBL-1 NEXT Short Path



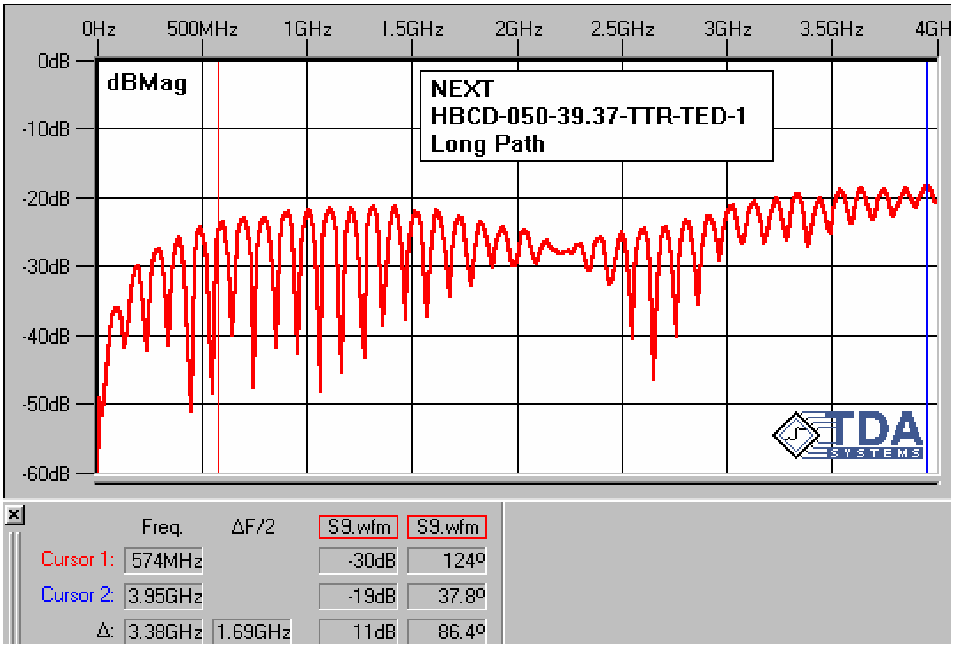
	Freq.	ΔF/2	S7.wfm	S7.wfm
Cursor 1:	541MHz		-31.8dB	3.87°
Cursor 2:	3.93GHz		-19dB	38.1°
Δ:	3.39GHz	1.7GHz	12.7dB	34.3°

Figure 17: HBCD-050-39.37-TTR-TBL-1 NEXT Long Path



	Freq.	ΔF/2	S8.wfm	S8.wfm
Cursor 1:	372MHz		-25.3dB	137º
Cursor 2:	1.73GHz		-21.4dB	40.2º
Δ:	1.36GHz	681MHz	3.9dB	96.8º

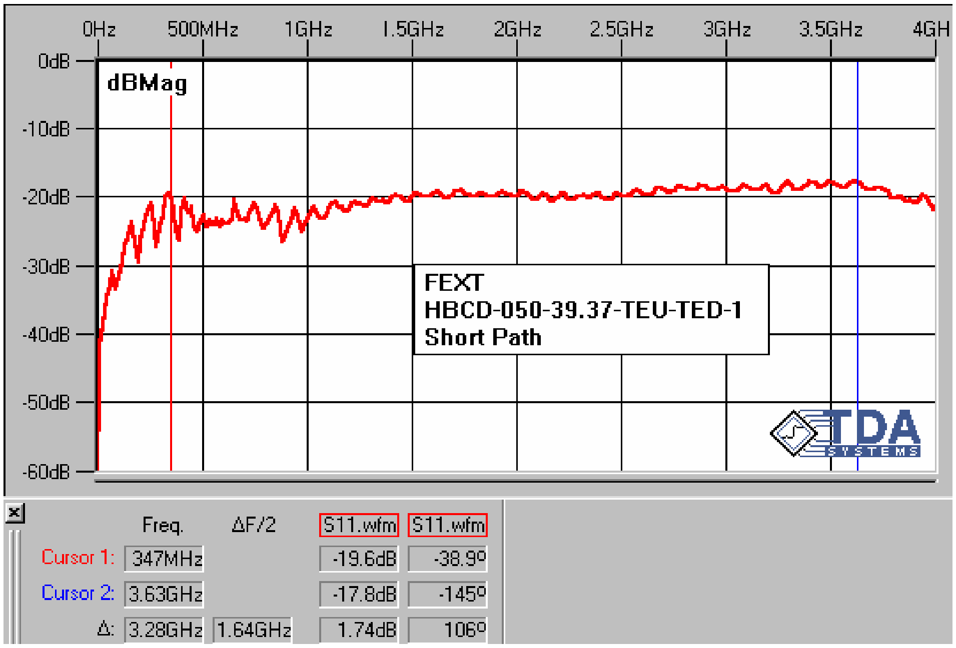
Figure 18: HBCD-050-39.37-TTR-TED-1 NEXT Short Path



	Freq.	ΔF/2	S9.wfm	S9.wfm
Cursor 1:	574MHz		-30dB	124º
Cursor 2:	3.95GHz		-19dB	37.8º
Δ:	3.38GHz	1.69GHz	11dB	86.4º

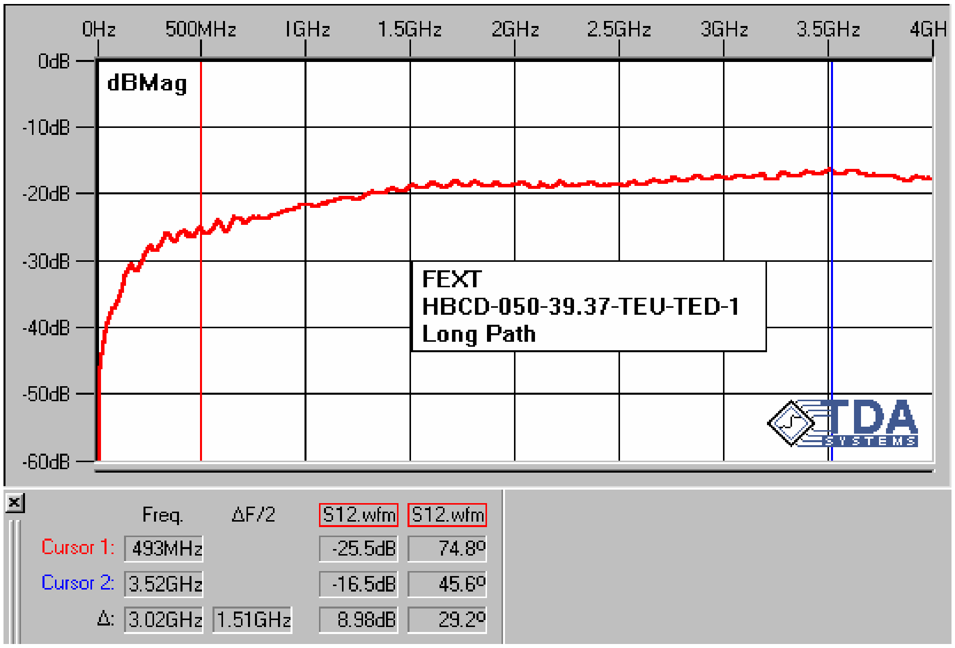
Figure 19: HBCD-050-39.37-TTR-TED-1 NEXT Long Path

Far End Crosstalk



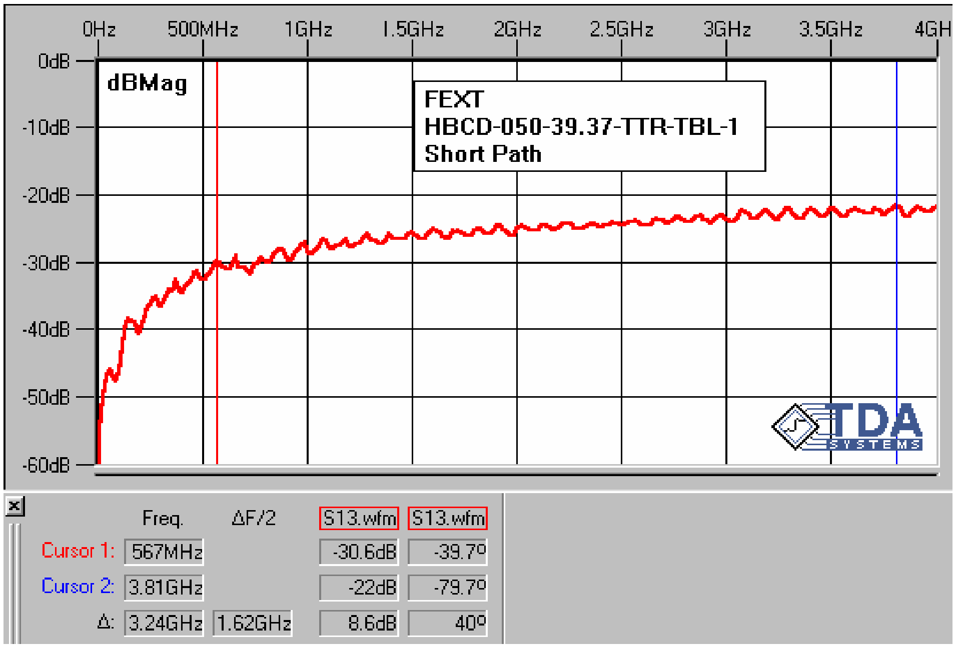
	Freq.	ΔF/2	S11.wfm	S11.wfm
Cursor 1:	347MHz		-19.6dB	-38.9º
Cursor 2:	3.63GHz		-17.8dB	-145º
Δ:	3.28GHz	1.64GHz	1.74dB	106º

Figure 20: HBCD-050-39.37-TEU-TED-1 FEXT Short Path



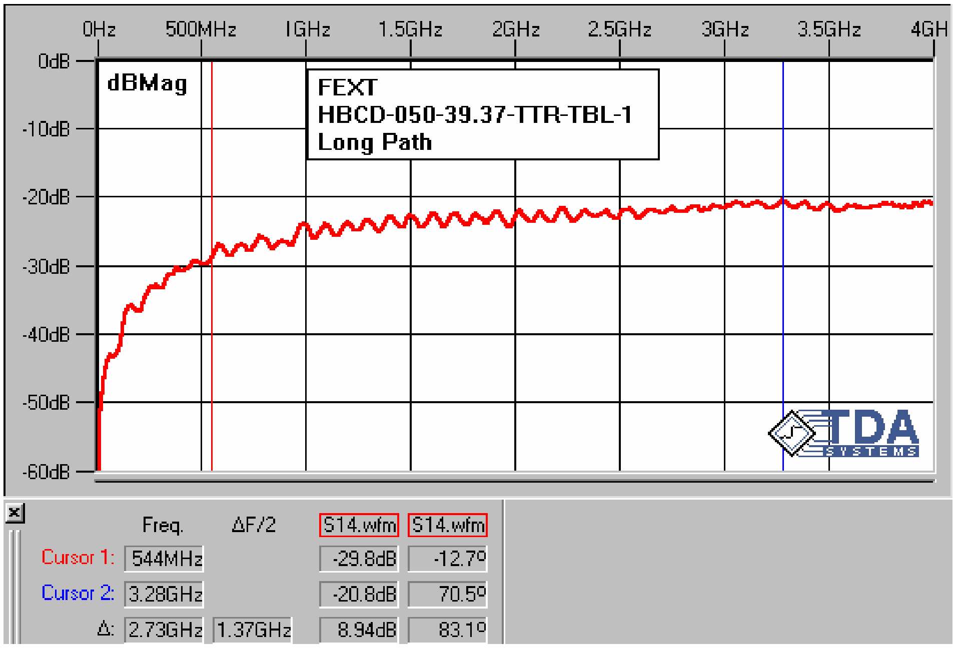
	Freq.	ΔF/2	S12.wfm	S12.wfm
Cursor 1:	493MHz		-25.5dB	74.8º
Cursor 2:	3.52GHz		-16.5dB	45.6º
Δ:	3.02GHz	1.51GHz	8.98dB	29.2º

Figure 21: HBCD-050-39.37-TEU-TED-1 FEXT Long Path



	Freq.	ΔF/2	S13.wfm	S13.wfm
Cursor 1:	567MHz		-30.6dB	-39.7°
Cursor 2:	3.81GHz		-22dB	-79.7°
Δ:	3.24GHz	1.62GHz	8.6dB	40°

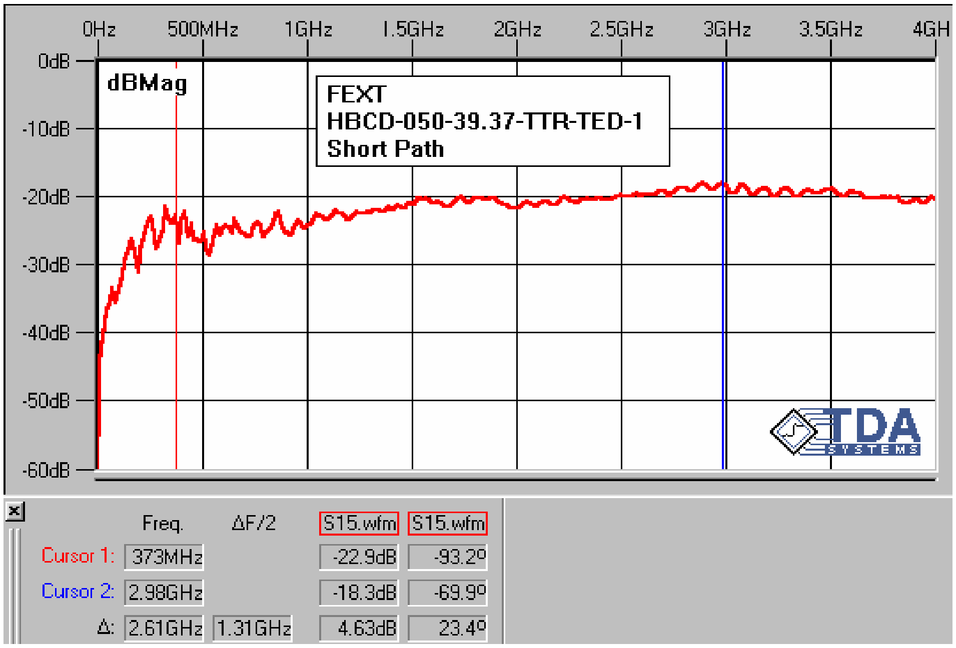
Figure 22: HBCD-050-39.37-TTR-TBL-1 FEXT Short Path



	Freq.	ΔF/2	S14.wfm	S14.wfm
Cursor 1:	544MHz		-29.8dB	-12.7°
Cursor 2:	3.28GHz		-20.8dB	70.5°
Δ:	2.73GHz	1.37GHz	8.94dB	83.1°

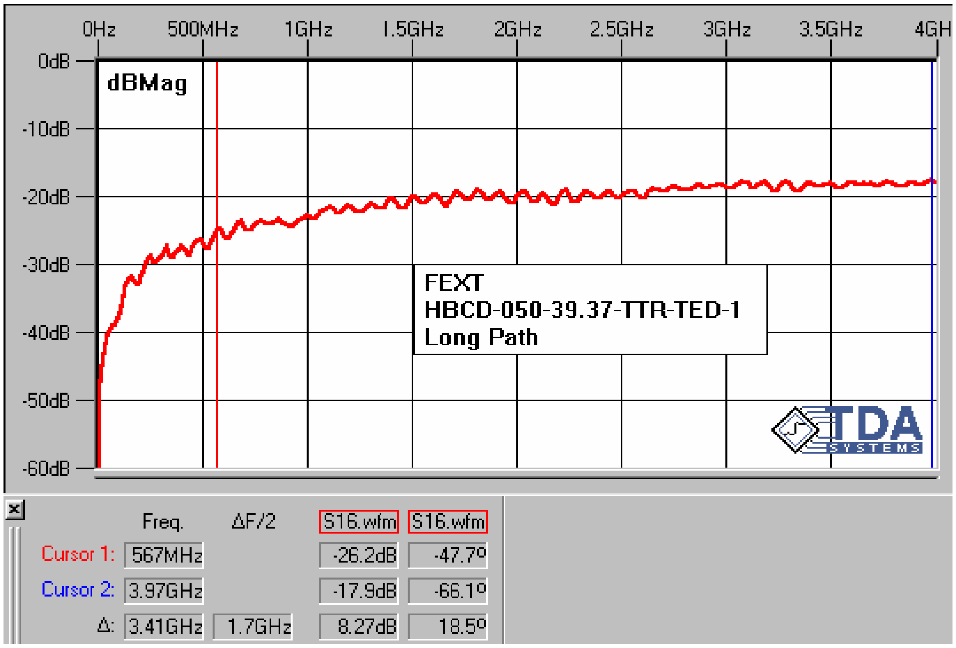
Figure 23: HBCD-050-39.37-TTR-TBL-1 FEXT Long Path

Series: HBCD
Description: Cable Assembly, High Data Rate, 0.5mm Pitch



	Freq.	ΔF/2	S15.wfm	S15.wfm
Cursor 1:	373MHz		-22.9dB	-93.2º
Cursor 2:	2.98GHz		-18.3dB	-69.9º
Δ:	2.61GHz	1.31GHz	4.63dB	23.4º

Figure 24: HBCD-050-39.37-TTR-TED-1 FEXT Short Path



	Freq.	ΔF/2	S16.wfm	S16.wfm
Cursor 1:	567MHz		-26.2dB	-47.7º
Cursor 2:	3.97GHz		-17.9dB	-66.1º
Δ:	3.41GHz	1.7GHz	8.27dB	18.5º

Figure 25: HBCD-050-39.37-TTR-TED-1 FEXT Long Path

Test Procedures

Fixturing:

All measurements were performed using the test boards specifically designed for this project. The test boards have trace lengths of 1.205 inches and provide for the interconnection to the HBCD cable by use of replaceable SMA connectors. Each test board has a THRU reference trace and an OPEN reference traces. Figure 26 below shows how the THRU reference trace was utilized to compensate for the losses due to the coaxial test cables, SMA launches, and the test board traces during testing.

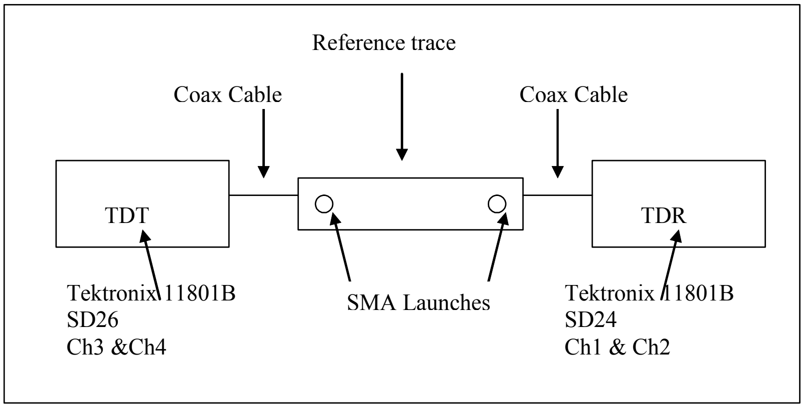


Figure 26: Test setup for Thru Reference Acquisition

Measurements were then performed using the test boards as shown in Figure 27. A picture of the test board and cable is shown in Figure 28 on the following page.

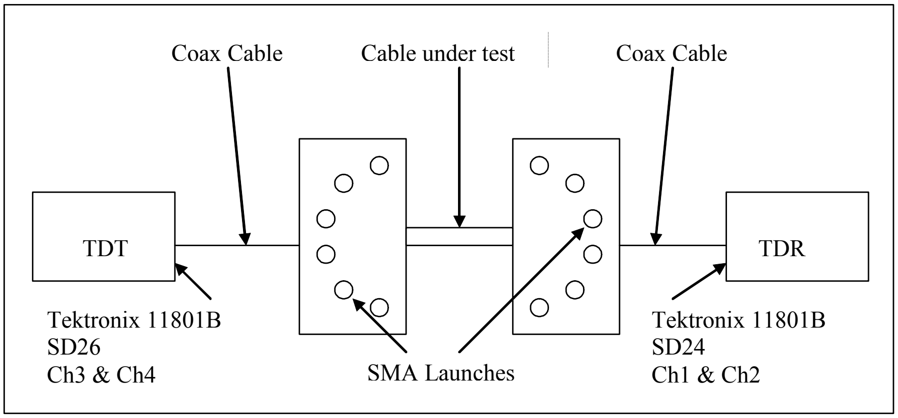


Figure 27: Characterization test setup

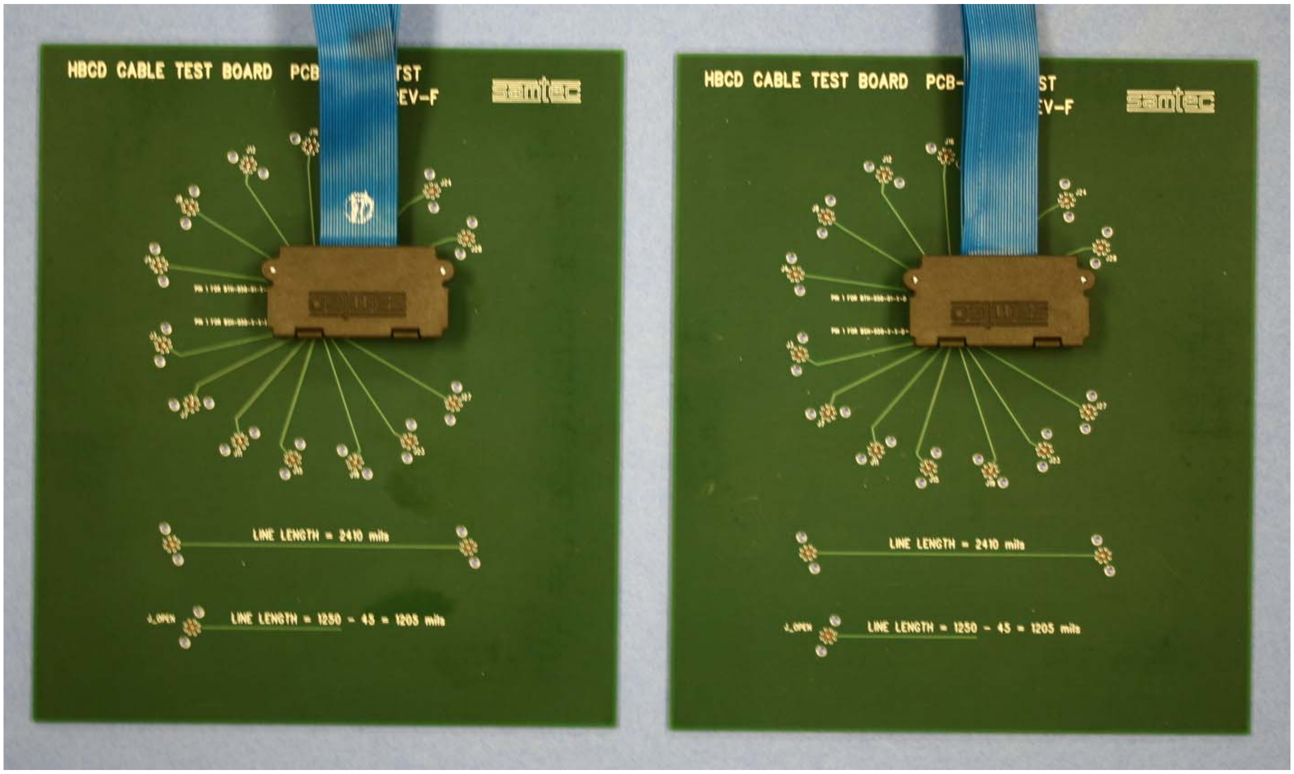


Figure 28: Test setup with Test PCBs and HBCD cable.

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 11801B oscilloscope was set up in TDR (time domain reflectometry) mode using a 100 pS filtered risetime and16 averages. The horizontal setup of the TDR used a record length of 512-points, and a horizontal scale of 200ps/div; allowing for the near-end connector and a portion of the cable to be displayed. All impedance measurements were made at the near-end cable termination and 200 pS into the cable.

Propagation Delay:

The propagation delay was measured and skew calculated by first acquiring a thru reference pulse of the reference board. Using the delay function of the TDR, set at 50% amplitude of the reference pulse, the sample was inserted and the sample delay was measured. The TDR delay function calculates the sample delay by subtracting the delay measurement of the reference pulse from the delay measurement of the sample plus the test board traces.

Skew:

Skew is defined as the difference between of the propagation delays of the longest (maximum delay) and the shortest (minimum delay) electrical paths.

NEXT and FEXT:

Near end crosstalk (NEXT) and far end crosstalk (FEXT) measurements were made using the Tektronix 11801B oscilloscope. A thru reference of the coaxial test cables, SMAs, and reference board was performed to determine the pulse amplitude of the TDR generator (see Figure 26).

To acquire NEXT, a signal was applied using the oscilloscope pulse generator. NEXT was measured on an adjacent signal line at the near end (see Figure 29). To acquire FEXT, a trace was driven with the oscilloscope pulse generator. FEXT was measured on an adjacent trace at the far end (see Figure 30). All adjacent lines were terminated, at both ends, with 50Ω SMA loads; refer to Figures 29 and 30.

Frequency Domain Testing

All frequency domain measurements were made using the Tektronix 11801B oscilloscope. Testing was performed using a risetime of 35 pS. The horizontal scale was set to 5 nS/div, the record length was set to 5120 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. End 1 of each assembly was the source end for all frequency domain measurements. All adjacent lines were terminated, at both ends, with 50Ω SMA loads; refer to Figures 29 and 30.

Attenuation:

Insertion Loss 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 26). A thru measurement of an assembly 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:

An open circuit reference measurement was taken using the J_OPEN reference line on the test board. A matched reflection waveform of the cable assembly, i.e. with the cable assembly terminated in a 50-Ω SMA load on the far end test board, 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 in the time domain using the oscilloscope and then converted to frequency domain data using TDA Systems' IConnect software (Version 3.0). Initially a thru reference measurement of the coaxial test cables, SMAs, and reference board was performed to compensate for the test setup losses (see Figure 26).

To acquire NEXT a trace was driven using the oscilloscope pulse generator. NEXT was measured, in the time domain, on an adjacent trace (see Figure 29). NEXT was then post processed using TDA Systems' IConnect software to generate the NEXT of the cable assembly in the frequency domain.

To acquire FEXT a trace was driven using the oscilloscope pulse generator. FEXT was measured, in the time domain, on an adjacent trace at the far end (see Figure 30). FEXT was then post processed using TDA Systems' IConnect software to generate the FEXT of the cable assembly in the frequency domain.

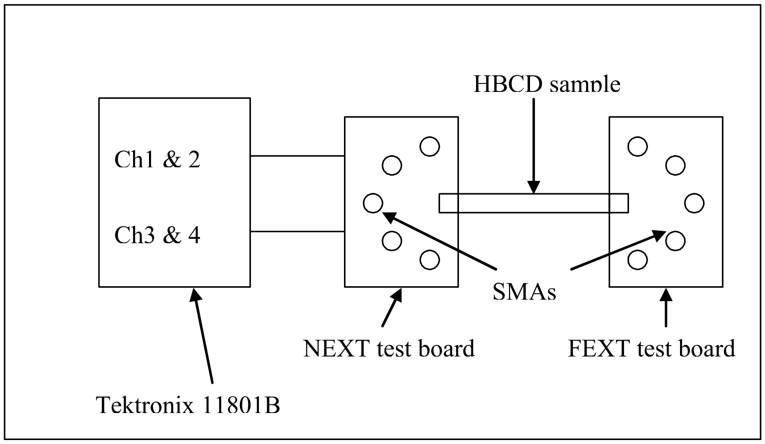


Figure 29: NEXT Measurement Setup.

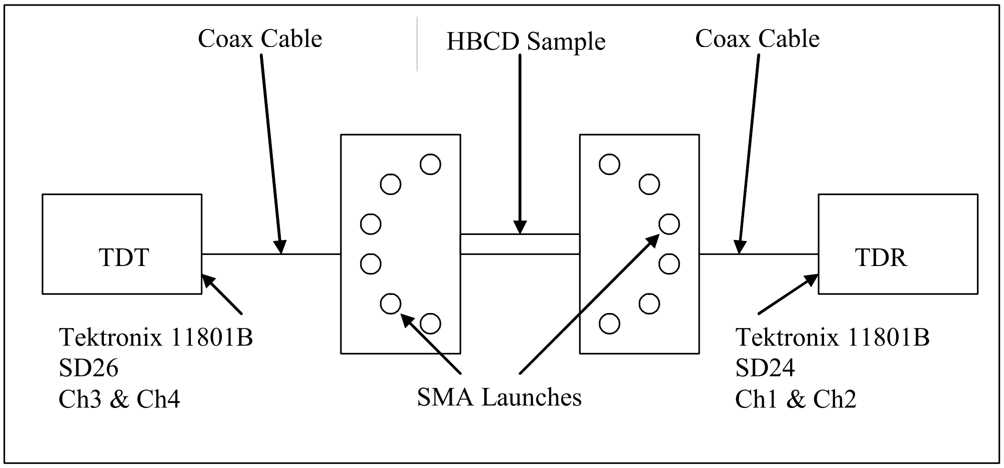


Figure 30: FEXT Measurement Setup

Equipment

Time Domain Testing

Tektronix 11801B Oscilloscope
Tektronix SD26 Sampling Head
Tektronix SD24 TDR/Sampling Head