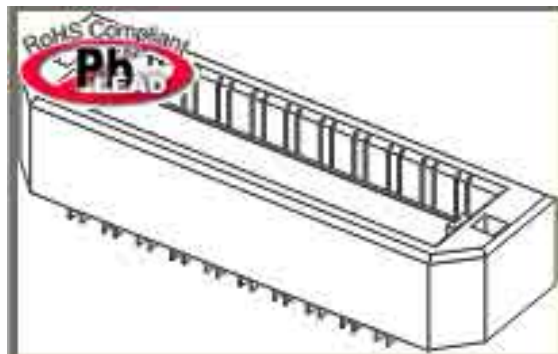


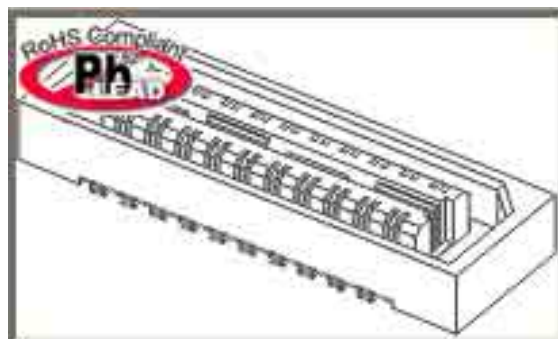


High Speed Characterization Report

QTH-020-02-L-D-DP-A



Mated With



QSH-020-01-L-D-DP-A

Description:

Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

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Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315”) Stack Height

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Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Connector Overview

Q Strip® .5mm (.020") pitch interfaces (QSH-DP/QTH-DP Series) are available with up to 200 I/Os and with standard board-to-board spacing of 5mm (0.197"), 8mm (0.315"), 11mm (0.433"), and 16mm (0.630") between boards. The data in this report is applicable only to the differential pair 8mm (0.315") board-to-board stack height version.

Connector System Speed Rating

QSH-DP/QTH-DP Series, Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

<u>Signaling</u>	<u>Speed Rating</u>
Differential:	8.5 GHz / 17 Gbps

The Speed Rating is based on the -3 dB insertion loss point of the connector system. The -3 dB point can be used to estimate usable system bandwidth in a typical, two-level signaling environment.

To calculate the Speed Rating, the measured -3 dB point is rounded up to the nearest half-GHz level. The up-rounding corrects for a portion of the test board's trace loss, since trace losses are included in the loss data in this report. The resulting loss value is then doubled to determine the approximate maximum data rate in Gigabits per second (Gbps).

For example, a connector with a -3 dB point of 7.8 GHz would have a Speed Rating of 8 GHz/ 16 Gbps. A connector with a -3 dB point of 7.2 GHz would have a Speed Rating of 7.5 GHz/ 15 Gbps.

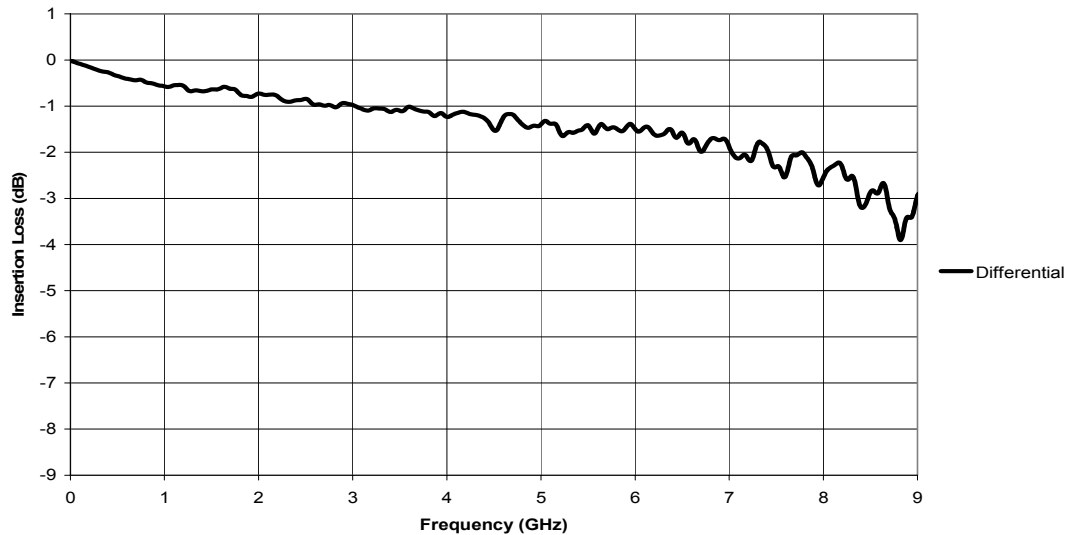
Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Frequency Domain Data Summary

Table 1 - Differential Connector System Bandwidth		
Test Parameter	Configuration	
Insertion Loss	SS	-3dB @ 8.38GHz
Return Loss	SS	< -5dB to 8.38GHz
Near-End Crosstalk	AA, QQ	< -25dB to 8.38GHz
	Xrow, AA to QQ	< -32dB to 8.38GHz
Far-End Crosstalk	AA QQ	< -30dB to 8.38GHz
	Xrow, AA to QQ	< -32dB to 8.38GHz

**PCB/Connector Test System
Differential Application
Series QSH-01 / QTH-02**

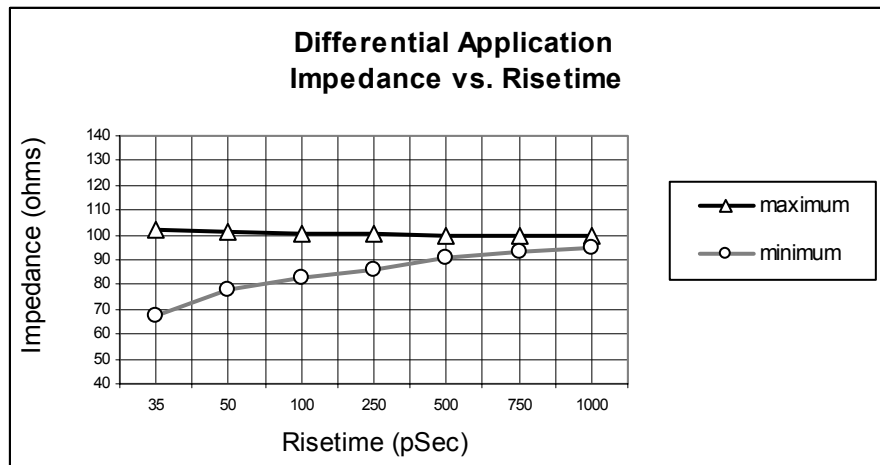


Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Time Domain Data Summary

Signal Risetime	30±5ps	50 ps	100 ps	250 ps	500 ps	750 ps	1 ns
Maximum Impedance	102.4	101.1	100.9	100.4	100.0	99.4	99.5
Minimum Impedance	67.6	77.6	82.9	86.0	90.9	93.5	95.2



Input (t_r)		30±5ps	50 ps	100 ps	250 ps	500 ps	750 ps	1 ns
NEXT	AA QQ	1.9	1.8	1.5	< 1.0%	< 1.0%	< 1.0%	< 1.0%
	Xrow ^{diff}	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%
FEXT	AA QQ	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%
	Xrow ^{diff}	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%	< 1.0%

Differential	86ps
--------------	------

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Characterization Details

This report presents data which characterizes the signal integrity response of a connector pair 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 test PCB from drive side probe tips to receive side probe tips. PCB effects are not removed or de-embedded from the test data. PCB designs with impedance mismatch, large losses, skew, cross talk, or similar impairments can have a significant impact on observed test data. Therefore, great design effort is put forth to limit these effects in the PCB utilized in these tests. Some board related effects, such as pad-to-ground capacitance and trace loss, are included in the data presented in this report. But other effects, such as via coupling or stub resonance, are not evaluated here. Such effects are addressed and characterized fully by the Samtec [Final Inch®](#) products.

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

Differential Data

Most Samtec connectors 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 a differentially driven only scenario where every third pin of the standard Samtec connector is removed.

Connector Signal to Ground Ratio

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

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

For this connector, the following configurations were evaluated:

Differential Impedance:

- SS (positive signal-negative signal)

Differential Crosstalk:

- Electrical "worst case": AAQQ (active+ active - quiet+ quiet -)
- Across row: Xrow^{diff} (from one row of terminals to the other row across the ground blade)

In all cases in this report, the center ground blade of the connector was grounded to the PCB. No electrical contact is made between inactive connector pins and PCB ground. Only one differential pair was driven for crosstalk measurements.

Other configurations can be evaluated upon request. Please contact sig@samtec.com for more information.

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 an 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 30 +/-5 ps. Generally, this should demonstrate worst case performance.

In many systems, the signal edge rate will be significantly slower at the connector than at the driver launch point. To estimate interconnect performance at other edge rates, data is provided for several rise times between 30 ps and 1.0 ns.

For this report, rise times were measured at 10%-90% signal levels.

Frequency Domain Data

Frequency domain parameters are helpful in evaluating the connector system's signal loss and crosstalk characteristics across a range of sinusoidal frequencies. In this re-

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

port, parameters presented in the frequency domain are insertion loss, return loss, and 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 from time domain measurements using Fourier Transform calculations. Procedures and methods used in generating the SUT's frequency domain data are provided in the frequency domain test procedures in [Appendix E](#) of this report.

Time Domain Data

Time Domain parameters indicate impedance mismatch versus length, signal propagation time, and crosstalk in a pulsed signal environment. Time Domain data 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.

Reference plane impedance is 100 ohms for differential measurements. The fastest risetime signal exciting the SUT is 30 ± 5 picoseconds.

In this report, propagation delay is defined as the signal propagation time through the PCB connector pads and connector pair. It does not include PCB traces. Delay is measured at 30 ± 5 picoseconds signal risetime. Delay is calculated as the difference in time measured between the 50% amplitude levels of the input and output pulses.

Crosstalk or coupled noise data is provided for various signal configurations. All measurements are single disturber. Crosstalk is calculated as a ratio of the input line voltage to the coupled line voltage. The input line is sometimes described as the active or drive line. The coupled line is sometimes described as the quiet or victim line. Crosstalk ratio is tabulated in this report as a percentage. Measurements are made at both the near-end and far-end of the SUT.

Data for other configurations may be available. Please contact our Signal Integrity Group at sig@samtec.com for further information.

As a rule of thumb, 10% crosstalk levels are often used as a general first pass limit for determining acceptable interconnect performance. But modern system crosstalk tolerance can vary greatly. For advice on connector suitability for specific applications, please contact our Signal Integrity Group at sig@samtec.com.



Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

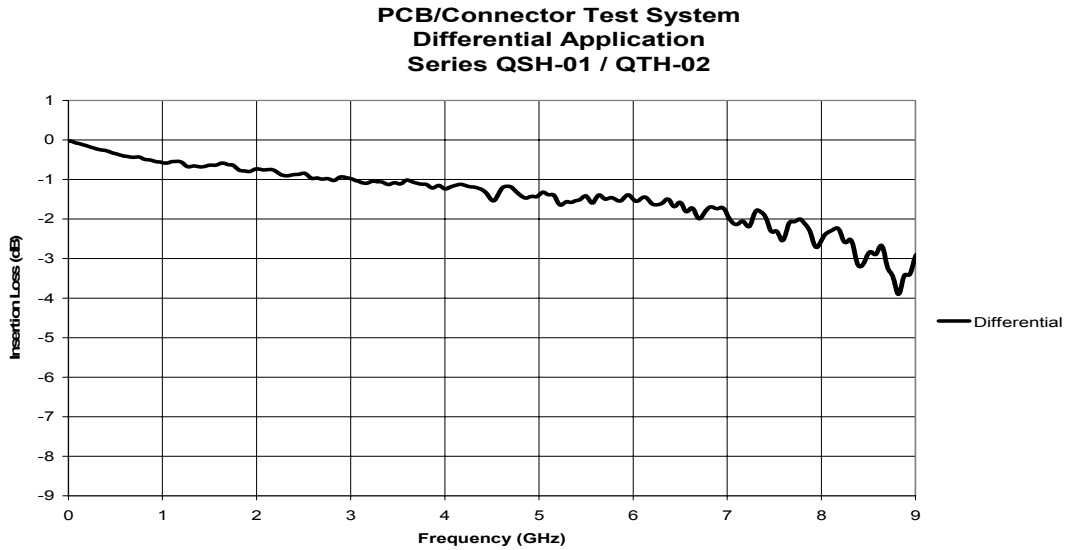
Additional information concerning test conditions and procedures is located in the appendices of this report. Further information may be obtained by contacting our Signal Integrity Group at sig@samtec.com.

Series: QTH-DP/QSH-DP

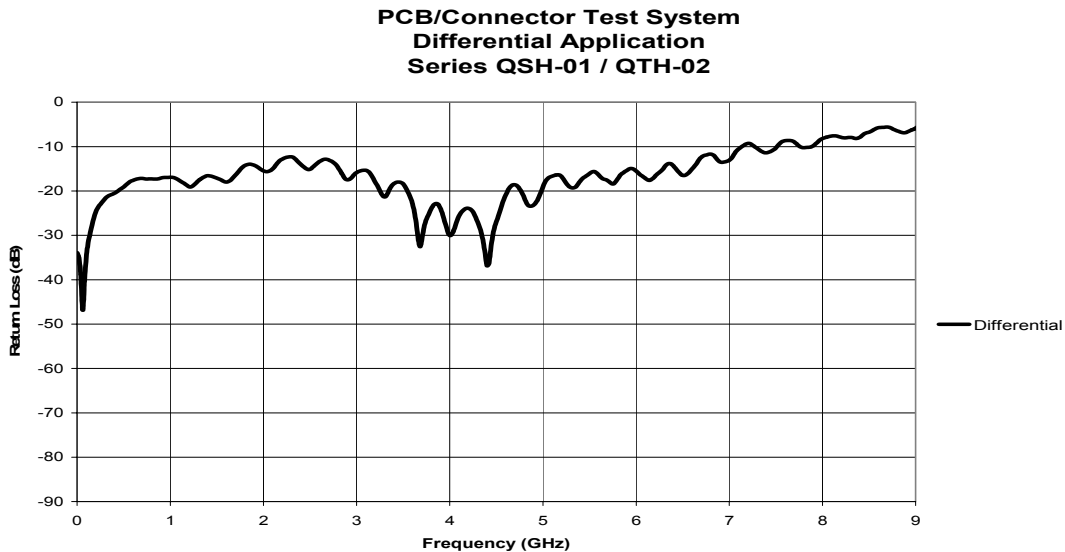
Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Appendix A – Frequency Domain Response Graphs

Differential Application – Insertion Loss



Differential Application – Return Loss

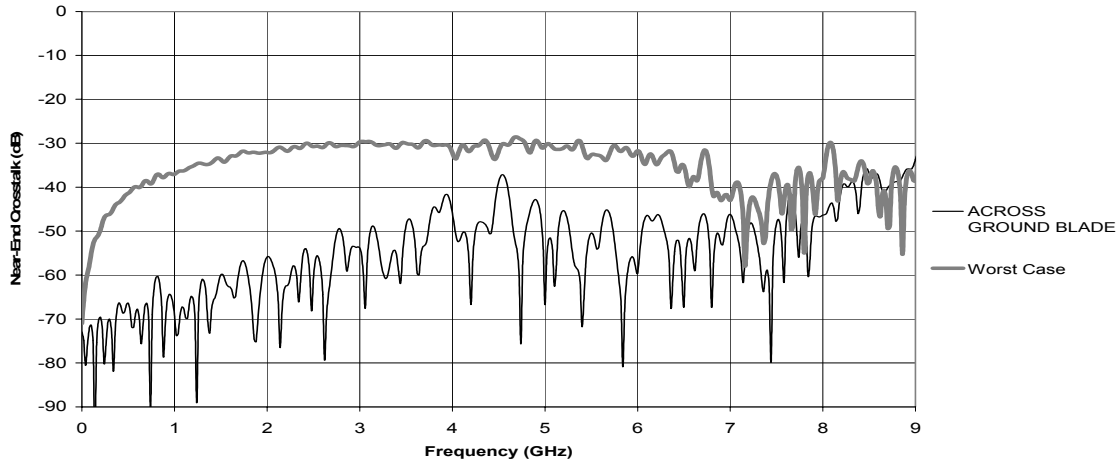


Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

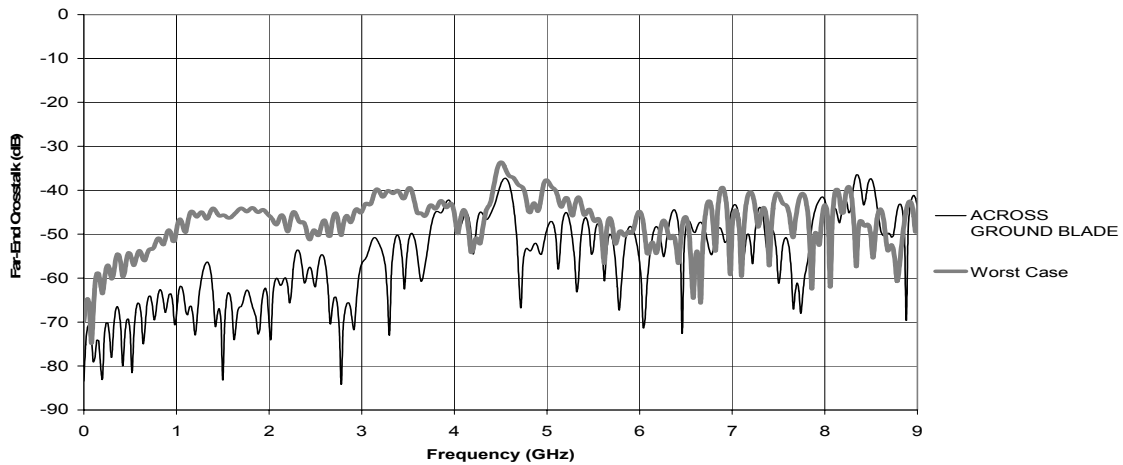
Differential Application – NEXT

PCB/Connector Test System
Differential Application
Series QSH-01 / QTH-02



Differential Application – FEXT

PCB/Connector Test System
Differential Application
Series QSH-01 / QTH-02

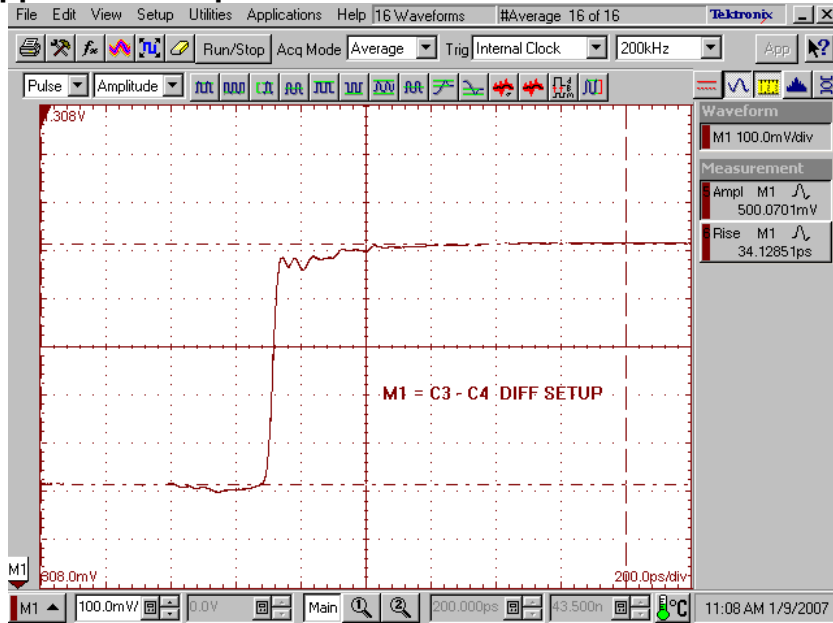


Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Appendix B – Time Domain Response Graphs

Differential Application – Input Pulse



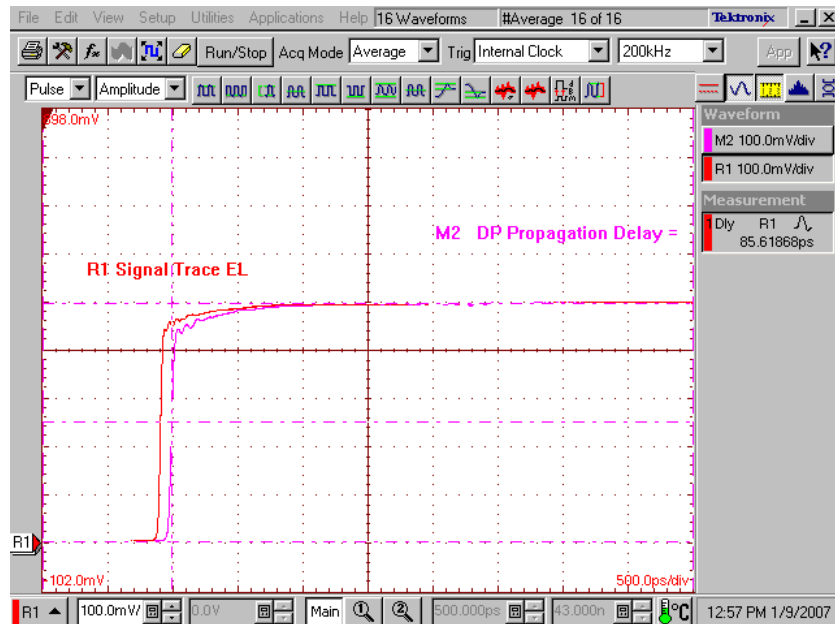
Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Differential Application – Impedance



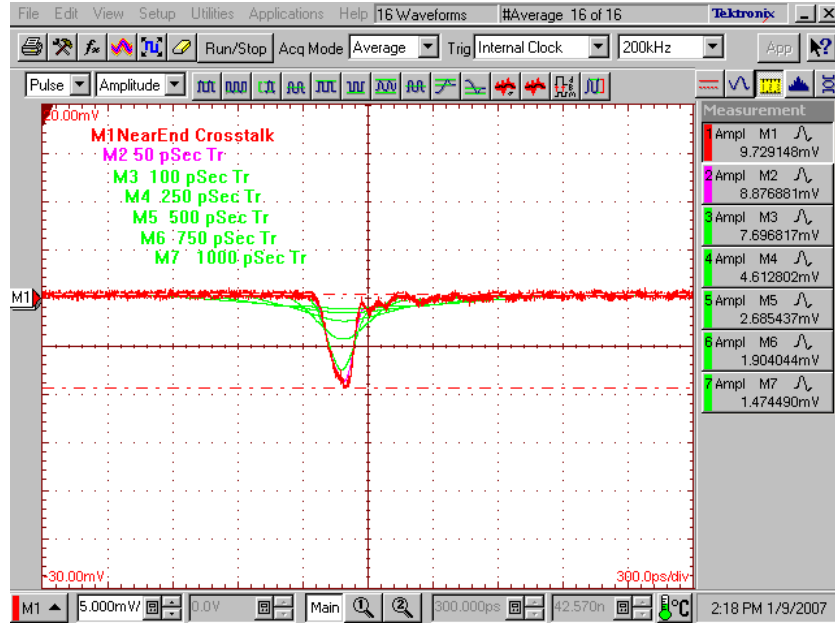
Differential Application – Propagation Delay



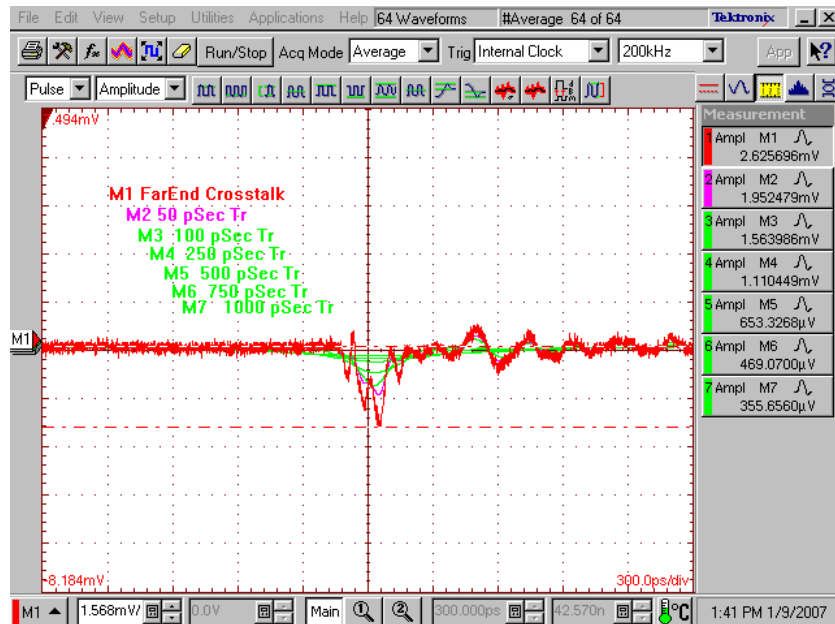
Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Differential Application – NEXT, “Worst Case” Configuration



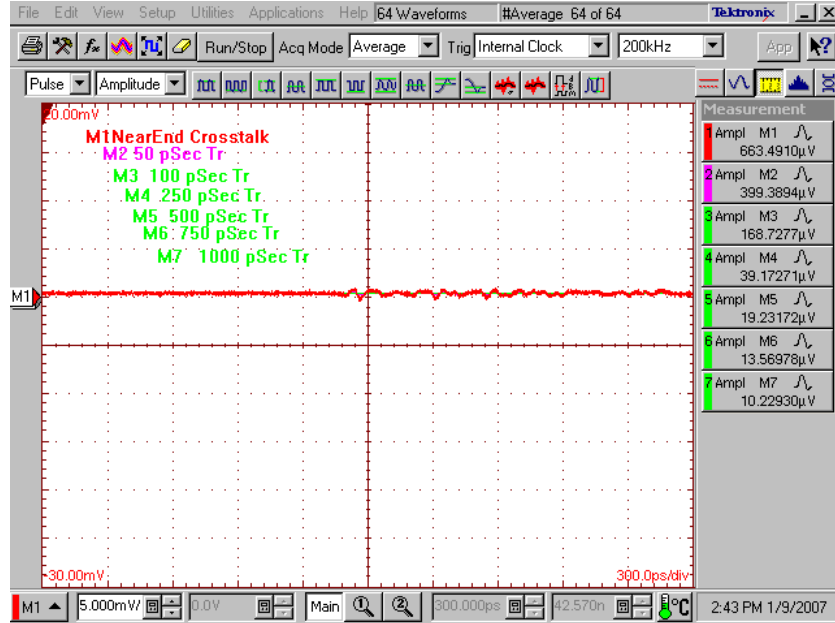
Differential Application – FEXT, “Worst Case” Configuration



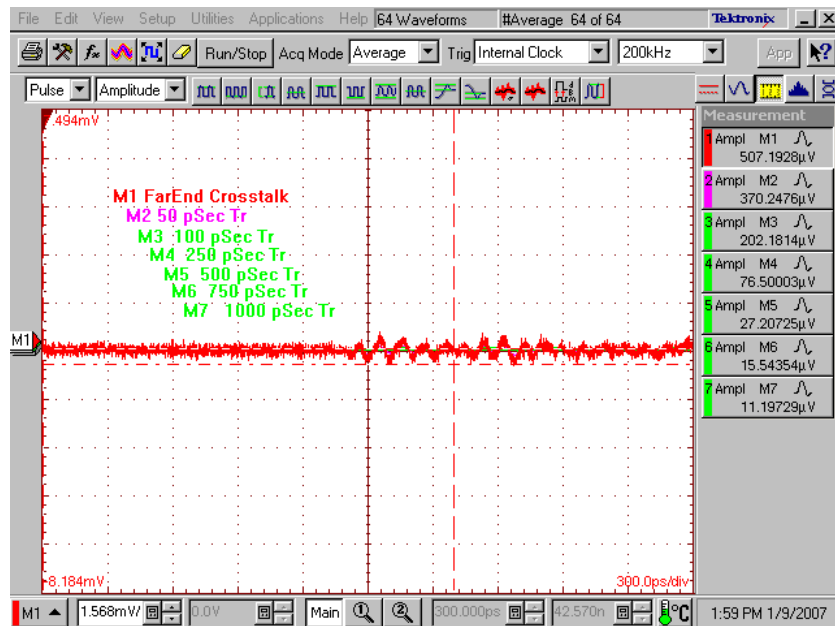
Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Differential Application – NEXT, Across Power/Ground Blade



Differential Application – FEXT, Across Power/Ground Blade



Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Appendix C – Product and Test System Descriptions

Product Description

Product samples are the 8mm (0.315") stack height Q Strip® High Speed QSH Series sockets P/N QSH-020-01-L-D-DP-A and the mating QTH Series header P/N QTH-020-01-L-D-DP-A.

Each connector structure under test consists of 20 contact terminal pairs mounted in a plastic housing with 10 pairs evenly distributed in each row. A metal ground or power blade lies lengthwise between terminal rows in the housing.

Test System Description

The Test fixtures are composed of a 4-layer FR-4 material with 100Ω signal trace and probing pad configurations designed for the electrical characterization of Samtec hi-speed connector products. The pictured fixtures are specific to the QSH-DP/QTH-DP series connector and are identified by Samtec P/N PCB-100254-TST-01 and P/N PCB-100254-TST-02 respectively (Figure 1).

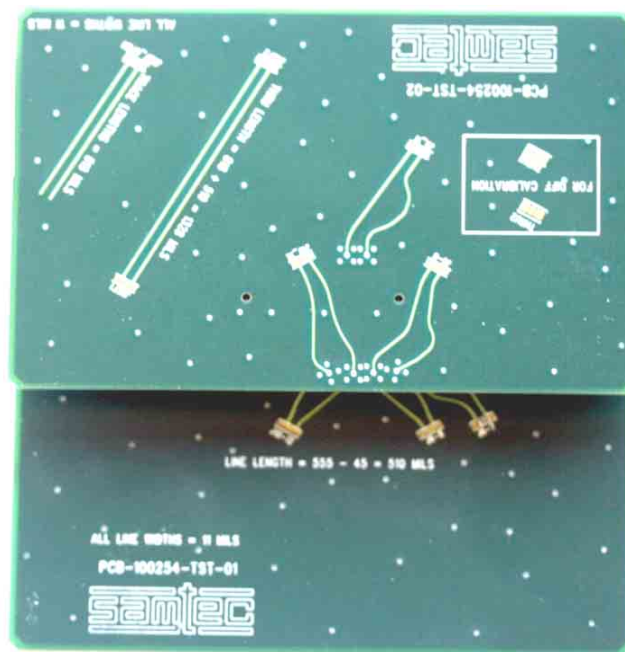


Figure 1 Mated Test Fixture

Terminated onto P/N PCB-100254-TST-01 (Figure 2) is the QSH socket series connector.

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

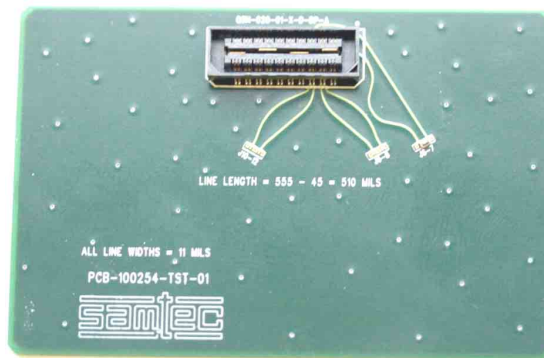


Figure 2 QSH-020-01-L-D-DP-A

P/N PCB-100254-TST-02 accepts the QTH terminal connector (Figure 3) and is designed to mate with PCB-1002254-TST-01. Design differences are that signal traces propagate through the board and are located on the opposite side from the mating connectors. QTH trace transitions can be observed on the top board in Figure 1.



Figure 3 QTH-020-02-L-D-DP-A

Test point signal paths coincide with each other upon mating and are marked accordingly. Differential signal terminal paths for the 20 pair connector are J6_8, J10_12, and J9_11. All signal paths are for monitoring through or adjacent signaling test conditions with the exception of the J9_11. This condition is setup for monitoring coupling across the terminal rows. The differential fixtures "J" number represents each terminal's designated position within the connector. Signals can be launched or received from either the socket or header side of the connector. All data and waveforms presented in the report are results from a socket side signal launch.

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Appendix D – Test and Measurement Setup

Test instruments are a Tektronix CSA8000 Communication Signal Analyzer Mainframe and the Agilent 8720ES Vector Network Analyzer. Four bays of the CSA8000 are occupied with three Tektronix 80E04 TDR/Sampling Heads and one Tektronix 80E03 Sampling Head. For this series of tests, four of the eight TDR/Sampling Head capability is used (*Figure 4*). The 8720ES serves as a supporting test instrument for verification or troubleshooting results obtained from the TDA Systems IConnect Software package. IConnect is a TDR based measurement software tool used in generating frequency domain related responses from high speed interconnects.

The probe stations illuminated video microscopy system, microprobe positioners, and 40GHz capable probes provide both the mechanical properties and electrical characteristics for obtaining the precise signal launch and calibrations that are critical in obtaining accurate high speed measurements. The 450 micron pitch probes are located to PCB launch points with 25X to 175X magnification and XYZ fine positioning adjustments available from both the probe table and micro-probe positioners. Electrically the microwave probes rate a < 1.0 dB insertion loss, a < 18 dB return loss, and an isolation of 38 dB to 40 GHz (*Figure 5*). Test cables and interconnect adapters are high quality and insure high-bandwidth and low parasitic measurements.

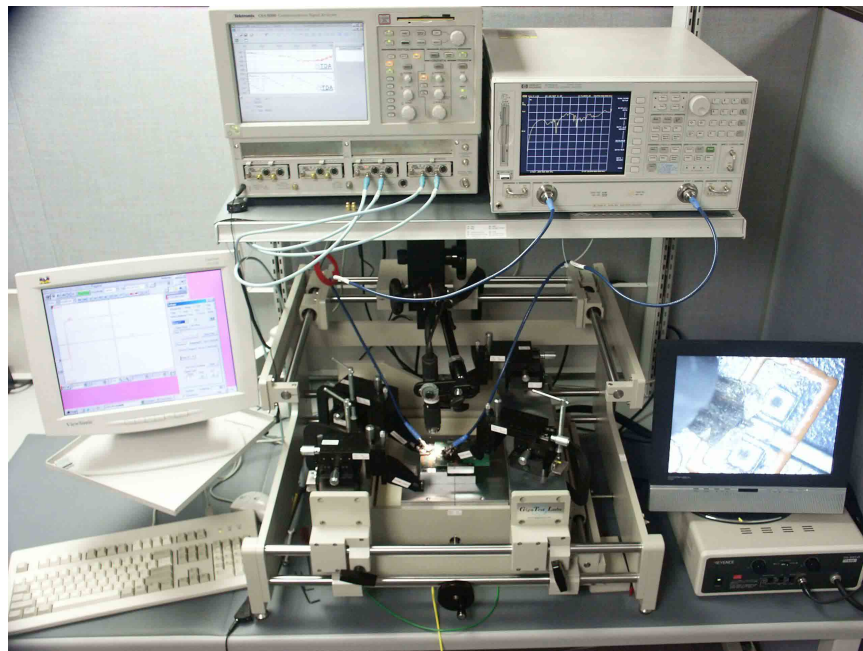


Figure 4 – Probe Station Measurements Capability

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

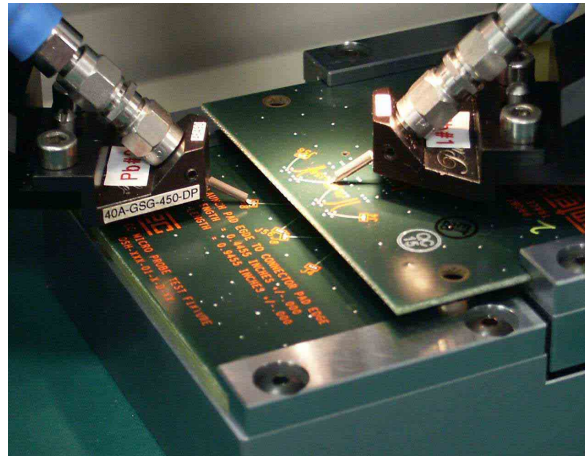


Figure 5 – 40 GHz Microwave Probes

QTY Description

- 1 Tektronix CSA8000 Communication Signal Analyzer
- 2 Tektronix 80E04 Dual Channel 20 GHz TDR Sampling Module

Test Instruments

QTY Description

- 1 GigaTest Labs Model (GTL3030) Probe Station
- 4 GTL Micro-Probe Positioners
- 2 Picoprobe by GGB Ind. Dual Model 40A GSG-GSG
- 1 Keyence VH-5910 High Resolution Video Microscope
- 1 Keyence VH-W100 Fixed Magnification Lens 100 X
- 1 Keyence VH-Z25 Standard Zoom Lens 25X-175X

Measurement Station Accessories

QTY

Description

- 4 Pasternack Enterprises 2.9mm Semi-Rigid (.086) 6" Cable Assemblies
- 2 Tektronix 1 Meter Module Extenders

Test Cables & Adapters

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Appendix E - Frequency and Time Domain Measurements

It is important to note before gathering measurement data that TDA Systems IConnect measurements and CSA8000 measurements are virtually the same measurements with diverse formats. This means that the operator, being extremely aware, can obtain SI time and frequency characteristics in an almost simultaneous fashion.

Since IConnect setup procedures are specific to the frequency information sought, it is mandatory that the sample preparation and CSA8000 functional setups be consistent throughout the waveform gathering process. If the operators test equipment permits recall sequencing between the various test parameter setups, it insures IConnect functional setups remain consistent with the TDR/TDT waveforms previously recorded. Related time and frequency test parameter data recorded for this report were gathered simultaneously.

Frequency (S-Parameter) Domain Procedures

Frequency data extraction involves two steps that first measure the frequency related time domain waveform followed by post-processing of the time domain waveforms into loss and crosstalk response parameters versus frequency. The first step utilizes the Tektronix CSA8000 time based instrument to capture frequency related single-ended or differential signal types propagating through an appropriately prepared SUT. The second step involves a correlation of the time based waveforms using the TDA Systems IConnect software tool to post-process these waveforms into frequency response parameters. TDA Systems labels these frequency related waveform relationships as the *Step* and *DUT* reference. This report establishes the setup procedures for defining the *Step* and *DUT* reference for frequency parameters of interest. Once established, the *Step* and *DUT* references are post-processed in IConnect's S-parameter computations window.

CSA8000 Setup

Listed below are the CSA 8000 functional menu setups used for single-ended and differential frequency response extractions. Both signal types utilize I-Connect software tools to generate S-parameter upper and lower frequency boundaries along with the step frequency. These frequency boundaries are determined by a time domain instruments functional settings such as window length, number of points and averaging capability. Once window length, number of points and averaging functions are set, maintain the same instrument settings throughout the extraction process.

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

	<u>Differential Signal</u>
Vertical Scale:	100 mV/ Div:
Offset:	Default / Scroll
Horizontal Scale:	1nSec/ Div = 20 MHz step frequency
Max. Record Length:	4000 = Min. Resolution
Averages:	≥ 128

Insertion Loss

SUT Preparation – Use the J6_8 or J10_12 signal path (*Figure 1*) to establish the differential through transmission waveform. Terminate any adjacent signal paths into a 100Ω characteristic impedance.

Step Reference – Establish the waveform by making a TDT transmission measurement that includes all cables, adapters, and probes connected in the test systems transmission path. The through transmission is accomplished by inserting a negligible length of transmission standard (*Figure 5*) between the microwave probes.

DUT Reference - Establish the waveform by making an active TDT transmission measurement that includes the SUT and all cables, adapters, and probes connected in the test systems transmission path.

Return Loss

Use the J6_8 or J10_12 signal path (*Figure 1*) to establish a TDR matched response waveform. Terminate any adjacent signal paths in a 100Ω characteristic impedance.

Step Reference - Establish the waveform by making a TDR measurement of the input cables and adapters leading to an open probe condition on the near end of the test system.

DUT Reference - Establish the waveform by making a TDT (matched) transmission measurement that includes all cables, adapters, and probes connected in the test systems transmission path (*Figure 5*). Cables and adapters located at the far-end of the SUT serve as the test systems characteristic impedance match.

Near-End Crosstalk (NEXT)

SUT Preparation – Terminate -02 terminal fixture (*Figure 2*) probe pad locations J6_8, J10_12, & J9_11 in a 100Ω characteristic impedance.

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Step Reference - Establish the waveform by making a TDR measurement of the input cables and adapters leading to an open probe condition on the near end of the test system.

DUT Reference - Establish the waveform by driving signal line J10_12 and monitoring worst case coupled energy at J6_8, both located on the -01 socket fixture. Repeat same procedure for across row coupling conditions at J9_11. Terminate -01 probe pad J6_8 in a 100Ω impedance.

Far-End Crosstalk (FEXT)

SUT Preparation - Terminate -01 socket fixture (*Figure 2*) probe pad locations J6_8 & J9_11 in 100Ω impedances. Terminate -02 terminal fixture (*Figure 2*) probe pad location J10_12 in a 100Ω characteristic impedance.

Step Reference - Establish this waveform by making a TDT transmission measurement that includes all cables, adapters, and probes connected in the test systems transmission path. The transmission path is completed by inserting a negligible length of transmission standard (*Figure 5*) between the microwave probes.

DUT Reference - Establish the waveform by driving -01 socket fixture signal line J10_12 and monitoring worst case coupled energy at J6_8 of the -02 terminal fixture. Repeat same procedure for across row coupling conditions at -02 terminal fixture J9_11. Terminate -02 probe pad J6_8 in a 100Ω impedance.

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Time Domain Procedures

Measurements involving digital type pulses are performed utilizing either Time Domain Reflectometer (TDR) or Time Domain Transmission (TDT) methods. For this series of tests, TDR methods are employed for the impedance and propagation delay measurements. Crosstalk measurements utilize TDT methods. The Tektronix 80E04 TDR/ Sampling Head provide both the signaling type and sampling capability necessary to accurately and fully characterize the SUT.

Impedance

The signal line(s) of the SUT's signal configuration is energized with a TDR pulse. The far-end of the energized signal line is terminated in the test systems characteristic impedance (e.g.; 50 Ω or 100 Ω terminations). By terminating the adjacent signal lines in the test systems characteristic impedance, the effects on the resultant impedance shape of the waveform is limited.

Propagation Delay

This connector series uses the fastest edge rate (30ps) of the TDR impedance waveform to measure propagation delay. Differential mated connector delay is the measured difference of propagation between known signal trace length delays and the delay of the mated SUT. The measurement is a one-way propagation result. Termination of the adjacent signal lines into the test systems characteristic impedance eliminate alternate current paths providing for better measurement accuracy.

Crosstalk

An active pulsed waveform is transmitted through a selected SUT signal line. The adjacent quiet signal lines are monitored for the coupled energy at the near-end and far-end. Active and quiet lines not being monitored are terminated in the test systems characteristic impedance. Signal lines adjacent to the quiet lines remain terminated on both ends throughout the test sequence. Failing to terminate the active near or far end, quiet lines, or in some cases, signal lines adjacent to the quiet line may have an effect on amplitude and shape of the coupled energy.

Series: QTH-DP/QSH-DP

Description: Parallel Board-to-Board, 0.5mm Pitch, 8mm (0.315") Stack Height

Appendix F – Glossary of Terms

BC – Best Case crosstalk configuration

DP – Differential Pair signal configuration

DUT – Device under test; TDA IConnect reference waveform

FEXT – Far-End Crosstalk

GSG – Ground–Signal–Ground; geometric configuration

NEXT – Near-End Crosstalk

PCB – Printed Circuit Board

SE – Single-Ended

SI – Signal Integrity

SUT – System under test

TDR – Time Domain Reflectometry

TDT – Time Domain Transmission

WC – Worse Case crosstalk configuration

Xrow^{se} – Cross ground/ power bar crosstalk, single-ended signal

Xrow^{diff} – Cross ground/ power bar crosstalk, differential signal

Z – Impedance (expressed in ohms)