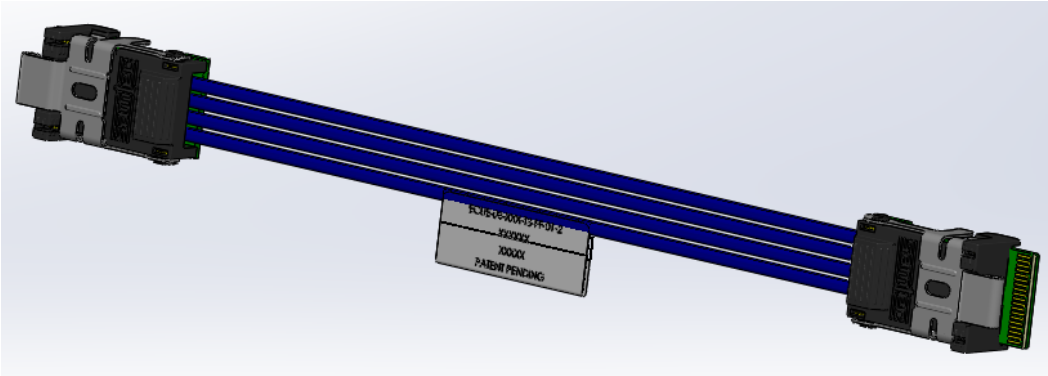
ECUE-08-XXX-T3-FF-02-2



Mated with:

UEC5-019-2-X-D-RA-2

Description

FireFly™ Low Profile Micro Flyover Cable Assembly, 100 Ω, 34 AWG Solid, Cu Micro Twinax Cable, A1 to B1 Wiring Option

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Report Revision: 12/12/2018

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

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Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Cable Assembly Overview

Samtec's FireFly™ Micro Flyover System is a complete interconnect system that uses either micro footprint optical or copper interconnects. The FireFly™ system enables chip-to-chip, board-to-board, and system-to-system connectivity at rates up to 28+ Gbps. FireFly™ is based on a high-performance interconnect system which allows the utilization of low-cost copper cables or high performance active optical engines. Firefly uses a 2-stage connector system. The UEC5-2 carries the high-speed digital signals while the UCC8 carries the DC/low frequency status line. The performance of the ECUE-2 to UCC8 is not considered in this report. The UCC8 is intended for low-speed signals and power only.

The test sample consists of two micro coaxial ribbon cables that contain 4 lines each. At each end of the cable there is a connector that is terminated to a small transition PCB. Each connector is soldered to its respective PCB. The connector terminals are on 0.5 mm centers. The cable assembly is wired to facilitate a Pin A1 to Pin B1 mapping between the cable terminations.

The ECUE-2 cable assemblies were tested by mating to UEC5-2 at both ends. One samples of each length assembly were tested. The actual part numbers that were tested are shown in Table 1, which also identifies End 1 and End 2 of each assembly. A relative sample picture is shown in Figure1. Four pairs of each assembly type were tested. The four paths are identified as J1_ A5,A6 to J2_B5,B6, J1_ A14,A15 to J2_B14,B15, J1_ B5,B6 to J2_A5,A6 and the J1_ B14,B15 to J2_A14,A15, respectively.

Length	Part Number	End 1	End 2
0.25 m	ECUE-08-025-T3-FF-02-2	J1, UEC5-2	J2, UEC5-2
0.5 m	ECUE-08-050-T3-FF-02-2	J1, UEC5-2	J2, UEC5-2
1 m	ECUE-08-100-T3-FF-02-2	J1, UEC5-2	J2, UEC5-2

Table 1: Sample Description

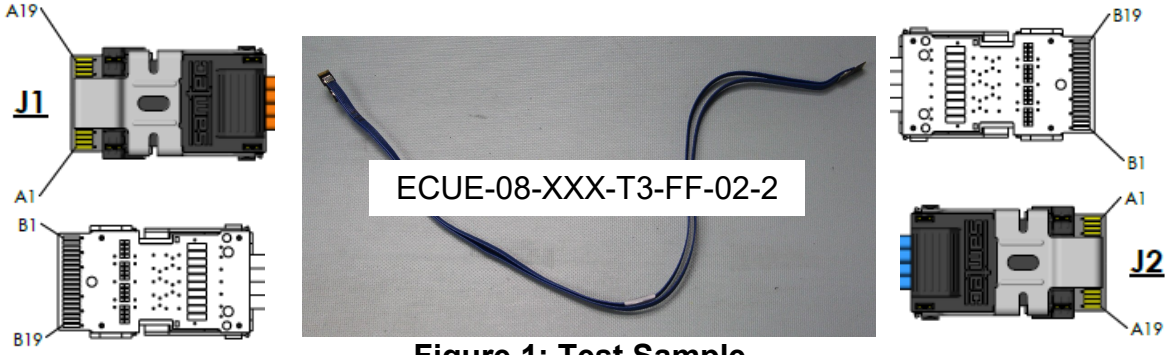


Figure 1: Test Sample

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Frequency Domain Data Summary

Bandwidth Chart – Differential Insertion Loss

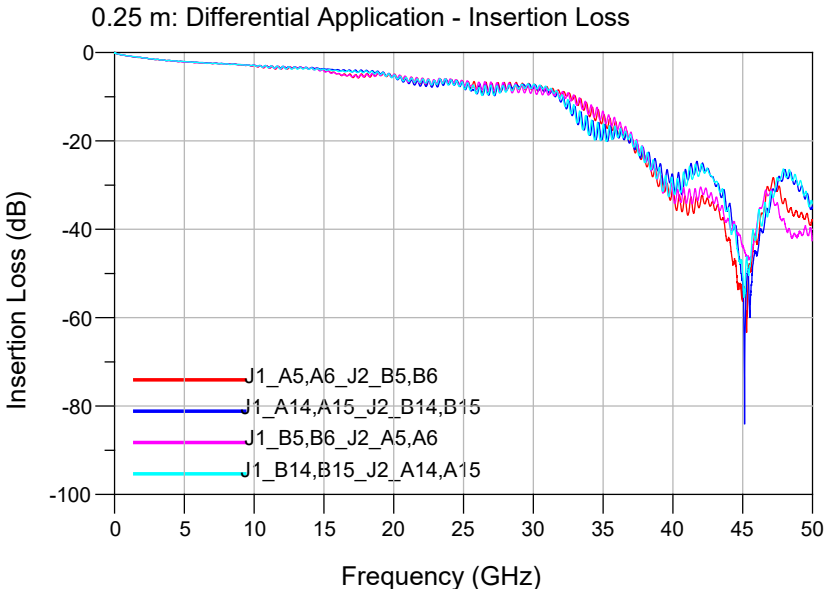


Figure 2

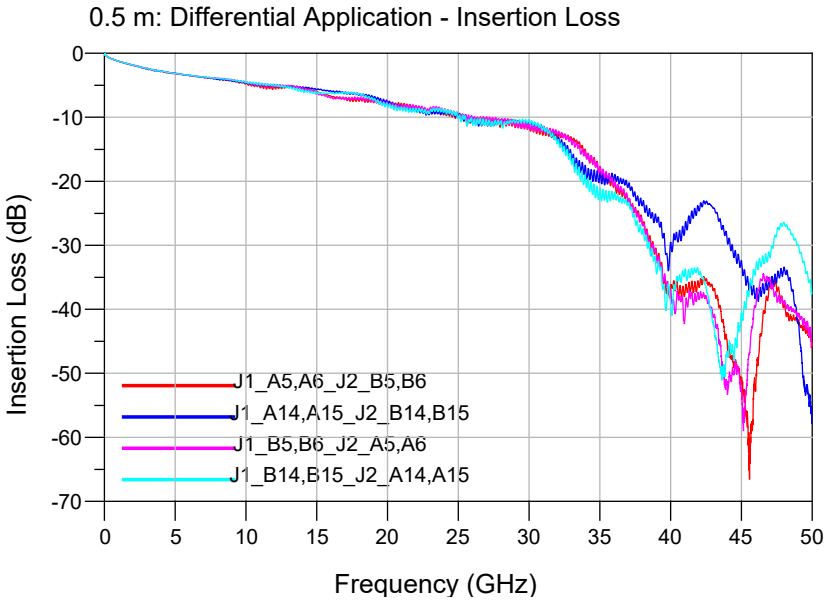


Figure 3

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

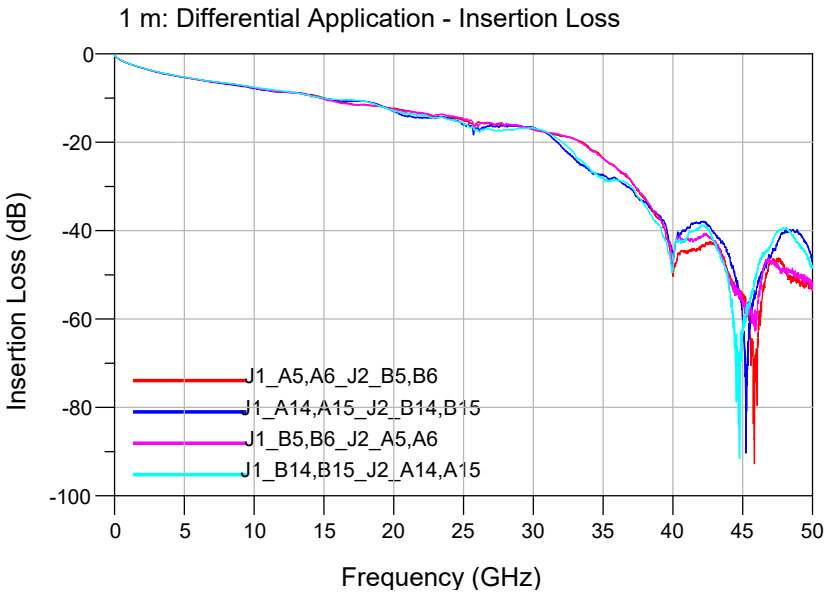


Figure 4

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Time Domain Data Summary

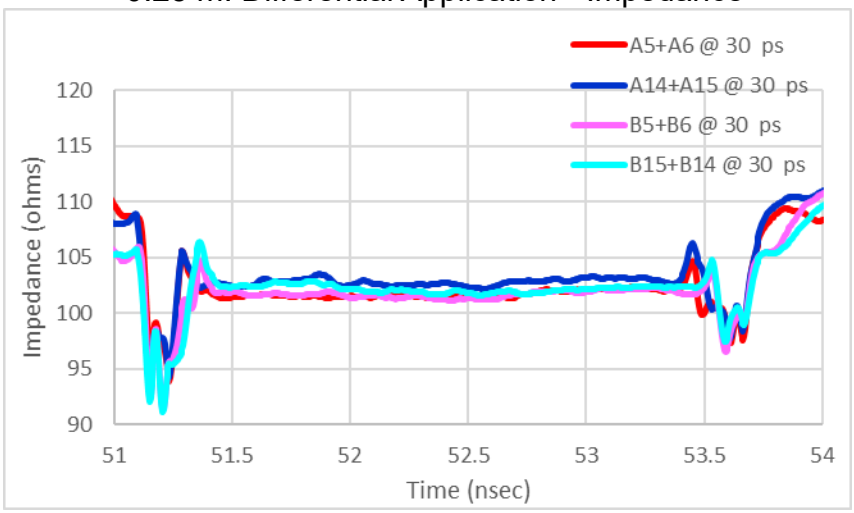


Figure 5

Because the same type of cable is used in the cable assemblies with different lengths, only the impedance profile of 0.25 m cable assembly is reported.

Table 2 - Propagation Delay (Cable Assembly)

Driver	Receiver	0.25 m	0.5 m	1 m
J1_A5,A6	J2_B5,B6	1.296 ns	2.491 ns	4.873 ns
J1_A14,A15	J2_B14,B15	1.292 ns	2.489 ns	4.872 ns
J1_B5,B6	J2_A5,A6	1.297 ns	2.490 ns	4.873 ns
J1_B14,B15	J2_A14,A15	1.295 ns	2.490 ns	4.871 ns

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

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 mating connectors, cable assembly, 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 and adapters. Where appropriate, calibration and de-embedding routines are also used to reduce residual effects.

Differential and Single-Ended Data

Most Samtec cable assemblies 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 "GSSG" differential drive configuration only.

Cable assembly Signal to Ground Ratio

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

See Appendix C - Product and Test System Descriptions for details

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

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

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 the interconnect can vary significantly depending on the edge rate or the rise time of the exciting signal. For this report, the fastest rise time used was 30 ps. Generally, this should demonstrate the worst-case performance.

In many systems, the signal edge rate will be significantly slower at the cable assembly than at the driver launch point. To estimate interconnect performance at other edge rates, data is provided for several rise times between 30ps and 100ps.

Unless otherwise stated, measured rise times were at 20%-80% signal levels.

Frequency Domain Data

Frequency Domain parameters are helpful in evaluating the cable assembly 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, Near-End and Far-End Crosstalk, and Mode Conversion. 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 network analyzer measurements.

Time Domain Data

Time Domain parameters indicate Impedance mismatch versus length and signal propagation time in a pulsed signal environment.

Impedance mismatch versus length is measured by DSA8300 Digital Serial Analyzer. Board related effects, such as pad-to-ground capacitance and trace loss, are included in the data presented in this report. The impedance data is provided in Appendix B of this report.

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

The measured S-Parameters from the network analyzer are post-processed using Keysight ADS to obtain the time domain response for signal propagation time. The Time Domain procedure is provided in Appendix D 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.

In this report, propagation delay is defined as the signal propagation time through the cable assembly, mating connectors, and connector footprint. It also includes 10 mils of PCB trace on each connector side. Delay is measured at 100 picoseconds signal rise-time. Delay is calculated as the difference in time measured between the 50% amplitude levels of the input and output pulses.

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

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

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Appendix A – Frequency Domain Response Graphs

Differential Application – Insertion Loss

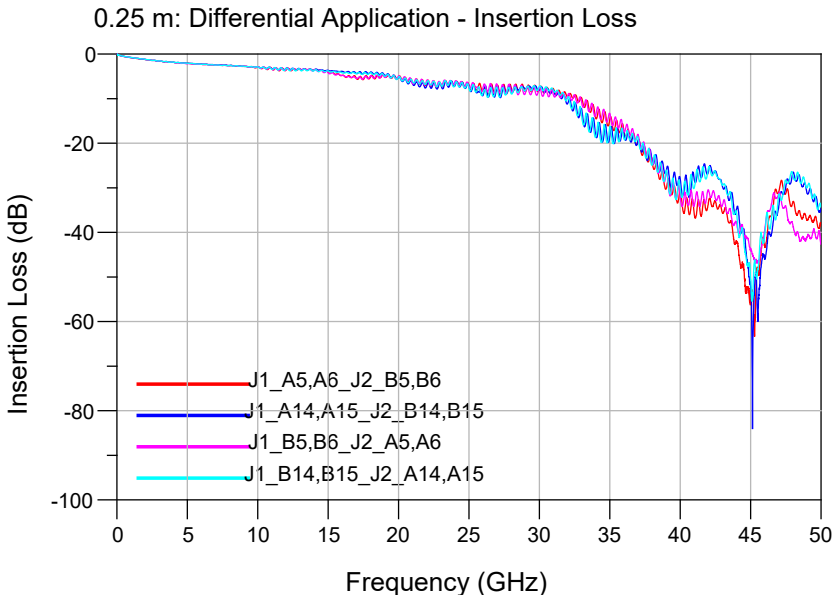


Figure 6

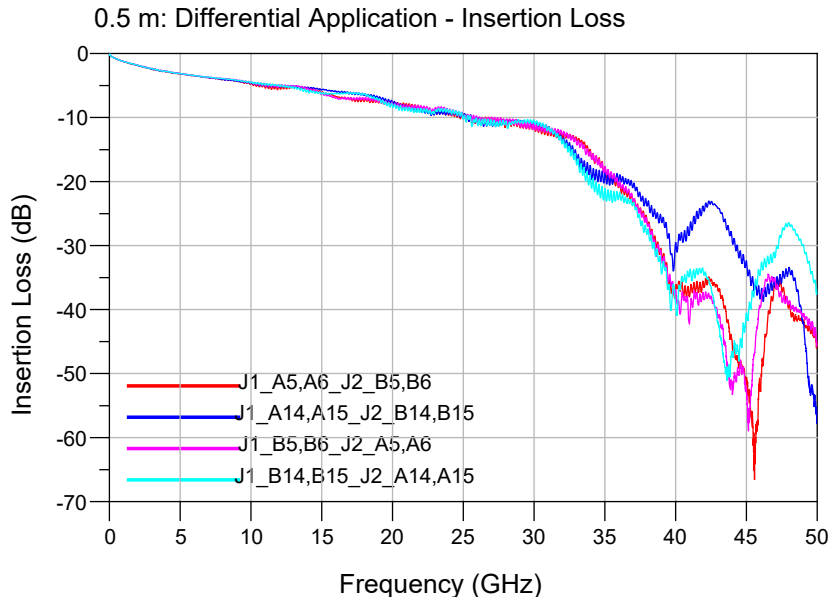


Figure 7

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

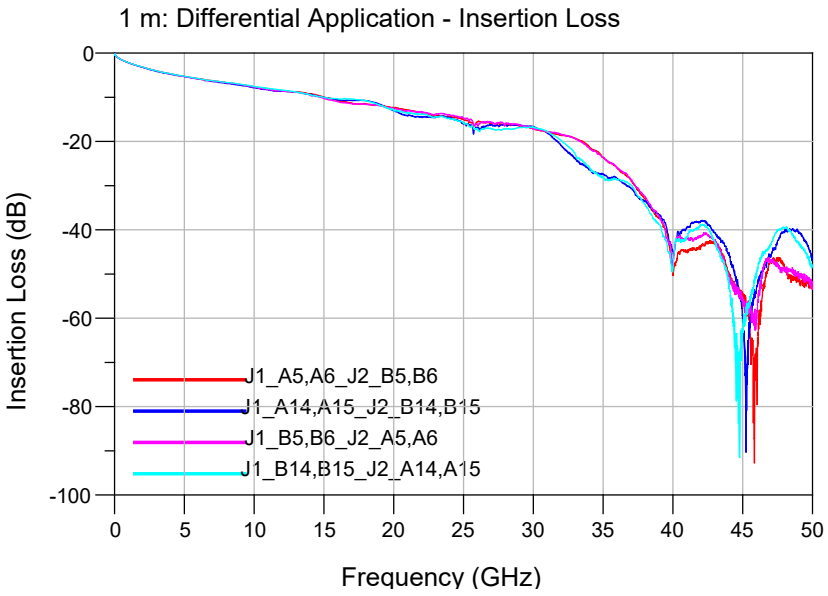


Figure 8

Differential Application – Return Loss

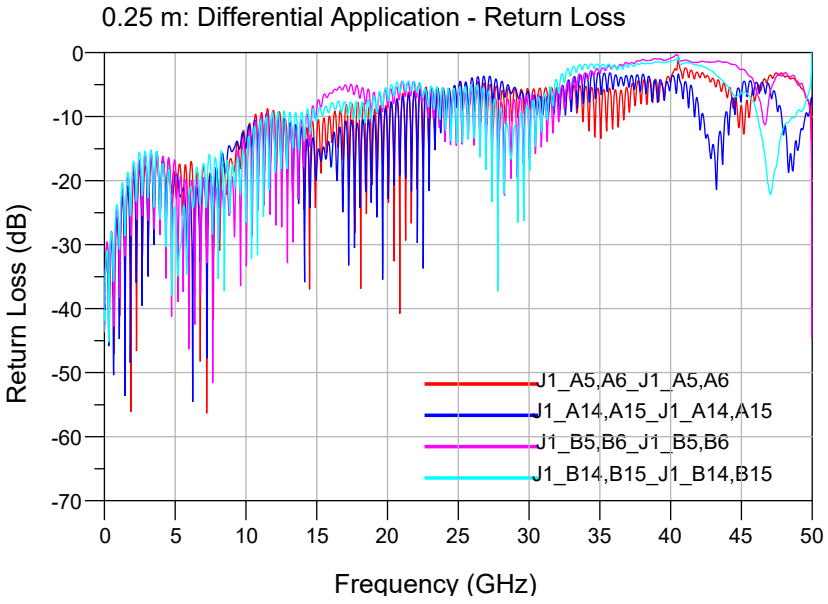


Figure 9

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

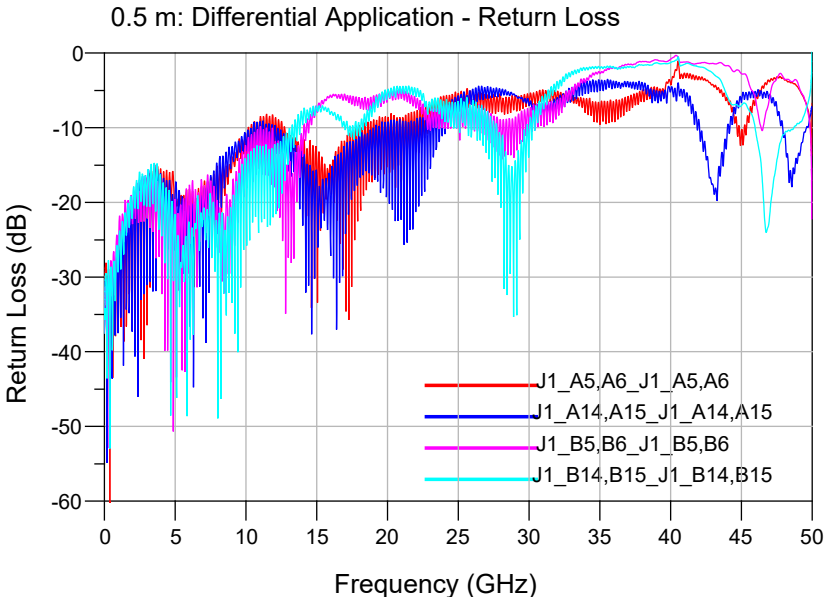


Figure 10

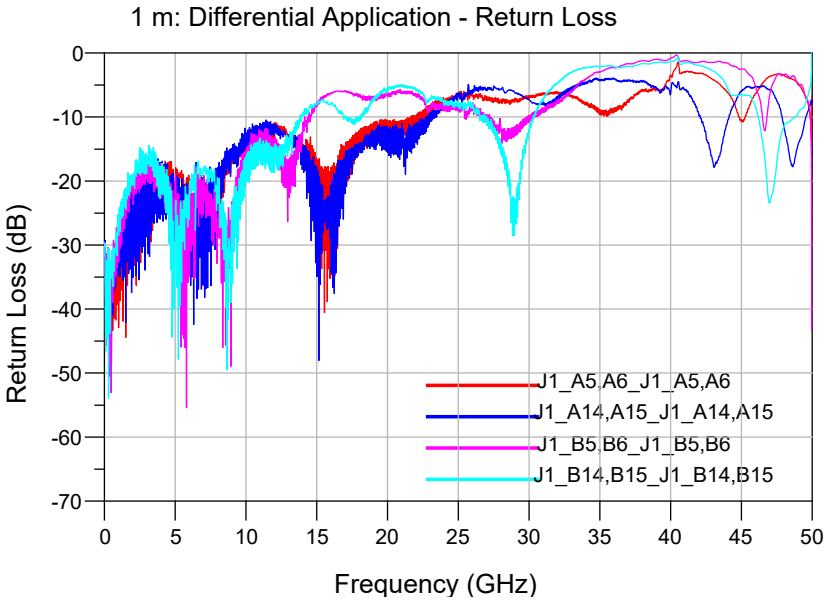


Figure 11

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Differential Application – NEXT Configurations

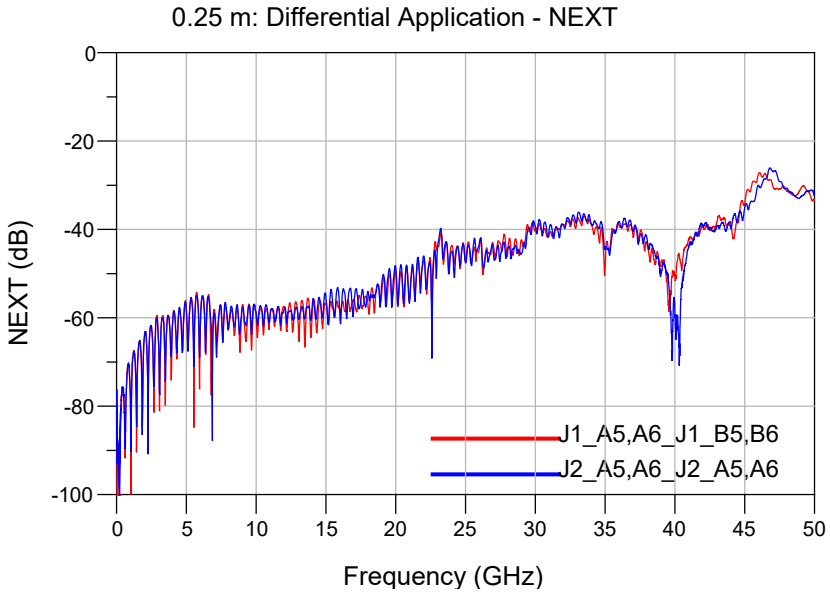


Figure 12

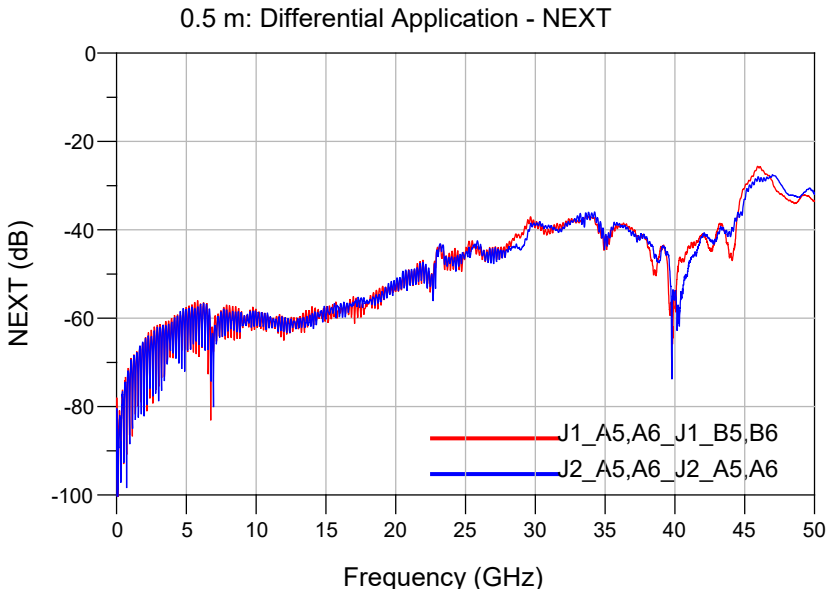


Figure 13

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

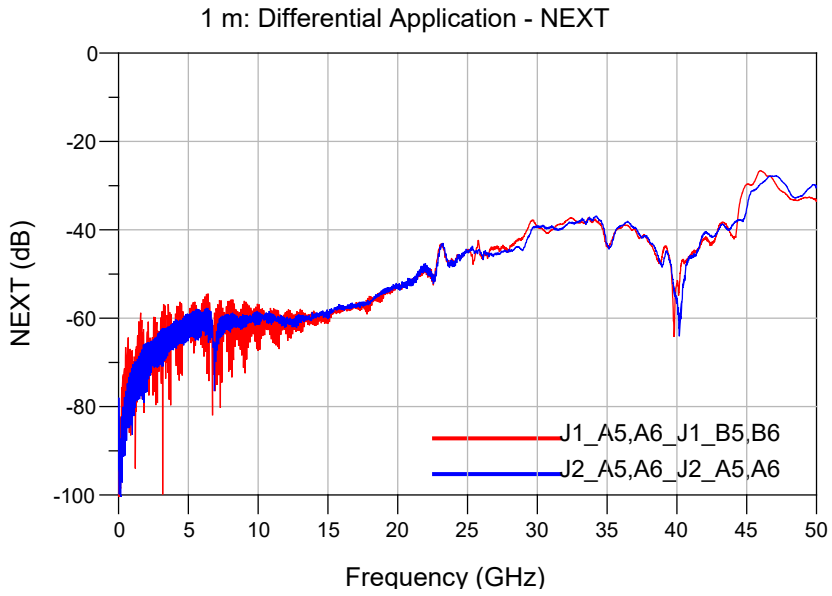


Figure 14

Differential Application – FEXT Configurations

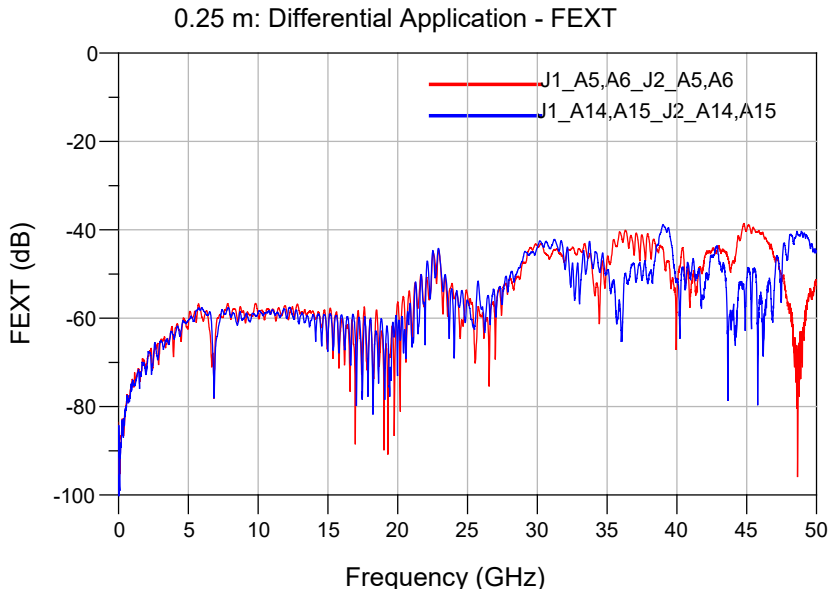


Figure 15

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

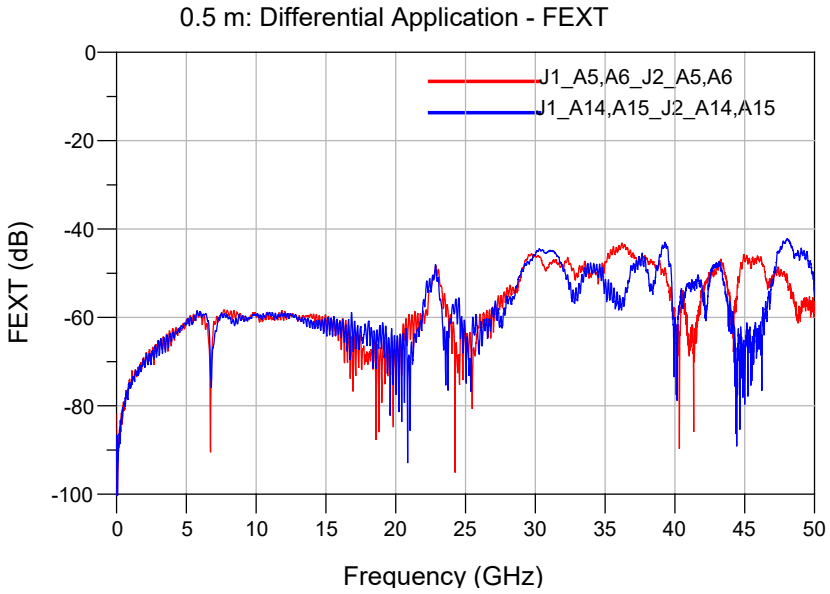


Figure 16

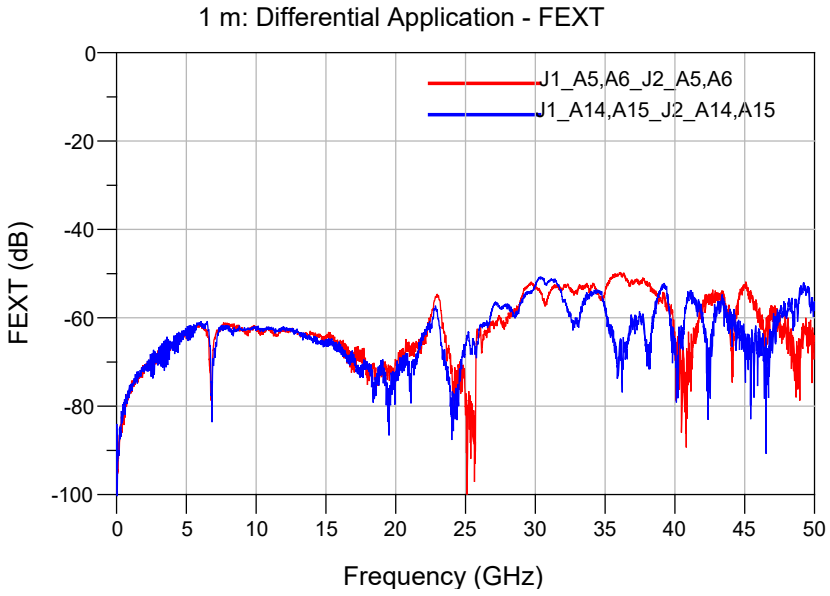


Figure 17

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Differential Application – Differential to Common Mode Conversion

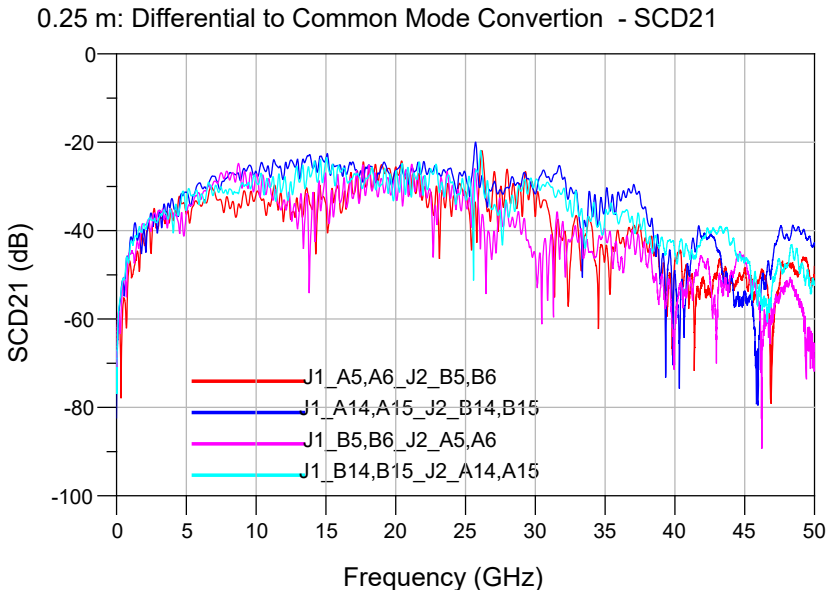


Figure 18

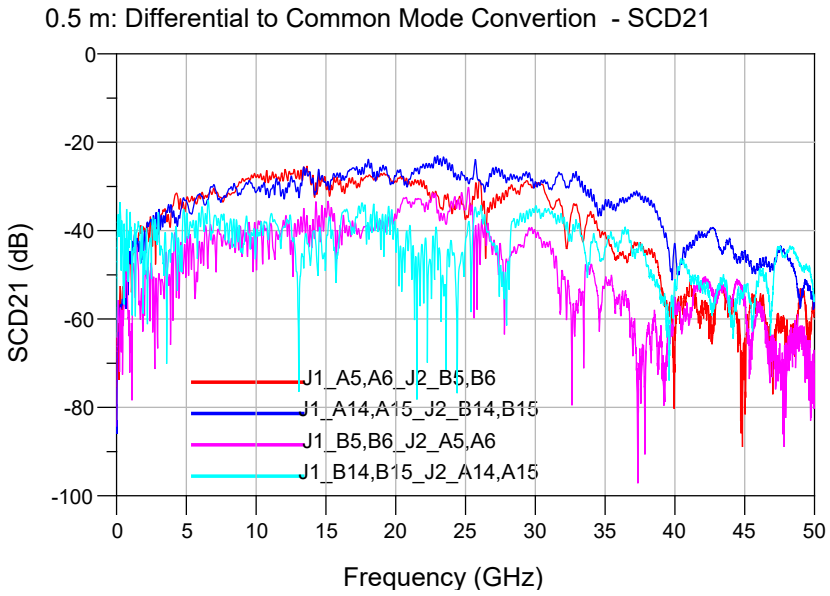


Figure 19

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

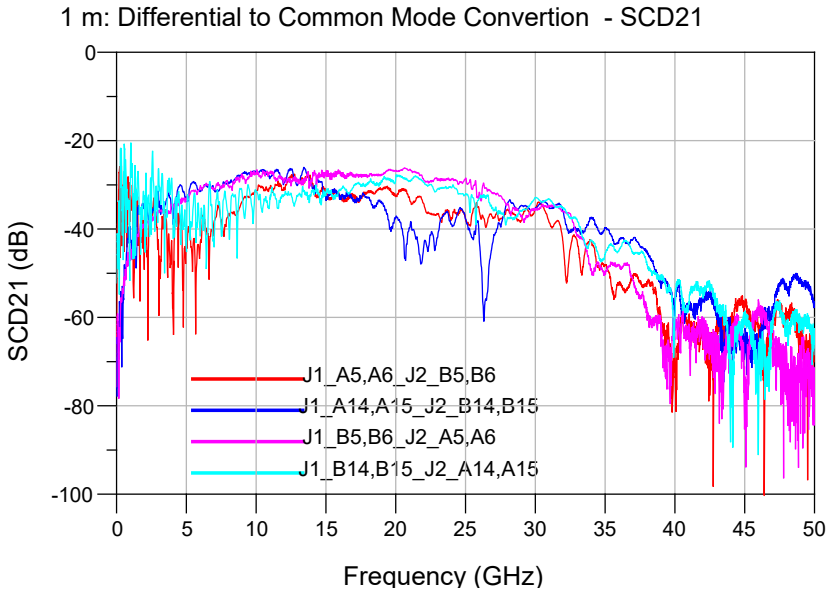


Figure 20

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Appendix B – Time Domain Response Graphs

Differential Application – Input Pulse

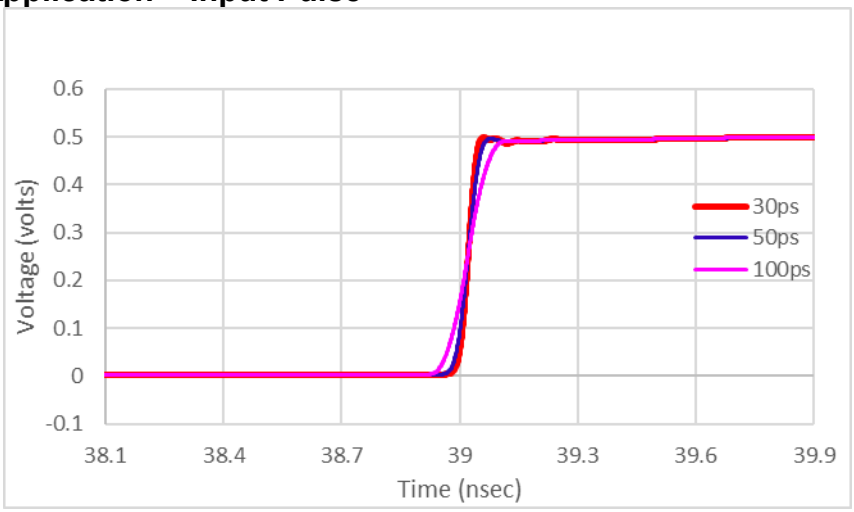


Figure 21

Differential Application – Cable Assembly Impedance

ECUE-08-025-T3-FF-02-2

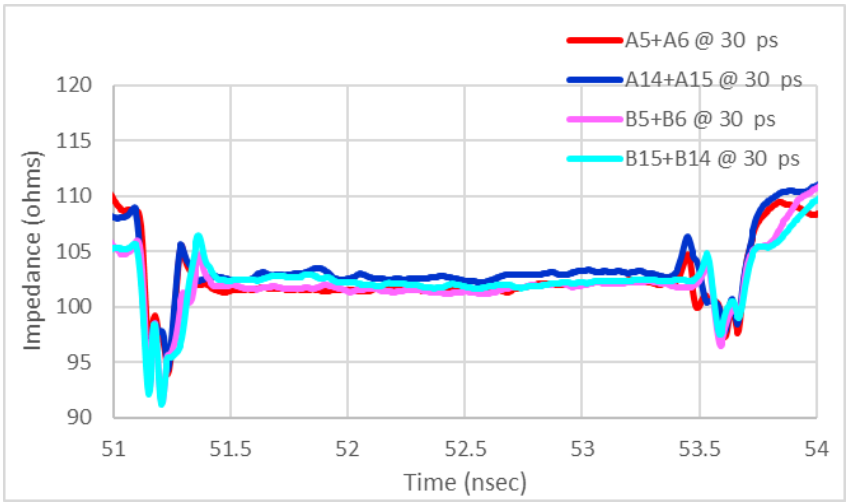


Figure 22

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

ECUE-08-025-T3-FF-02-2

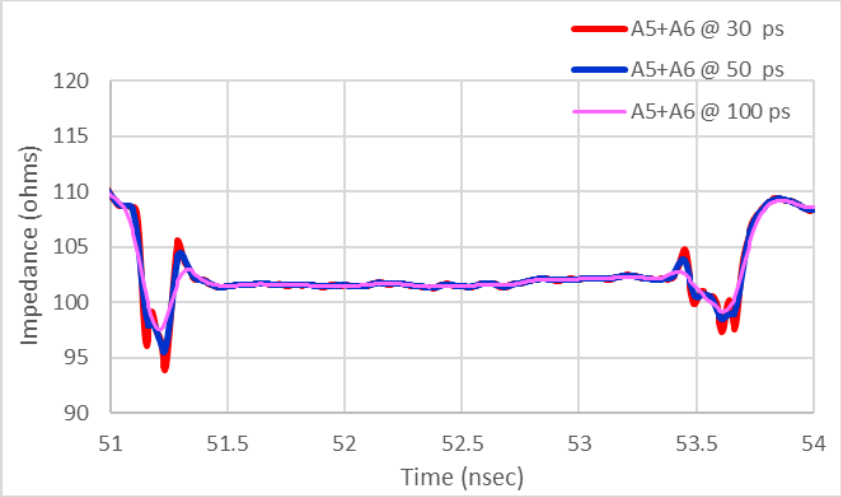


Figure 23

ECUE-08-025-T3-FF-02-2

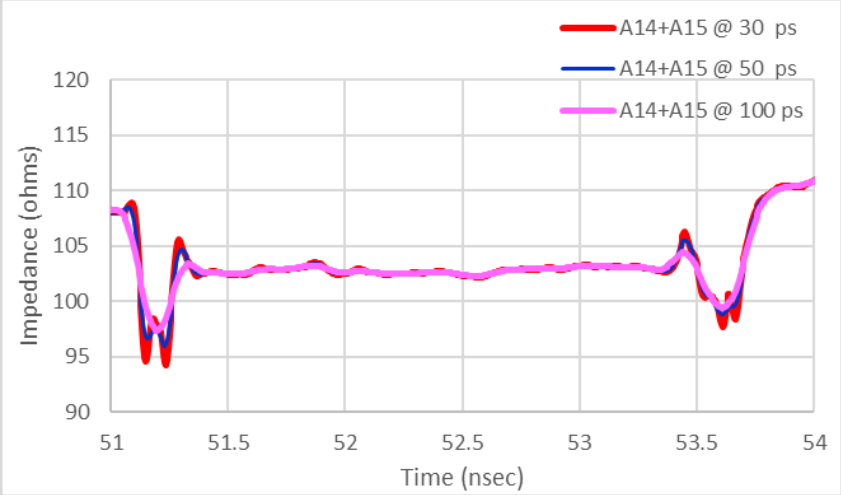


Figure 24

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

ECUE-08-025-T3-FF-02-2

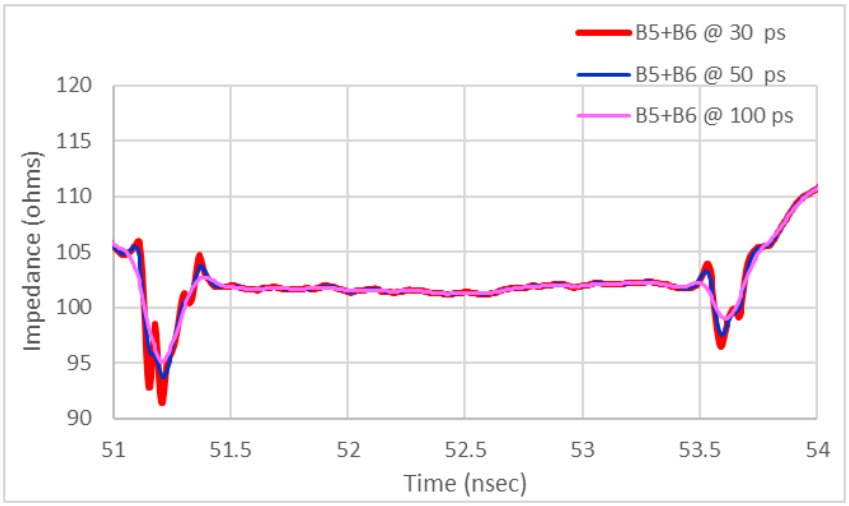


Figure 25

ECUE-08-025-T3-FF-02-2

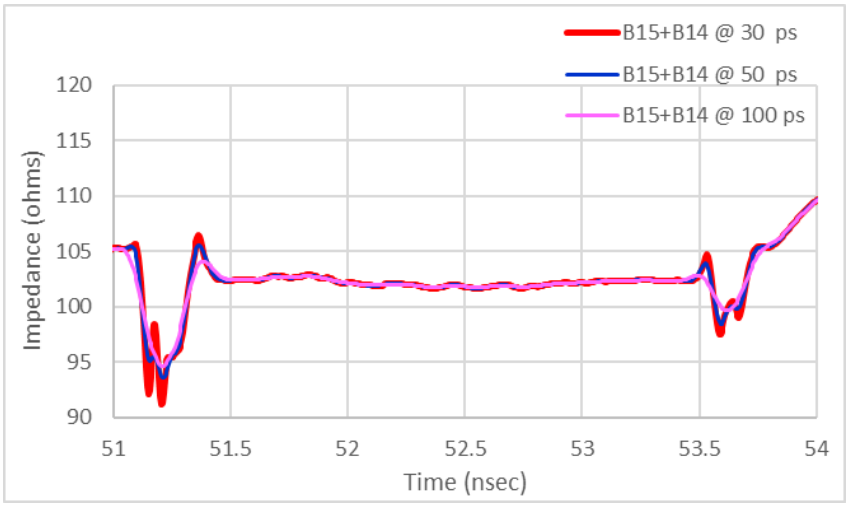


Figure 26

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Differential Application – Propagation Delay

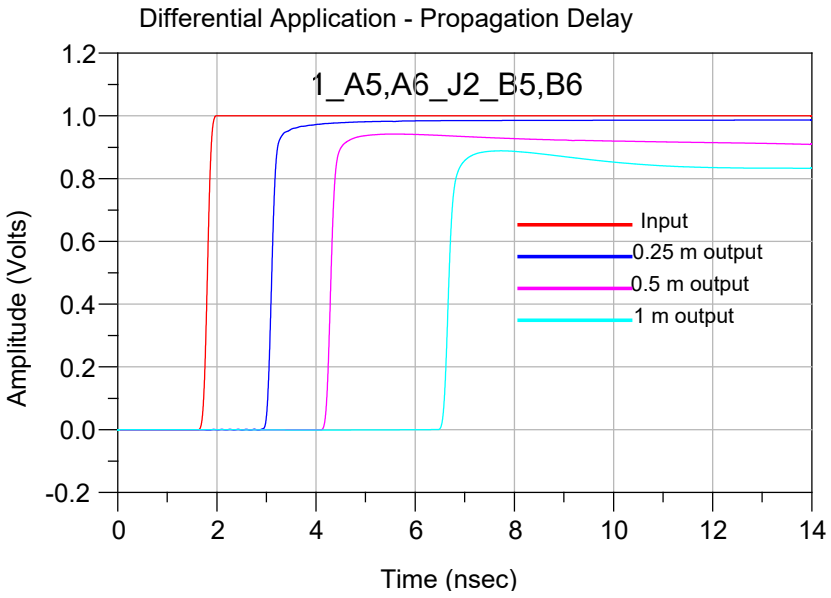


Figure 27

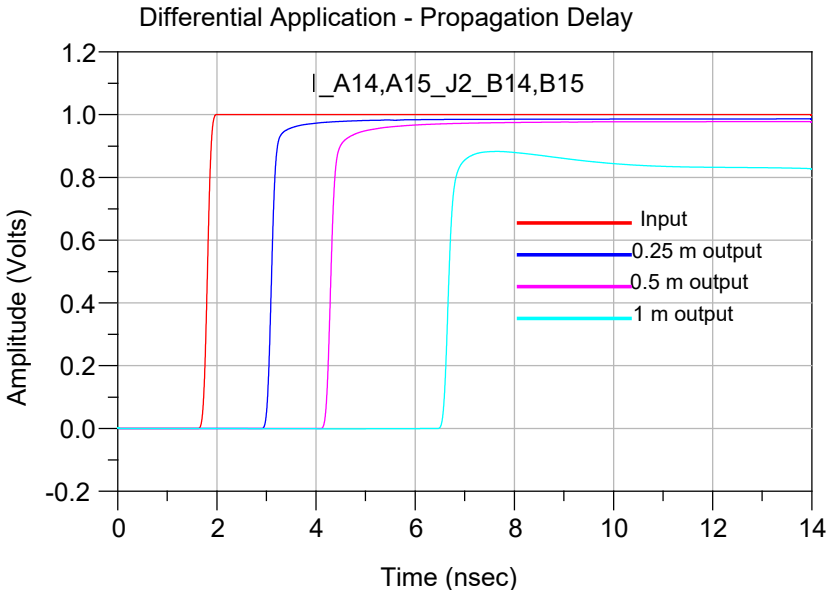


Figure 28

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

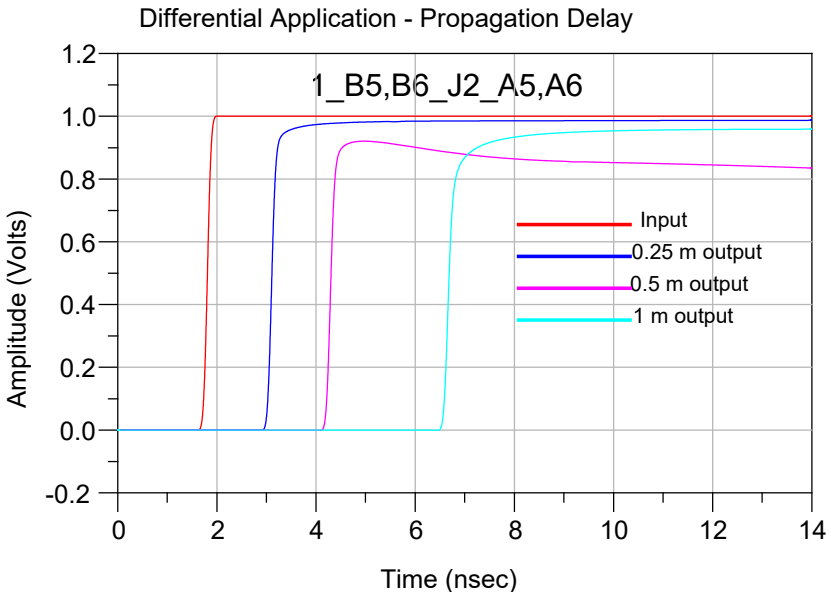


Figure 29

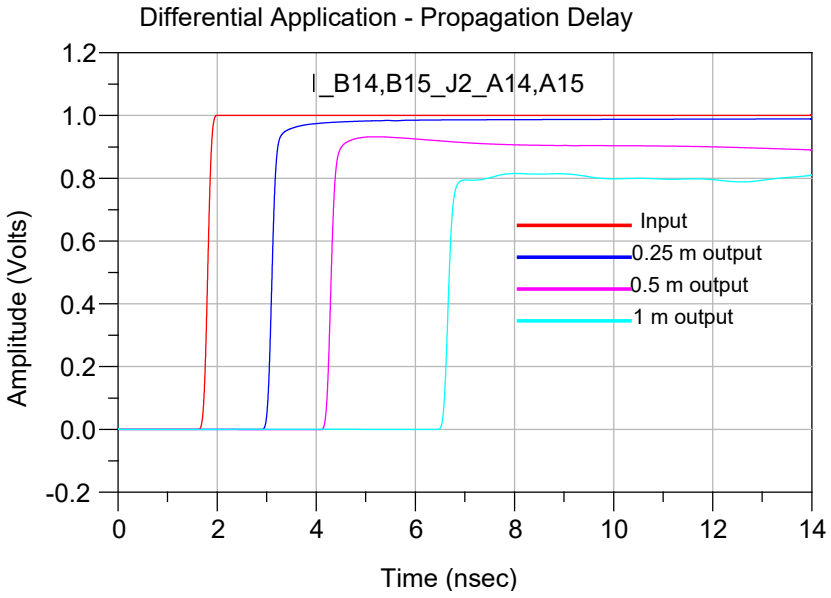


Figure 30

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Appendix C – Product and Test System Descriptions

Product Description

Product test samples are FireFly™ Low Profile Micro Flyover Cable Assemblies. The part numbers are ECUE-08-025-T3-FF-02-2, ECUE-08-050-T3-FF-02-2 and ECUE-08-100-T3-FF-02-2. They mate with UEC5-019-2-X-D-RA-2. A photo of the mated test article mounted to SI test boards is shown below.

The cable assembly terminations had a particular signal line configuration. The respective signal line numbers are shown in Table 3 below. There are total of 8 pairs.

J1	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19
NAME	G	S	S	G	S	S	G	NC	NC	NC	NC	NC	G	S	S	G	S	S	G	G	S	S	G	S	S	G	NC	NC	NC	NC	NC	G	S	S	G	S	S	G
J2	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19

Table 3: Respective signal line numbers

Test System Description

The test fixtures are composed of six-layer FR-4 material with 100 Ω differential trace and pad configurations designed for the electrical characterization of Samtec high speed cable assembly products. A PCB mount 2.4 mm connector is used to interface the VNA test cables to the test fixtures. Optimization of the 2.4 mm connector launch was performed using full wave simulation tools to minimize reflections. Two test fixtures are specific to ECUE series cable assembly and identified by part number PCB-107671-SIG-01. The 2X THRU (Through) designed specifically for the ECUE series is located on PCB-107671-SIG-99. Displayed on the following pages is the information for the ECUE and 2X THRU and directives for the mating ECUE fixtures.

PCB-107671-SIG Test Fixtures

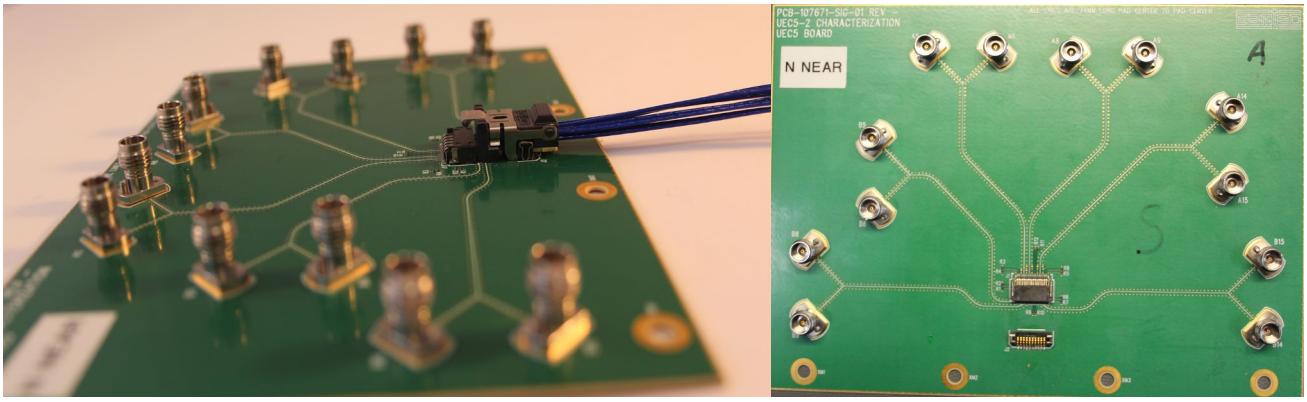


Figure 31

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Artwork of the PCB design is shown below.

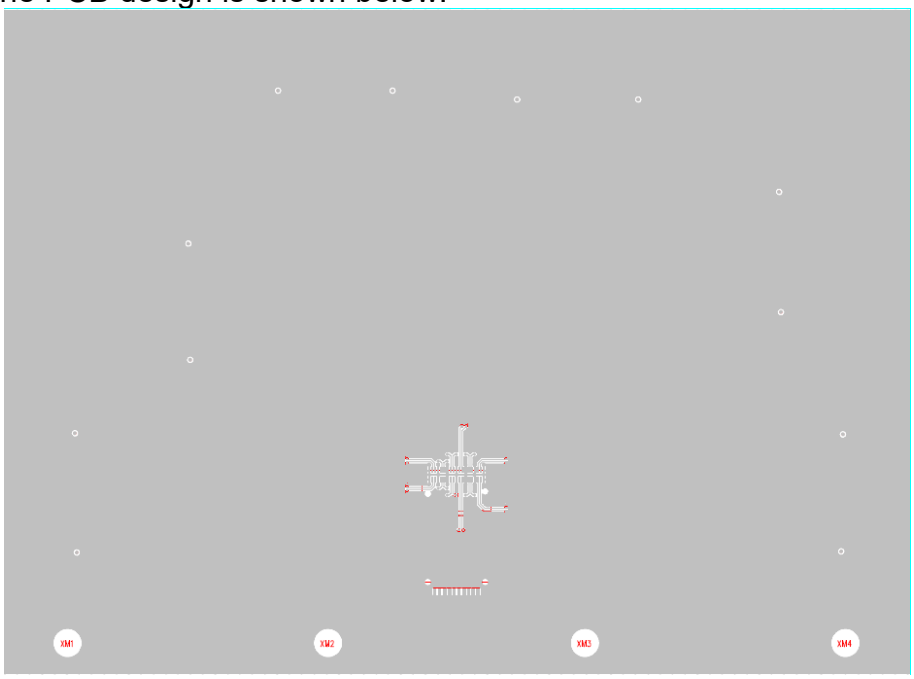


Figure 32

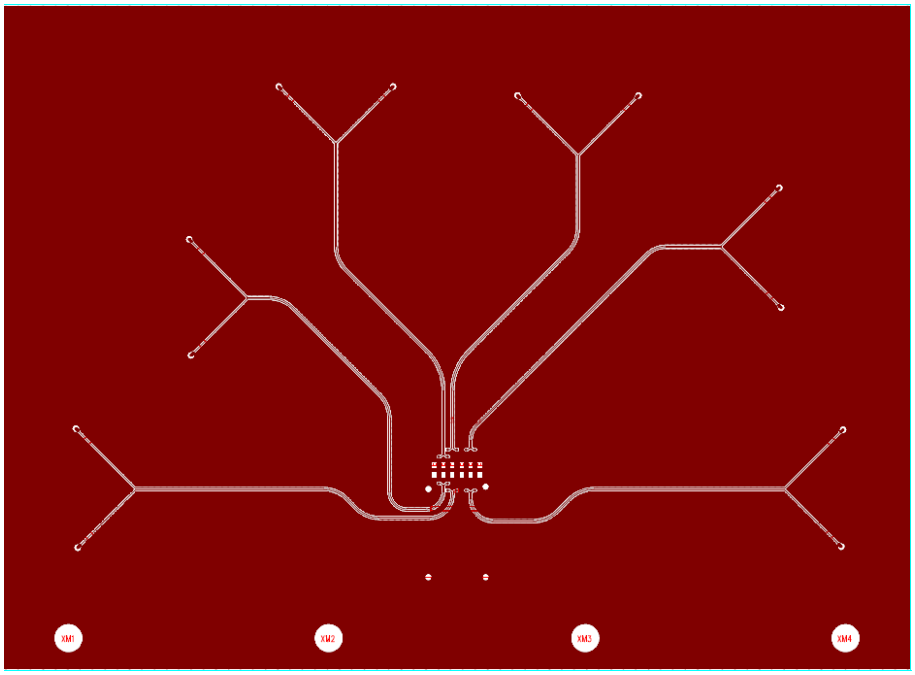


Figure 33

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

PCB Fixtures

The test fixtures used are as follows:

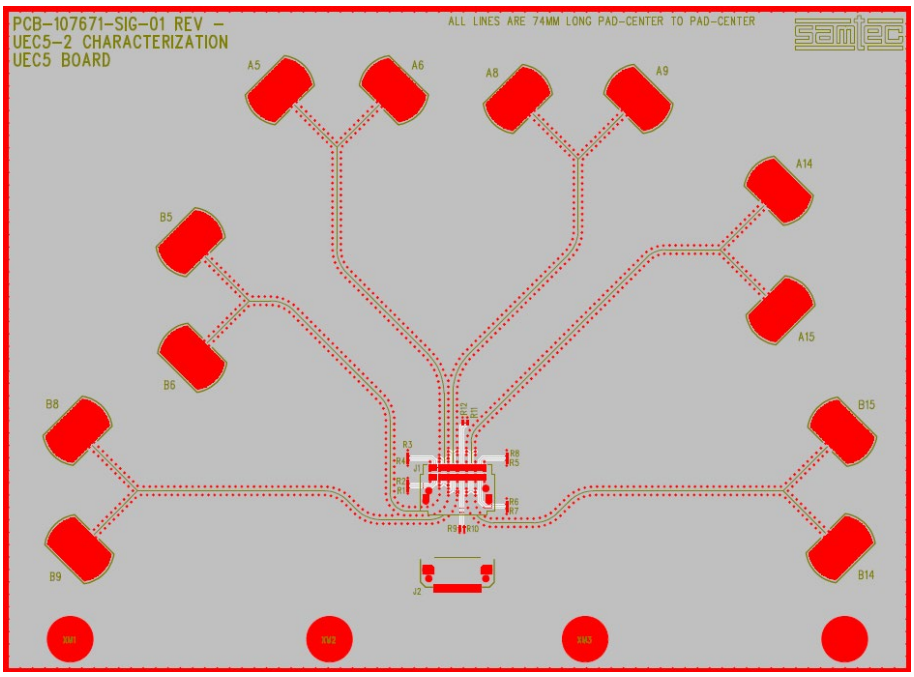


Figure 34

2X THRU Board

Test fixture losses and test point reflections were removed from the data by use of the Vector Peeling (VP). The VP is compatible with Keysight AFR (Automatic Fixture Removal). The 2X THRU board is shown below. The 142.02 mm length of 2X THRU was used for the de-embedding.

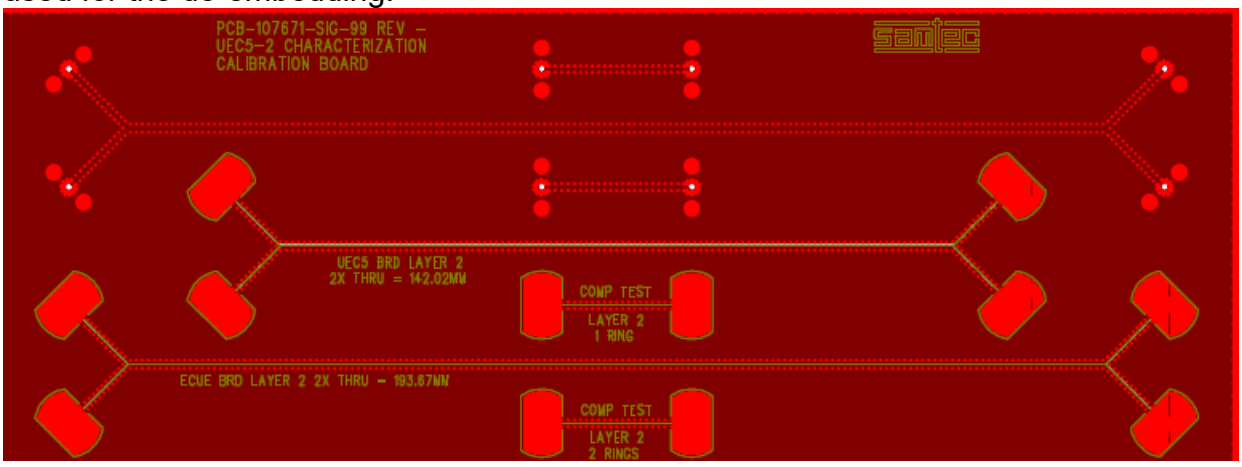


Figure 35

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Appendix D – Test and Measurement Setup

For frequency domain measurements, the test instrument is the Keysight N5227A PNA-L network analyzer. Frequency domain data is extracted from the instrument the VP. Post-processed time domain data and figures are generated using convolution algorithms within Keysight ADS (Advanced Design System). The network analyzer is configured as follows:

Start Frequency - 10 MHz	Stop Frequency - 50 GHz
Number of points - 5000	IFBW - 200 Hz
Averages - 2	Step Delay - 2 us

With these settings, the measurement time is approximately 30 seconds.

N5227A Measurement Setup

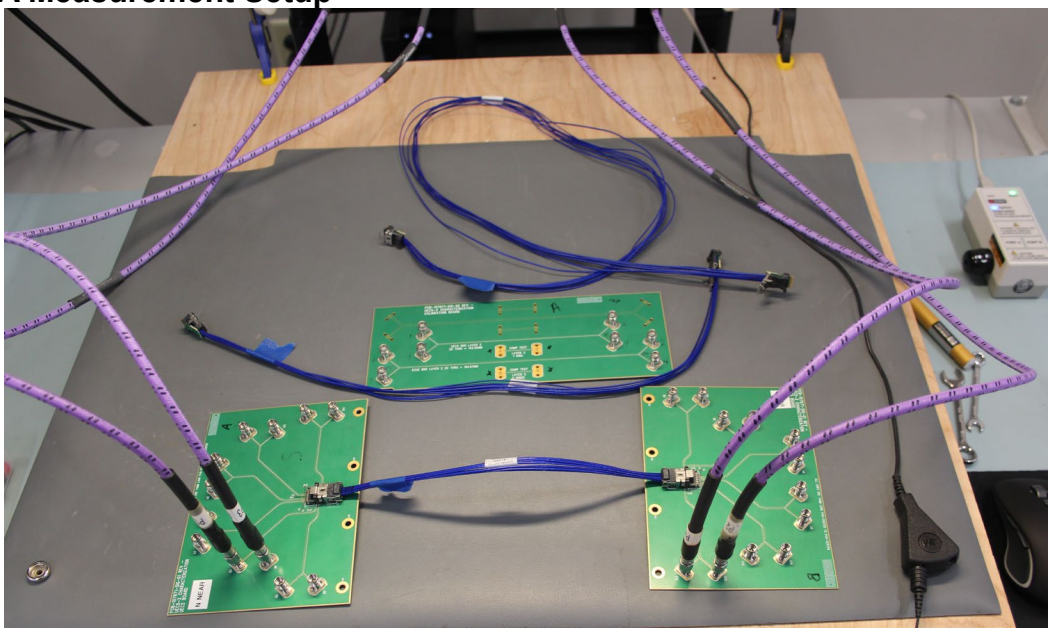


Figure 36

Test Instruments

QTY	Description
1	Keysight N5227A PNA-L Network Analyzer (10 MHz to 67 GHz)
1	Keysight 8770D Mechanical Module (10 MHz to 50 GHz)

Test Cables & Adapters

QTY	Description
4	1 m Gore 1.85 mm male to 2.4 mm female test cables

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

For impedance measurements, the test instrument is the Tektronix DSA8300 Digital Serial Analyzer mainframe and 80E10B sampling module. The impedance data and profiles are obtained directly from the instrument. The Digital Analyzer is configured as follows:

	Differential Signal
Vertical Scale:	5 ohm / Div:
Offset:	Default / Scroll
Horizontal Scale:	200 ps / Div
Record Length:	16000
Averages:	≥ 16

DSA8300 Measurement Setup

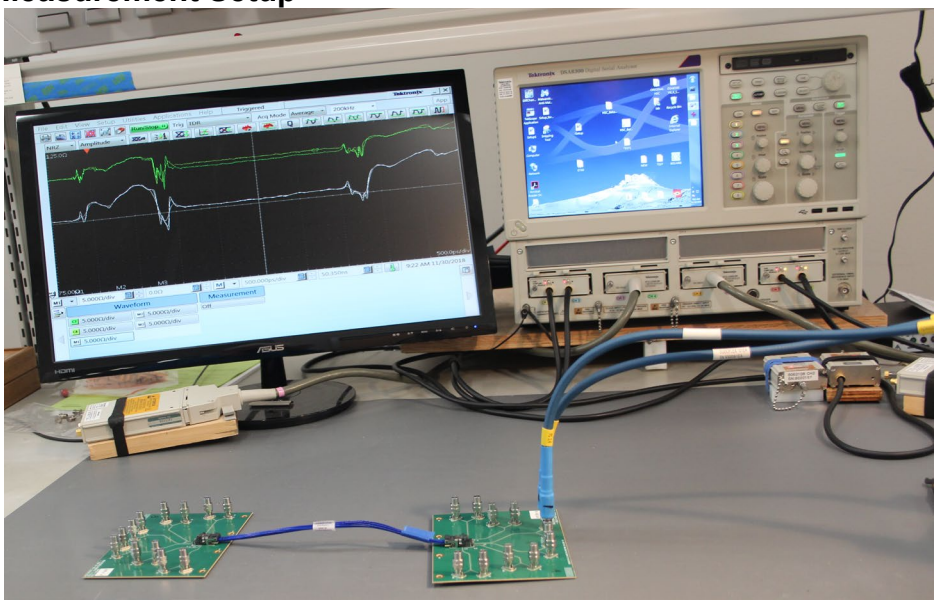


Figure 37

Test Instruments

QTY	Description
1	Tektronix DSA8300 Digital Serial Analyzer
2	Tektronix 80E10B Dual Channel 67 GHz TDR Sampling Module

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

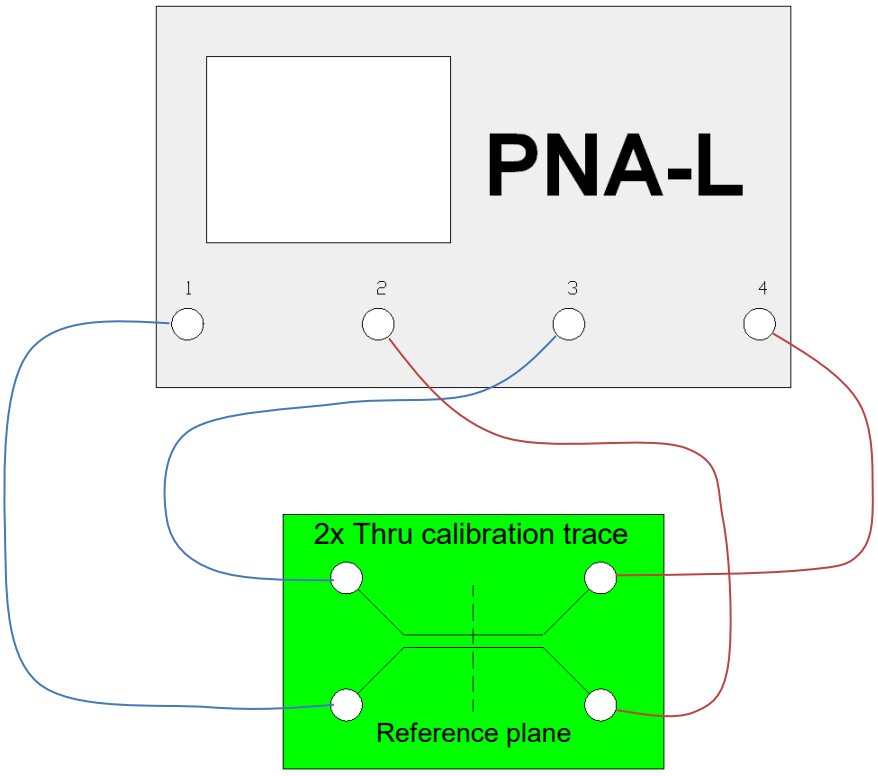
Appendix E - Frequency and Time Domain Measurements

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 calibration standards, the SI test boards, and the selection of the PCB vendor.

The measurement process begins with a measurement of the 2X THRU. A coaxial SOLT calibration is performed using a N8770D mechanical module. This measurement is required in order to obtain precise values of the line standard offset delay and frequency bandwidth. The measurement of the 2X THRU can be used to determine the maximum frequency for which the calibration standards are valid. For the ECUE test boards, this is greater than 50 GHz.

The figure below shows how the 2X THRU reference traces is utilized to compensate for the losses due to the coaxial test cables and the test fixture during testing. The calibration board is characterized to obtain parameters required to define the 2X THRU.



Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

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 band-width-limited data, such as measured with modern network analyzer.

The Time Domain responses were generated using Keysight ADS 2017 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://suddendocs.samtec.com/notesandwhitepapers/tech-note_using-plts-for-time-domain-data_web.pdf

Propagation Delay (TDT)
The Propagation Delay is a measure of the Time Domain delay through the cable assembly and footprint. A step pulse is applied to the touchstone model of the cable assembly 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.

Impedance (TDR)
Measurements involving digital pulses are performed using either Time Domain Reflectometer (TDR) or Time Domain Transmission (TDT) methods. The TDR method is used for the impedance measurements in this report.

The signal line(s) of the SUT's is energized with a TDR pulse and the far-end of the energized signal line is terminated in the test systems characteristic impedance (e.g.; 50Ω or 100Ω 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. The "best case" signal mapping was tested and is presented in this report.

Series: ECUE-2
Description: FireFly™ Low Profile Micro Flyover Cable Assembly, A1 to B1 Wiring Option

Appendix F – Glossary of Terms

ADS – Keysight Advanced Design System
AFR – Automatic Fixture Removal
PCB – Printed Circuit Board
SUT – System Under Test
SOLT – acronym used to define Short, Open, Load & Thru Calibration Standards
TDR – Time Domain Reflectometry
TDT – Time Domain Transmission
XROW – Across Row