

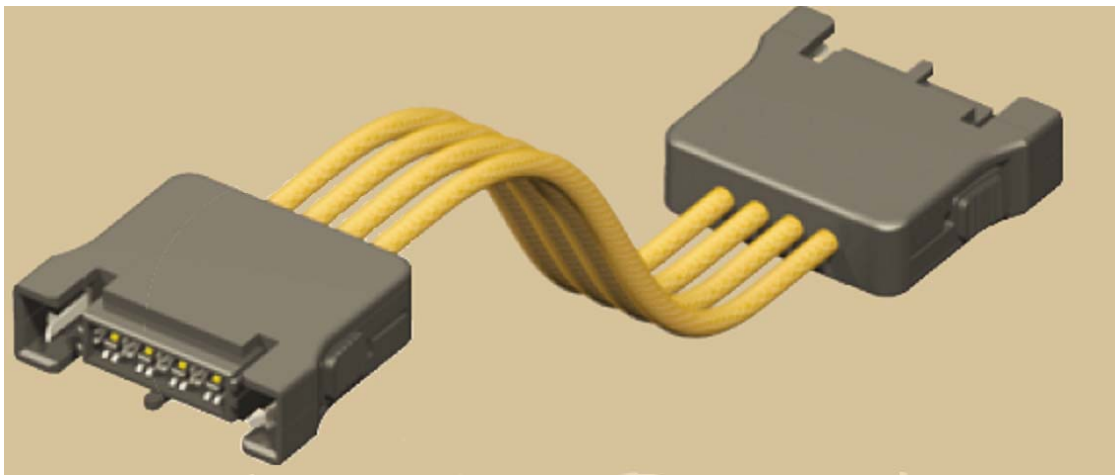


RF Characterization Report

IJ5C-04-0100-S-D-NUS-1

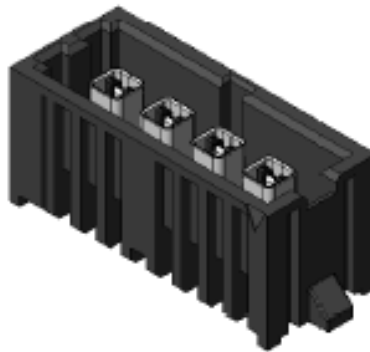
IJ5C-04-0300-S-D-NUS-1

IJ5C-04-1000-S-D-NUS-1



Mates with

IP5-04-05.0-L-S-1-TR



Description:

ISO Rate™ Series RF Jack Cable Assembly, 4mm Centerline

Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

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Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Connector Overview

The 4mm (0.157") pitch cable assembly (IJ5C) and plug (IP5) provides 1, 2, 4 or 8 positions per row. The IJ5C/IP5 Series is a through hole mount with single and double row options. When mated, the IJ5C/IP5 system provides a cable assembly with standard lengths from 100mm to 1000mm. The data presented in this report is applicable only to 100, 300 and 1000 mm long IJ5C cable assemblies mated to a 4mm pitch single row IP5 connector.

Connector System Speed Rating

IJ5C, ISO Rate™ Series RF Jack Cable Assembly

<u>Length</u>	<u>Speed Rating</u>
100mm	9.5 GHz/19 Gbps
300mm	8.5 GHz/17 Gbps
1000mm	3.5 GHz/7 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 a short length of trace loss is 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 cable assembly 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: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Case and Configuration Nomenclature

In this report, the terms Case and Configuration are used. Case refers to the length of the IJ5C cable assembly. Configuration refers to the source and victim positions within the cable assembly.

- Case 1 = 100mm IJ5C/IP5
- Case 2 = 300mm IJ5C/IP5
- Case 3 = 1000mm IJ5C/IP5

- Configuration 1 – ATVT – Aggressor line is 1 position away from victim line
- Configuration 2 – ATTV - Aggressor line is 2 positions away from victim line
- Configuration 3 – TAVT - Aggressor line is adjacent to the victim line

- A - Aggressor Signal Line
- V - Victim Signal Line
- T – Terminated Line

Frequency Domain Data Summary

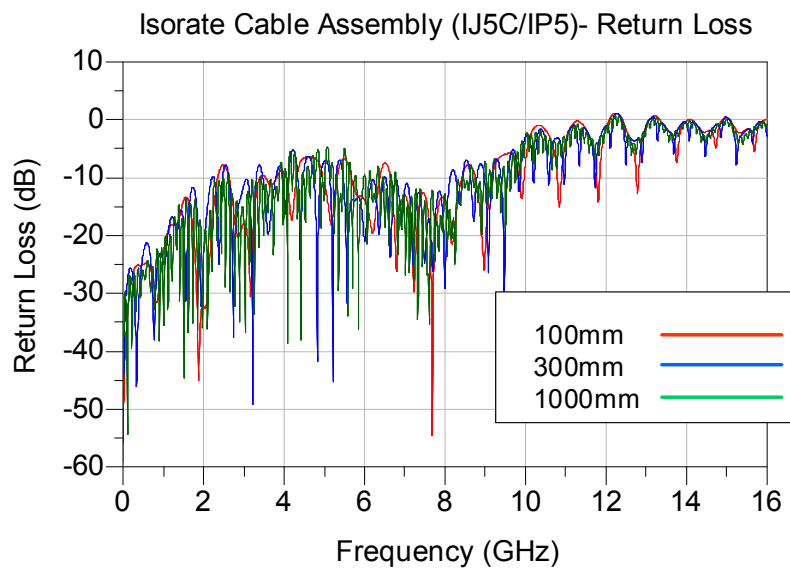
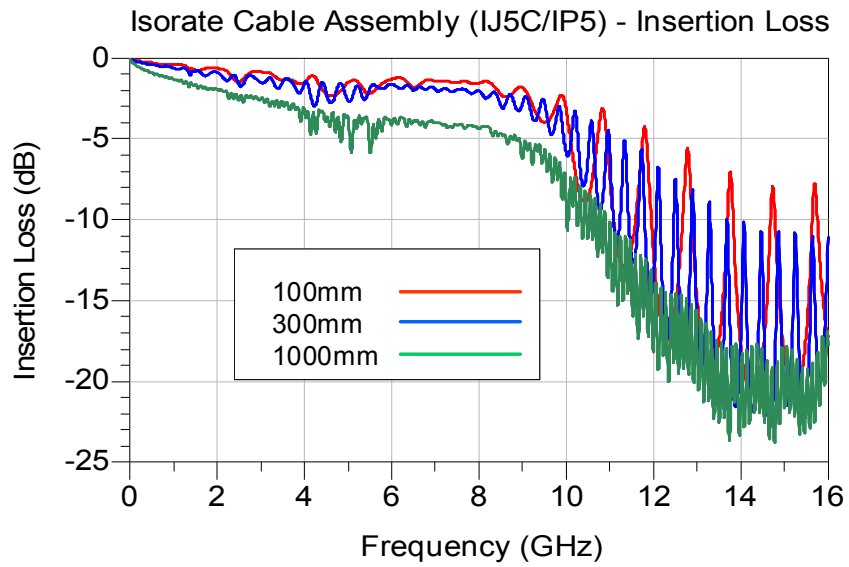
Table 1 – Frequency Domain Performance Summary

Test Parameter		Case 1 (100mm)	Case 2 (300mm)	Case 3 (1000mm)
Insertion Loss (3 dB)		9.2 GHz	8.5 GHz	3.4 GHz
Return Loss (at 3 dB IL Frequency)		8.0 dB	7.2 dB	10.5 dB
NEXT (at 3 dB IL frequency)	Configuration 1 (ATVT)	-62 dB	-70 dB	-56 dB
	Configuration 2 (ATTV)	-68 dB	-65 dB	-55 dB
	Configuration 3 (TAVT)	-83 dB	-67 dB	-63 dB
FEXT (at 3 dB IL frequency)	Configuration 1 (ATVT)	-69 dB	-67 dB	-67 dB
	Configuration 2 (ATTV)	-66 dB	-67 dB	-57 dB
	Configuration 3 (TAVT)	-85 dB	-72 dB	-64 dB

Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Insertion Loss and Return Loss Charts



Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Time Domain Data Summary

Table 2 - Impedance (Ω)

Risetime	Impedance (minimum)	Impedance (maximum)
30	37	58
50	41	57
100	43	54
250	45	51
500	47	51

Table 3 - Crosstalk (%)

(Case 1 (100mm) is shown below, other Cases have lower crosstalk)

	Risetime	Configuration 1 (ATVT)	Configuration 2 (ATTV)	Configuration 3 (TAVT)
	30 ps	0.011	0.01	0.032
	50 ps	0.007	0.006	0.016
NEXT (%)	100 ps	<0.005	<0.005	0.008
	250 ps	<0.005	<0.005	<0.005
	500 ps	<0.005	<0.005	<0.005
	30 ps	0.012	0.009	0.019
	50 ps	0.008	0.005	0.012
FEXT (%)	100 ps	<0.005	<0.005	0.009
	250 ps	<0.005	<0.005	<0.005
	500 ps	<0.005	<0.005	<0.005

Table 4 - Propagation Delay

	Prop Delay (nS)
Case 1 (100mm)	1.166
Case 2 (300mm)	1.937
Case 3 (1000mm)	4.978

Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Characterization Details

This report presents data that characterizes the signal integrity response of a cable assembly 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 cable assembly, mating connector and footprint effects on a typical multi-layer PCB. PCB effects (trace loss) are de-embedded from test data. Board related effects, such as pad-to-ground capacitance, are included in the data presented in this report.

Additionally, intermediate test signal connections can mask the cable assembly's 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 and Single-Ended 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 only for single-ended drive scenarios as this is the target application for the IJ5C/IP5 cable assembly system,

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 report, 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 directly from network analyzer measurements.

Time Domain Data

Time Domain parameters indicate impedance mismatch versus length, signal propagation time, and crosstalk in a pulsed signal environment. The measured S-parameters from the network analyzer are post-processed using Agilent Advanced Design System to obtain the time domain response. 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.

Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

In this report, propagation delay is defined as the signal propagation time through the connector and connector footprint. It includes 200mils of PCB trace on each end of the connector. Delay is measured at 35 ± 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.

Crosstalk data in this report is labeled as "ATVT", "ATTV" or "TAVT". The IJ5C/IP5 connector tested in this report has 4 positions. For example, a "TAVT" crosstalk configuration excites position 2 and monitors the coupled noise on position 3. Positions 1 and 4 are at the end of the connector while position 2 and 3 are in the middle of the connector.

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.

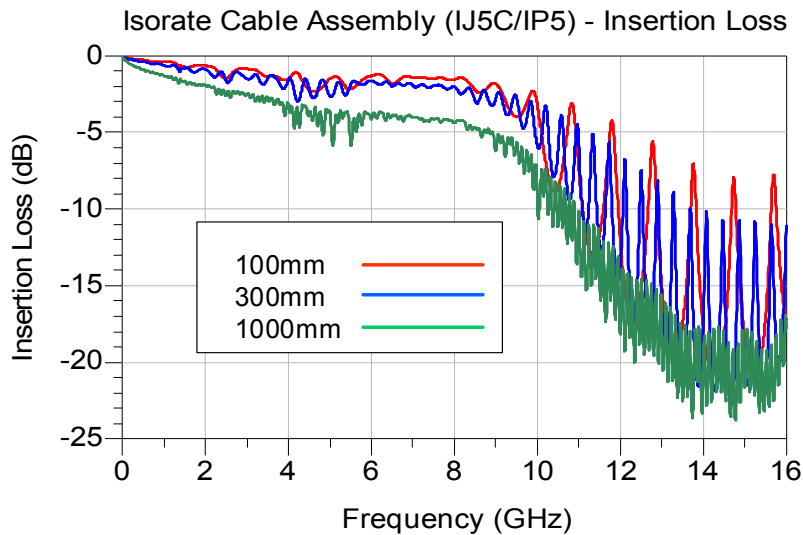
Additional information concerning test conditions and procedures is located in the appendices of this report. Further information may be obtained by contacting our Signal Integrity Group at sig@samtec.com.

Series: IJ5C

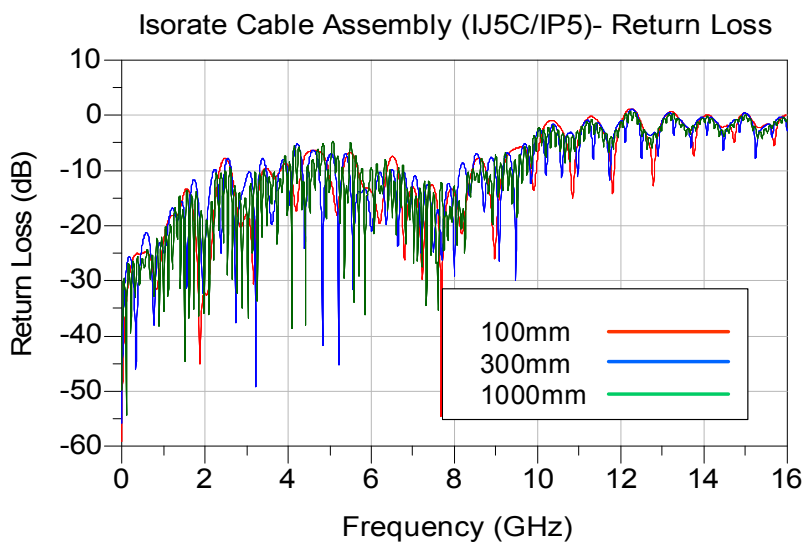
Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Appendix A – Frequency Domain Response Graphs

Insertion Loss



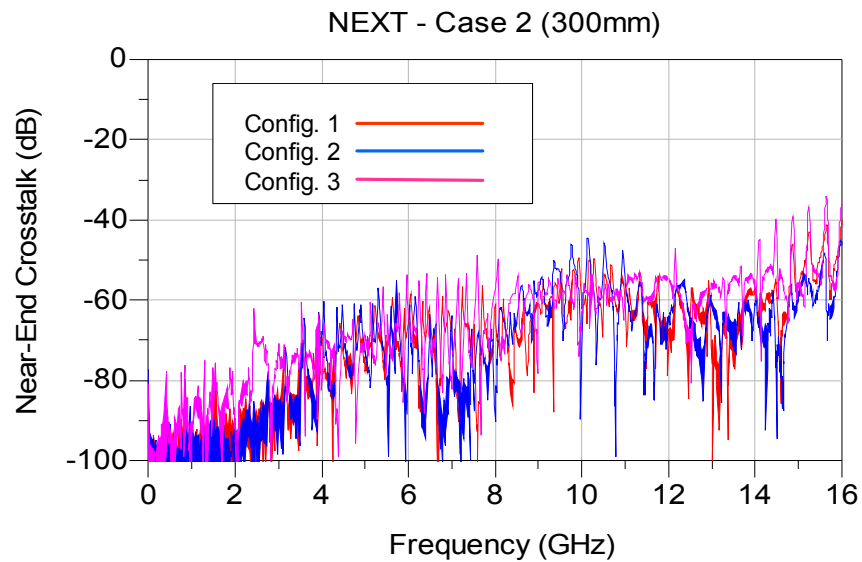
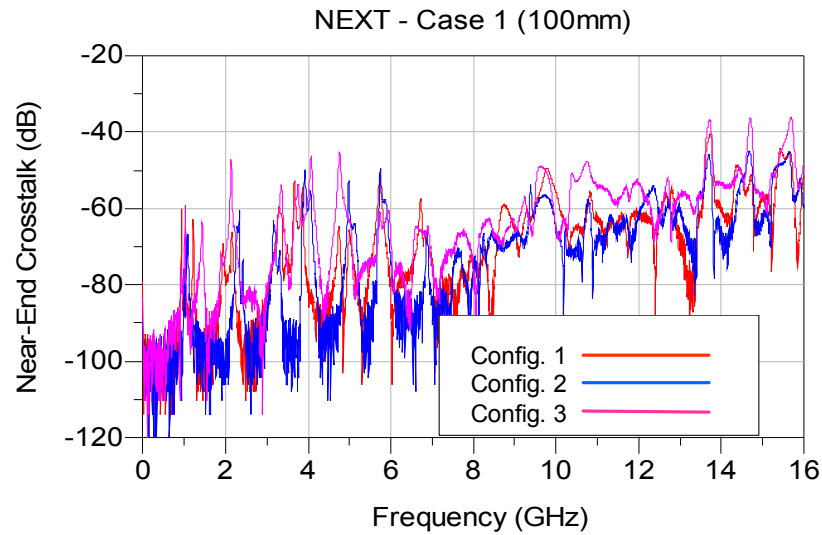
Return Loss



Series: IJ5C

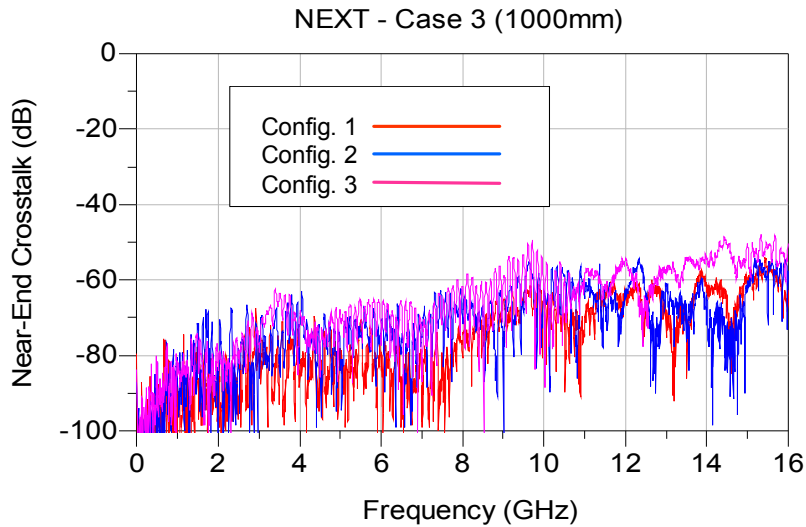
Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Near End Crosstalk

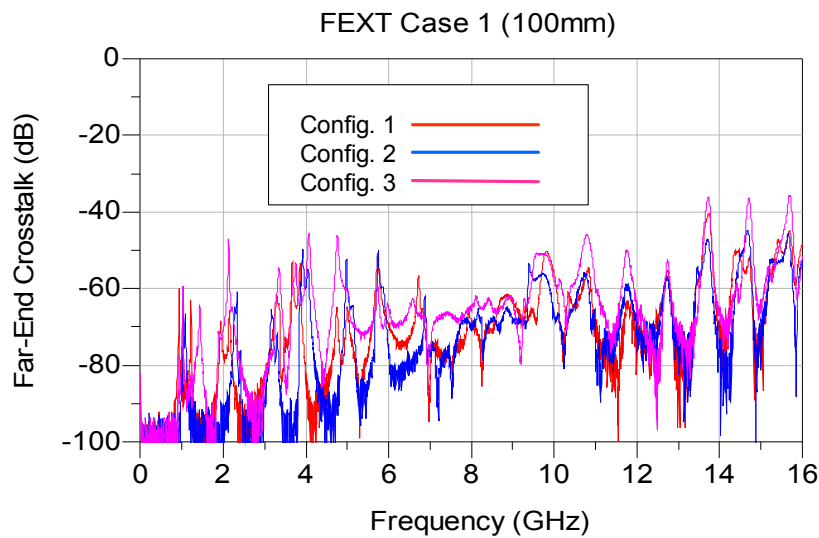


Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

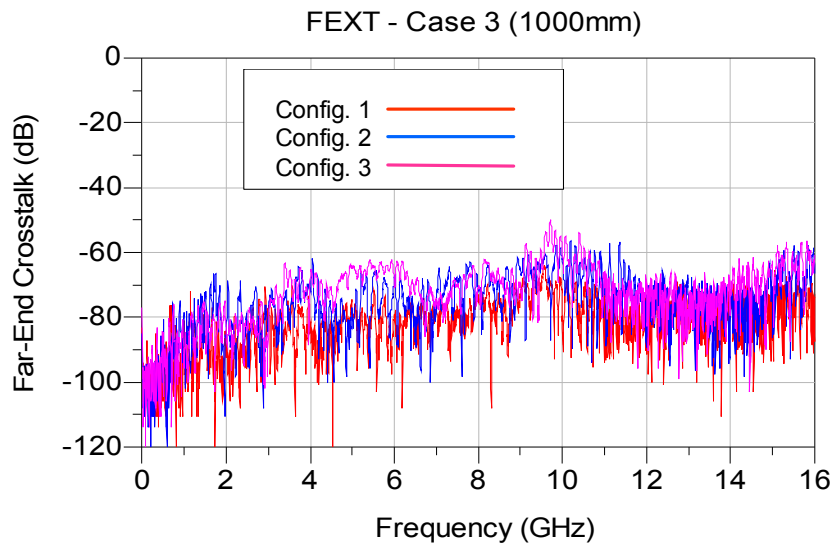
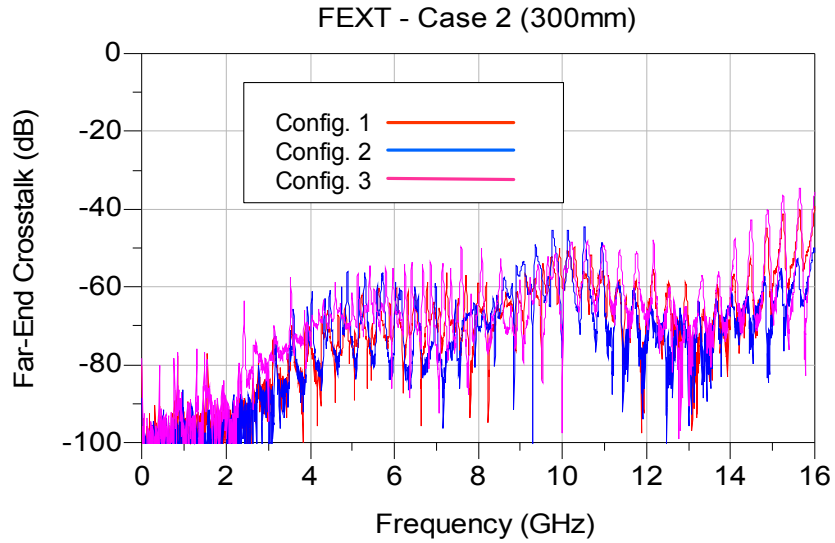


Far End Crosstalk



Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

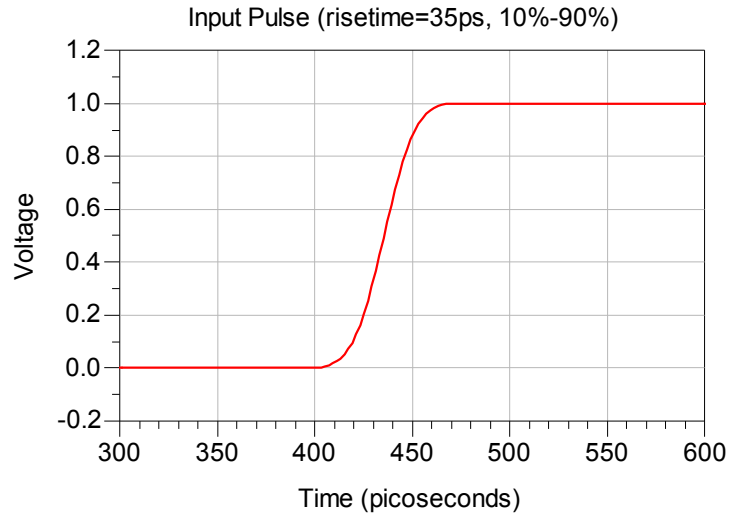


Series: IJ5C

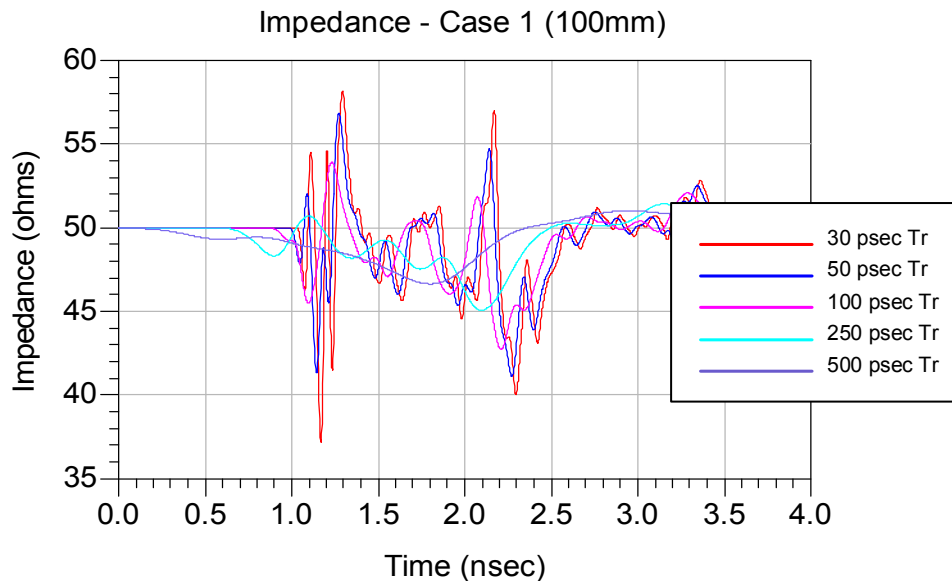
Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Appendix B – Time Domain Response Graphs

Input Pulse

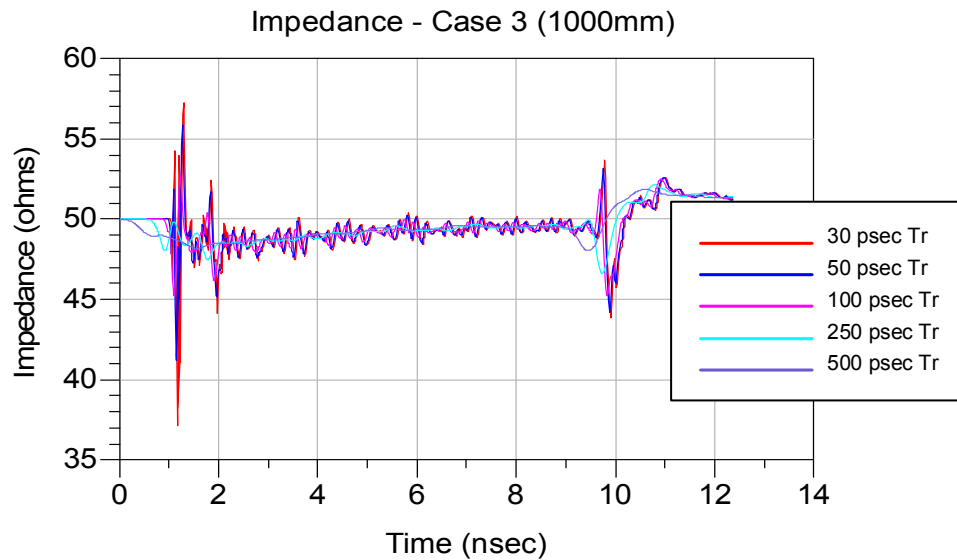
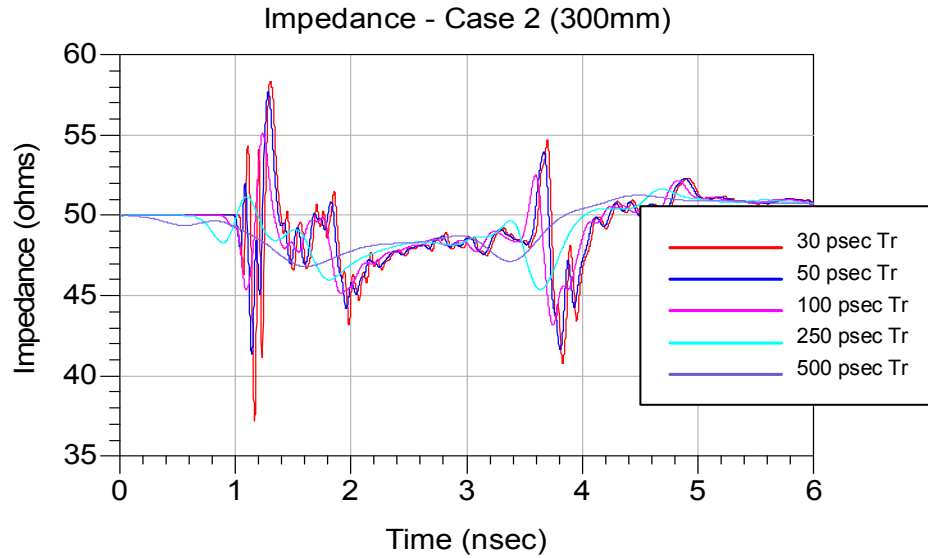


Impedance



Series: IJ5C

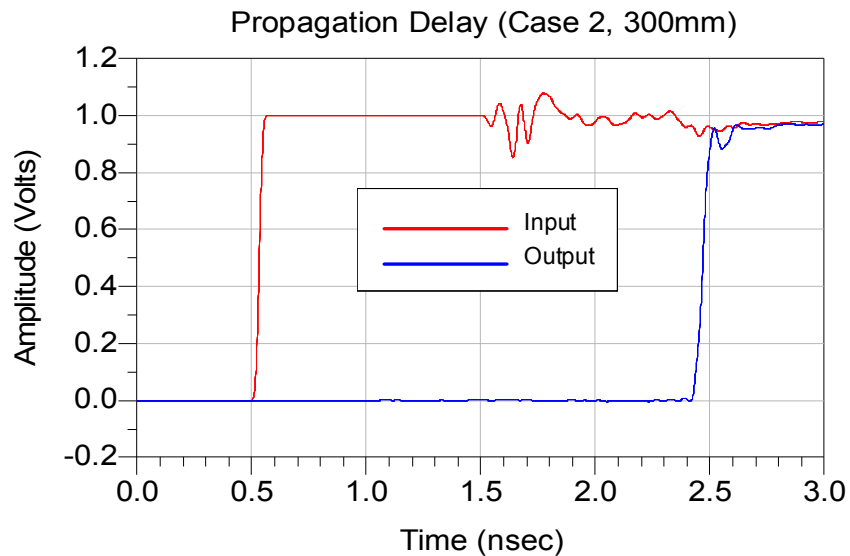
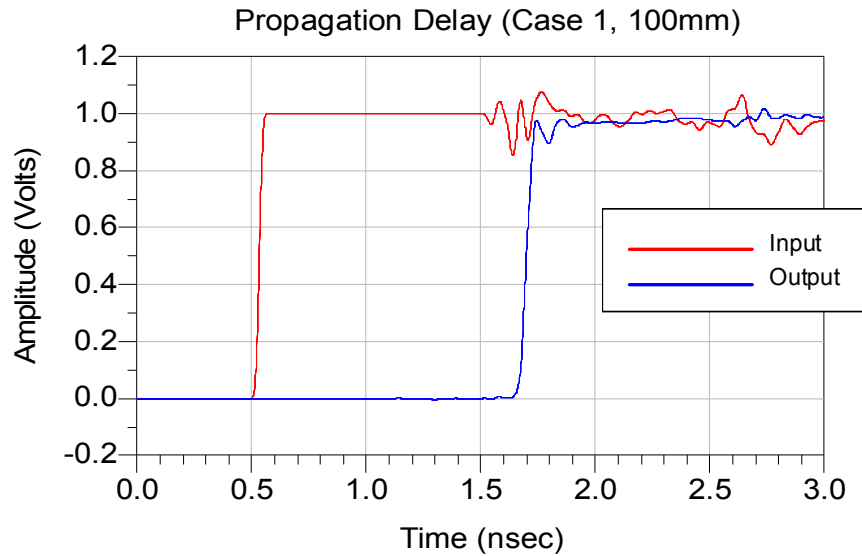
Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths



Series: IJ5C

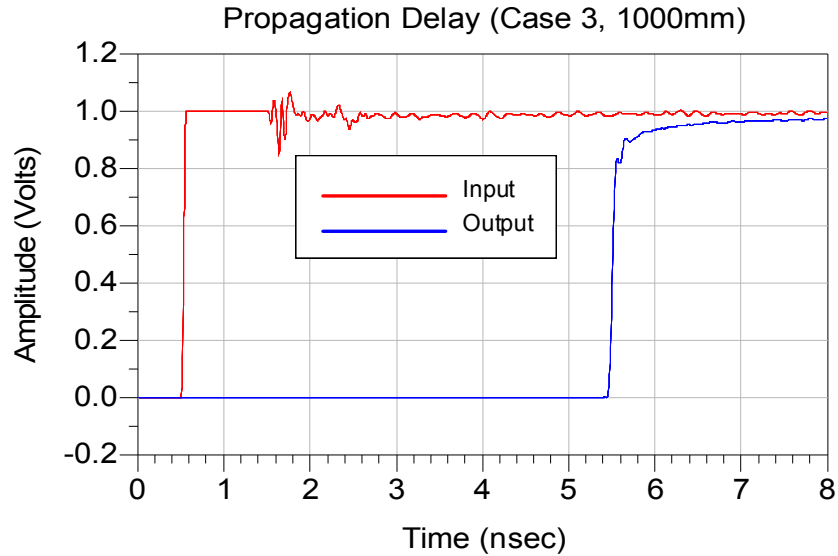
Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Propagation Delay



Series: IJ5C

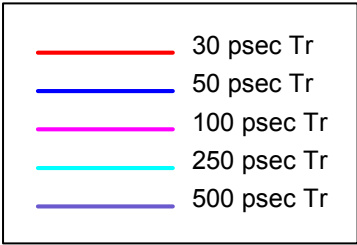
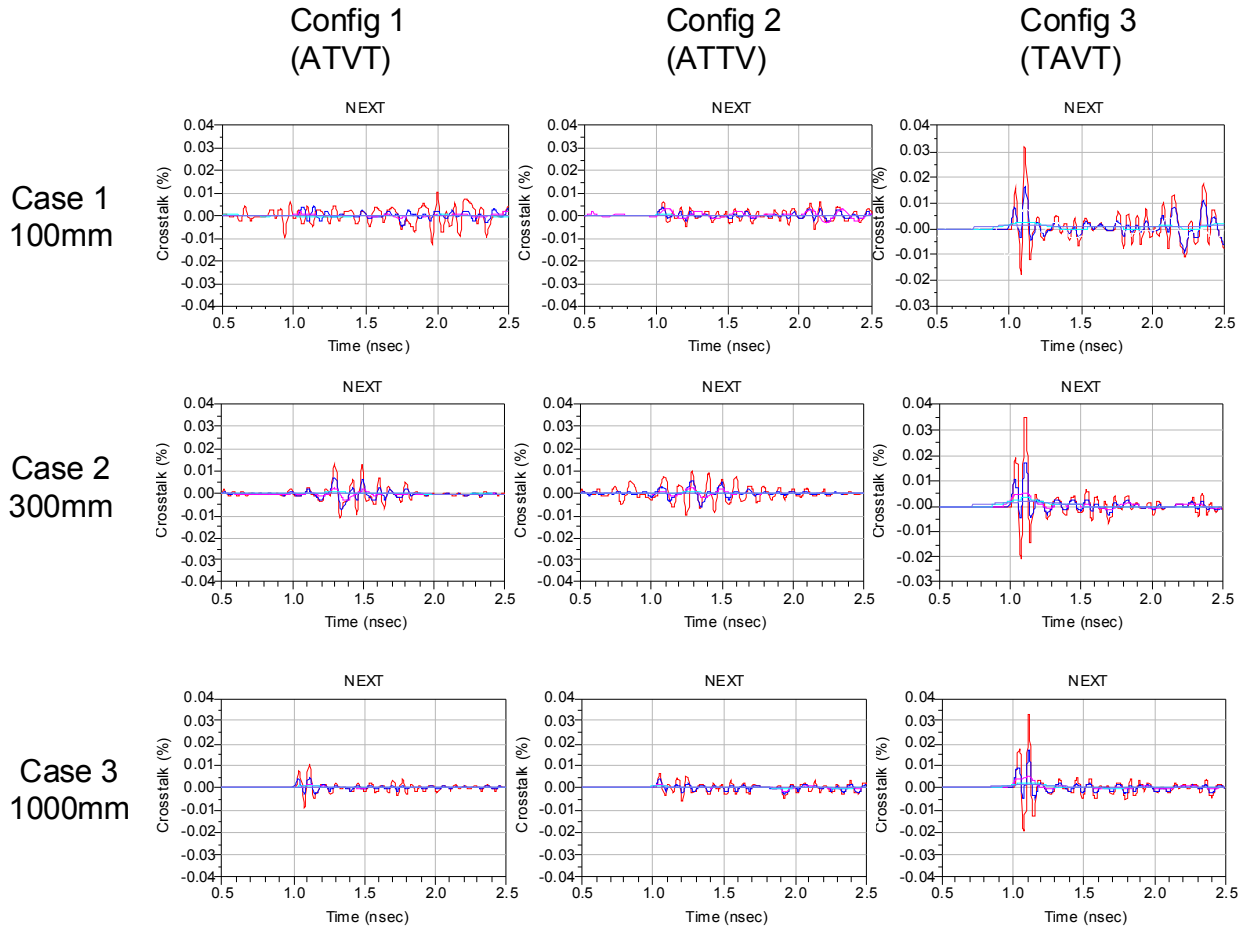
Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths



Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

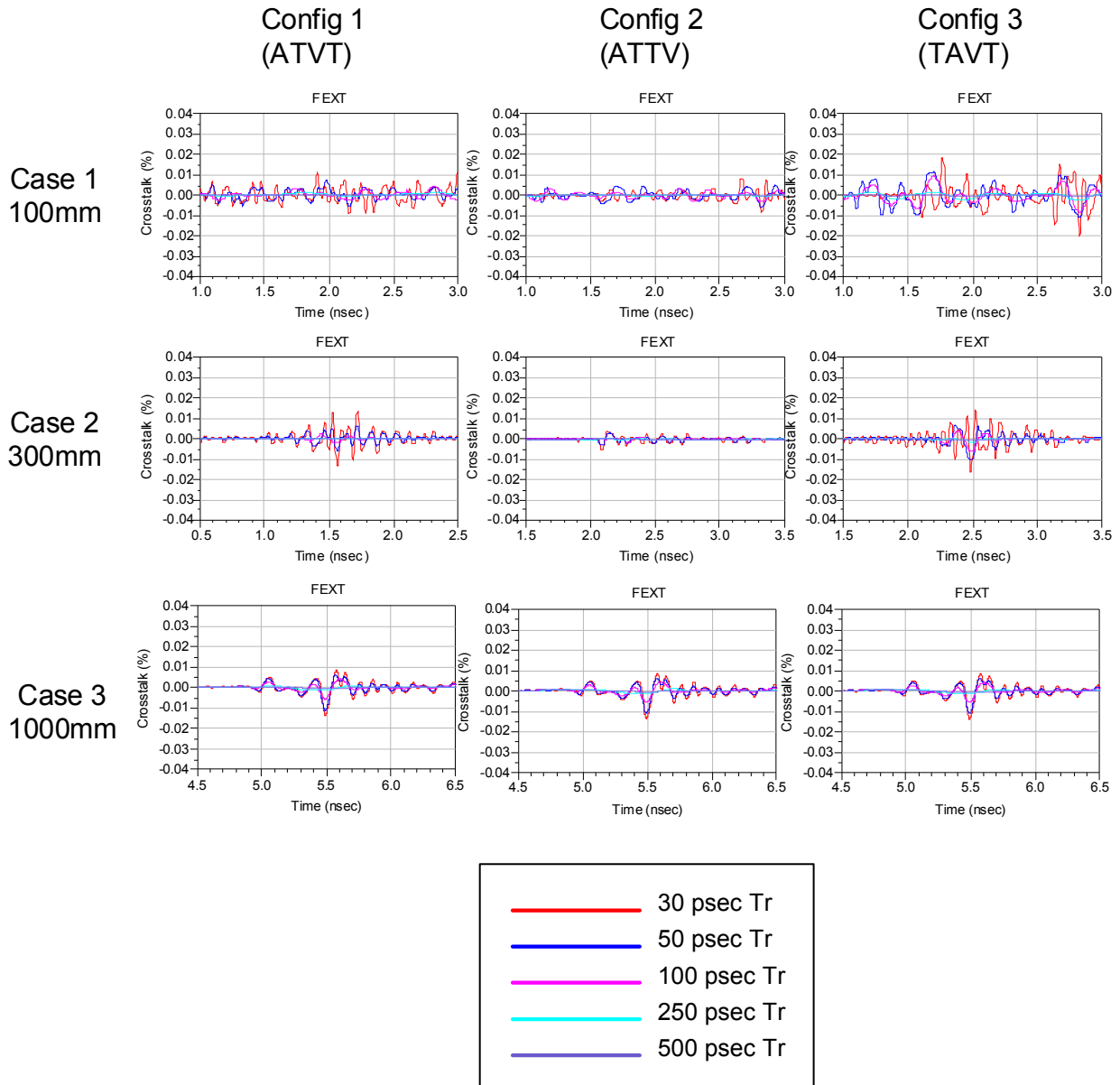
NEXT



Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

FEXT



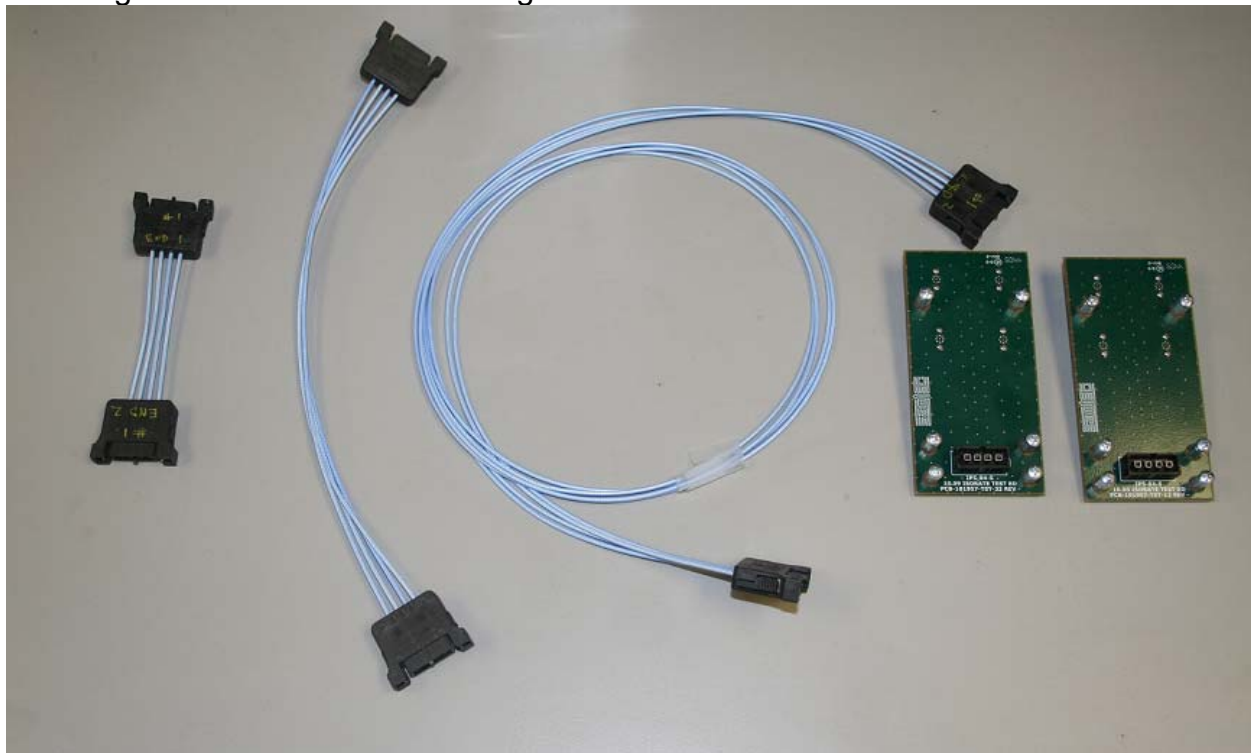
Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Appendix C – Product and Test System Descriptions

Product Description

Product test samples are the IJ5C cable assembly, part numbers IJ5C-04-0100-S-D-NUS-1, IJ5C-04-0300-S-D-NUS-1, and IJ5C-04-1000-S-D-NUS-1. The mating plug part number was IP5-04-05.0-L-S-1-TR. The IP5 connector is PCB through hole mount. Three cable assemblies were tested with lengths of 100, 300 and 1000mm. Each connector structure consists of one row of coaxial connectors. Center contacts are evenly spaced at a 4mm (.1575”) pitch. A photo of the test articles are shown below including the SI test boards on the right.



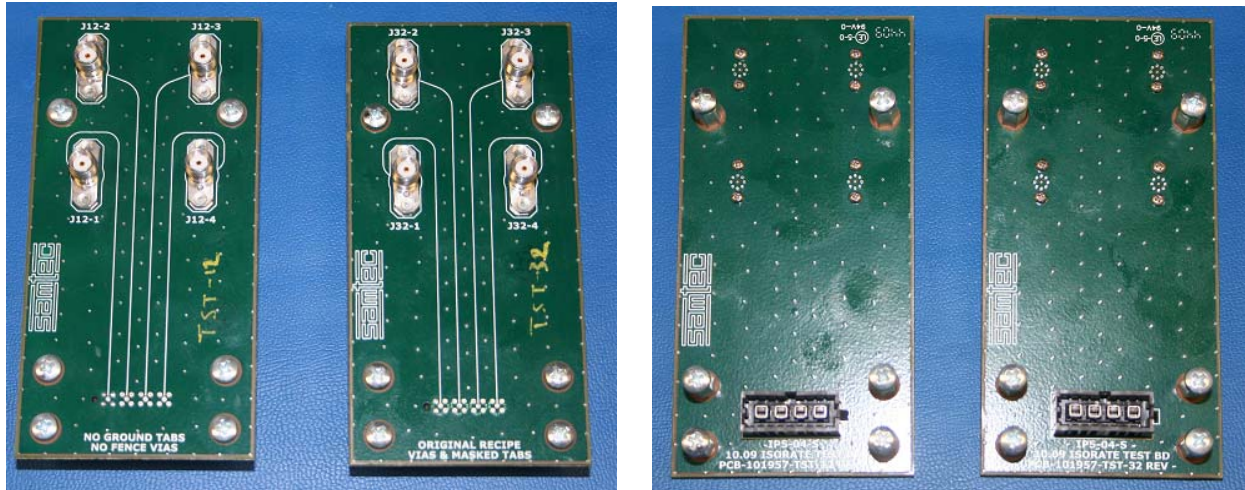
Test System Description

The test fixtures are composed of 4-layer FR-4 material with 50Ω signal trace and pad configurations designed for the electrical characterization of Samtec hi-speed connector products. The test fixtures are specific to the IJ5C/IP5 connector series and identified by part numbers PCB-101957-TST-12 and PCB-101957-TST-32. Electrical continuity exists between all the labeled test points when board numbers 12 & 32 are mated to an IJ5C cable assembly. Reference plane and calibration standards specific to the IJ5C/IP5 series are located on the calibration board, PCB-101957-TST-99. All data and waveforms presented are results from an -32 test board plug side launch. Pictured on page 18 are photos of the test boards and the printed circuit board layout panel.

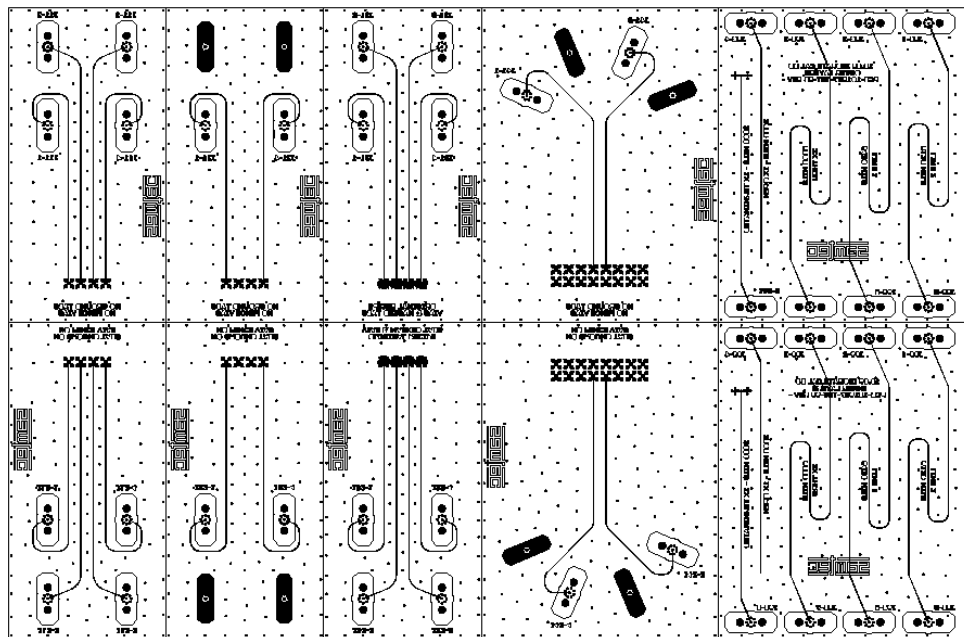
Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

PCB-101957-TST –XX Test Fixtures



PCB-101957-TST PCB Layout Panel



Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

PCB Fixtures

The test fixtures used for this testing areas follows:

PCB-101957-TST-32 Rev – IP5 Test Board

PCB-101957-TST-12 Rev – IP5 Test Board

The test ports used for crosstalk tests are as follows:

Crosstalk Test Parameters – TD NEXT, TD NEXT, FD FEXT, TD FEXT,

Configuration 1, (ATVT)

Near-End Aggressor: J32-1, Victim; J32-3

Far-End Aggressor: J32-1, Victim; J12-3

Configuration 2 (ATTV)

Near-End Aggressor: J32-1, Victim; J32-4

Far-End Aggressor: J32-1, Victim; J12-4

Configuration 3 (TAVT)

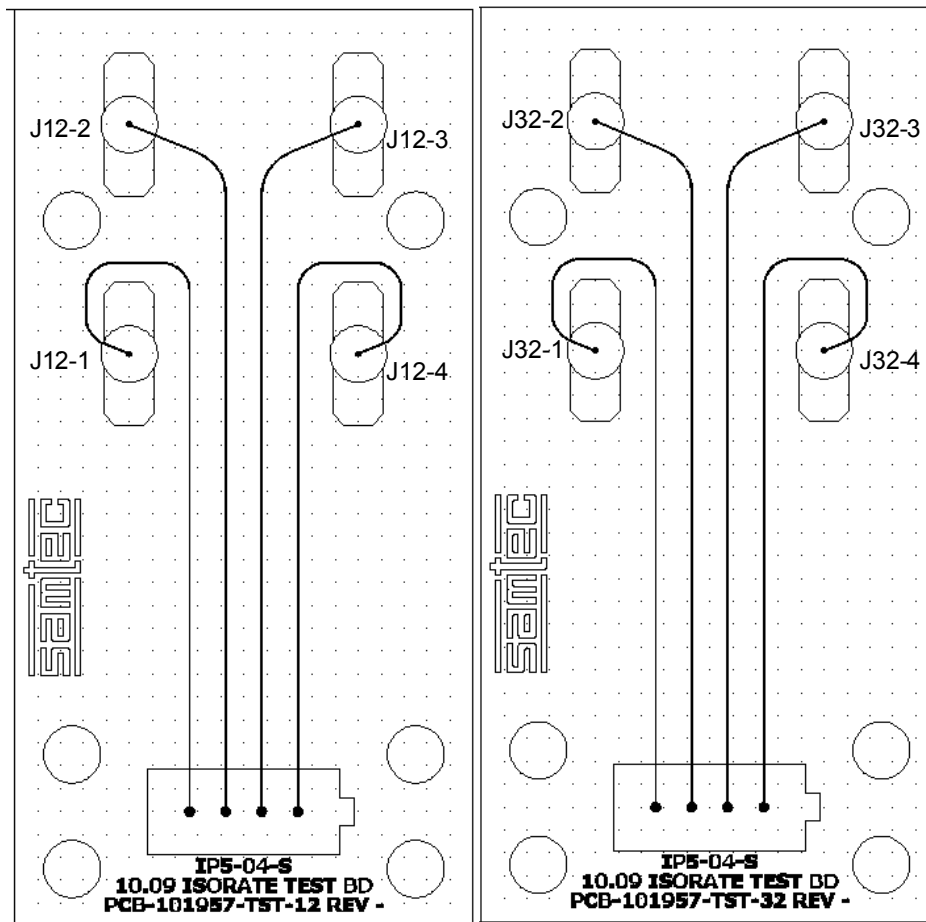
Near-End Aggressor: J32-2, Victim; J32-3

Far-End Aggressor: J32-2, Victim; J12-3

The PCB layout for these test boards are shown on page 20.

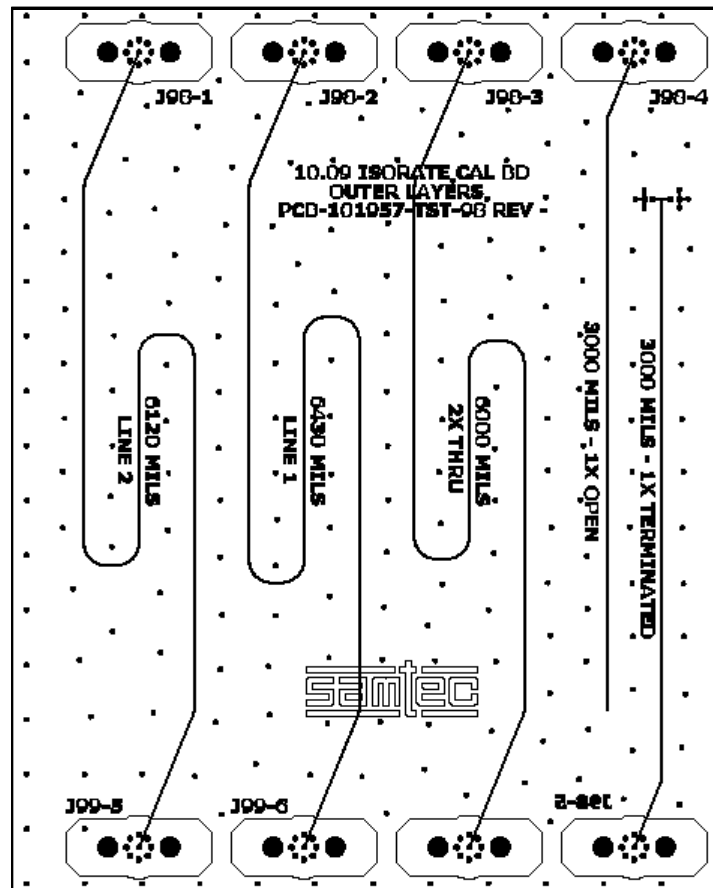
Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths



Series: IJ5C**Description:** ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths**Calibration Board**

Test fixture losses and test point reflections were removed from the data by use of TRL calibration. The calibration board is shown below. Prior to making any measurements the calibration board is characterized to obtain parameters required to define the calibration kit. Once a cal kit is defined, calibration using the standards on the calibration board can be performed. Finally, the device can be measured and the test board effects are automatically removed.



Thru line – 6000 mils

Open Reflect – 3000 mils

Line 1 – 6430 mils

Line 2 – 6120 mils

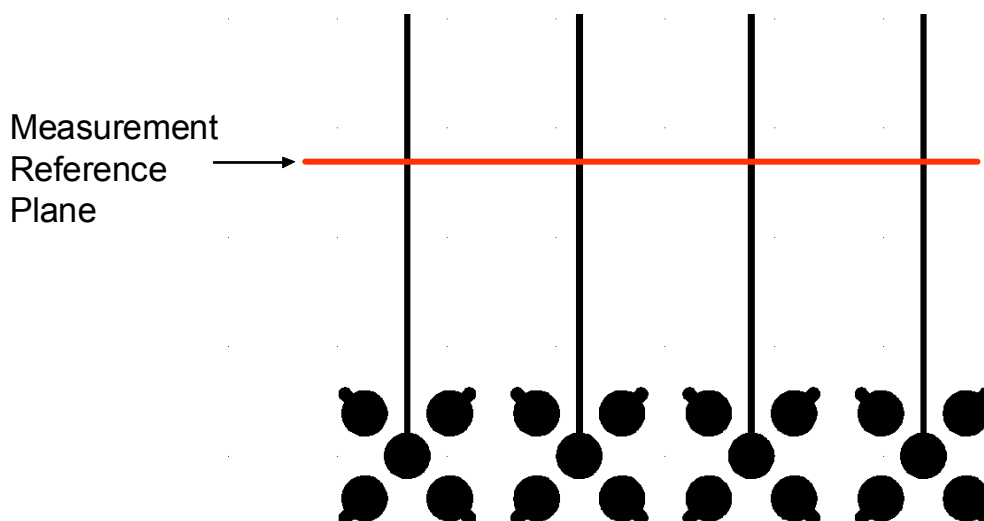
Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

All traces on the test boards are length matched to 3.260". The TRL calibration effectively removes 3" of test board trace effects. This means that 0.260" of test board trace length effects are include in the measurement. The S-parameter measurement includes:

- A- The IJ5C cable assembly
- B- The IP5 board mount connector,
- C- test board vias, pads (footprint effects)
- D- 260 mils of 5.5 mil stripline trace.

The figure below shows the location of the measurement reference plane.



Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Appendix D – Test and Measurement Setup

The test instrument is the Agilent N5230A PNA-L network analyzer. Frequency domain data and graphs are obtained directly from the instrument. Post-processed time domain data and graphs are generated using convolution algorithms within Agilent ADS. The network analyzer is configured as follows:

Start Frequency – 300 KHz

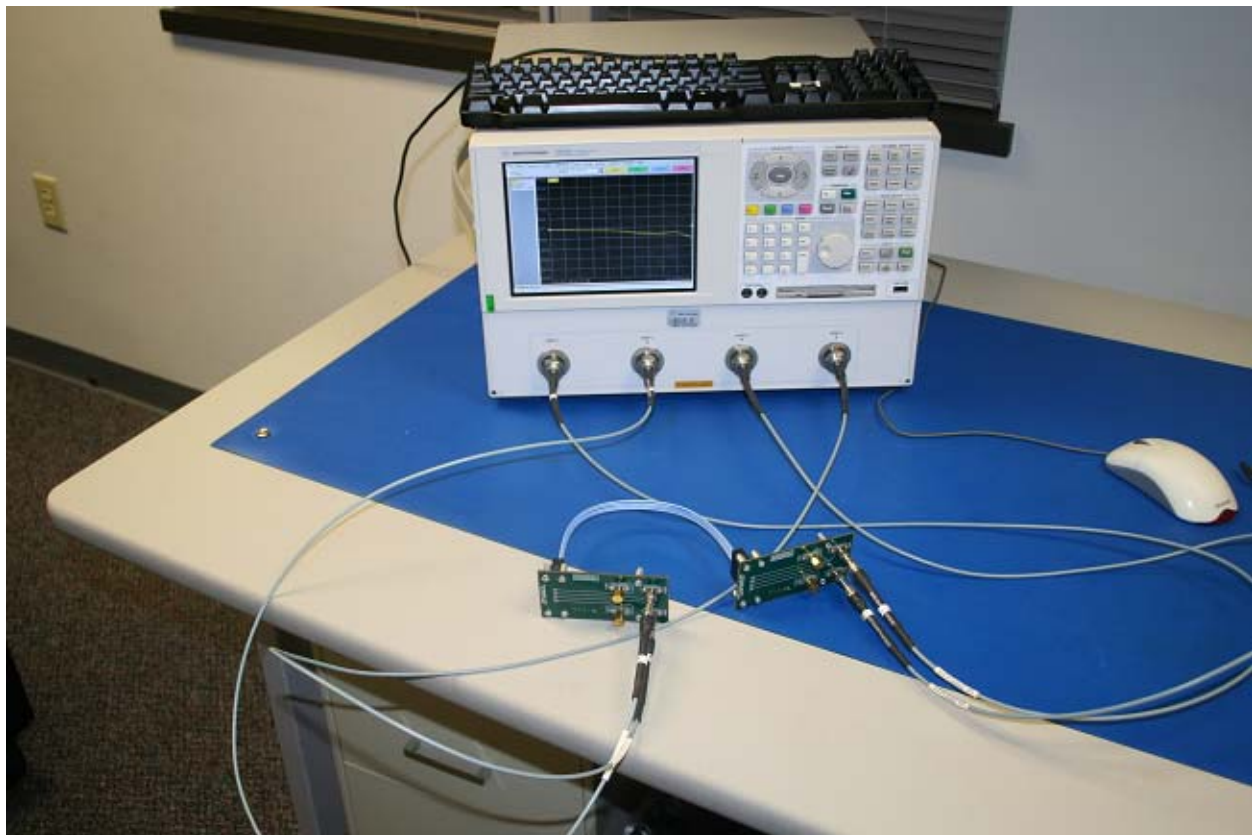
Stop Frequency – 16 GHz

Number of points -3201

IFBW – 300 Hz

With these settings, the measurement time is approximately 2 minutes.

N5230A Measurement Setup



Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Test Instruments

<u>QTY</u>	<u>Description</u>
------------	--------------------

- | | |
|---|---|
| 1 | Agilent N5230A PNA-L Network Analyzer (300 KHz to 20 GHz) |
| 1 | Agilent N4433A ecal module (300 KHz to 20 GHz) |

Test Cables & Adapters

<u>QTY</u>	<u>Description</u>
------------	--------------------

- | | |
|---|----------------------------|
| 4 | Megaphase CM40 (DC-40 GHz) |
|---|----------------------------|

Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Appendix E - Frequency and Time Domain Measurements

Frequency (S-Parameter) Domain Procedures

The quality of any data taken with a network analyzer is directly related to the quality of the calibration standards and the use of proper test procedures. For this reason, extreme care is taken in the design of the LRM calibration standards, the SI test boards and the selection of the PCB vendor.

The measurement process begins with a measurement of the LRM calibration standards. A coaxial SOLT calibration is performed using an N4433A ecal module. This measurement is required in order to obtain precise values of the line standard offset delay and frequency bandwidths. Measurements of the reflect and 2x through line standard can be used to determine the maximum frequency for which the calibration standards are valid. For the IP5/IJ5 test boards this is roughly 16 GHz.

From the LRM calibration standard measurements, a user defined calibration kit is developed and stored in the network analyzer. Calibration is then performed on all 4 ports following the calibration wizard within the Agilent N5230. This calibration is saved and can be recalled at any time. Calibration takes roughly 30 minutes to perform.

Time Domain Procedures

Mathematically, frequency domain data can be transformed to obtain a time domain response. Perfect transformation requires frequency domain data from DC to infinity Hz. Fortunately, a very accurate time domain response can be obtained with bandwidth-limited data, such as measured with modern network analyzer.

The time domain responses were generated using Agilent ADS 2009 update 1. This tool has a transient convolution simulator which can generate a time domain response directly from measured S-parameters. An example of a similar methodology is provided in the Samtec Technical Note on domain transformation

[http://www.samtec.com/Technical_Library/reference/articles/pdfs/tech-note_using-PLTS-for-time-domain-data_web.pdf](http://www.samtec.com/Technical_Library/reference/articles/pdfs/tech-note_using_PLTS-for-time-domain-data_web.pdf)

Impedance(TDR)

A step pulse is applied to the touchstone model of the connector and the reflected voltage is monitored. The reflected voltage is converted to a reflection coefficient and then transformed into an impedance profile. All ports of the Touchstone model are terminated in 50 ohms.

Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Propagation Delay (TDT)

The propagation delay is a measure of the time domain delay through the connector and footprint. A step pulse is applied to the touchstone model of the connector and the transmitted voltage is monitored. The same pulse is also applied to a reference channel with zero loss and the time domain pulses are plotted on the same graph. The difference in time, measured at the 50% point of the step voltage is the propagation delay.

Near-End Crosstalk (TDT) & Far End Crosstalk (TDT)

A step pulse is applied to the touchstone model of the connector and the coupled voltage is monitored. The amplitude of the peak coupled voltage is recorded and reported as a percentage of the input pulse.

Series: IJ5C

Description: ISO Rate™ Series RF Jack Cable Assembly, 100mm, 300mm, 1000mm Lengths

Appendix F – Glossary of Terms

TD – Time Domain

FD – Frequency domain

DUT – Device under test, term used for TDA IConnect & Propagation Delay waveforms

EC6 – Edge Card with a .635mm signal pad pitch

FEXT – Far-End Crosstalk

GSG – Ground–Signal–Ground; geometric configuration

GSSG - Ground–Signal–Signal–Ground; geometric configuration

LEC6 – Signal Launch Edge Card with a .635 mm signal pad pitch

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 – Worst Case crosstalk configuration

BC – Best Case crosstalk configuration

Z – Impedance (expressed in ohms)

OV – Optimal Vertical

OH – Optimal Horizontal

HDV – High Density Vertical

PPO – Pin Population Option

S – Static (independent of PCB ground)