GT-14-18

High Speed Characterization Report

For Differential Data Applications

Mated Pair

801-038-07M6-7SA

High Speed PC Tail Connector

801-036-16M6-7PA

High Speed Cable Mount Connector

Glenair, Inc.
1211 Air Way
Glendale, CA 91201-2497 USA

WWW.GLENAIR.COM

Phone: 818-247-6000
Fax: 818-500-9912

Revision History

Rev	Date	Approved	Description
A	8/29/2013	D. Armani / R. Ghiselli	Initial Release
B	10/22/2013	G. Hunziker / D. Armani	Released
C	3/5/2014	D. Armani / C. Parsons	Released

Glenair, Inc.
1211 Air Way
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Fax: 818-500-9912

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1.0 Introduction

This testing was performed in order to evaluate the high-frequency electrical performance of the Series 80 High Speed Mighty Mouse interconnect system. Frequency domain and time domain measurements were performed using the Agilent E5071C ENA network analyzer with TDR option, and test boards which were designed specifically for this report. Frequency domain analysis includes Insertion Loss (IL), Return Loss (RL), Near End Crosstalk (NEXT), and Far End Crosstalk (FEXT).

2.0 Connector Overview

The Series 80 High Speed features all the same performance attributes as our original Mighty Mouse, but adds special purpose PFA (Teflon®) inserts that deliver superior insertion loss and balanced impedance performance for high-speed data applications at frequencies above 1 GHz.

For the purposes of this test, two PC tail connectors (High-Speed Mighty Mouse part number 801-038-07M6-7SA) were terminated to the test board. The connectors were mated to a back-to-back cable assembly, consisting of two plug connectors (High-Speed Mighty Mouse part number 801-036-16M6-7PA, rear grommets removed) terminated to approximately 12 inches of low-loss cable.

It should be noted that the performance of the plug connectors is greatly dependent on the termination of the Low-loss Cable. Specifically, care needs to be taken to ensure that the wires in each pair are separated for as short a distance as possible between the cable jacket and the rear of the PFA connector insert. The wires in each pair used to build the test cables were separated no more than 0.400" prior to crimping the contacts, in accordance with Glenair's recommended assembly instruction procedure, AI80001.

3.0 Configuration

The pin-out configurations for frequency domain analysis were selected in order to test the electrical performance of differential signals through adjacent contacts in various configurations.

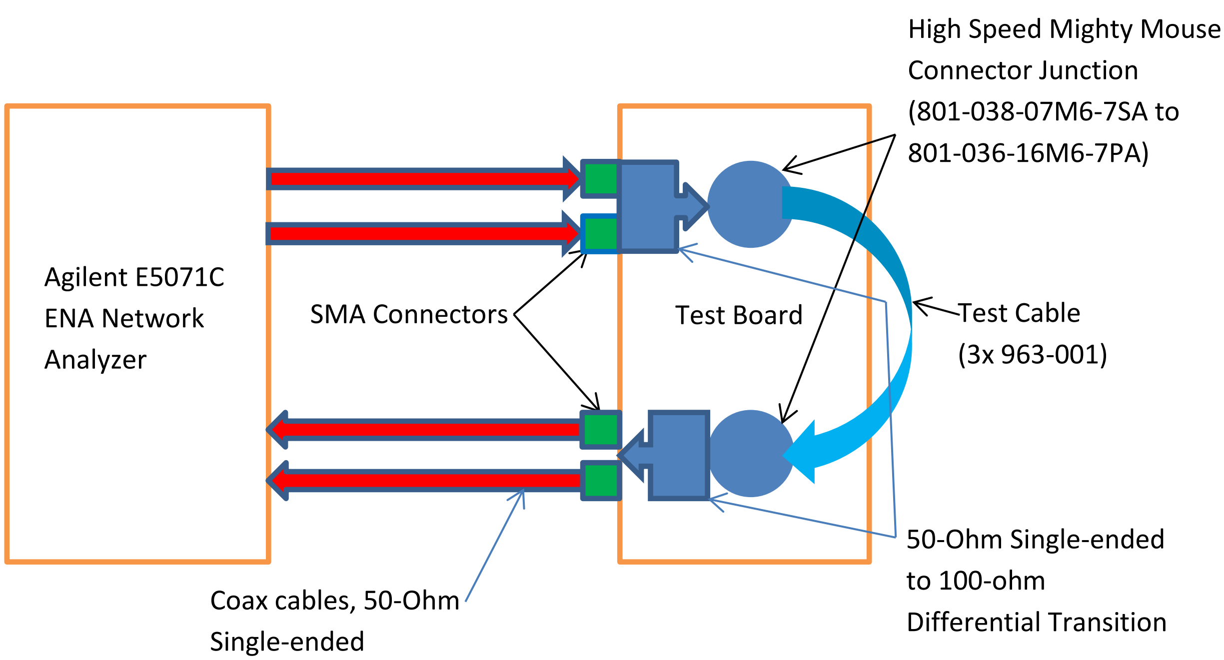
For Insertion Loss and Return Loss, the layouts were selected to determine the effect of different grounding patterns. Configuration A measured the performance of a differential signal with a single, adjacent ground signal, and Configuration B measured the performance of the same differential signal surrounded by ground lines.

For Crosstalk, the layouts were selected to determine whether separating the pairs with a barrier of ground signals would significantly reduce inter-pair noise. In Configuration A, the victim pair is placed adjacent to the aggressor pair, and in Configuration B, there is a row of ground signals separating the victim and aggressor pairs.

Insertion/Return Loss Layout	Crosstalk Layout
S – signal G – ground Q – quiet	A – aggressor V – victim G – ground Q – quiet
A: S S Q G Q Q Q	**A:** A A Q G V Q V
B: S S G G G Q Q	**B:** A A G G G V V

In order to perform the desired tests, a custom test board was fashioned. The traces were carefully designed in order to minimize their effects on the test results. High-performance edge-mount SMA connectors were attached to the launch ends, and High-speed Mighty Mouse connectors, 801-038-07M6-7SA, were mounted to the test patterns in the center.

The test board and test cables were connected to the Agilent E5071C ENA Network Analyzer via high-performance 50-ohm coaxial cables and SMA connectors. The system configuration is shown in the block diagram below:



4.0 Performance Summary

Table 1 – Differential Connector System Performance		
Parameter	**Layout**	**Results**
Insertion Loss	A	-3dB @ 1.69GHz
NEXT	A	< -26 dB
FEXT	A	< -24 dB
Insertion Loss	B	-3dB @ 1.32GHz
NEXT	B	< -31 dB
FEXT	B	< -31 dB

Table 2 - Impedance						
Input Risetime	**50ps** (9.0GHz)	**100ps** (4.5GHz)	**200ps** (2.2GHz)	**300ps** (1.5GHz)	**400ps** (1.1GHz)	**500ps** (0.9GHz)
Maximum Impedance	114	107	103	101	101	100
Minimum Impedance	61	70	80	83	85	85

5.0 Connector System Differential Speed Rating

801-038-07M6-7SA PC tail receptacle to 801-036-16M6-7PA Plug (with rear grommet removed)

Differential Speed Rating: **3.0-4.0 Gbps (1.5-2.0 GHz)**

The Connector System Speed Rating is based on the -3 dB insertion loss point of the connector system (rounded up to the nearest half-GHz). Rounding up corrects for a portion of the loss which can be attributed to the test set-up, as short lengths of cable loss are included in the loss data in this report. The rounded frequency 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 2.3 GHz would have a Differential Speed Rating of 5.0Gbps (2.5 GHz).

Glenair, Inc.
1211 Air Way
Glendale, CA 91201-2497 USA

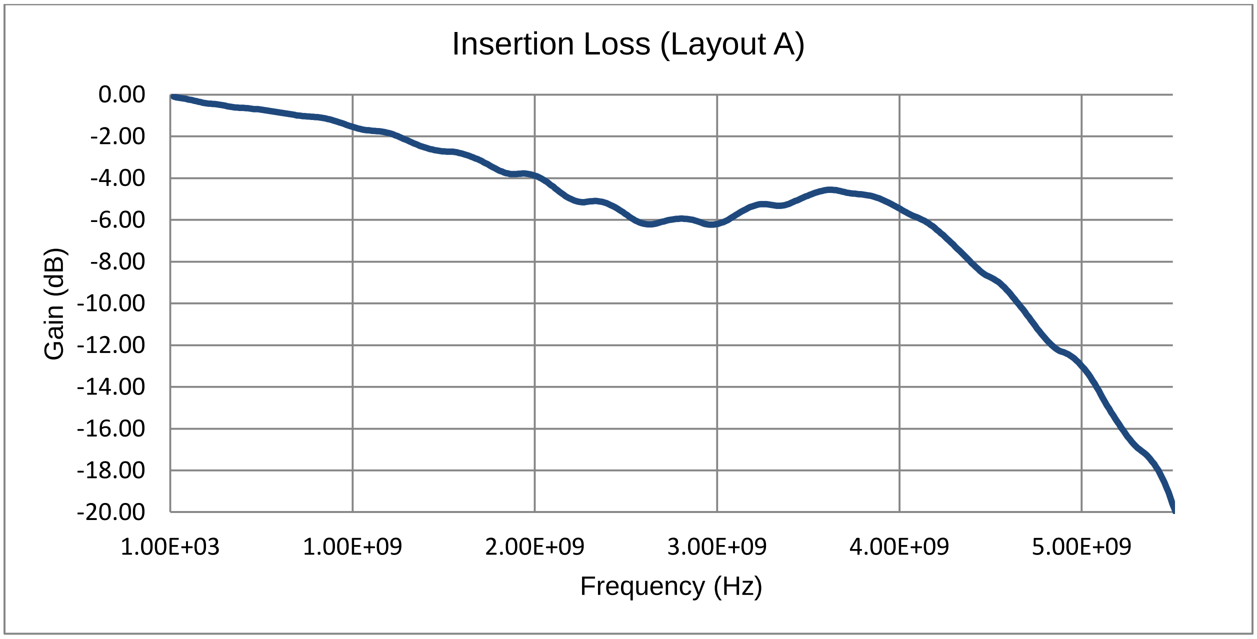
Phone: 818-247-6000
Fax: 818-500-9912

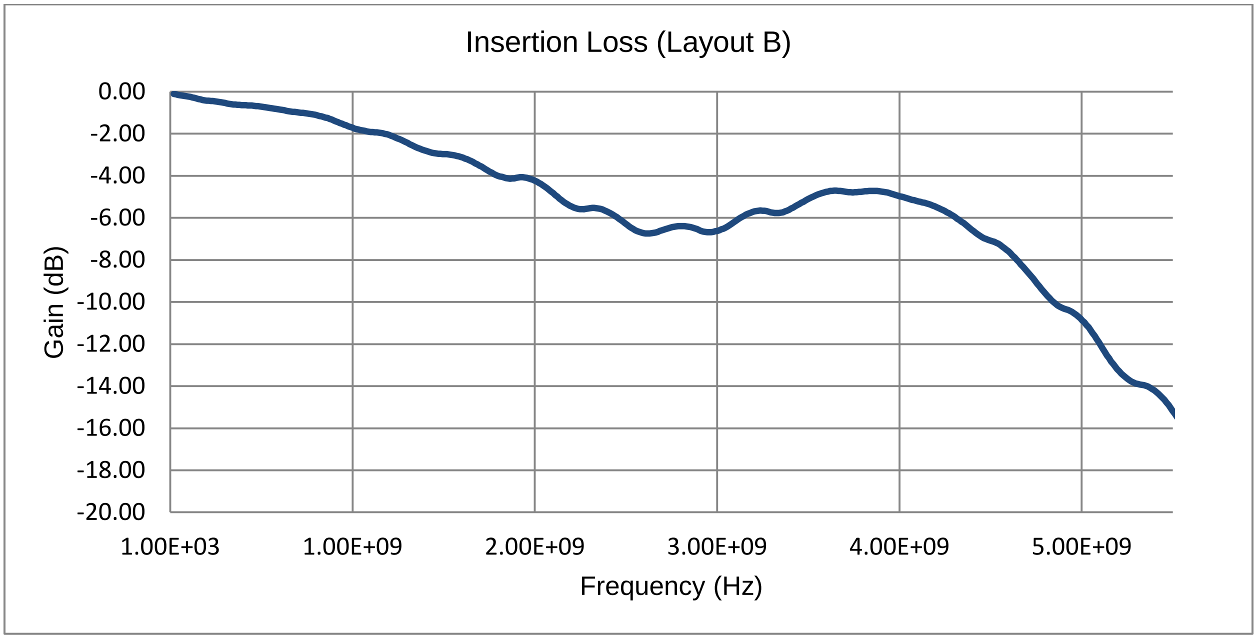
6.0 Frequency Domain Analysis

In this section, the Insertion Loss (IL), Return Loss (RL), Near End Crosstalk (NEXT), and Far End Crosstalk (FEXT) of the High Speed Mighty Mouse connector system are analyzed for Configurations A and B. Smoothing and algebraic functions have been applied to the raw data as applicable in order to present it in a legible fashion, while still maintaining its accuracy.

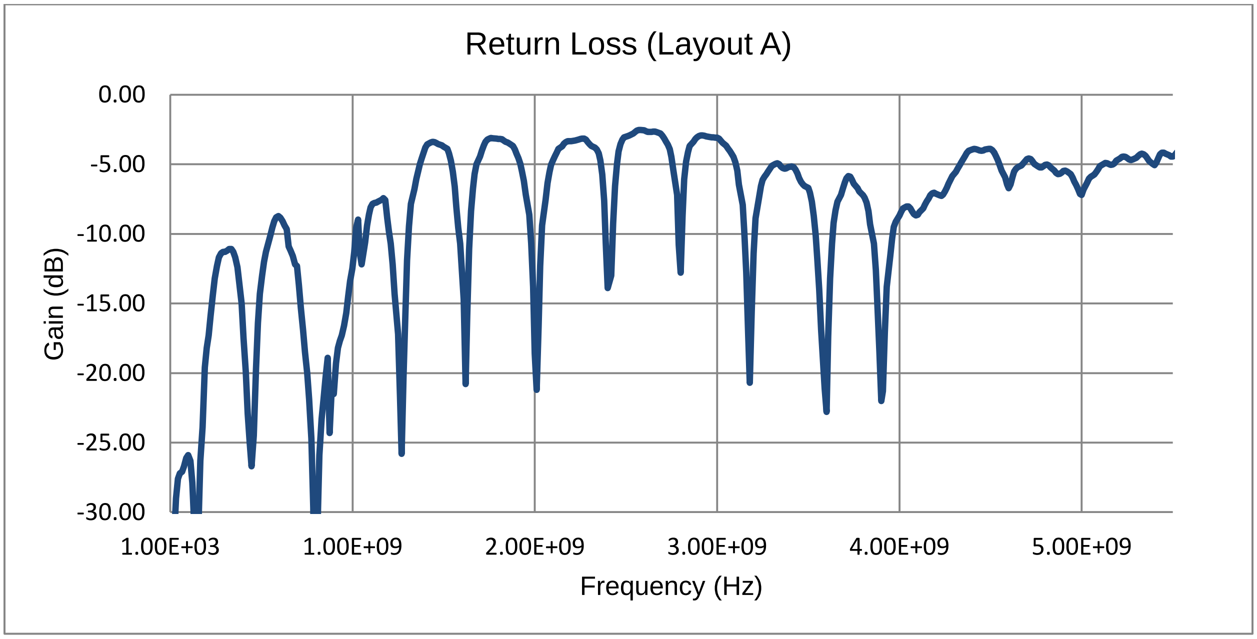
6.1 Insertion Loss

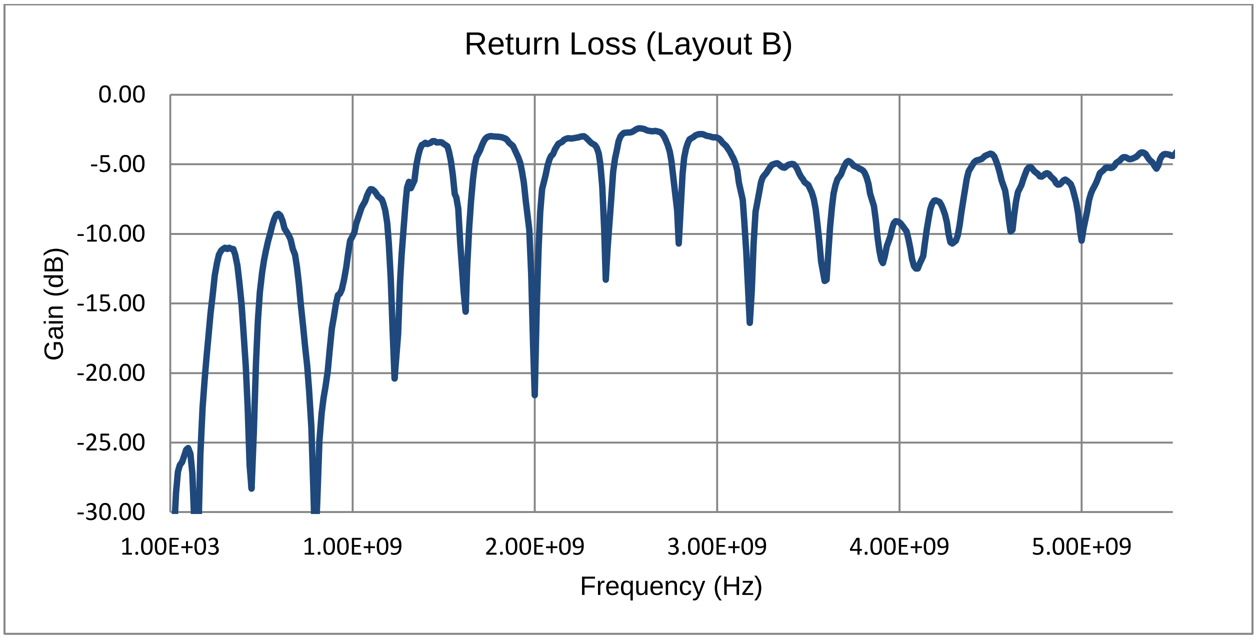
The insertion loss was measured through the entire test system, which included the test board, PC tail connector, plug connector, low-loss cable, plug connector, PC tail connector, and test board. In order to show the insertion loss through a single connector junction, the loss in the traces was subtracted out, and the resulting value was divided by two. However, the loss of the cable was not compensated for and remains in the data shown below.



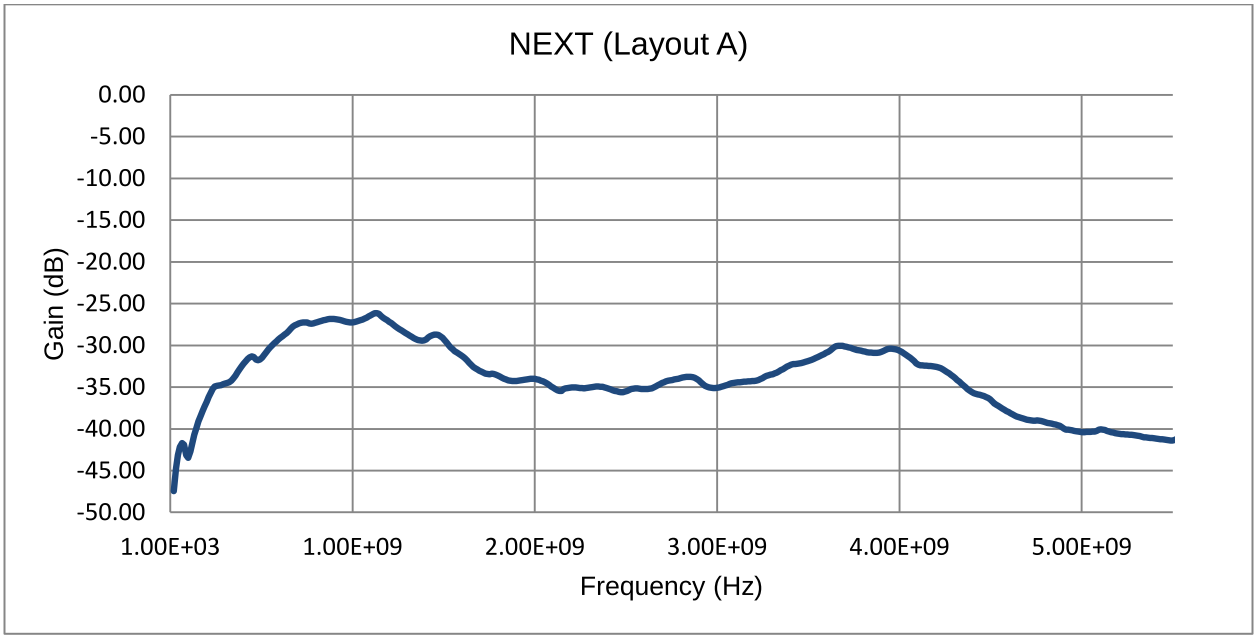


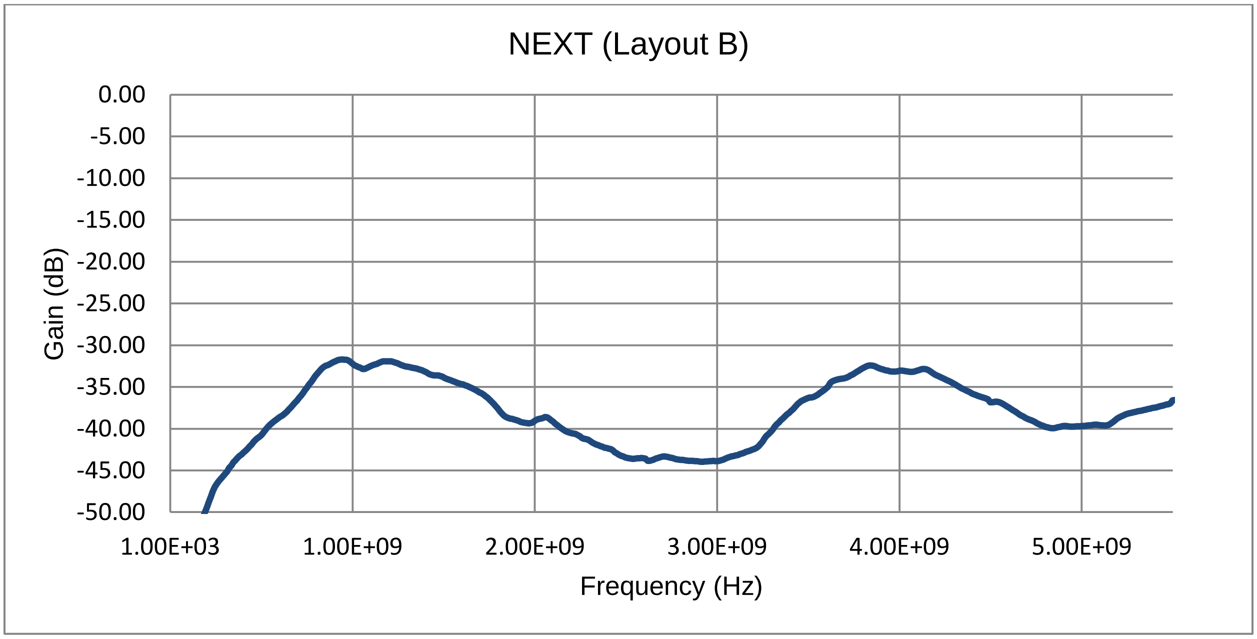
6.2 Return Loss



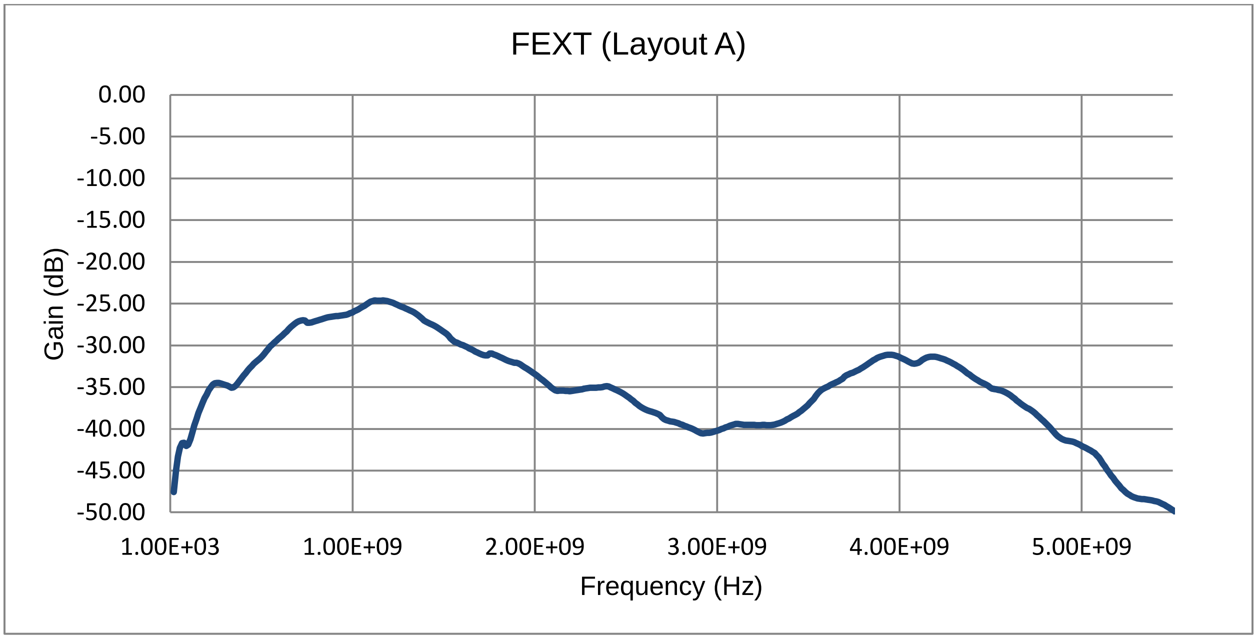


6.3 Near End Crosstalk (NEXT)





6.4 Far End Crosstalk (FEXT)



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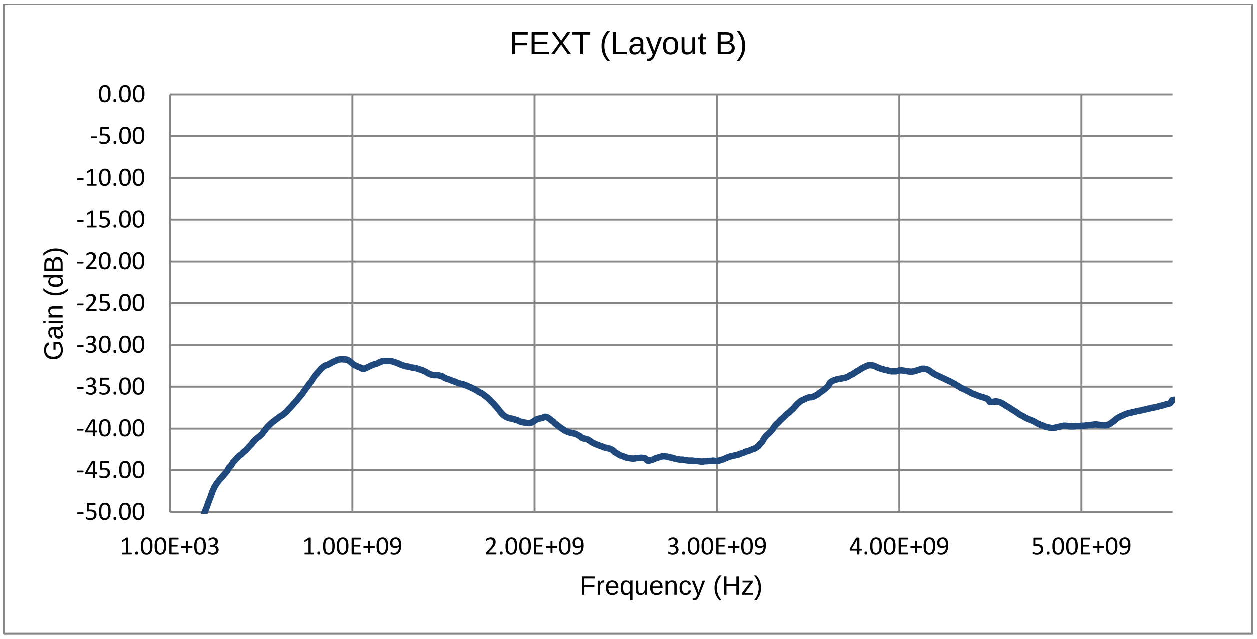


6.5 Conclusions

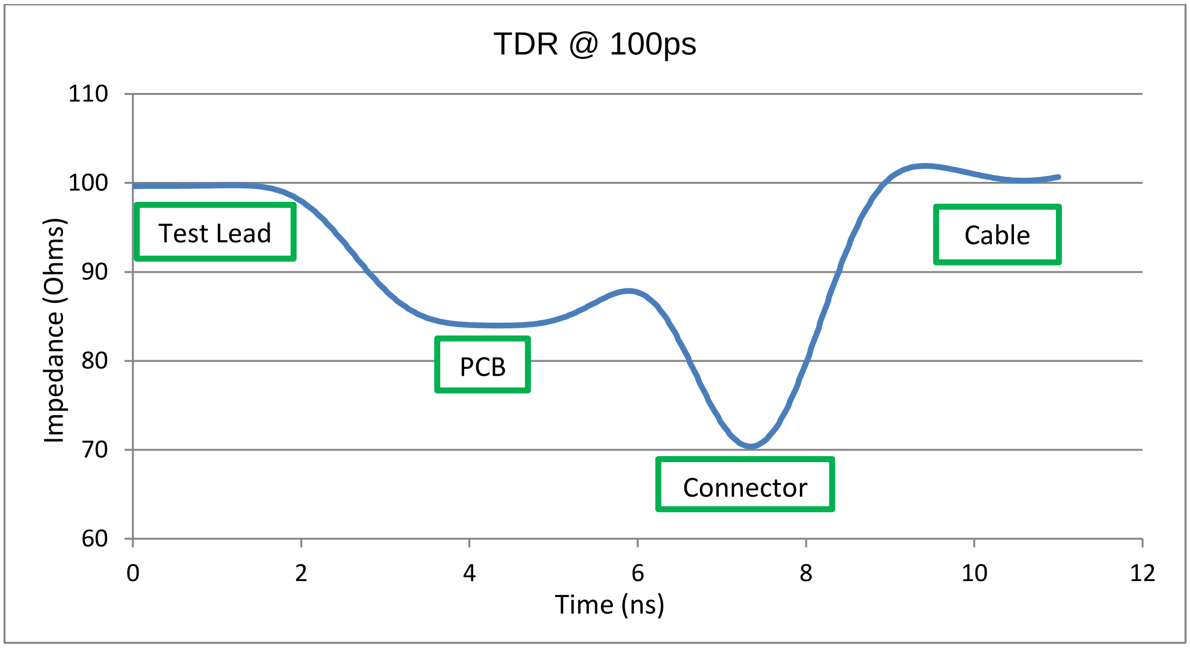
In the bandwidth of interest, the grounding configuration has no significant effect on the Insertion or Return Loss. The data is almost identical up to approximately 4 GHz, at which point the additional grounds in Configuration B appears to slightly enhance its performance.

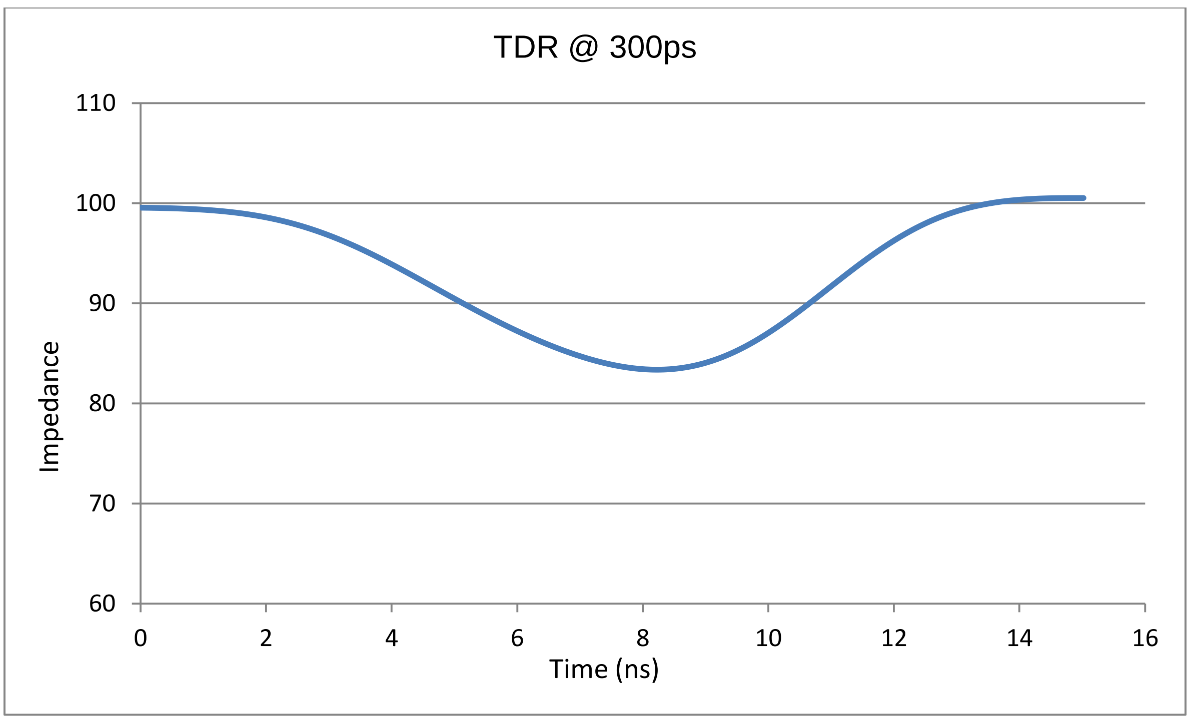
The additional layer of shielding in Configuration B does, however, greatly reduce the amount of crosstalk seen throughout the frequency band. Both Near End and Far End Crosstalk are reduced by 5 dB or more at the maximum gain level, and both show a similar shift down in crosstalk throughout the chart up to approximately 4 GHz.

7.0 Time Domain Analysis

For the Time Domain Reflectometry (TDR) measurements, the test fixture was filtered out in order to focus on a single mated pair of connectors. The components shown in the data below include a small portion of the Test Lead (2x 50 Ohm coaxial cables), the near end of the Test PCB, the Connector junction, and a small portion of the Low-loss Cable that was terminated to the plug connector. Each component is labeled in the 100ps rise time chart for reference.

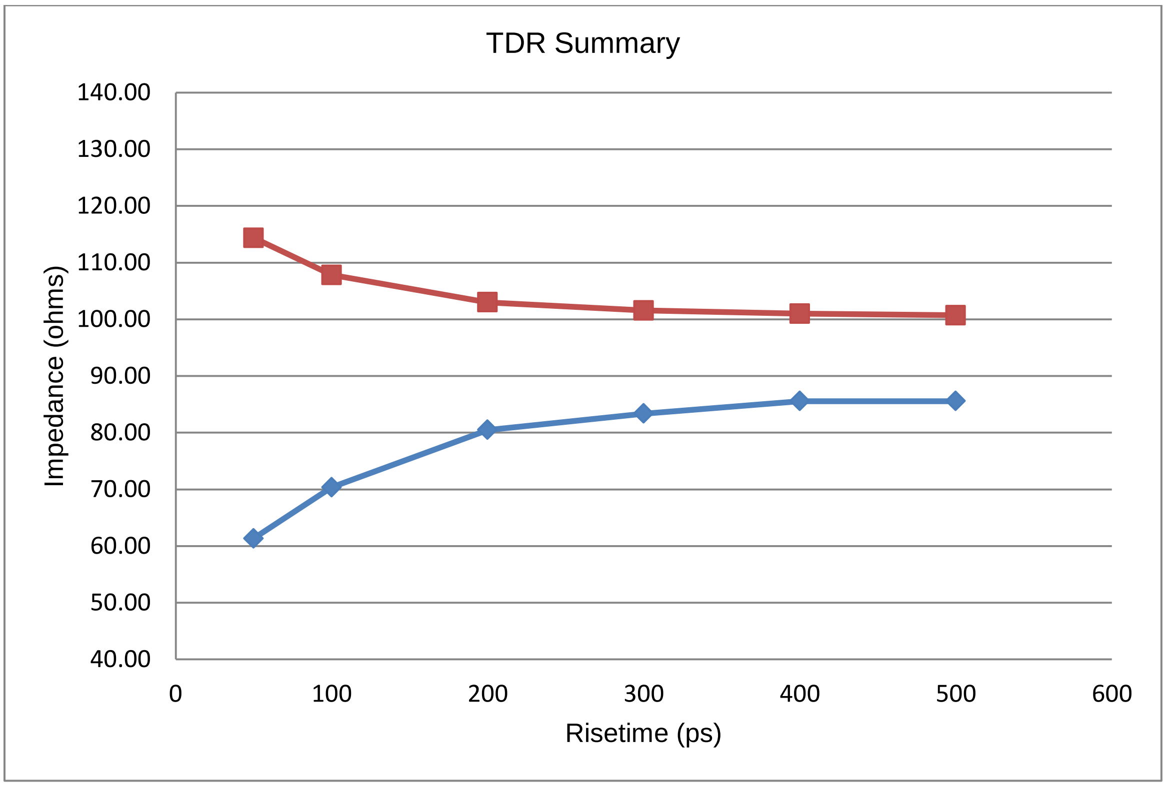
7.1 Time Domain Reflectometry (TDR)





7.2 Impedance Summary

The following charts summarize the impedance performance through the mated pair of connectors for input risetimes of 50ps (9.0GHz) to 500ps (900MHz) at 20-80% definition. The highest and lowest measured impedances through the connector junction have been tabulated and plotted in order to show a representation of how the connector system will perform throughout this frequency band.



8.0 Eye Diagrams

The following sample eye diagrams were generated using the Agilent 5071C ENA Network Analyzer. The patterns were simulated in the time domain based upon measurements taken in the frequency domain. The bitrates of two common high-speed applications, SATA and 10GBase-T Ethernet, were generated, and the mask of each respective protocol was superimposed onto the correlating diagram.

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1211 Air Way
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WWW.GLENAIR.COM
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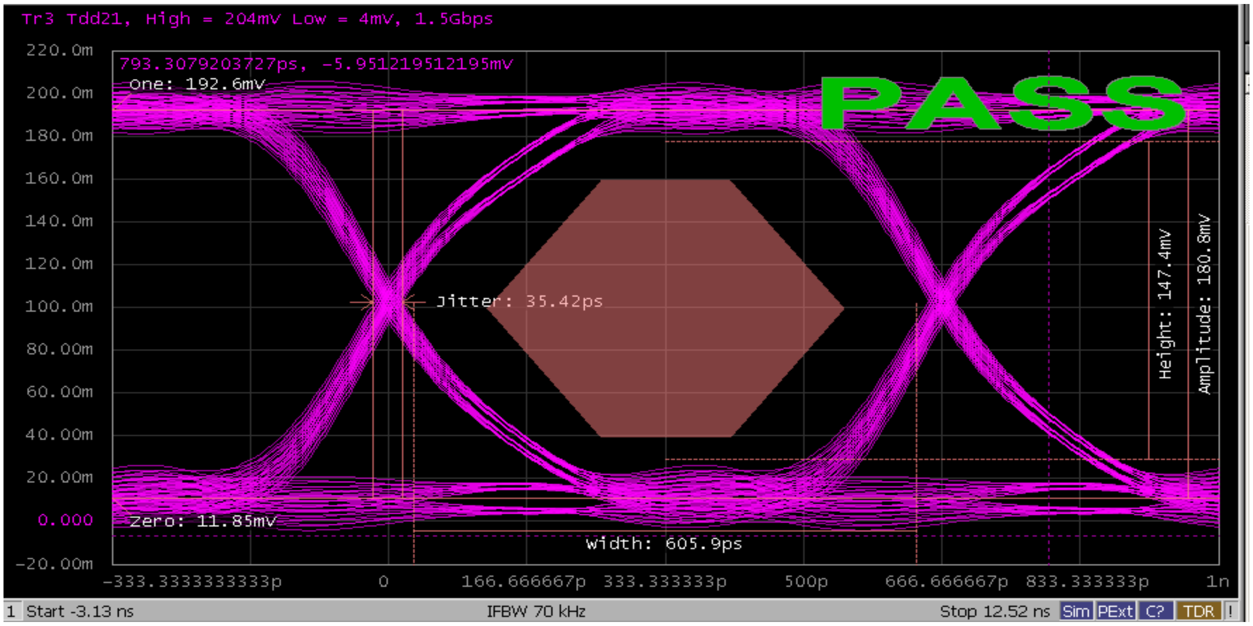
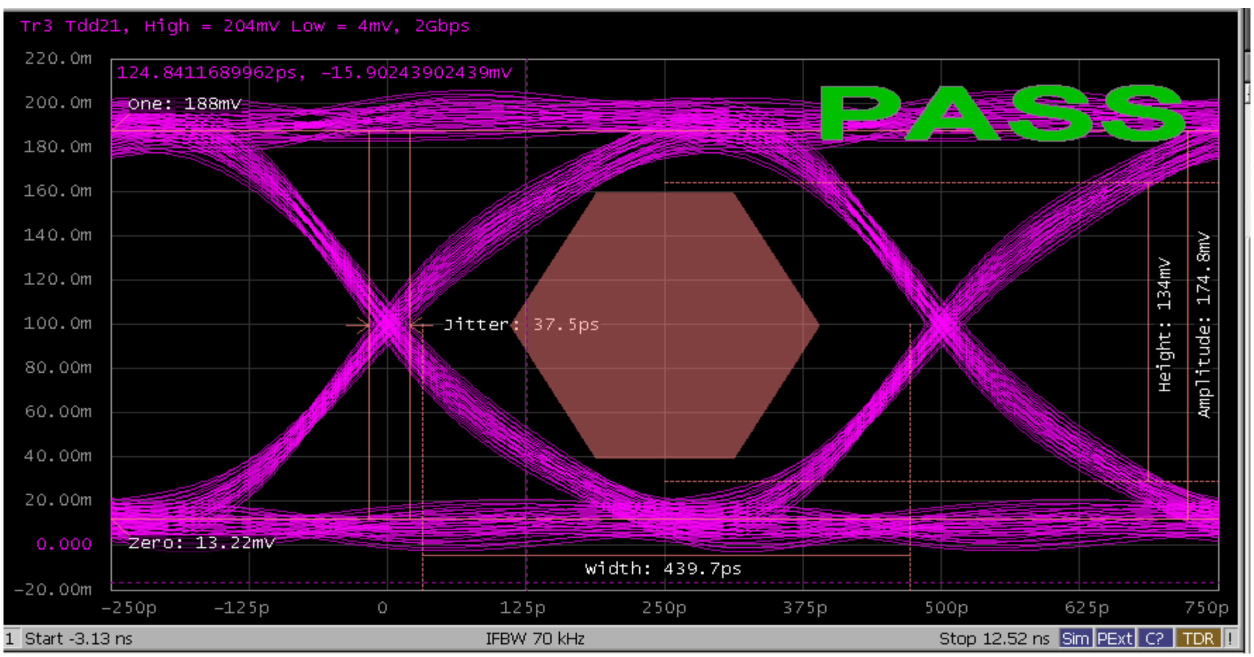
Fax: 818-500-9912

It should be noted that the subject 7-pin High-speed Mighty Mouse connector system has too few contacts to run a 10GBase-T Ethernet signal (which requires eight connections); the diagram is intended only to show the performance capabilities of the system.



Sample Eye Diagram with SATA I Mask



Sample Eye Diagram with 10GBase-T Ethernet Mask

Appendix A – Product and Test System Descriptions

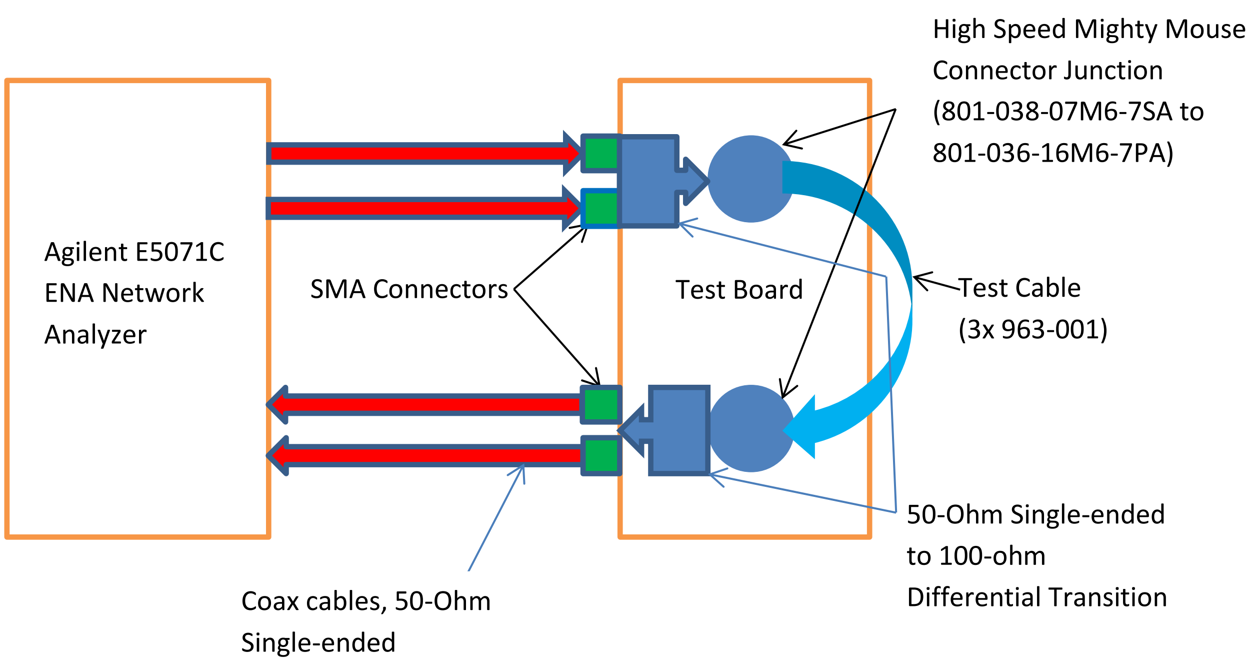
Product Description

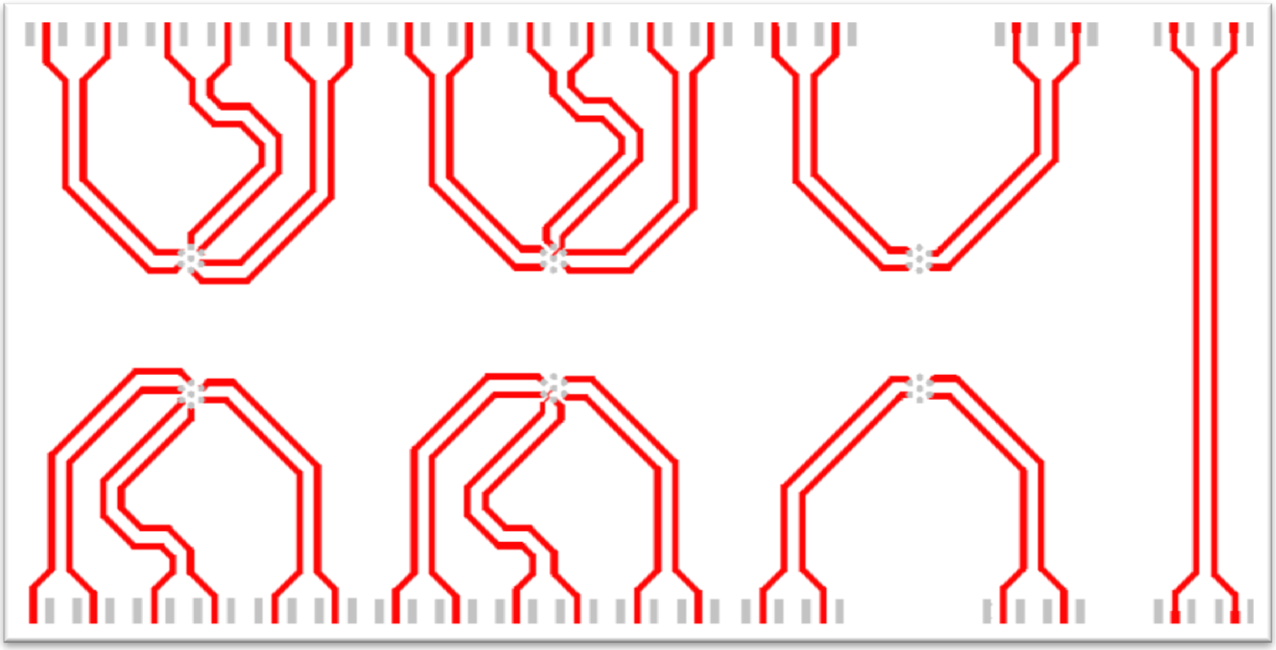
Product test samples are 801-series High Speed Mighty Mouse connectors. The part numbers are 801-036-13M6-7PA and 801-038-07M6-7SA. The 801-036 connector is a plug with crimp contacts, and the 801-038 connector is a receptacle with PC tail contacts. Both connectors utilize a PFA dielectric insert in order to enhance the high-frequency signal performance of the Series 80 Mighty Mouse interconnect system.

Test System Description

All tests were performed using the Agilent E5071C ENA network analyzer with option TDR. The test board was designed specifically for the electrical characterization of the High Speed Mighty Mouse interconnect system. Edge launch SMA connectors were used to interface the network analyzer test cables to the test board.

Insertion loss, return loss, and crosstalk responses have ENA smoothing filter applied. Device under test includes two mated connector pairs with 12" of low-loss cable. Insertion loss shows response of a single mated pair.





Test Board Trace Layout

High-performance Edge Launch SMA Connectors

Appendix B – Frequency and Time Domain Measurements

Frequency (S-Parameter) Domain Procedures

The quality of any data taken with a network analyzer is highly dependent on the use of proper practices, procedures, and test fixtures. For this reason, extreme care is taken in the design of the test boards and the set-up of the test equipment.

The test process begins by connecting the test board to the network analyzer. The included Test Setup software is used to de-skew the launch cables and test fixtures, and to select the parameters of the test.

Time Domain Procedures

Frequency Domain data can be transformed mathematically to obtain a Time Domain response. Perfect transformation requires Frequency Domain data from DC to infinity Hz. Fortunately, bandwidth-limited data, such as that measured with a network analyzer, can be used to obtain a very accurate Time Domain response.

The Time Domain responses were generated using the Agilent ENA Option TDR upgrade. This tool measures the characteristics of a device as a function of frequency. The Frequency Domain data is then used to calculate the inverse Fourier transform in order to generate a simulated Time Domain model. A virtual bit pattern can be applied to this model to generate accurate Time Domain response measurements.

Glossary of Terms

DUT – Device Under Test
FD – Frequency Domain
FEXT – Far-end Crosstalk
NEXT – Near-end Crosstalk
PCB – Printed Circuit Board
SE – Single-ended transmission
SI – Signal Integrity
SUT – System Under Test
TD – Time Domain
TDA – Time Domain Analysis
TDR – Time Domain Reflectometry
TDT – Time Domain Transmission
Z – Impedance (expressed in Ohms)

Glenair, Inc.
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