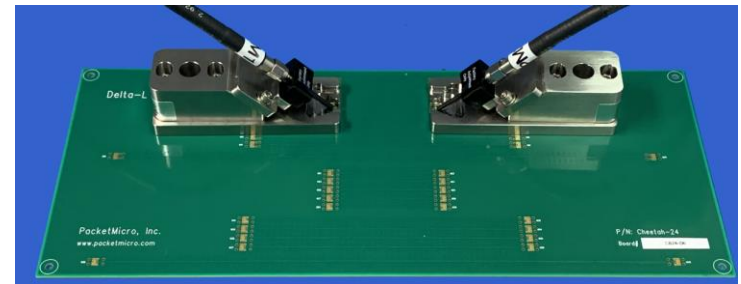
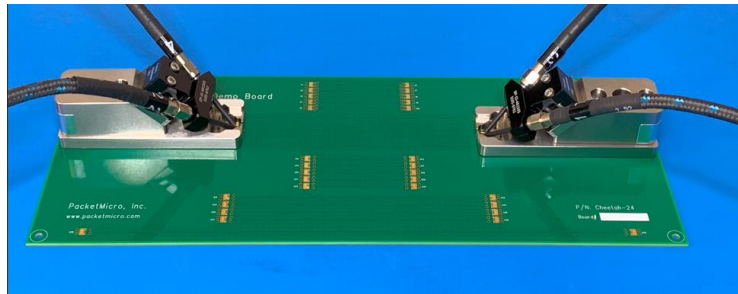


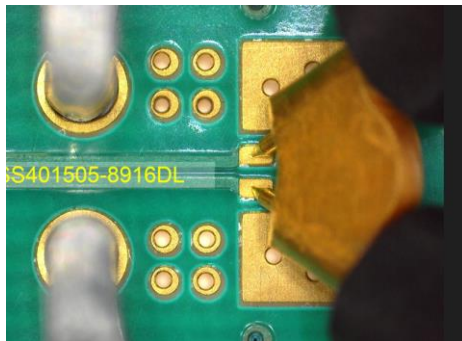
40/20 GHz Solutions for Delta-L 4.0/3.0 PCB Characterization

AITT-DLP SW Tool & Rugged Handheld Probes for VNAs

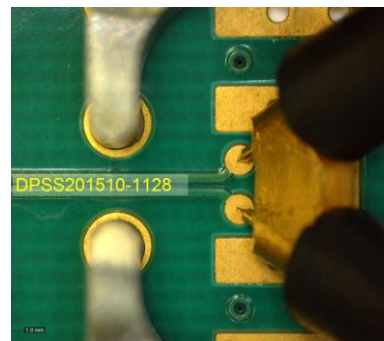


Differential Signal-Signal Probes

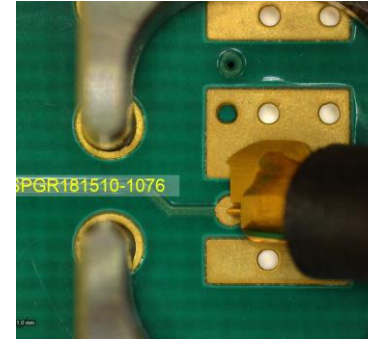
Single-ended Signal-GND Probes



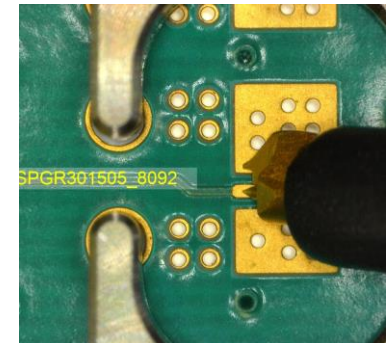
Delta-L 4.0
(40 GHz 0.5mm D-Probe)



Delta-L 3.0
(20 GHz 1.0mm D-Probe)



Delta-L 3.0
(18 GHz 1.0mm S-Probe)

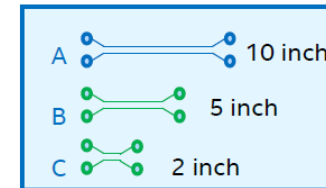


Non-standard
(30 GHz 0.5mm S-Probe)

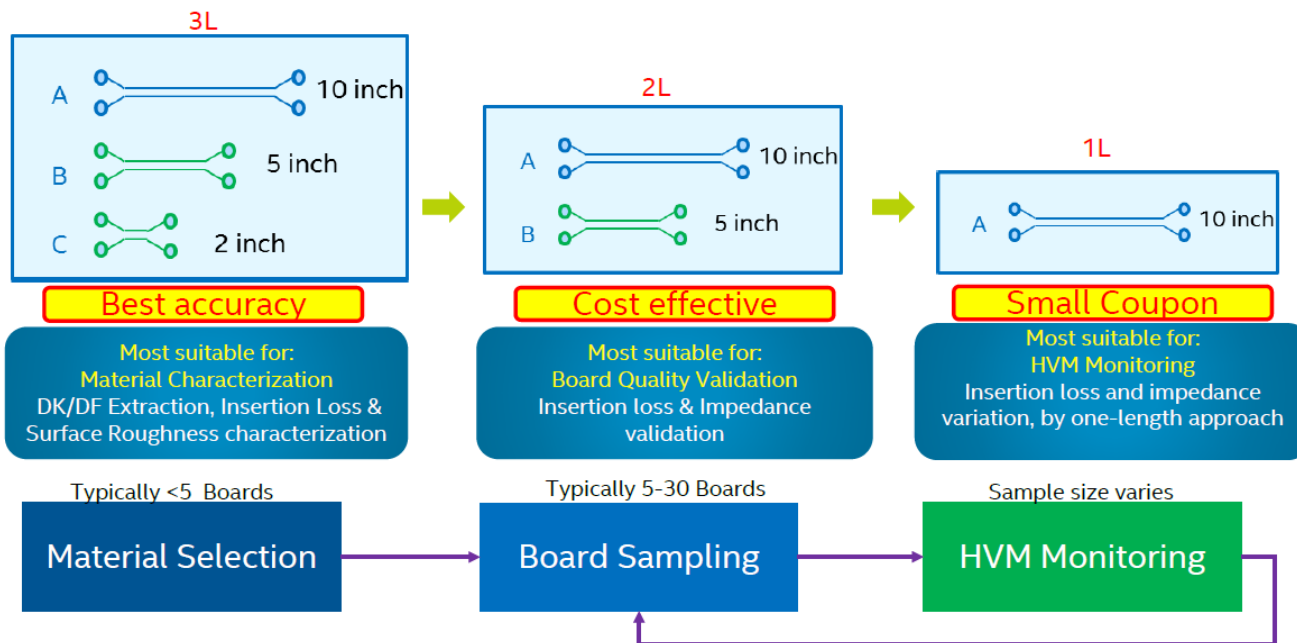
Intel Delta-L+ PCB Characterization

Delta-L+ Metrology

Choose coupons with different length combinations at different stages of PCB Characterization

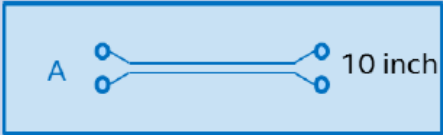
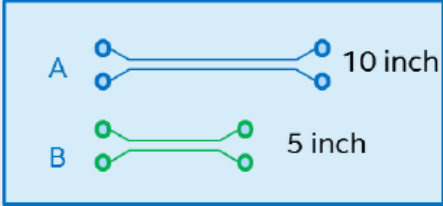
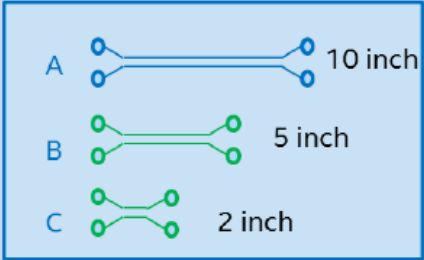


Note: Actual length may vary



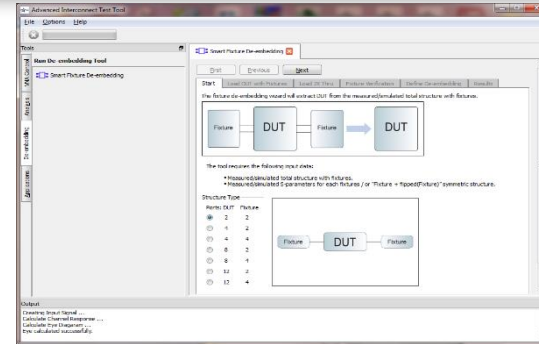
<https://www.intel.com/content/dam/www/public/us/en/documents/guides/delta-l-plus-methodology-for-electrical-characterization-guide.pdf>

Delta-L+ Usage Model

Category	Primary Usage	Note
1L 	PCB house, HVM monitoring	Lowest cost solution, TDR/TDT or VNA is ok
2L 	PCB House (optional) OxM seeking low cost “de-embedding”	This is Delta-L 2.0, TDR/TDR or VNA is ok, VNA is preferred
3L 	Material vendor OxMs Any measurement capability verification	VNA preferred. Prefer rigorous de-embedding (AFR, SFD, TRL, etc.)

40 GHz PCB Test Solution for Delta-L 4.0

Rohde & Schwarz ZNB40
100 kHz - 40 GHz VNA



CSS AITT Tool

De-embedding (2X & 1X), Analysis
(Freq/Time domains), Material Extraction



PacketMicro Probes
40 GHz Rugged Probes



AITT Delta-L+ for PCB manufacturing

AITT-DLP Test Software

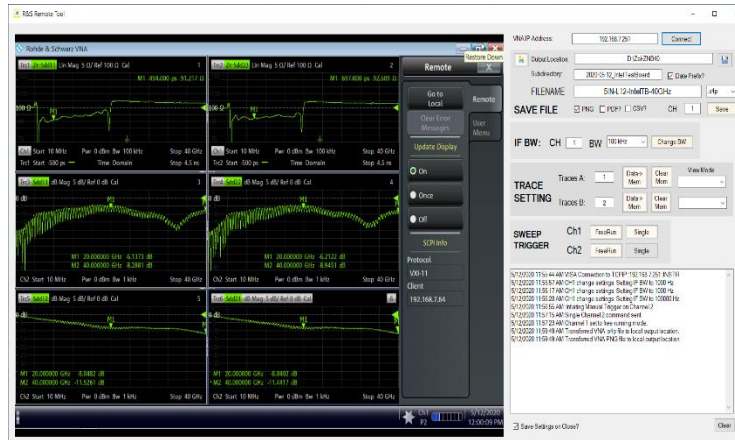
40 GHz Delta-L Test Tool



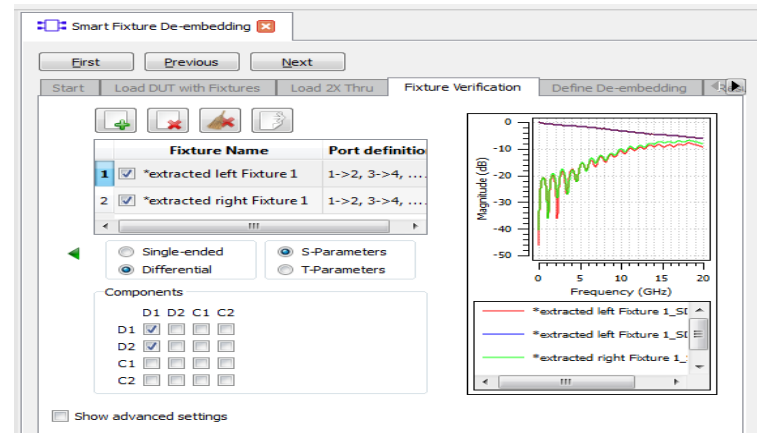
- AITT-DLP guides an operator to make measurements and generates Delta-L test reports.

Advanced Interconnect Test Tool (AITT)

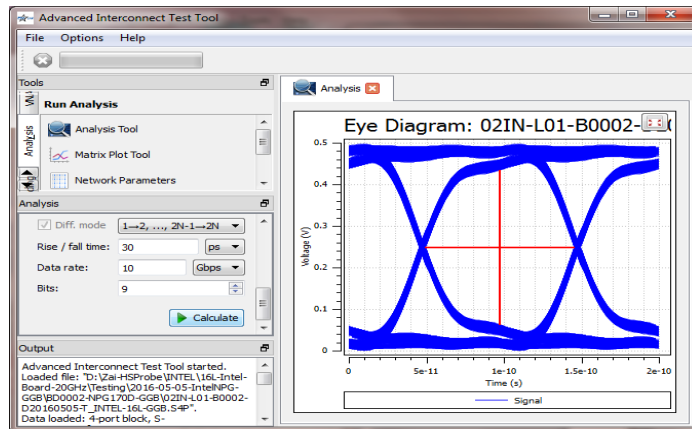
Versatile Tool for Interconnect analysis and Characterization



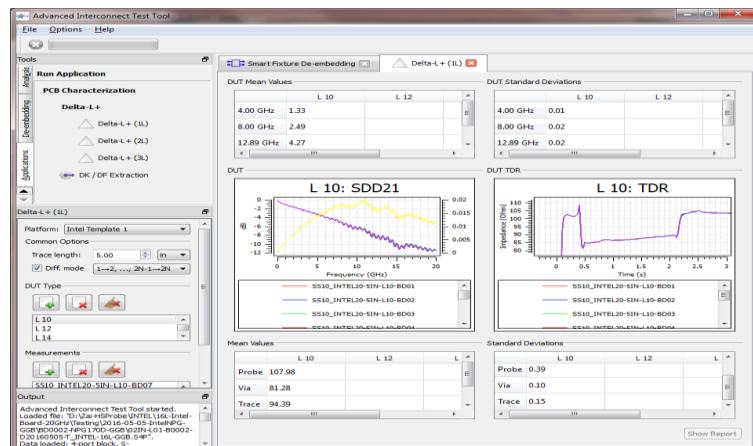
VNA Control



De-embedding Tool

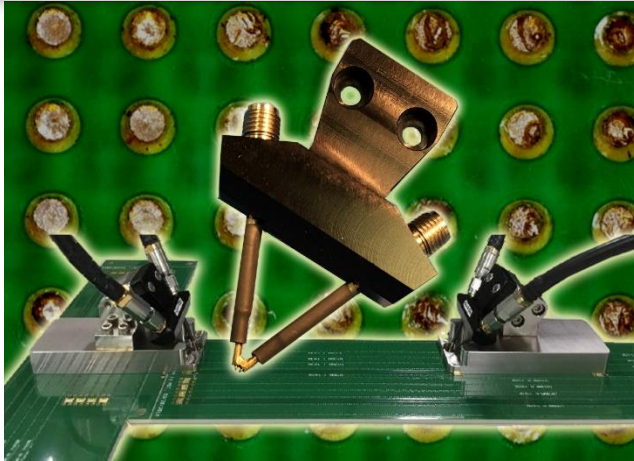


Analysis Tool



Applications (DK/DF Delta-L+)

40/20 GHz D-Probe

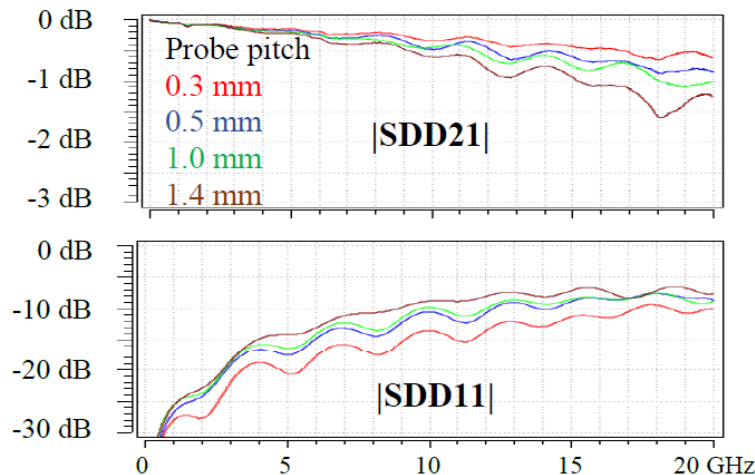


Features

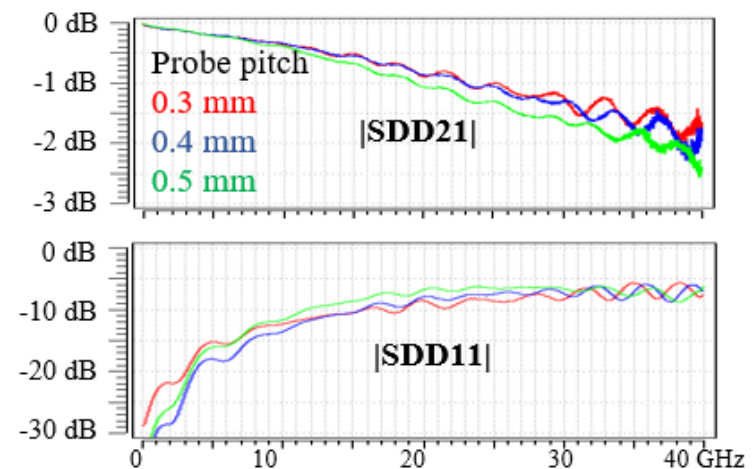
- **High Bandwidth:** DC to 20 or 40 GHz
- **Ruggedness:** Beryllium Copper tips
- **High Repeatability:** No moving part

D-Probe Part No.

- **DP-SS-201504** – 20 GHz, 0.4 mm/16 mil pitch
- **DP-SS-201505** – 20 GHz, 0.5 mm/20 mil pitch
- **DP-SS-201508** – 20 GHz, 0.8 mm/32 mil pitch
- **DP-SS-201510** – 20 GHz, 1.0 mm/40 mil pitch
- **DP-SS-201512** – 20 GHz, 1.2 mm/48 mil pitch
- **DP-SS-401503** – 40 GHz, 0.3 mm/12 mil pitch
- **DP-SS-401504** – 40 GHz, 0.4 mm/16 mil pitch
- **DP-SS-401505** – 40 GHz, 0.5 mm/20 mil pitch

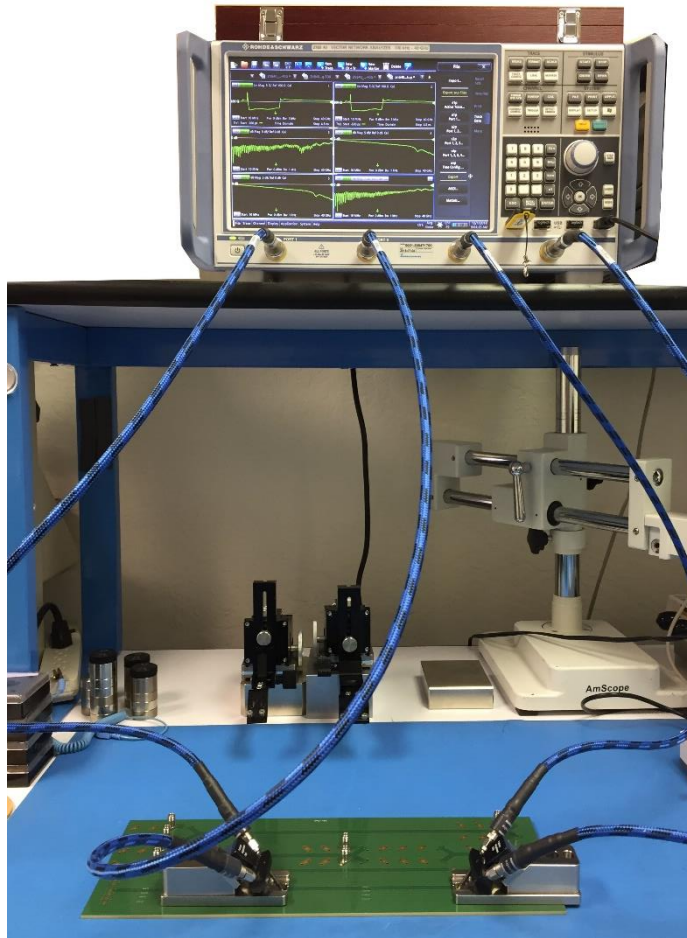


20 GHz D-Probes

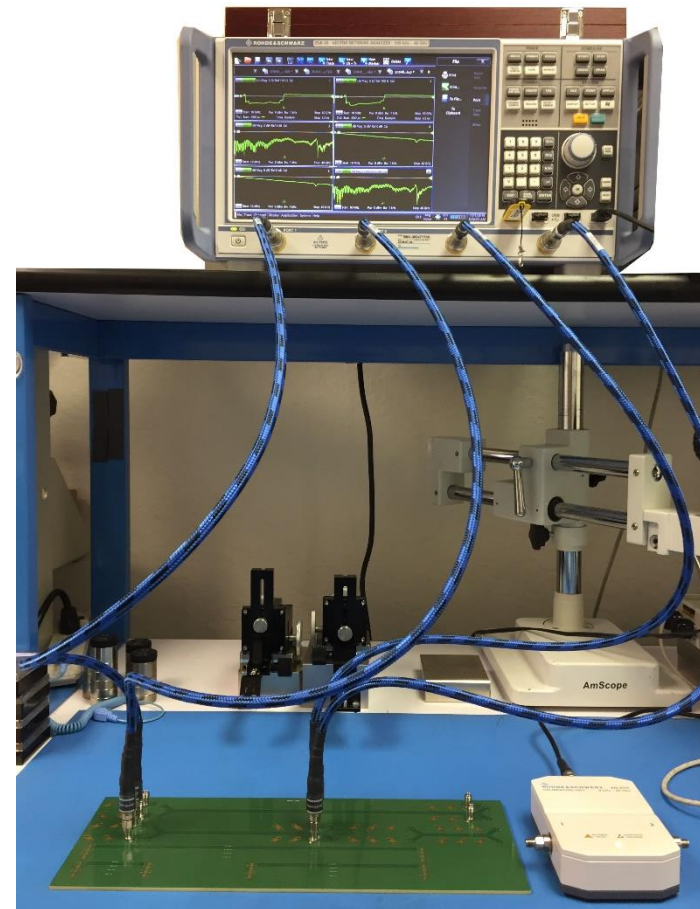


40 GHz D-Probes

40 GHz PCB Testing with R&S ZNB40 VNA

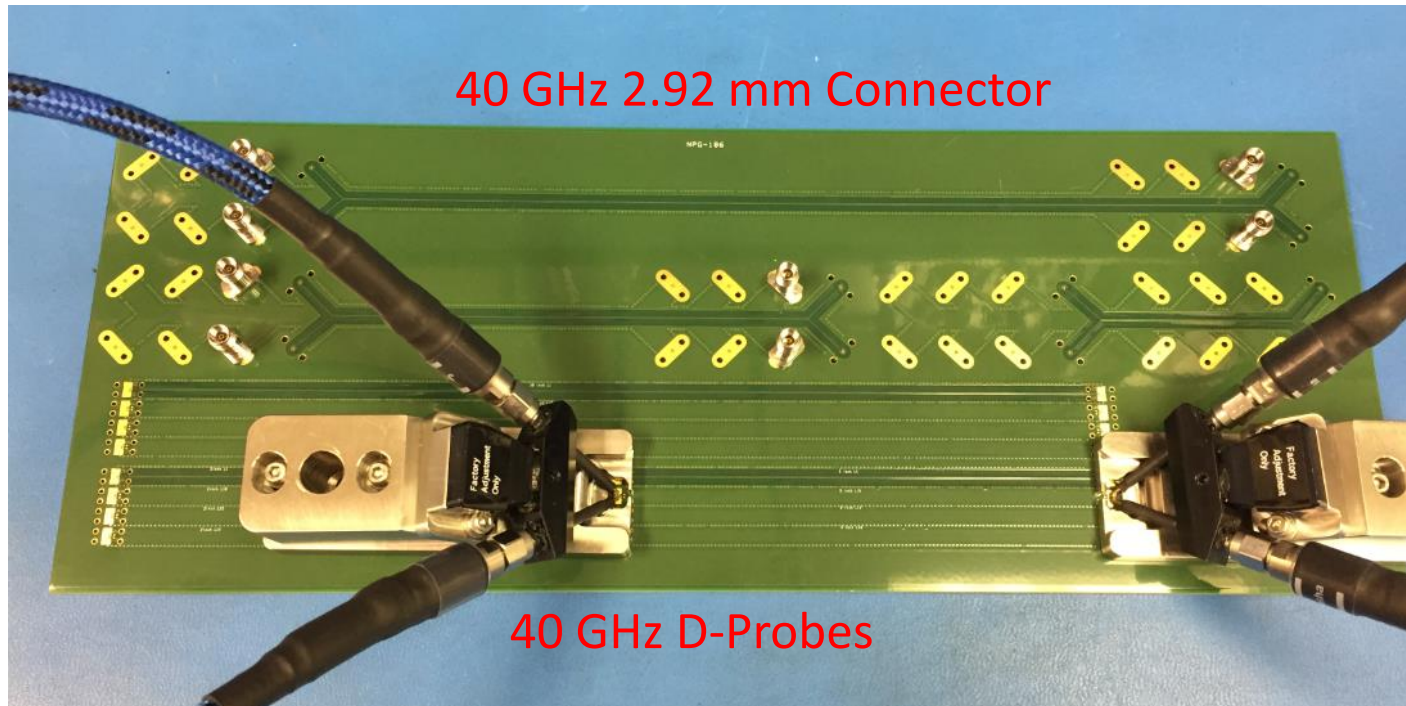


VNA measurement with D-Probe

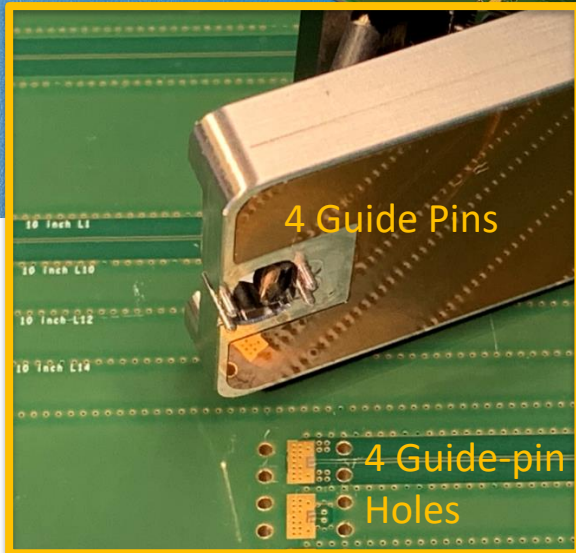
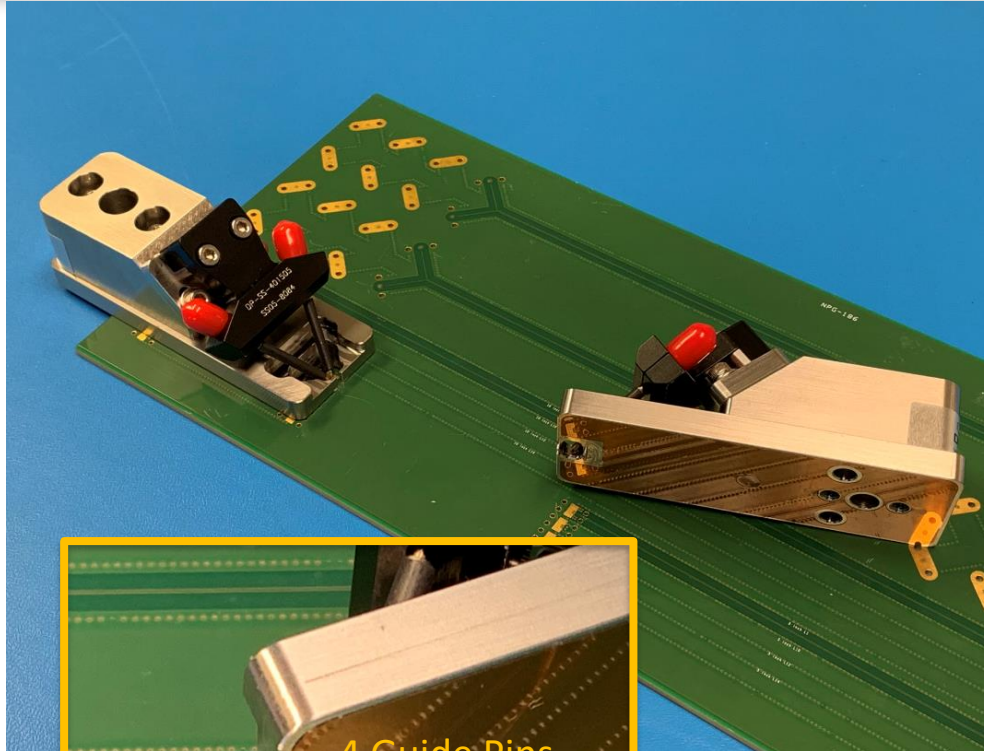


VNA measurement with 2.92 mm

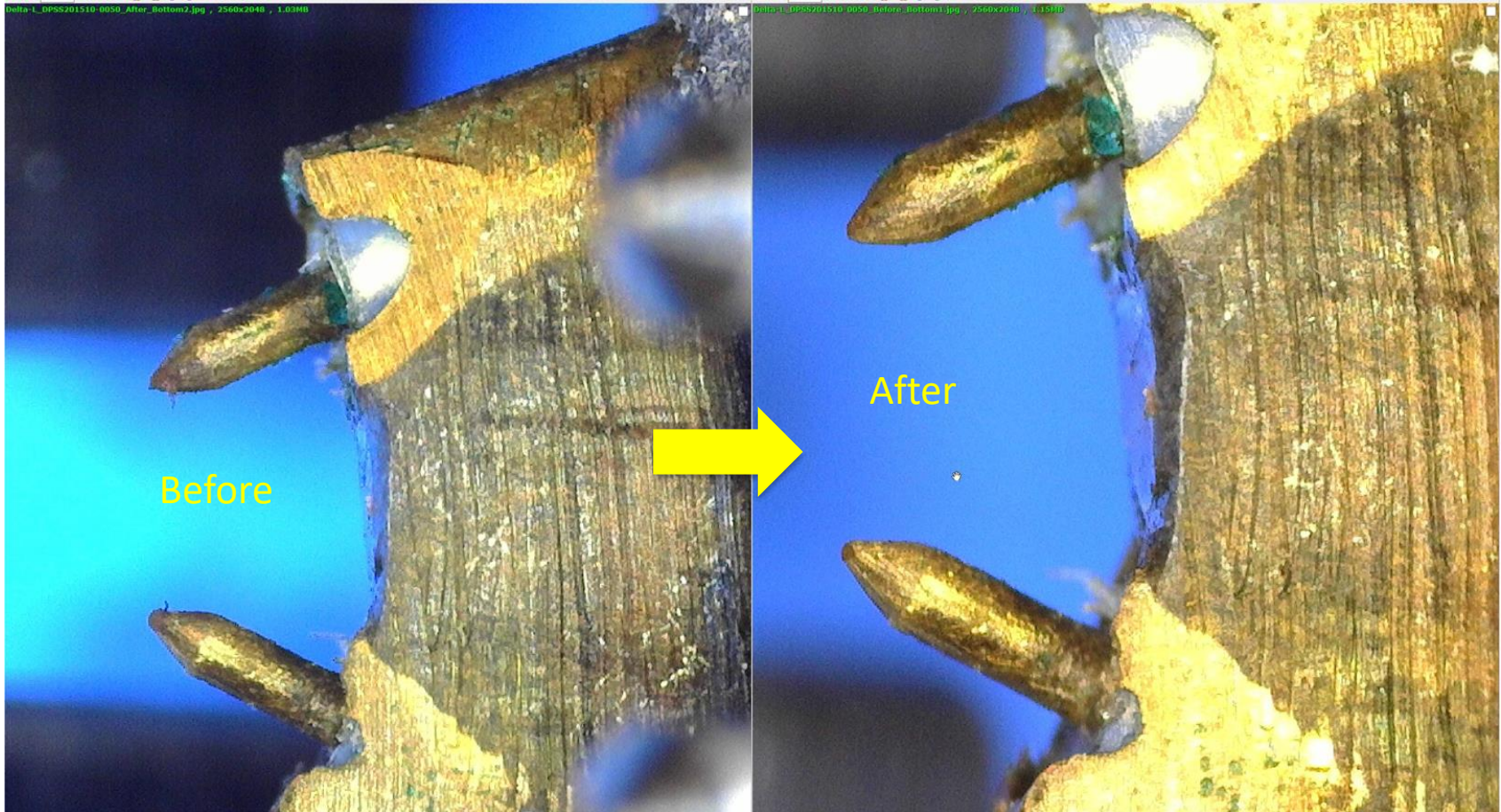
16-Layer NPG-186 Test Board



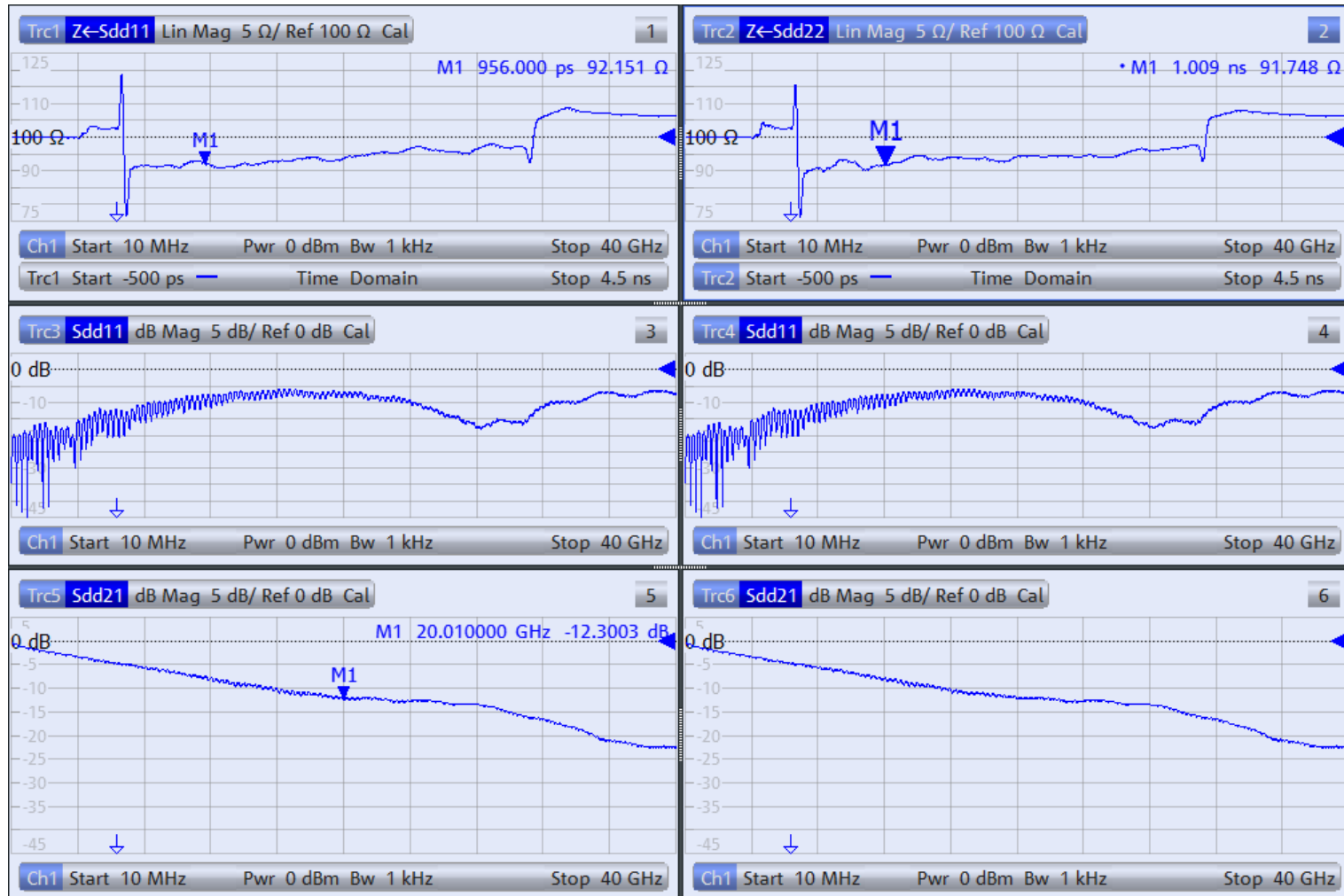
40 GHz DP-SS-401505DL Probe



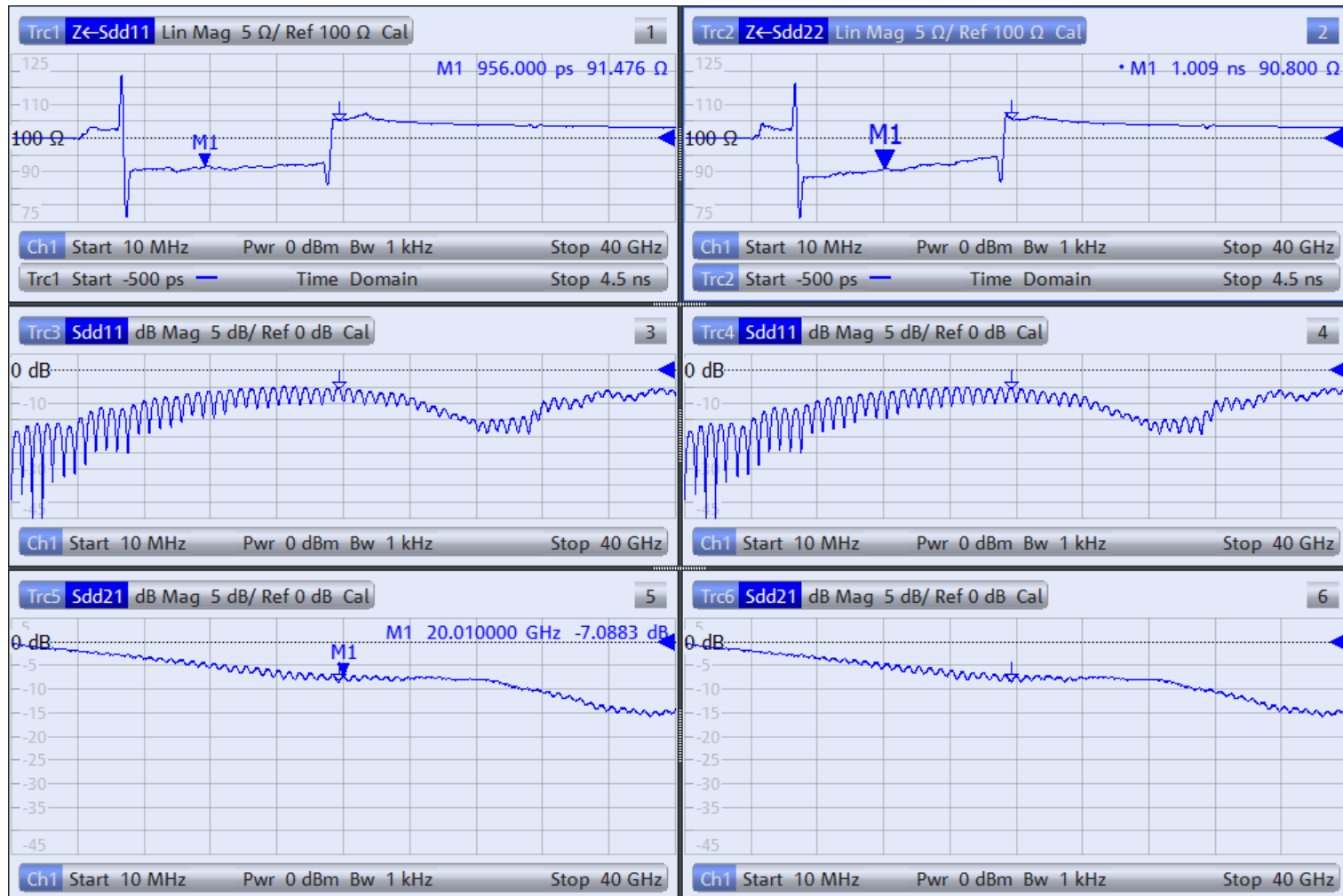
Probe Wear after 1000+ Tests



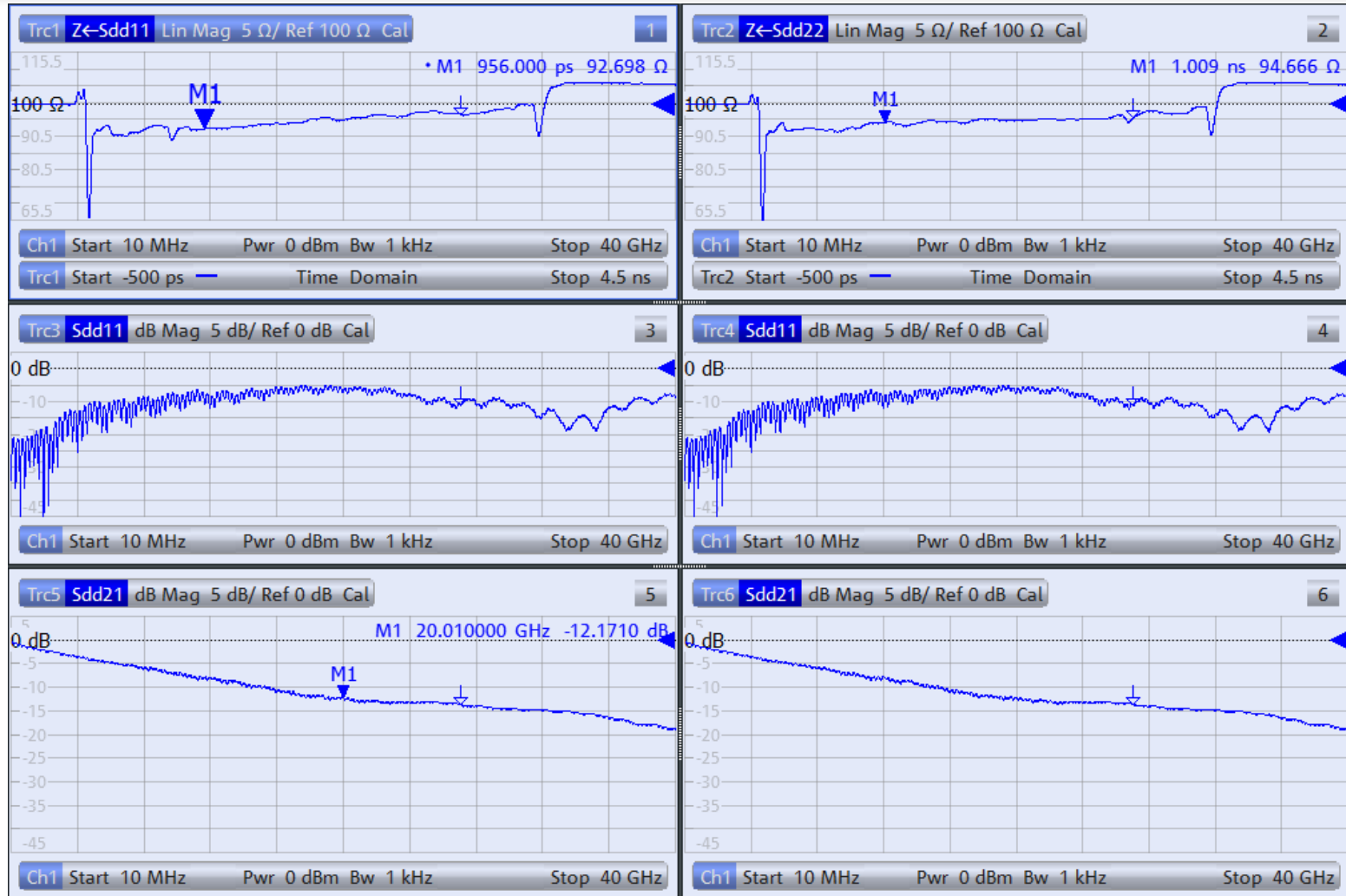
D-Probe Measurement – 10" Stripline



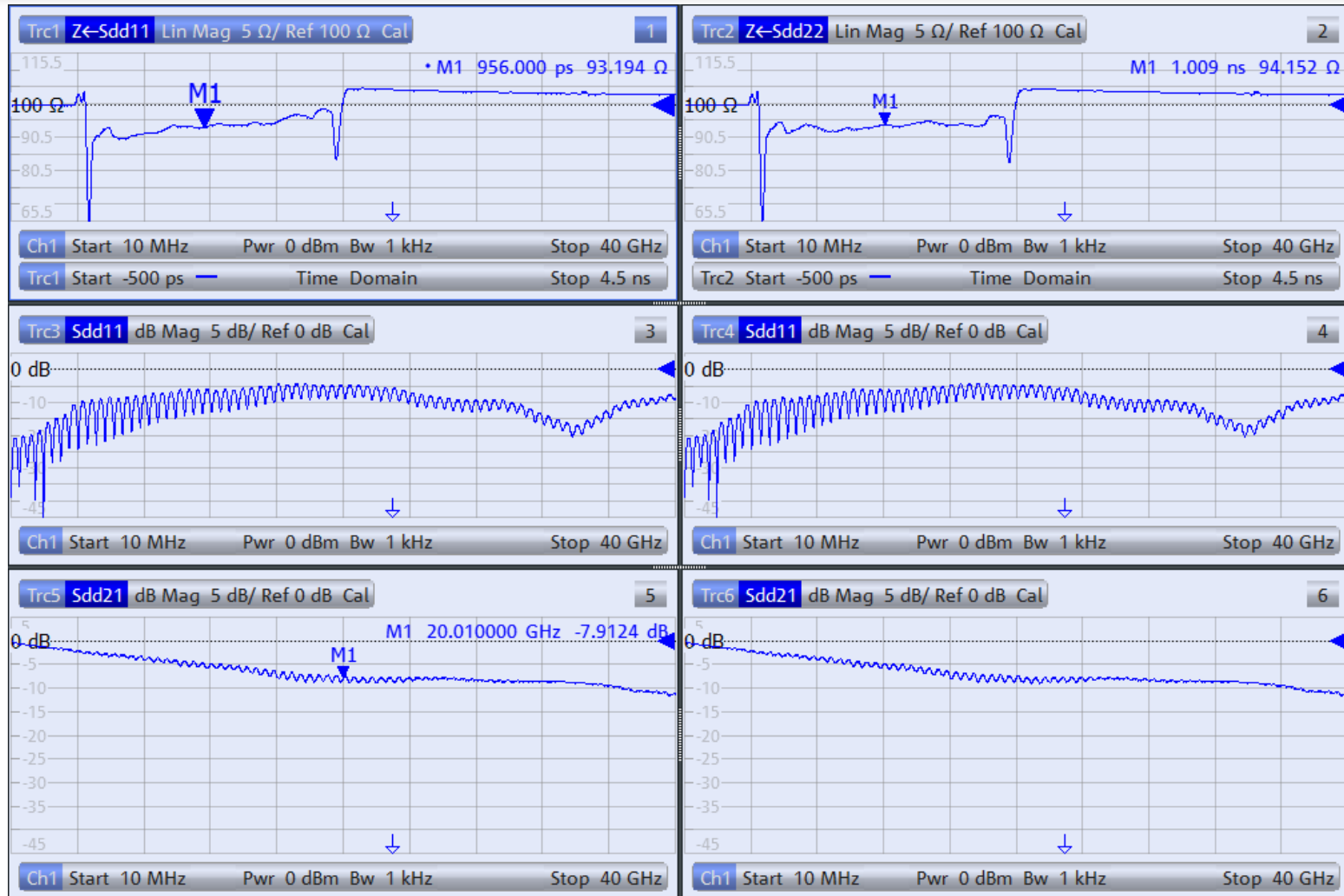
D-Probe Measurement – 5" Stripline



2.92 mm Connector Measurement – 10"

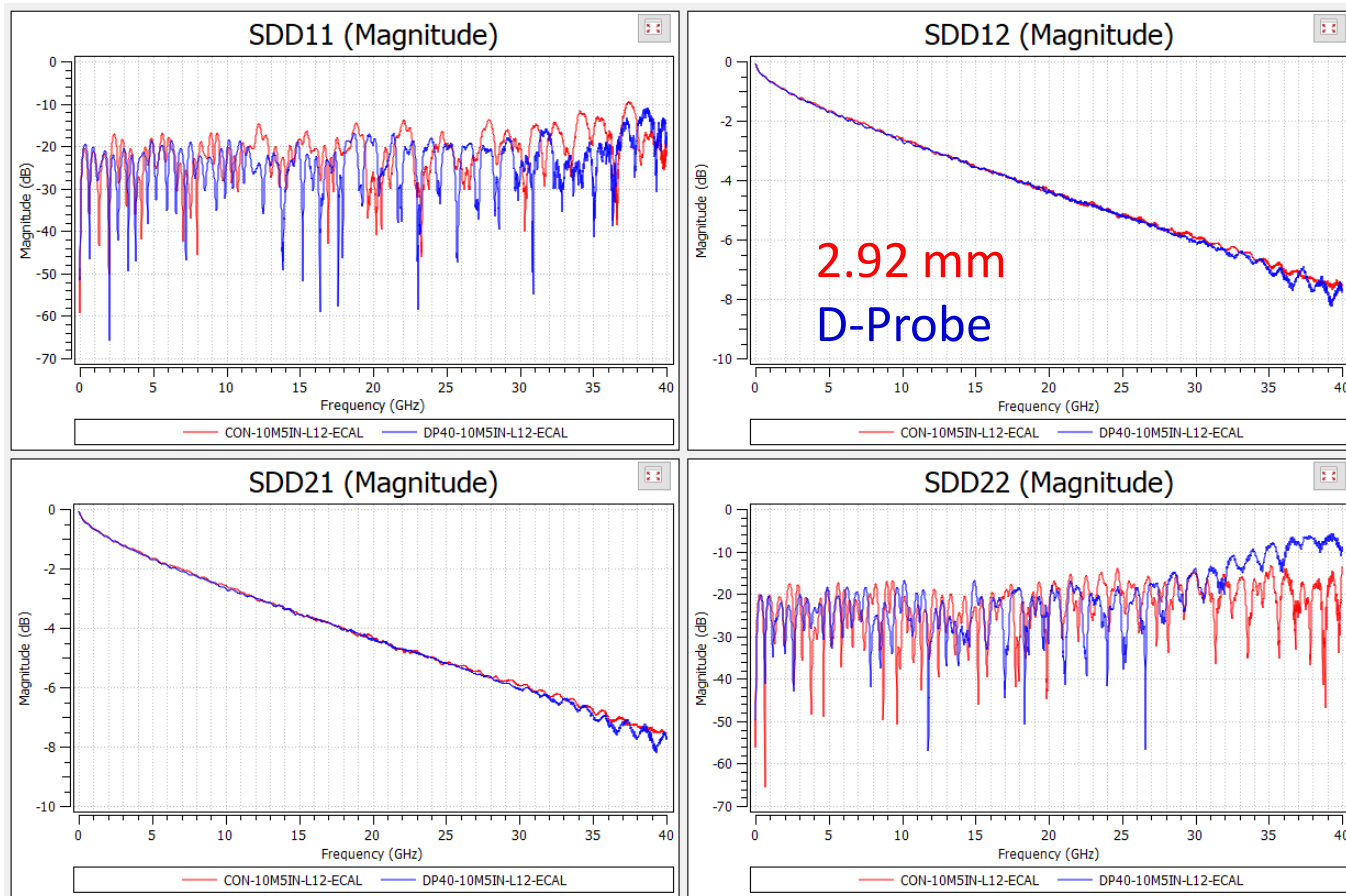


2.92 mm Connector Measurement – 5"



D-Probe vs. 2.92 mm Connector

De-embedded Results



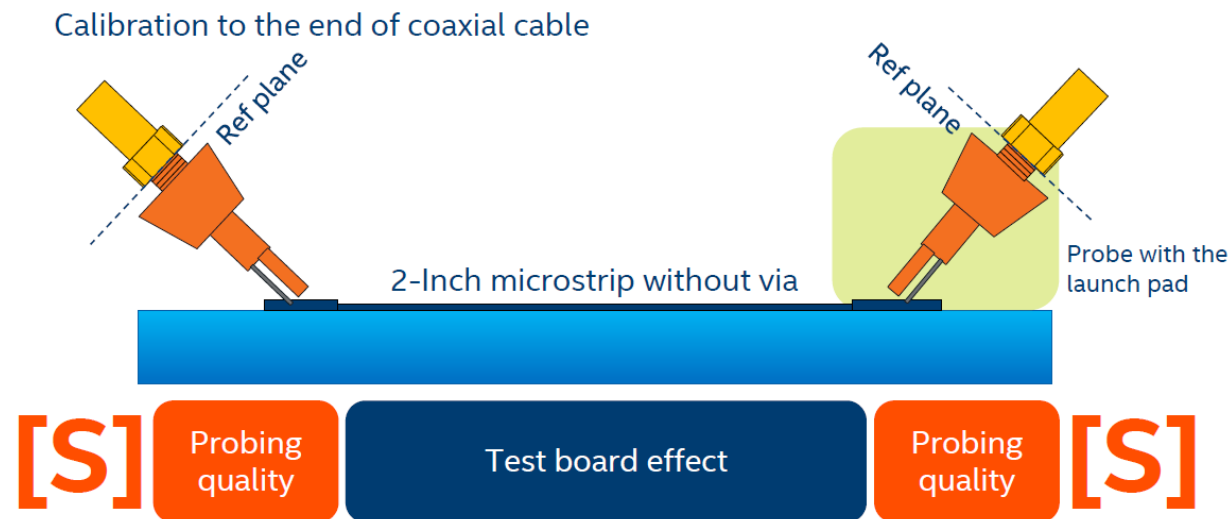
D-Probe and 2.92 mm connector have comparable accuracy up to 35 GHz!

Probing Quality

How to Assure Probing Quality: Electrical Requirement

Electrical requirement =

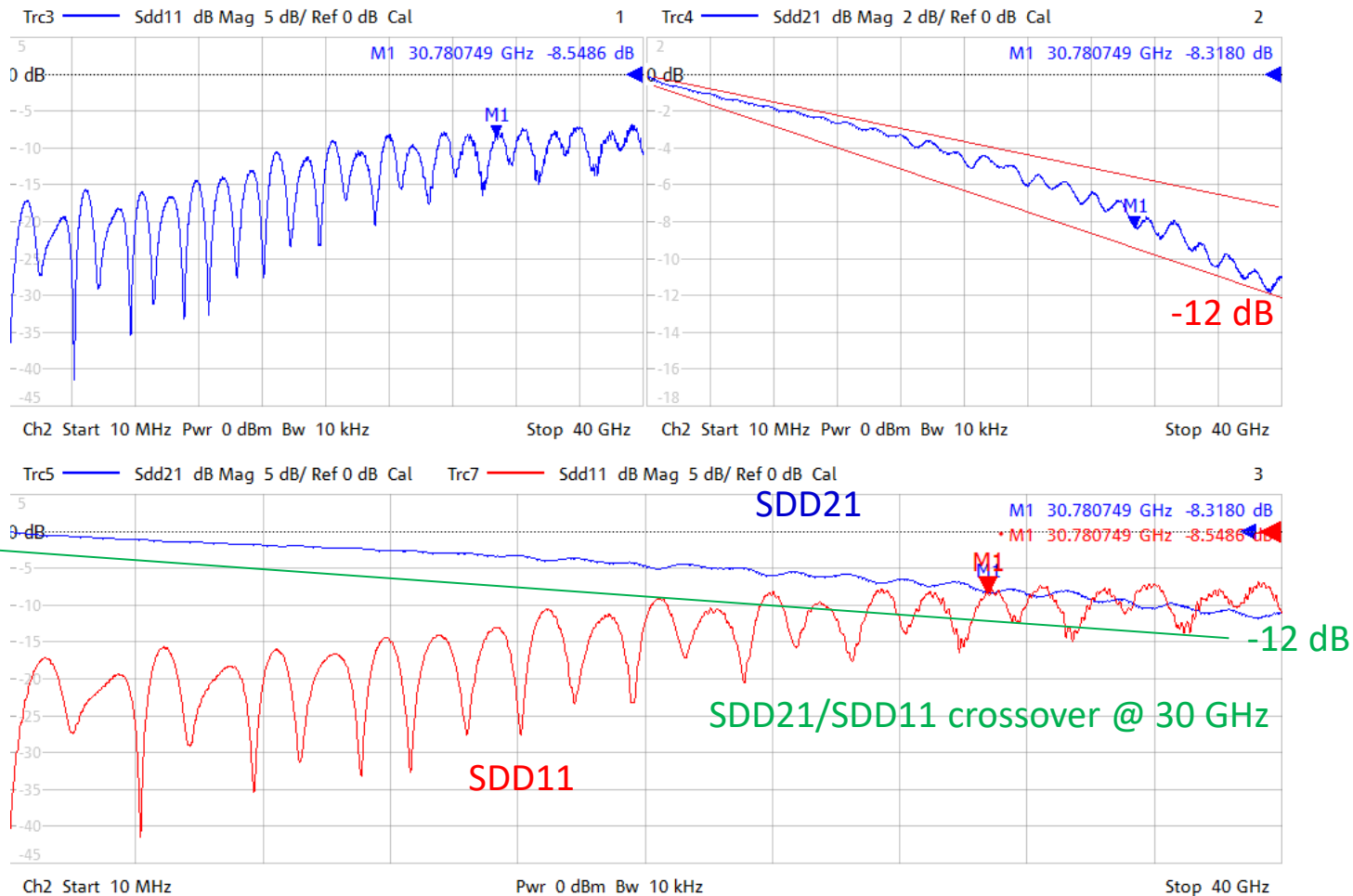
2x probe with the launch (each < 3.5 dB at 40 GHz) + 2-Inch microstrip loss



12 dB Insertion Loss @ 40 GHz = 3.5 dB + 5 dB + 3.5 dB
(2" microstrip trace loss is about 5 dB @40 GHz, Intel reference Board)

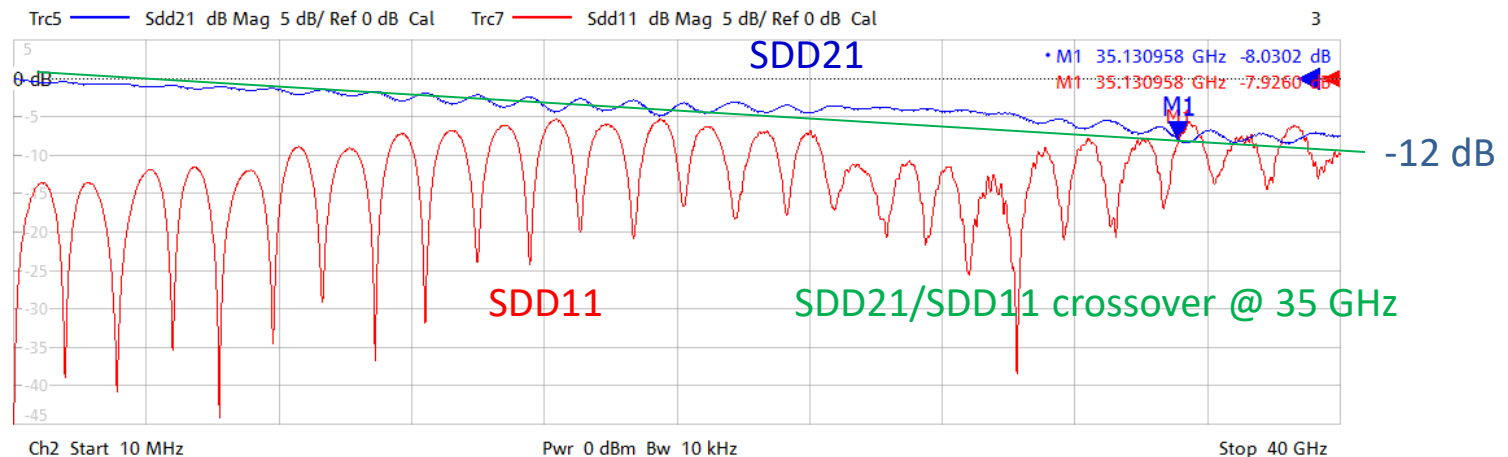
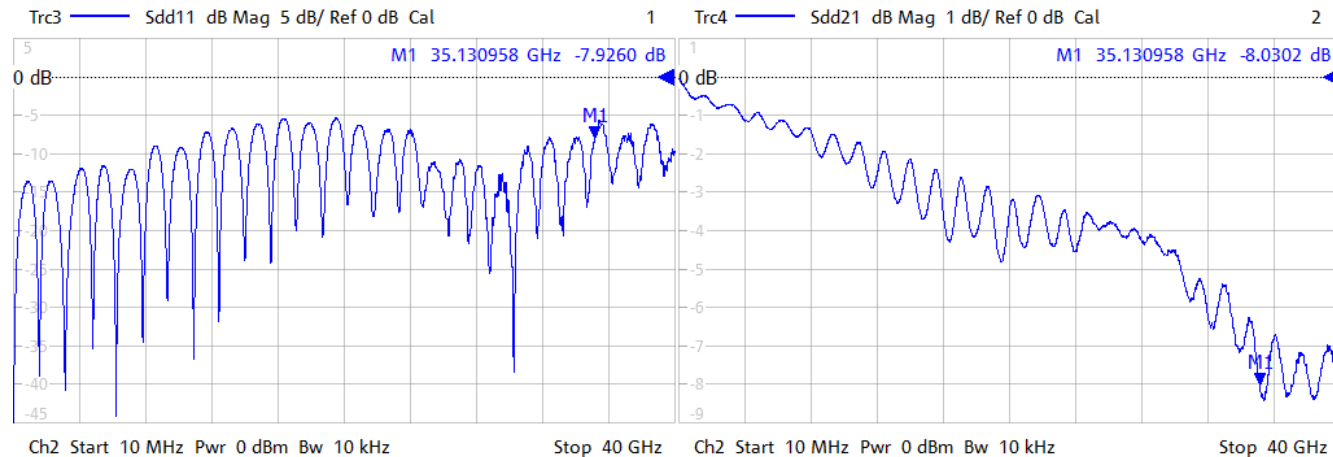
DProbe Quality for 2" Microstrip

6/26/2019 2:41:38 PM
1311.6010K84-101343-KG

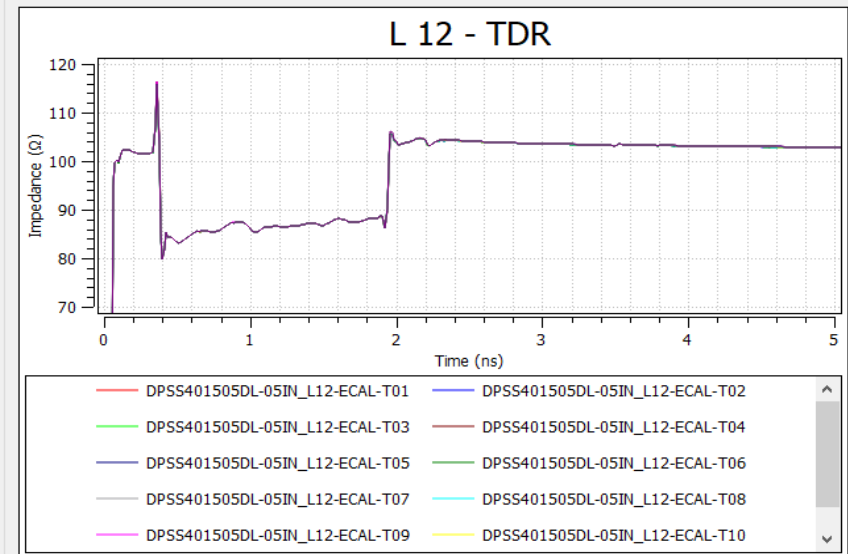
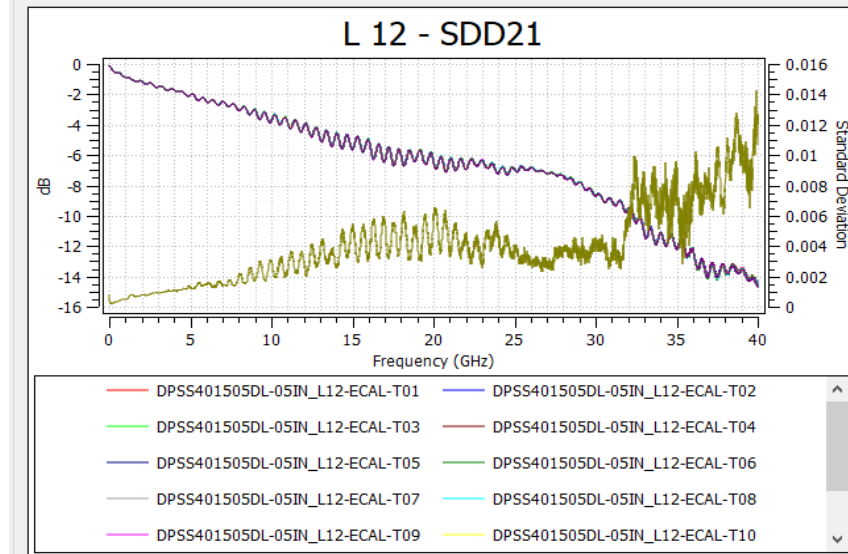


DProbe Quality for 2" Stripline

6/26/2019 2:33:53 PM
1311.6010K84-101343-KG



Differential Delta-L 4.0 (1L) Repeatability



DUT Information

	Mean	Maximum	Minimum	Range	Standard Deviation
L 12					
4.000 GHz	0.341	0.342	0.339	0.003	0.001
8.000 GHz	0.612	0.616	0.609	0.007	0.002
12.890 GHz	0.884	0.891	0.880	0.011	0.003
16.000 GHz	0.997	1.004	0.990	0.014	0.003
28.000 GHz	1.478	1.485	1.470	0.015	0.004

Summary

	Mean	Maximum	Minimum	Range	Standard Deviation
L 12					
Probe	115.933	116.531	115.103	1.429	0.409
Via	79.699	79.753	79.640	0.113	0.035
Trace	86.677	86.684	86.668	0.015	0.004

- Good repeatability for 12 separate measurements of the same 5" trace
- The standard deviation is 0.004 dB @ 28 GHz

Differential Delta-L 4.0 (2L) Repeatability

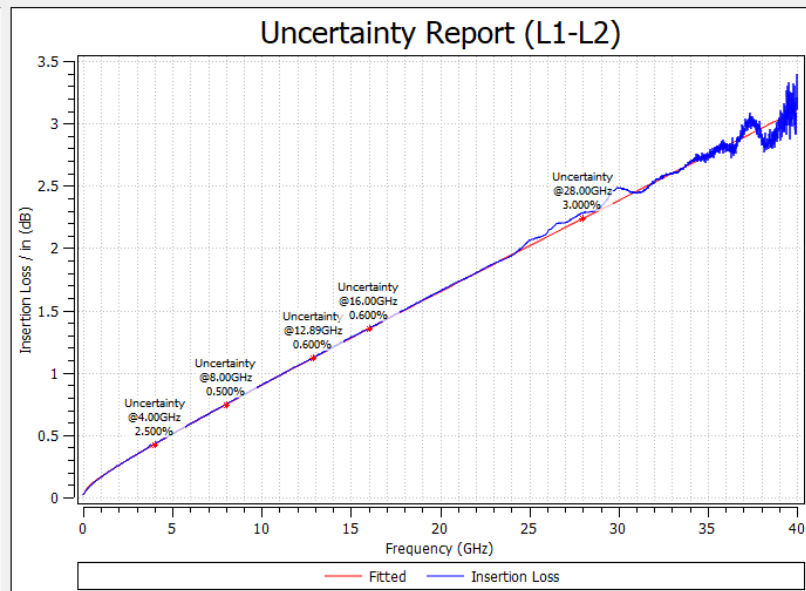
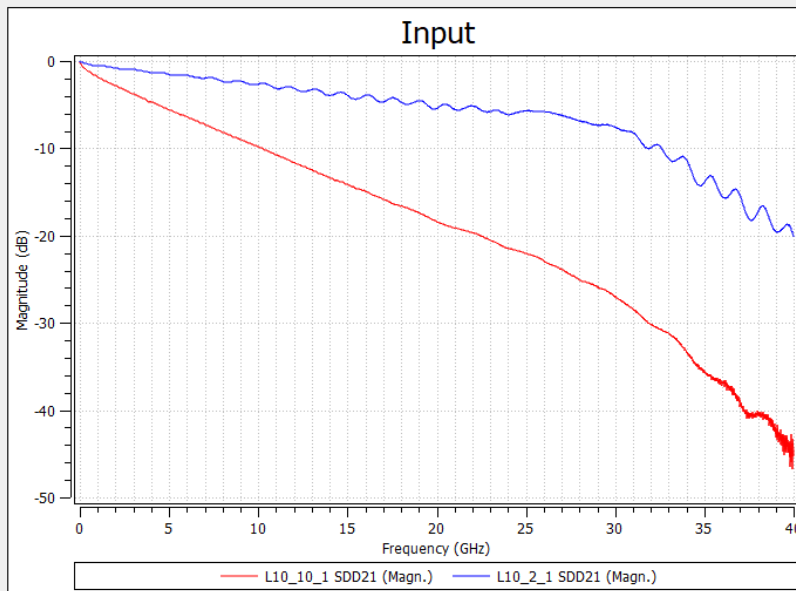
“10 IN – 5 IN” De-embedded Results

L10	4GHz	8GHz	12.89GHz	16GHz
T1	0.468	0.821	1.233	1.488
T2	0.467	0.820	1.231	1.486
T3	0.467	0.820	1.231	1.485
T4	0.468	0.821	1.232	1.488
T5	0.468	0.821	1.232	1.486
T6	0.468	0.821	1.232	1.487
T7	0.468	0.821	1.232	1.487
T8	0.468	0.822	1.234	1.490
T9	0.468	0.822	1.234	1.489
T10	0.468	0.821	1.233	1.489
T11	0.468	0.821	1.233	1.488
T12	0.468	0.821	1.232	1.488
Average	0.468	0.821	1.232	1.488
Max	0.468	0.822	1.234	1.490
Min	0.467	0.820	1.231	1.485
Range	0.001	0.002	0.003	0.005
σ	0.0003	0.0005	0.0010	0.0014
Average + 3 σ	0.469	0.823	1.235	1.492

4GHz Uncertainty	8GHz Uncertainty	12.89GHz Uncertainty	16GHz Uncertainty
1.0	0.6	0.7	1.1
0.8	0.4	0.8	0.6
0.9	0.5	1.3	0.6
0.9	0.5	0.6	0.5
0.8	0.5	0.7	0.7
0.8	0.4	0.5	0.7
0.8	0.4	0.6	0.6
0.8	0.4	0.6	0.6
0.8	0.5	0.5	0.7
0.7	0.4	0.5	0.7
0.7	0.4	0.6	0.7
0.7	0.5	0.4	0.7

Good repeatability for 12 separate measurements of the same 10” and 5” traces

Differential Delta-L 4.0 (2L)



DUT Length (in)	Ref. Length (in)	Effective Length (in)
10.000	2.000	8.000

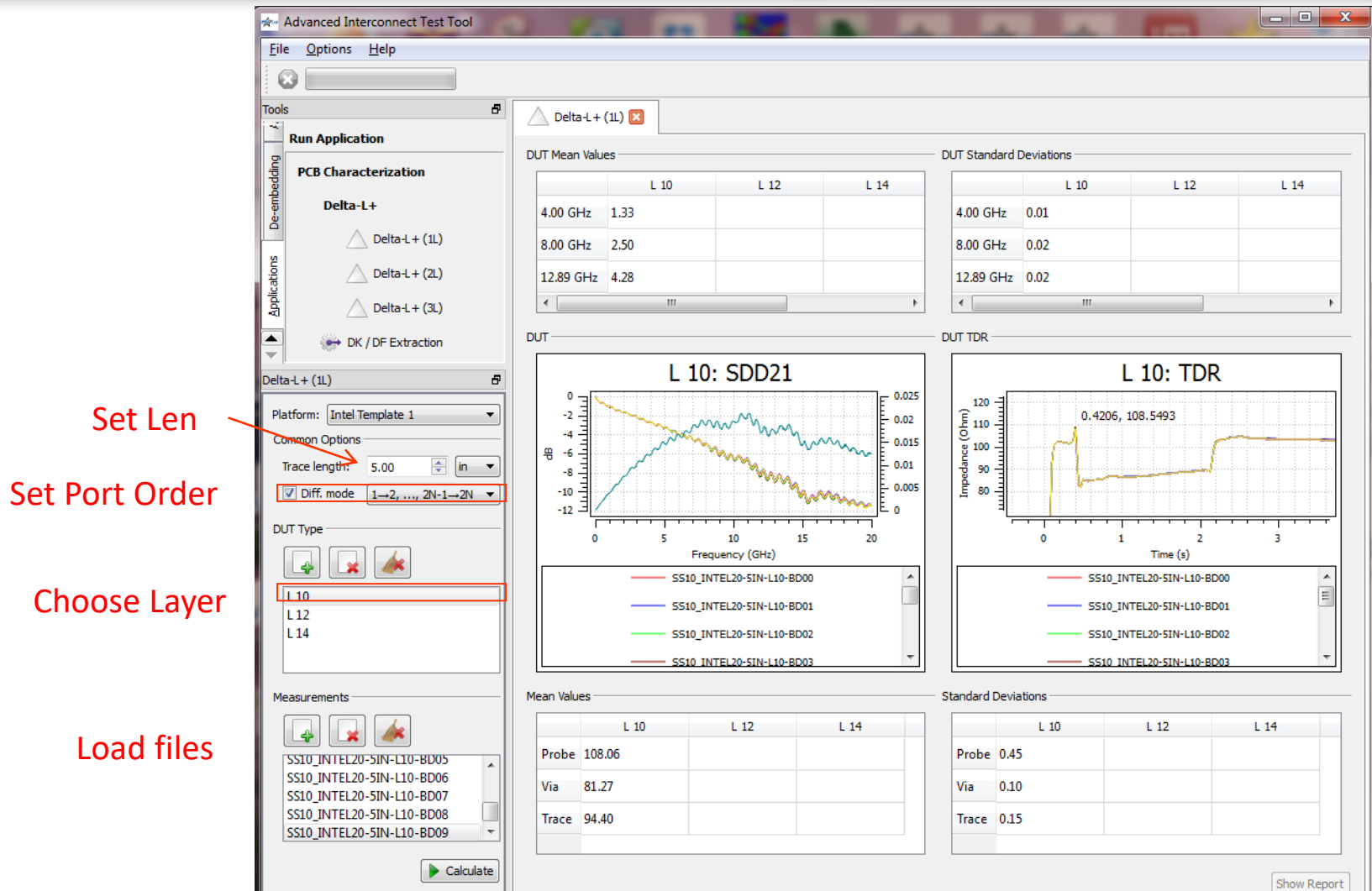
Z of Trace 1 (Ω)	Z of Trace 2 (Ω)
92.309	97.084

Uncertainty (%)	dB/in
0.500	0.746
Frequency: 12.89 GHz	
0.600	1.120
Frequency: 16.00 GHz	
0.600	1.353
Frequency: 28.00 GHz	
3.000	2.236

$$uncertainty@f_0 = \frac{mean(IL_{res}) + 3 \times \sigma(IL_{res})}{IL_{fit}@f_0} \times 100\%$$

$$IL_{res}(i) = IL_{raw}(i) - IL_{fit}(i)$$

20 GHz Differential Delta-L 3.0 (1L)



Set Len

Set Port Order

Choose Layer

Load files

Advanced Interconnect Test Tool

Delta-L+ (1L)

Platform: Intel Template 1

Common Options

Trace length: 5.00 in

☒ Diff. mode 1→2, ..., 2N-1→2N

DUT Type

☒ L 10

L 12

L 14

Measurements

SS10_INTEL20-SIN-L10-BD05

SS10_INTEL20-SIN-L10-BD06

SS10_INTEL20-SIN-L10-BD07

SS10_INTEL20-SIN-L10-BD08

SS10_INTEL20-SIN-L10-BD09

Calculate

Delta-L+ (1L)

DUT Mean Values

	L 10	L 12	L 14
4.00 GHz	1.33		
8.00 GHz	2.50		
12.89 GHz	4.28		

DUT Standard Deviations

	L 10	L 12	L 14
4.00 GHz	0.01		
8.00 GHz	0.02		
12.89 GHz	0.02		

L 10: SDD21

Frequency (GHz)

SS10_INTEL20-SIN-L10-BD00

SS10_INTEL20-SIN-L10-BD01

SS10_INTEL20-SIN-L10-BD02

SS10_INTEL20-SIN-L10-BD03

L 10: TDR

Impedance (Ohm)

Time (s)

0.4206, 108.5493

SS10_INTEL20-SIN-L10-BD00

SS10_INTEL20-SIN-L10-BD01

SS10_INTEL20-SIN-L10-BD02

SS10_INTEL20-SIN-L10-BD03

Mean Values

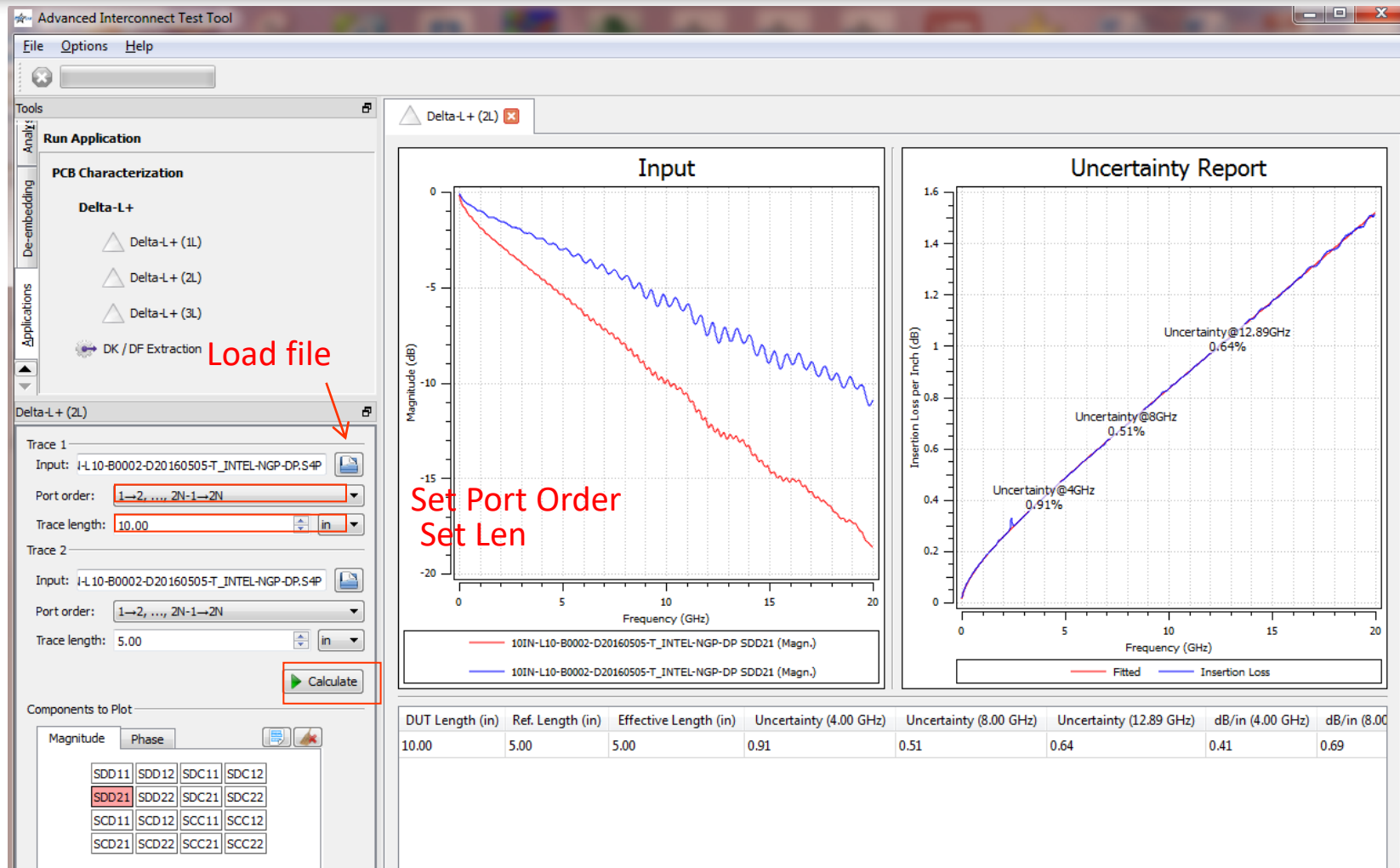
	L 10	L 12	L 14
Probe	108.06		
Via	81.27		
Trace	94.40		

Standard Deviations

	L 10	L 12	L 14
Probe	0.45		
Via	0.10		
Trace	0.15		

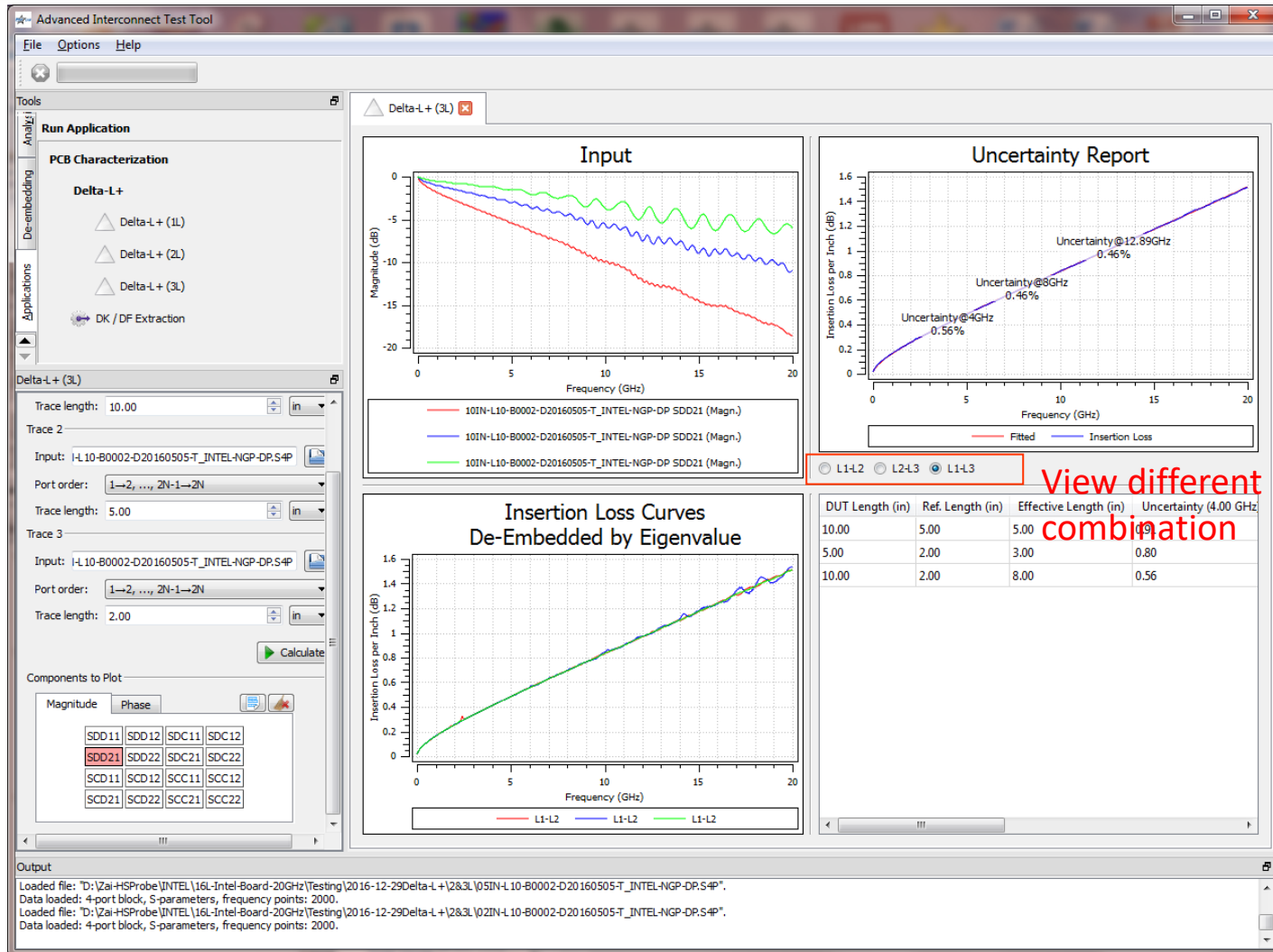
Show Report

20 GHz Differential Delta-L 3.0 (2L)

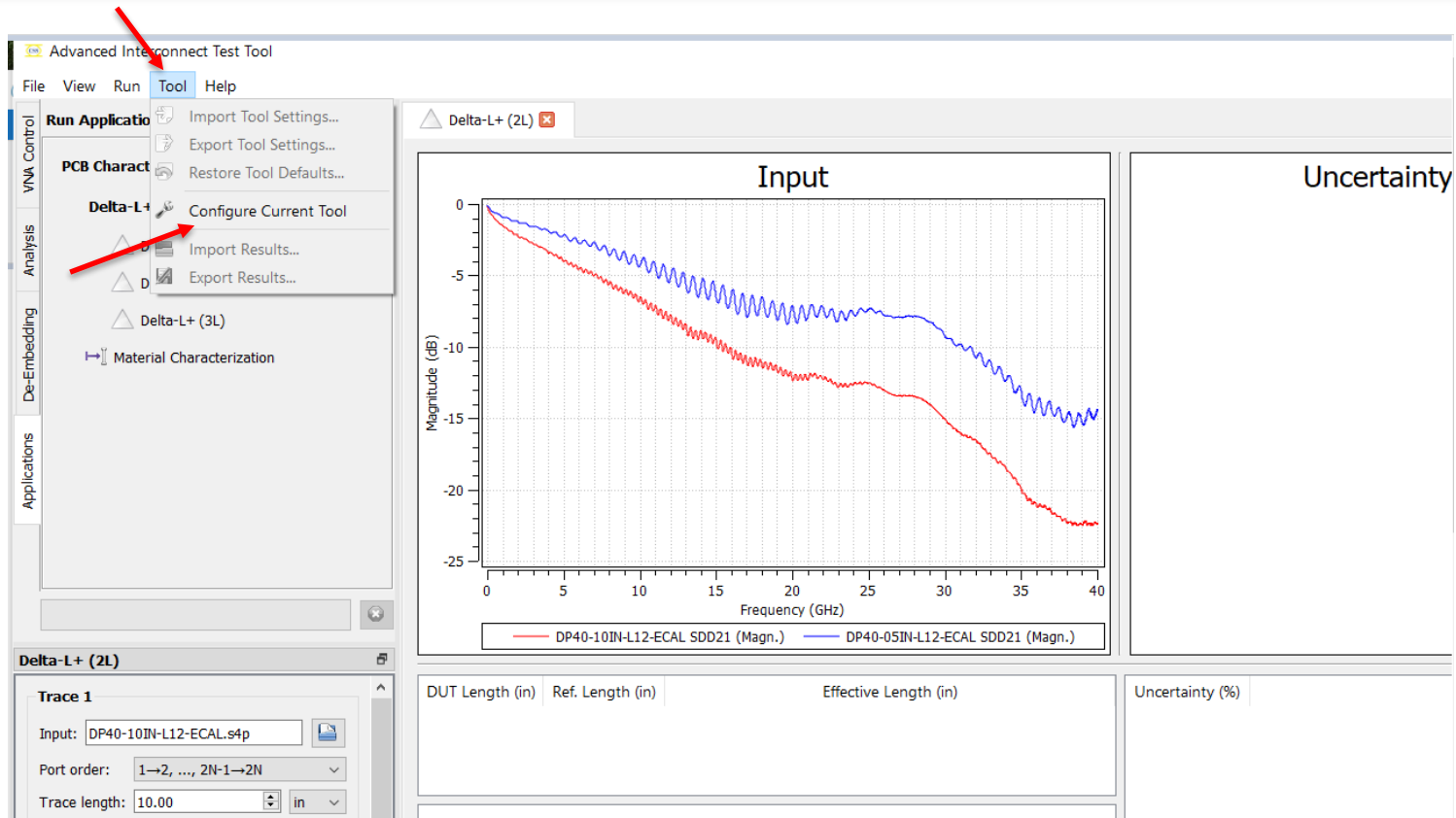


- Make sure to enter trace length

20 GHz Differential Delta-L 3.0 (3L)

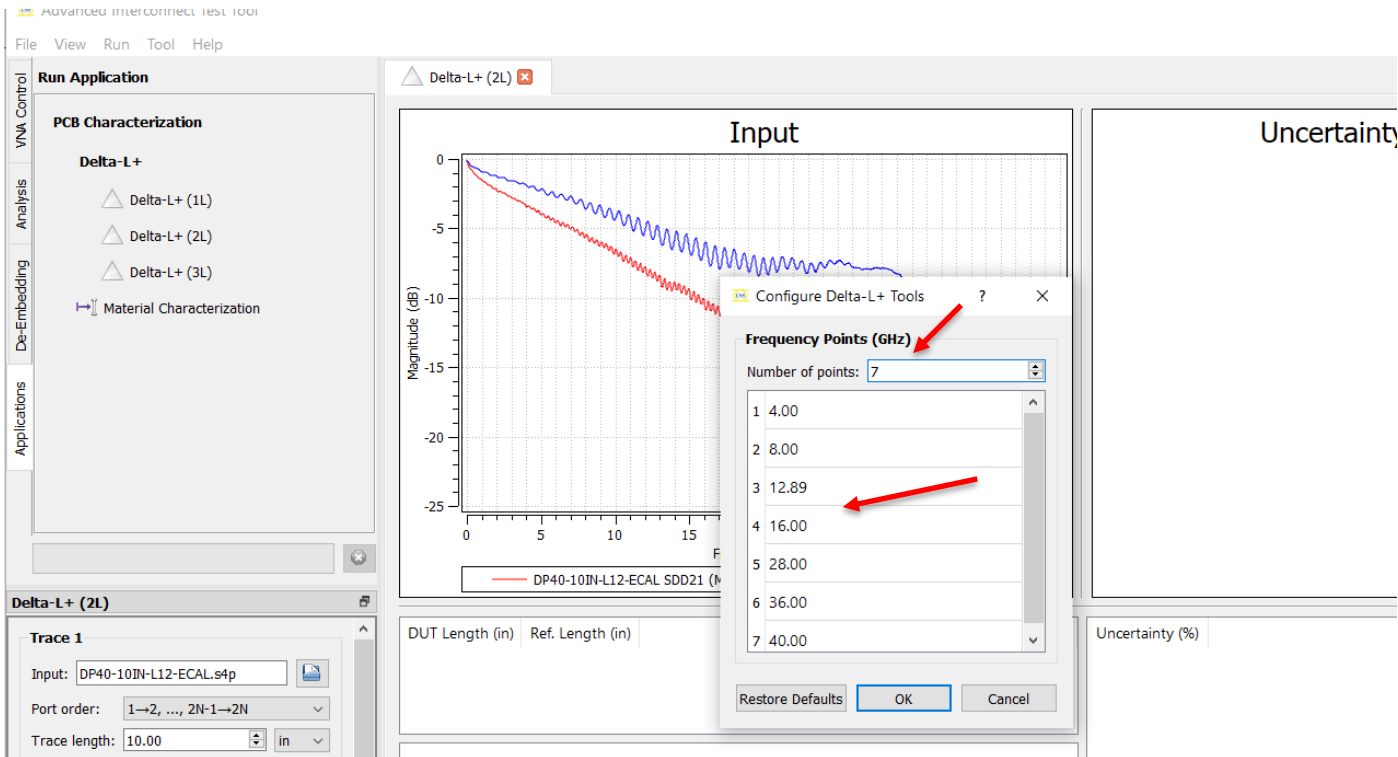


Configure Frequency Points



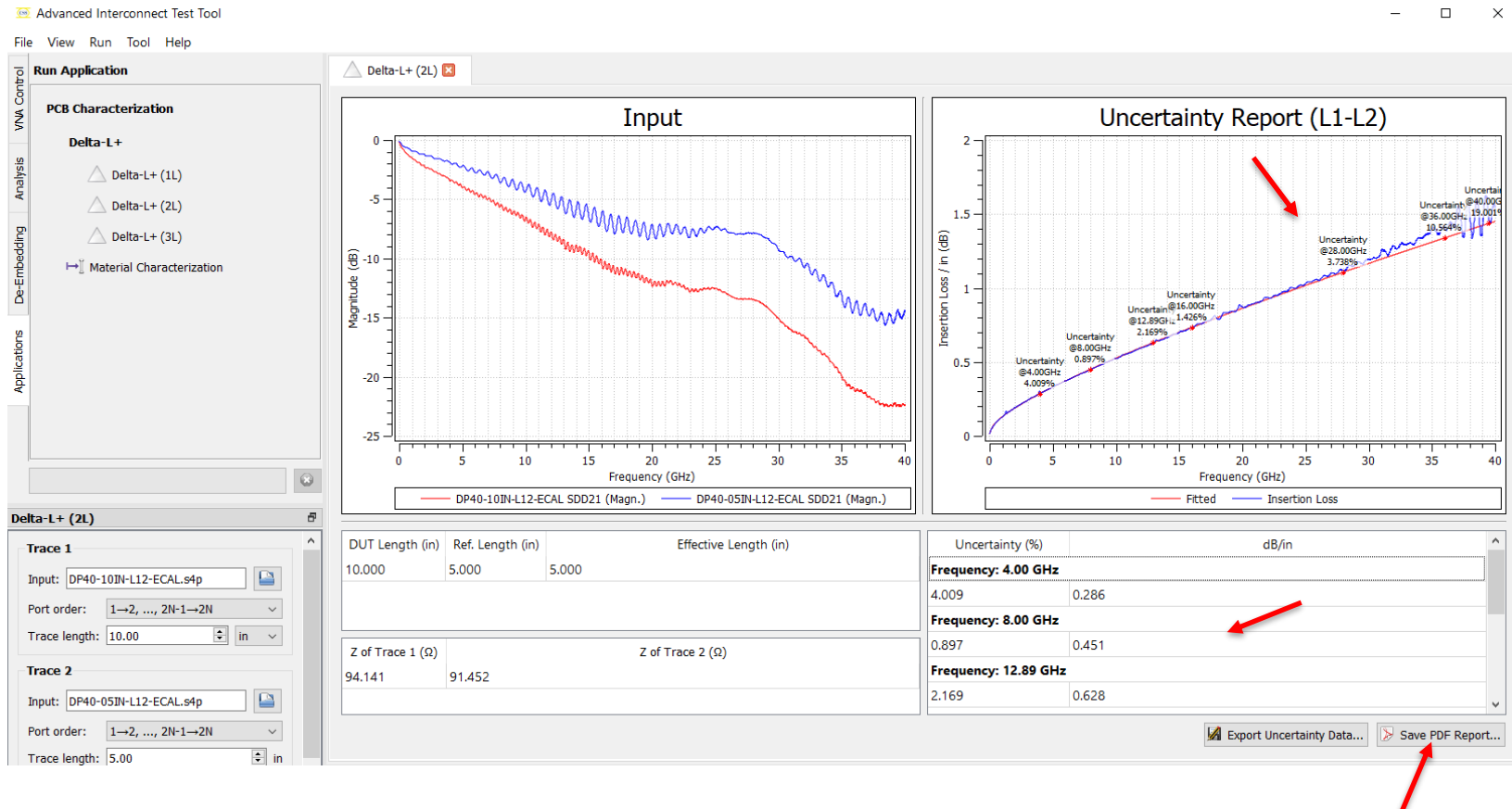
-> Tool -> Configure Current Tool

Configure the Frequency Points – cont.



- Enter the “Number of the points”
- Enter the frequency setting for each point
- Hit “OK”

Configure the Frequency Points – cont.



- Frequency points show at both the chart and table
- Export Uncertainty Data and save PDF Report

Delta-L+ Data & Report

Delta-L+ 2L Uncertainty Data.csv - Excel Richard Zai

File Home Insert Page Layout Formulas Data Review View Developer Help Tell me Share

Paste Font Alignment Number Conditional Formatting Format as Table Cell Styles Clipboard Styles

A1

	A	B	C	D	E	F	G	H	I	J
1		Uncertain dB/in								
2		4.00 GHz								
3	L1-L2	4.008685	0.286257							
4		8.00 GHz								
5	L1-L2	0.896687	0.451074							
6		12.89 GHz								
7	L1-L2	2.169393	0.628366							
8		16.00 GHz								
9	L1-L2	1.426116	0.733428							
10		28.00 GHz								
11	L1-L2	3.737836	1.107071							
12		36.00 GHz								
13	L1-L2	10.56403	1.338503							
14		40.00 GHz								
15	L1-L2	19.00116	1.436708							
16										
17										
18										
19										

Delta-L+ 2L Uncertainty Data

Ready Accessibility: Unavailable 100%

.CSV Data

Delta-L+ Report

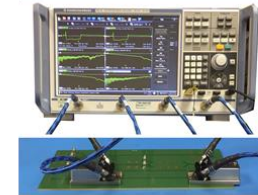
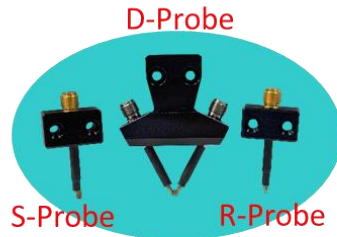
	DUT Length (in)	Ref. Length (in)	Effective Length (in)
L1-L2	10.000	5.000	5.000

Z of Trace 1 (Ω)	Z of Trace 2 (Ω)
94.141	91.452

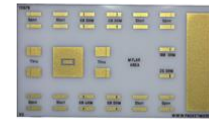
	Uncertainty (%)	dB/in
Frequency: 4.00 GHz		
L1-L2	4.009	0.286
Frequency: 8.00 GHz		
L1-L2	0.897	0.451
Frequency: 12.89 GHz		
L1-L2	2.169	0.628
Frequency: 16.00 GHz		
L1-L2	1.426	0.733
Frequency: 28.00 GHz		
L1-L2	3.738	1.107
Frequency: 36.00 GHz		
L1-L2	10.564	1.339
Frequency: 40.00 GHz		
L1-L2	19.001	1.437

PDF Report

PacketMicro Product Offering



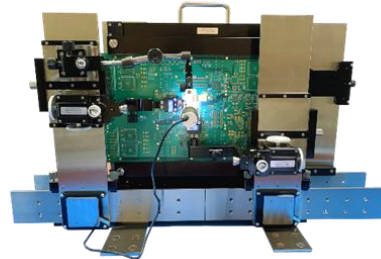
Delta-L 4.0 Solution



TCS70
Cal Substrate



VPS10 2-Sided Probe Station

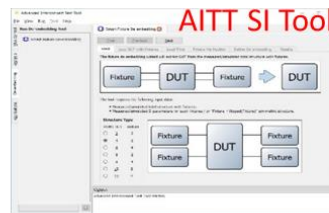


Flex Positioners

FP160MS



USB Type-C Fixtures HPS24 Probe Station



Slim Phase Stable Cable
Up to 67 GHz Junkosha MWX161



PacketMicro offers one-stop shopping for your needs in PCB probing and SI analysis.

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- Probe Positioners
- DIY Probe Stations
- Junkosha phase-stable cables
- CSS AITT Signal-Integrity Tool
- Dino-Lite Microscopes

PacketMicro Customers (of 200+ in 30+ Countries)



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- Rugged 40 GHz Differential Probes
- Rugged 30 GHz Single-ended Probes
- Laboratory Rental
- Engineering Services
- Signal Integrity Consulting

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Office: 408-675-3900

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