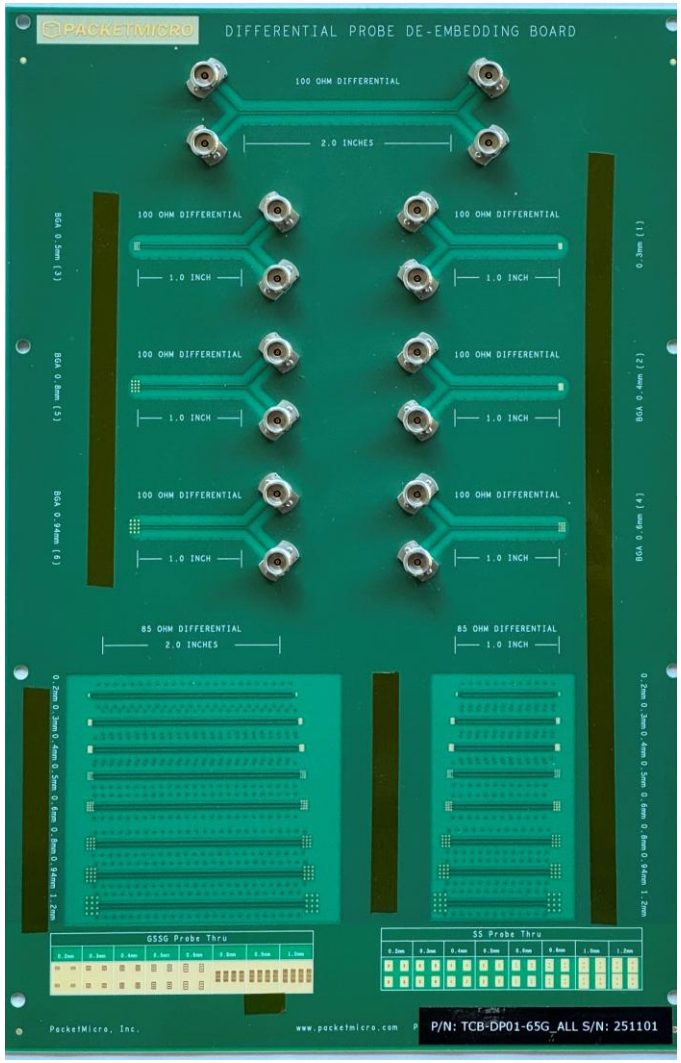
De-embedding Board for Differential Probes



TCB-DP01-65G

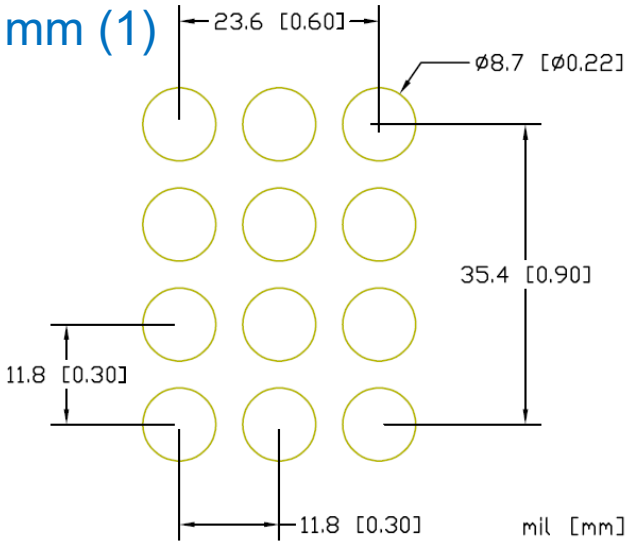
- Frequency: 0 – 65 GHz
- Connectors: 1.85 mm
- Probe Pitches: 0.3mm (1), 0.4mm (2), 0.5mm (3), 0.6mm (4), 0.8mm (5), 0.94mm (6)
- P/N: TCB-DP01-65G_356 (0.5, 0.8, 0.94 mm, 3 pitches mounted)

TCB-DP01-40G

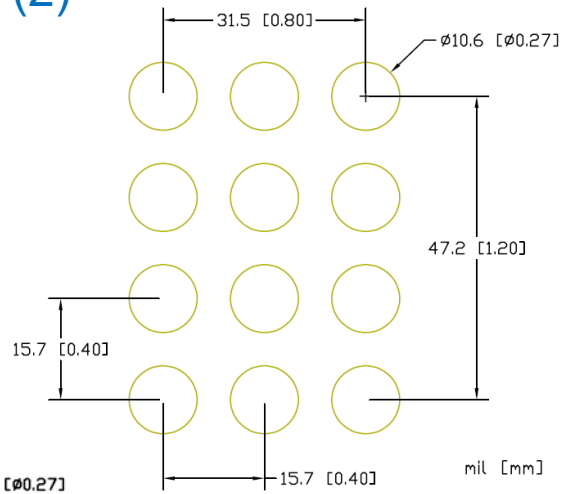
- Frequency: 0 – 40 GHz
- Connectors: 2.92 mm
- Probe Pitches: 0.3mm (1), 0.4mm (2), 0.5mm (3), 0.6mm (4), 0.8 mm (5), 0.94mm (6)
- P/N: TCB-DP01-40G_136 (0.3, 0.5, 0.94 mm, 3 pitches mounted)

Launch Footprints

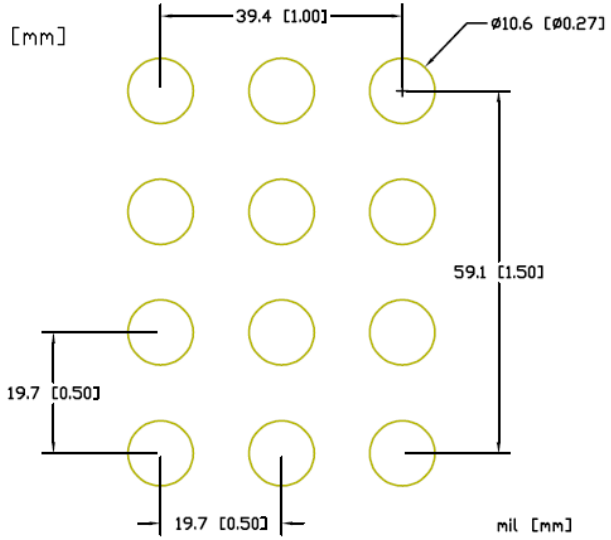
0.3 mm (1)



0.4 mm (2)

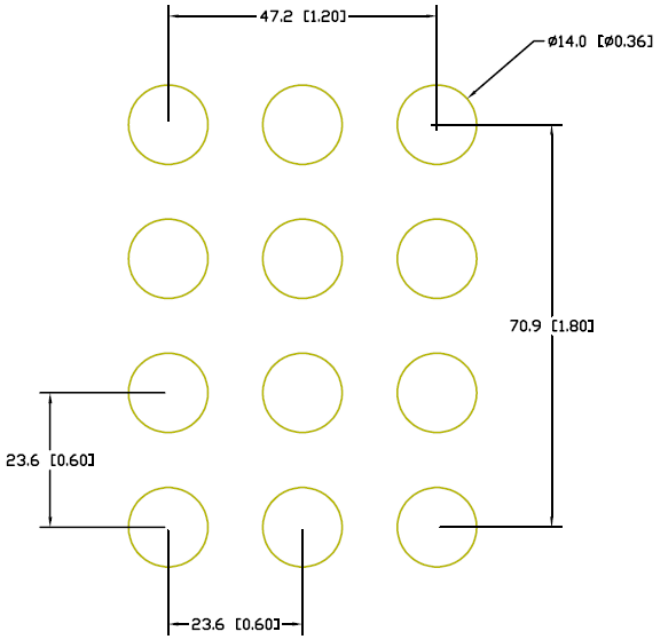


0.5 mm (3)

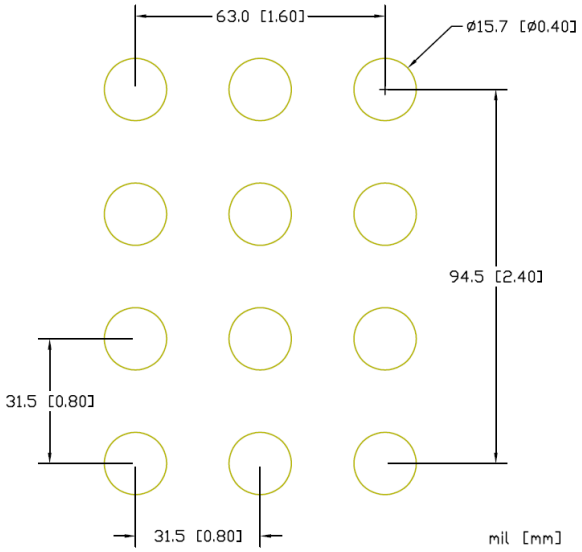


Launch Footprints – cont.

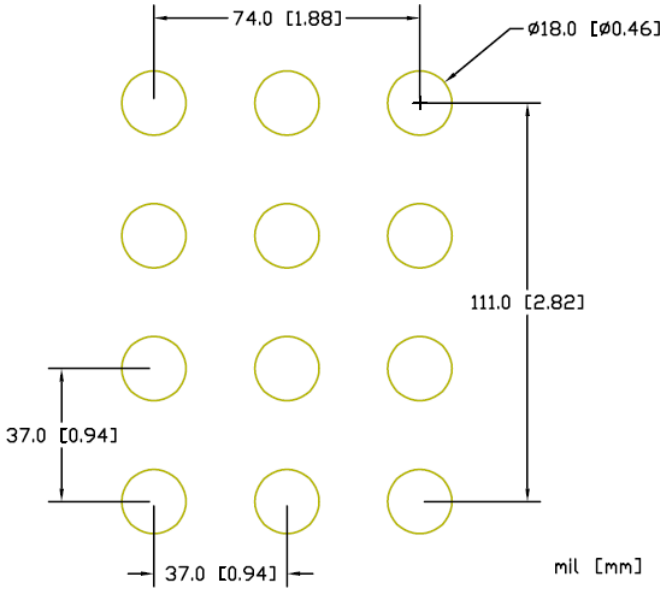
0.6 mm (4)



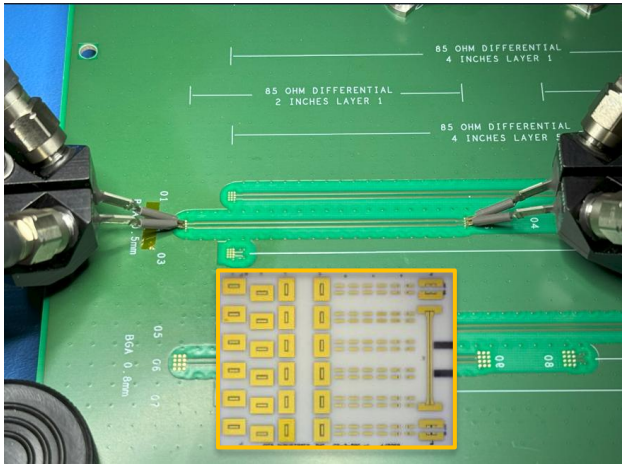
0.8 mm (6)

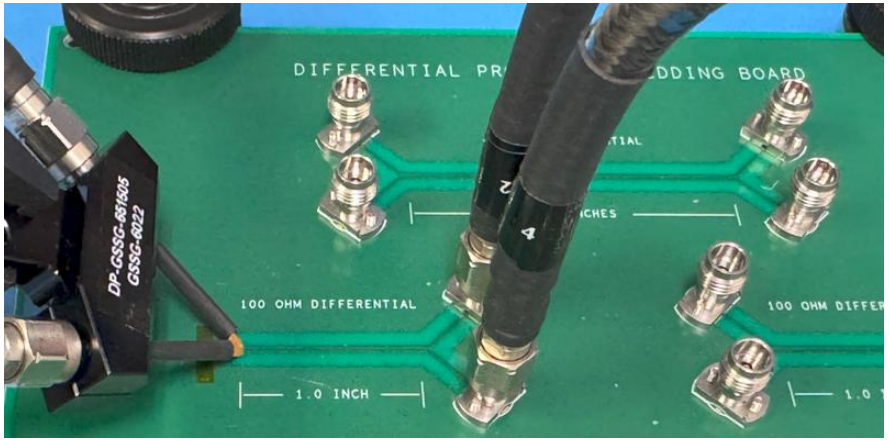


0.94 mm (5)



Probe SOLT Calibration vs. De-embedding





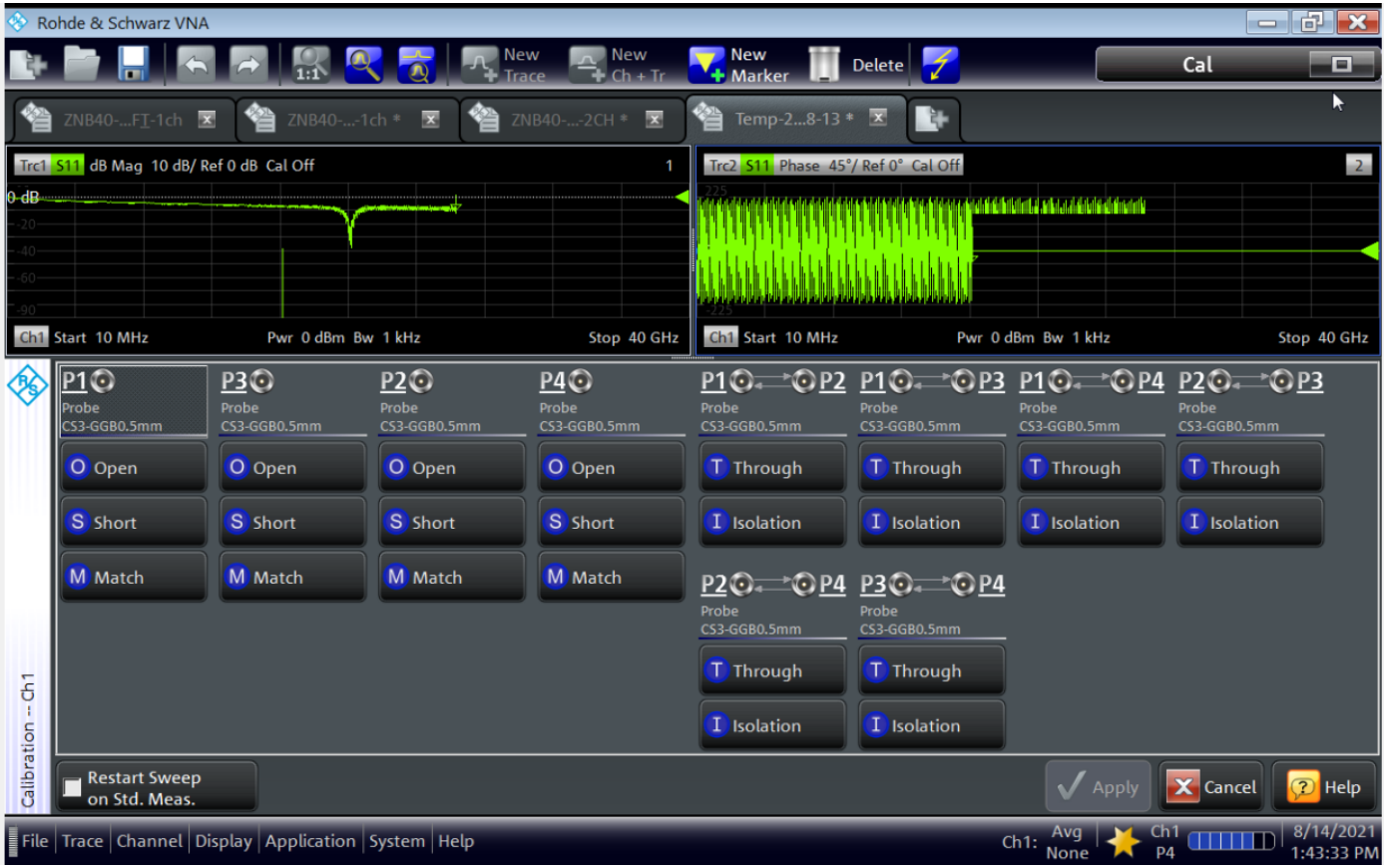
SOLT Calibration

- Accuracy is typically limited to ~50% of probe bandwidth due to mismatch of probe launches between calibration substrate and PCB under test.
- Require 18 probing steps

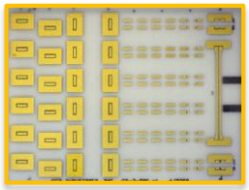
Probe De-embedding Approach

- Good accuracy can be achieved by matching the probe launches of the de-embedding board and PCB under test.
- Require 2 probing steps

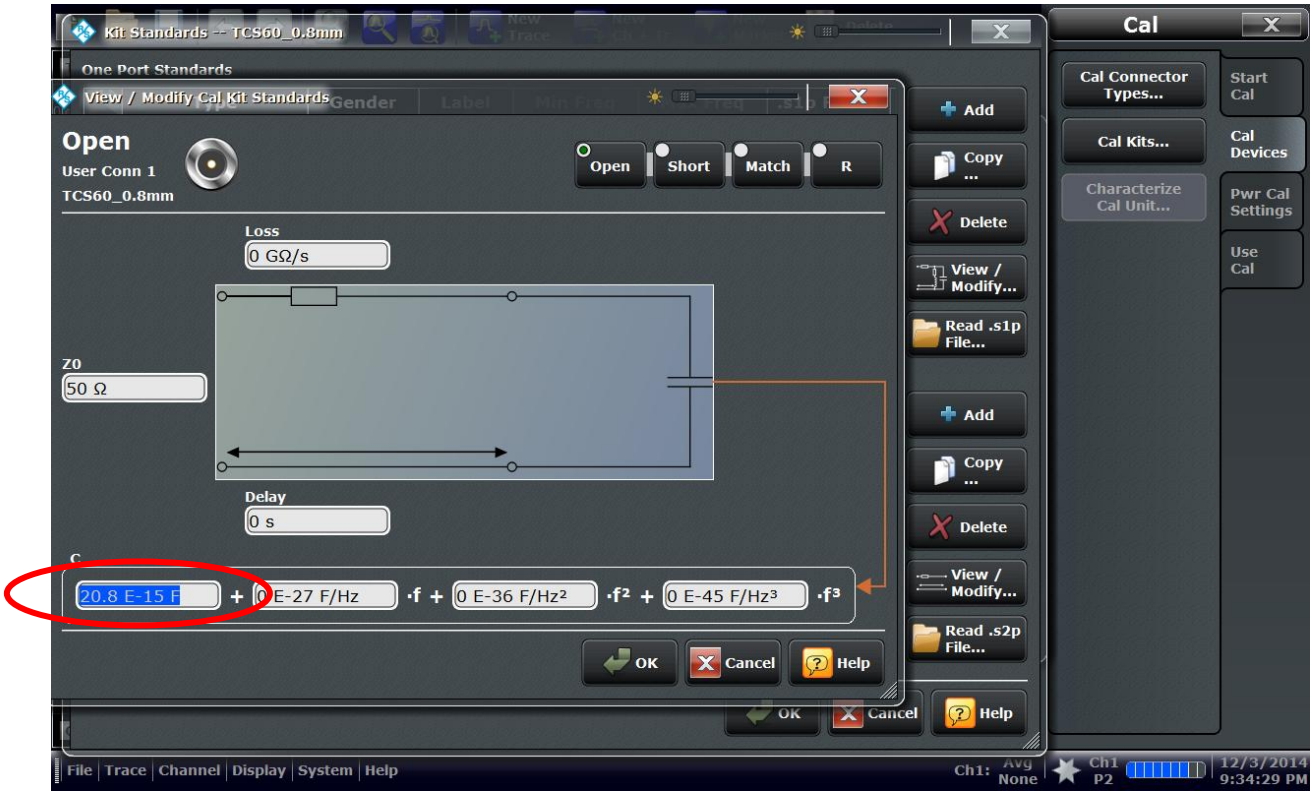
Challenge of SOLT Probe-tip Calibration



- Difficult to perform 18 probing actions (SOL x 4, 2-port Thru x 6) accurately

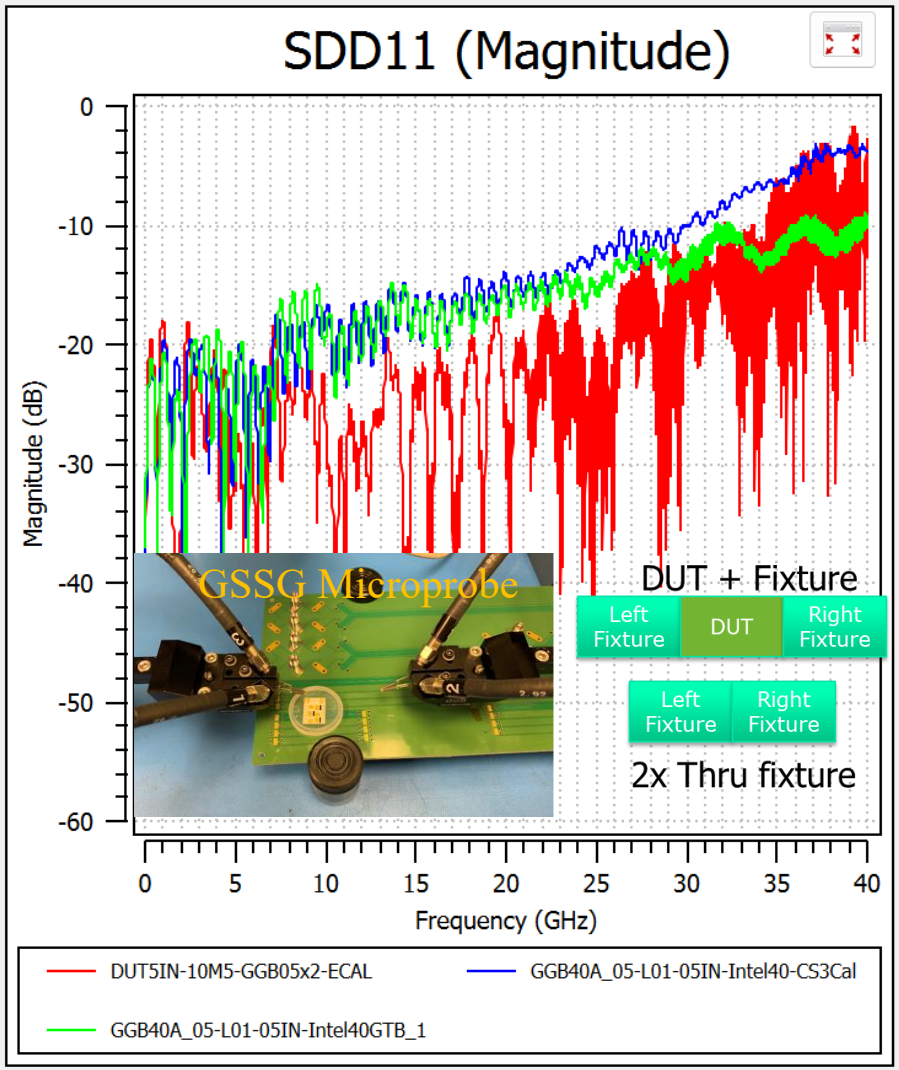


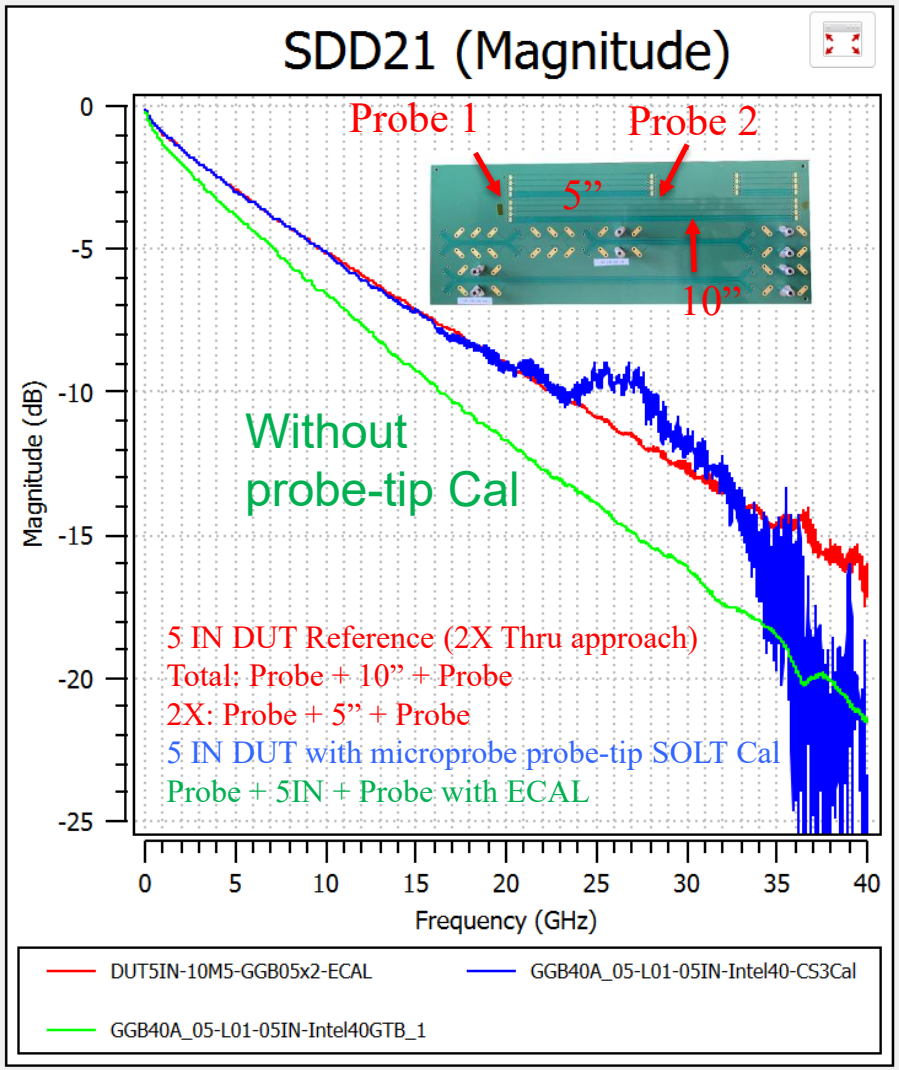
Probe SOL Coefficients



- Only f° is provided by probe manufacturers because higher-order terms are probe-launch dependent.
- This constraint causes inaccurate probe measurements with SOLT calibration at high frequencies.

SOLT Calibration Example





- SOLT calibration accuracy is typically limited to ~50% of probe bandwidth

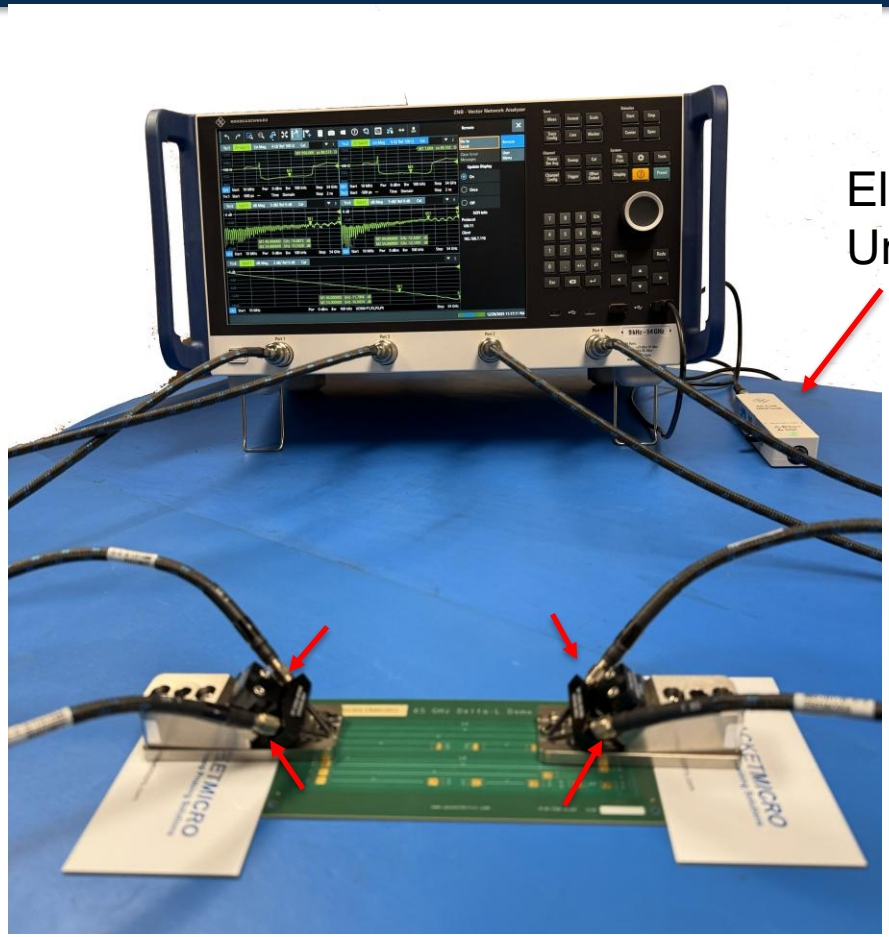
De-embedding Steps with VNA

- Step 1: Perform VNA calibration at the 4 cable-end connectors
- Step 2: Measure the S4P of Connector + 2 IN + Connector
- Step 3: Extract 1 IN + Connector
- Step 4: Load extracted 1 IN + Connector into VNA for de-embedding
- Step 5: Measure Probe#1 and Probe#2
- Step 6: Load Probe#1 and Probe#2 into VNA for de-embedding
- Step 7: Make measurements

Notes:

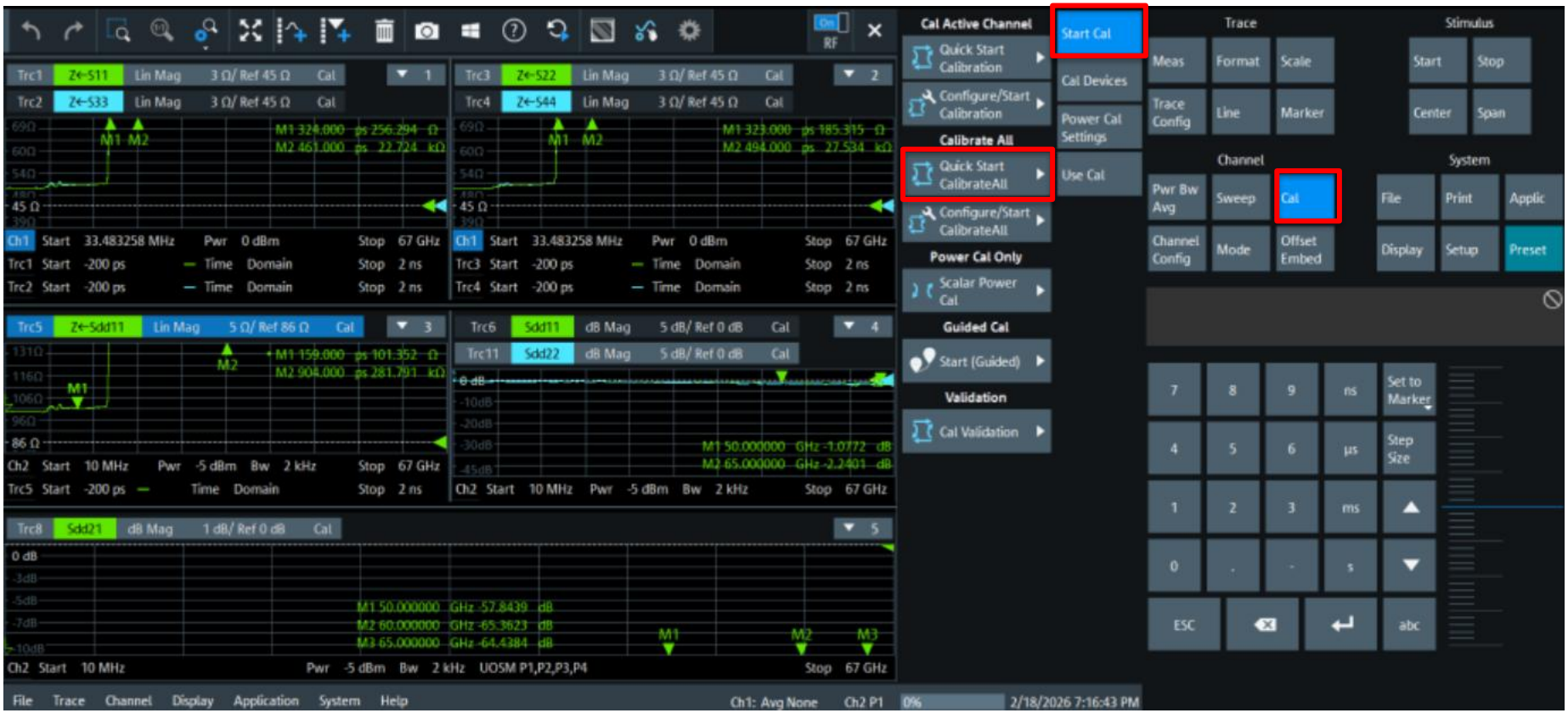
- Only Step 3 requires AITT, AFR, or other software tools.
- PacketMicro can provide the extracted S4P files upon request.

Step 1: VNA Calibration



- Perform VNA calibration at the 4 cable-end connectors that will be connected to the two probes

Step 1: Perform VNA Calibration

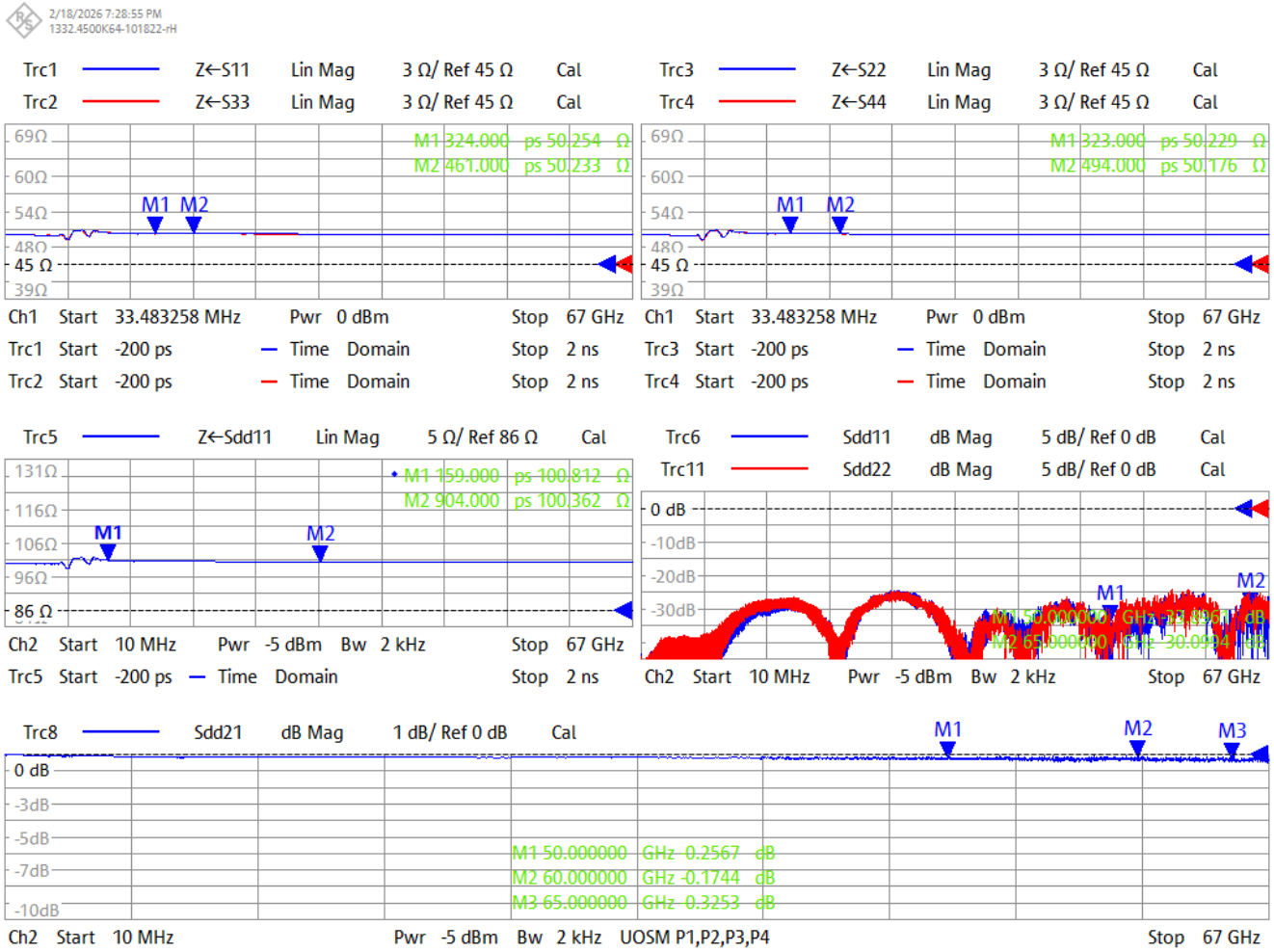


- Perform VNA calibration at the 4 cable-end connectors that will be connected to the two probes

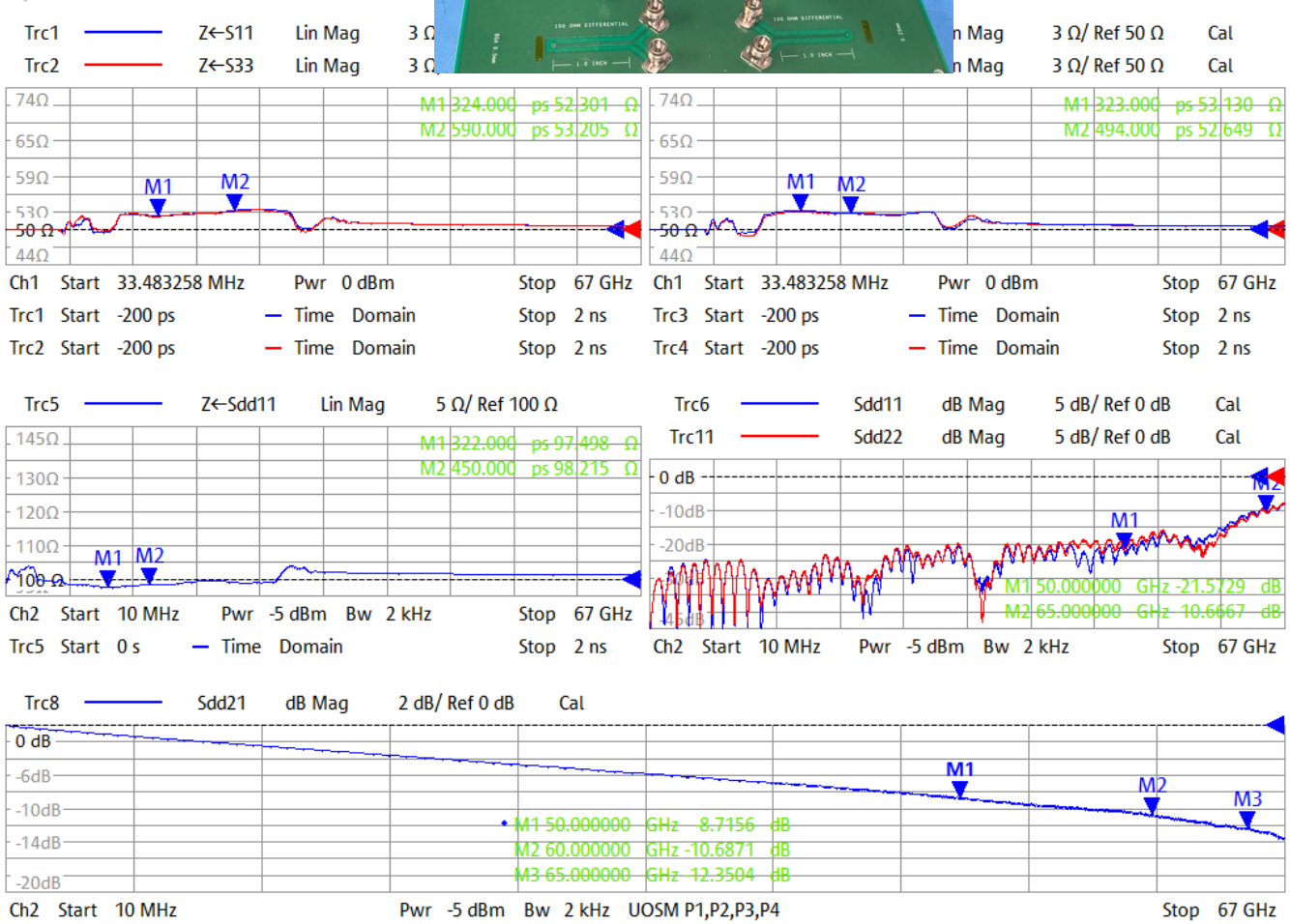
Step 1: VNA Calibration – cont.

Step 1: VNA Calibration – Cont.

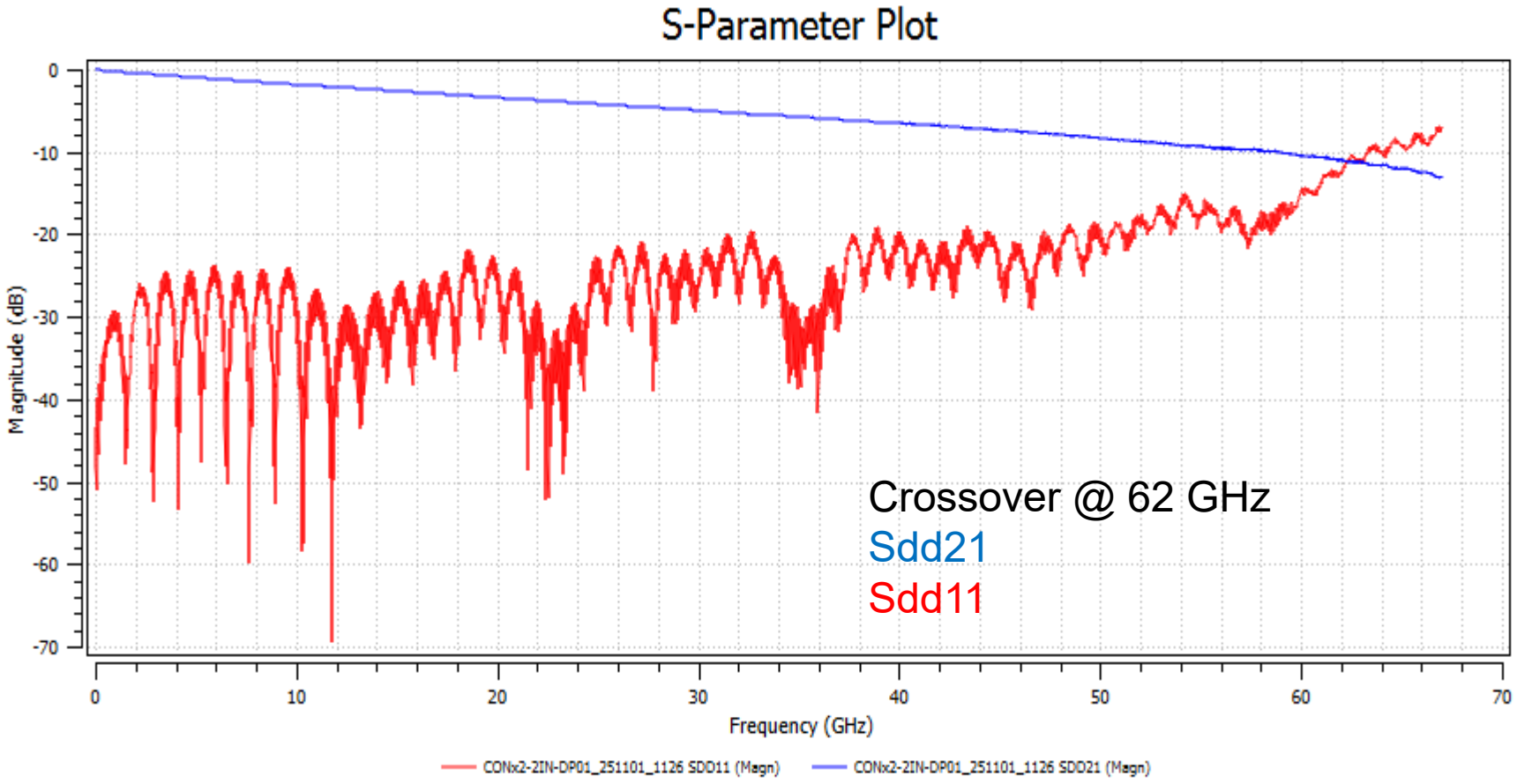
Verification with 2 Thru Adapters



Step 2: Measure the S4P of Connector + 2 IN + Connector



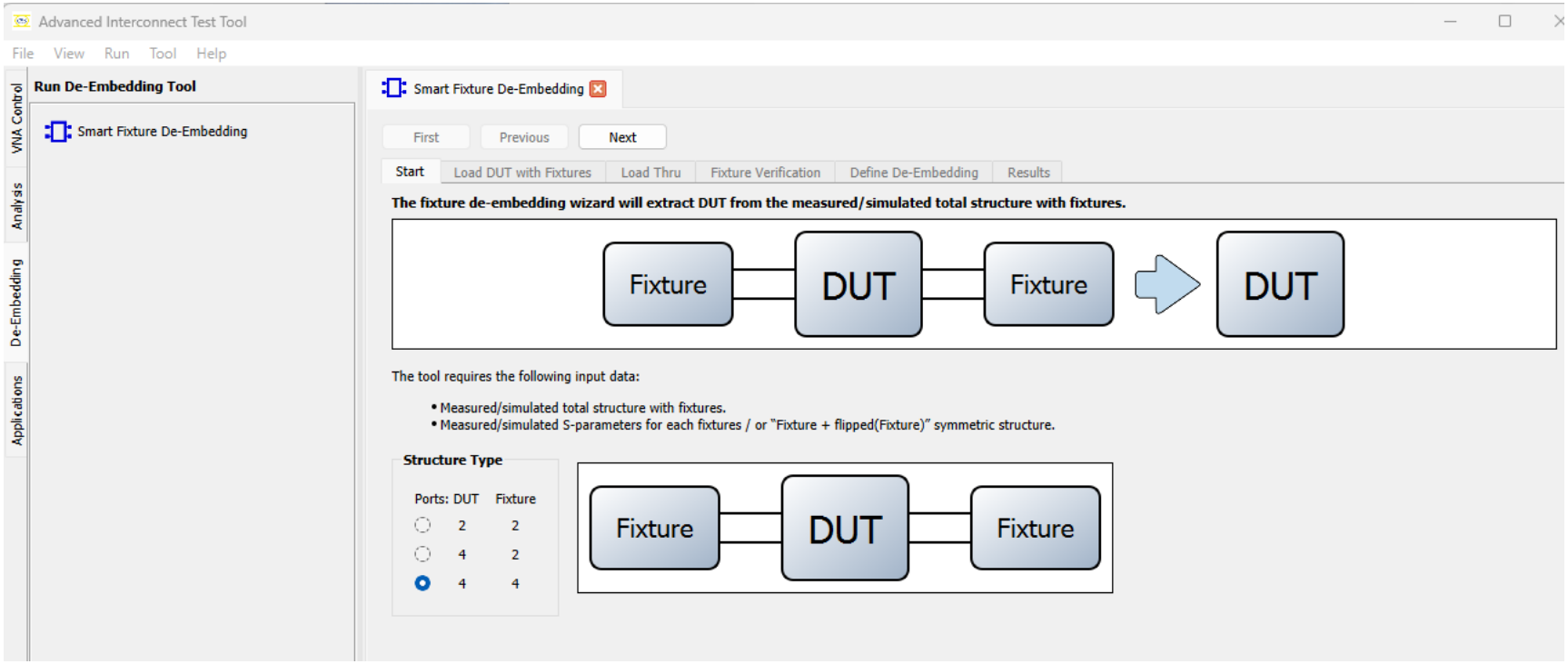
Step 2: Measure the S4P of Connector + 2 IN + Connector – cont.



- |Sdd21| should be greater than the |Sdd11| at the target max frequency.

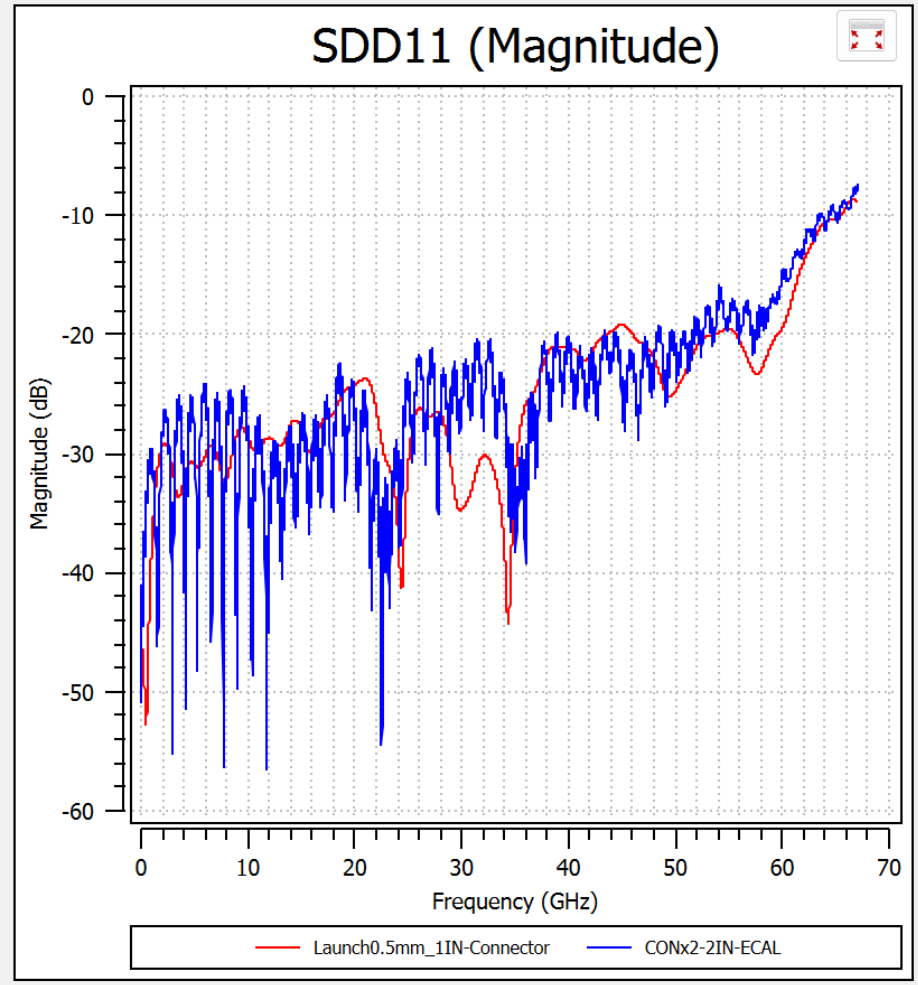
Step 3: Extract 1 IN + Connector”

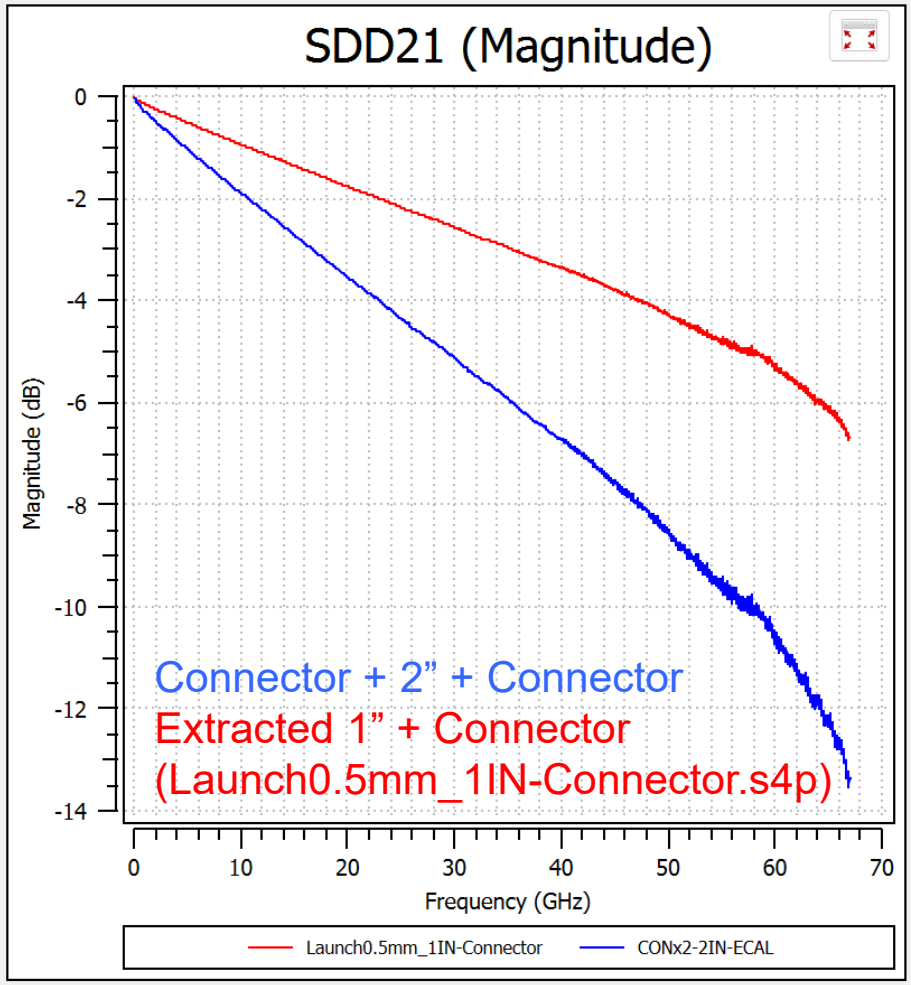
Extract “1 IN + Connector” s4p with AITT-SFD Tool



- PacketMicro can provide the extracted S4P files upon request.

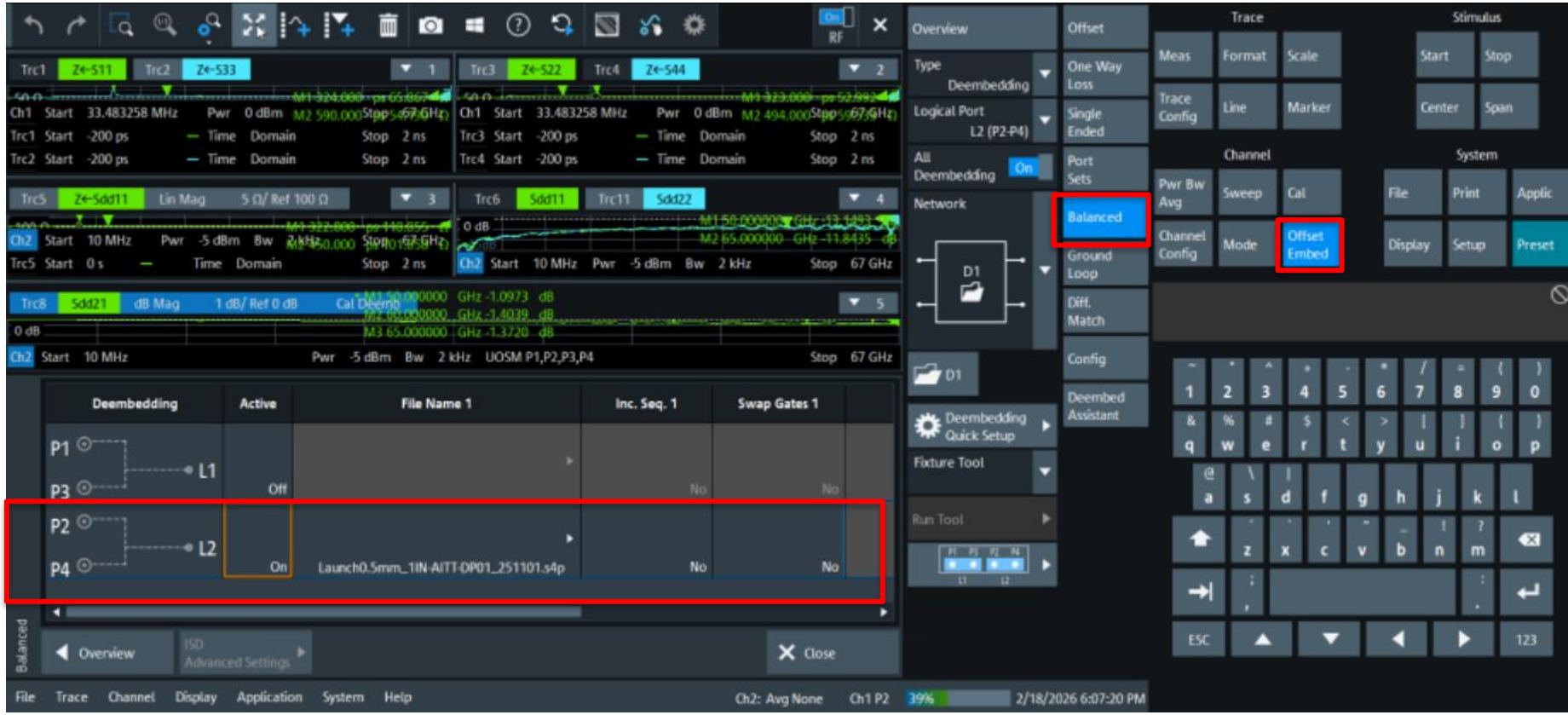
Step 3: Extract “1 IN + Connector” – cont.





- PacketMicro can provide the extracted S4P files upon request.

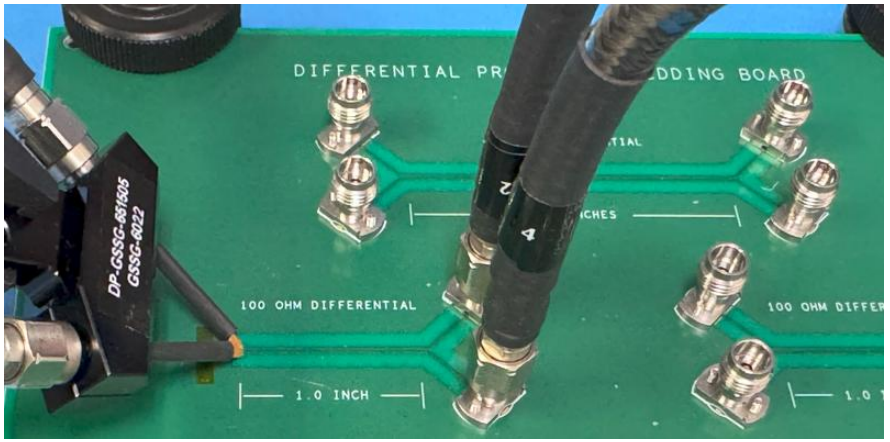
Step 4: Load extracted “1 IN + Connector” into VNA for de-embedding



Step 5: Measure Probe S4P

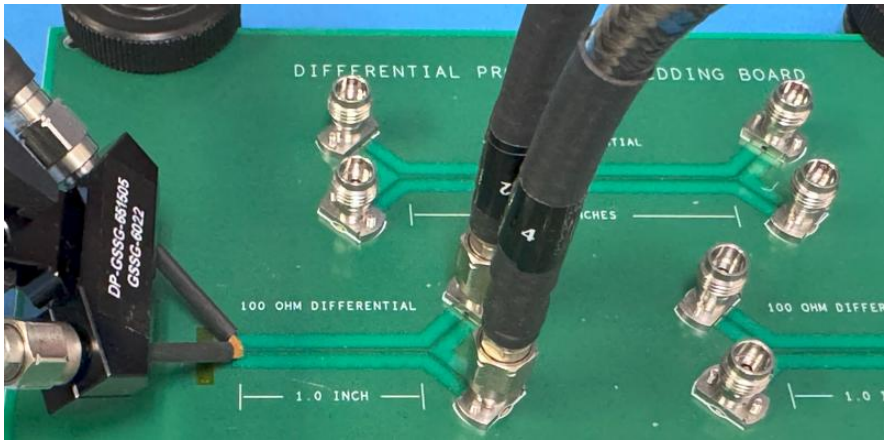
Measure Probe#1
(with De-embedding on)

Save
GSSG05_6019-DE-VNA.s4p

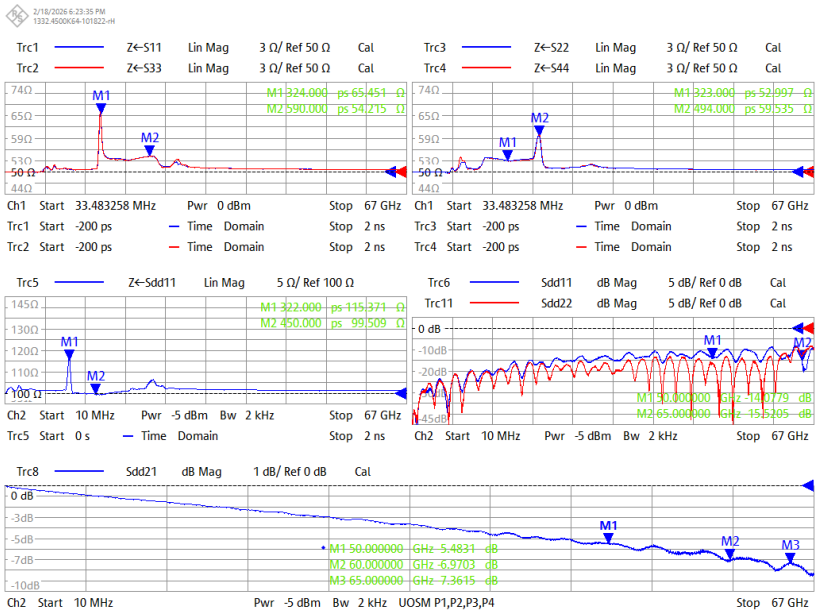


Measure Probe#2
(with De-embedding on)

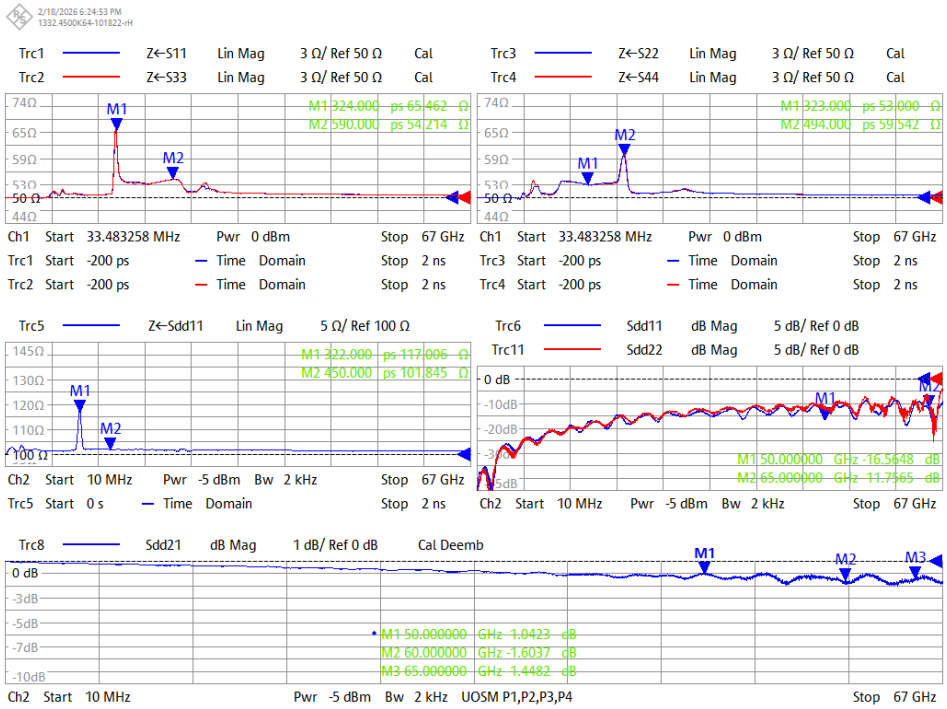
Save
GSSG05_6020-DE-VNA.s4p



Step 5 - Continued

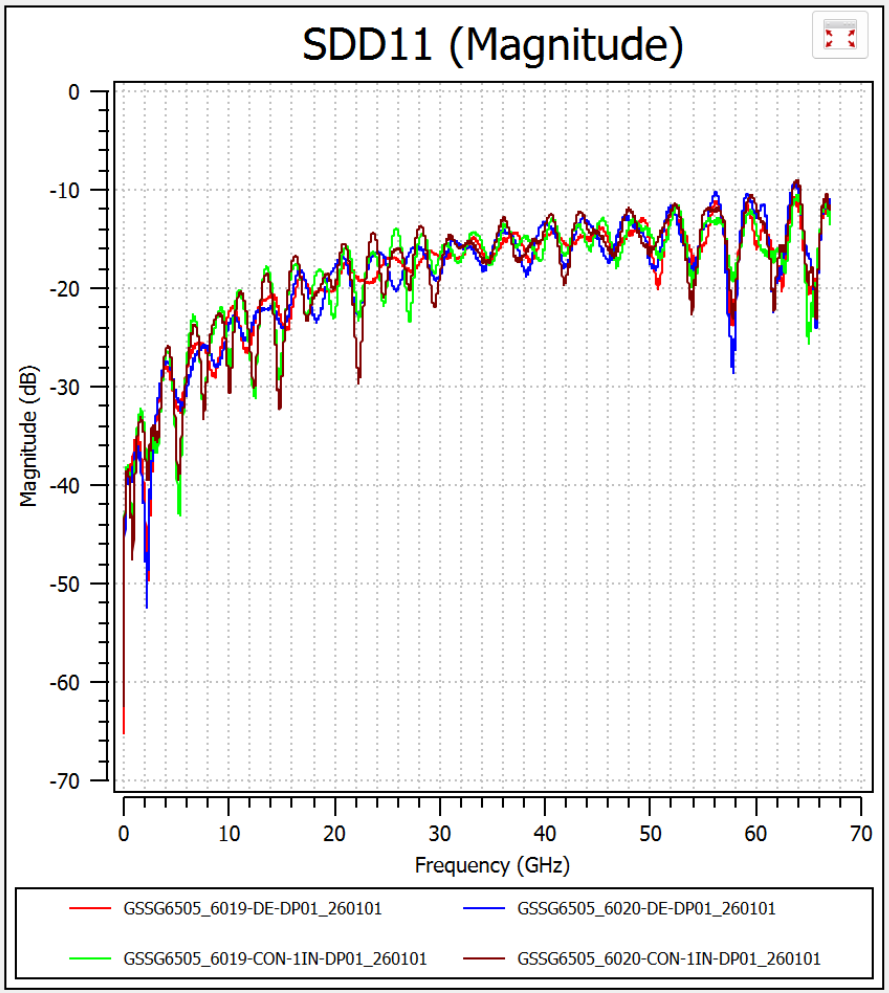


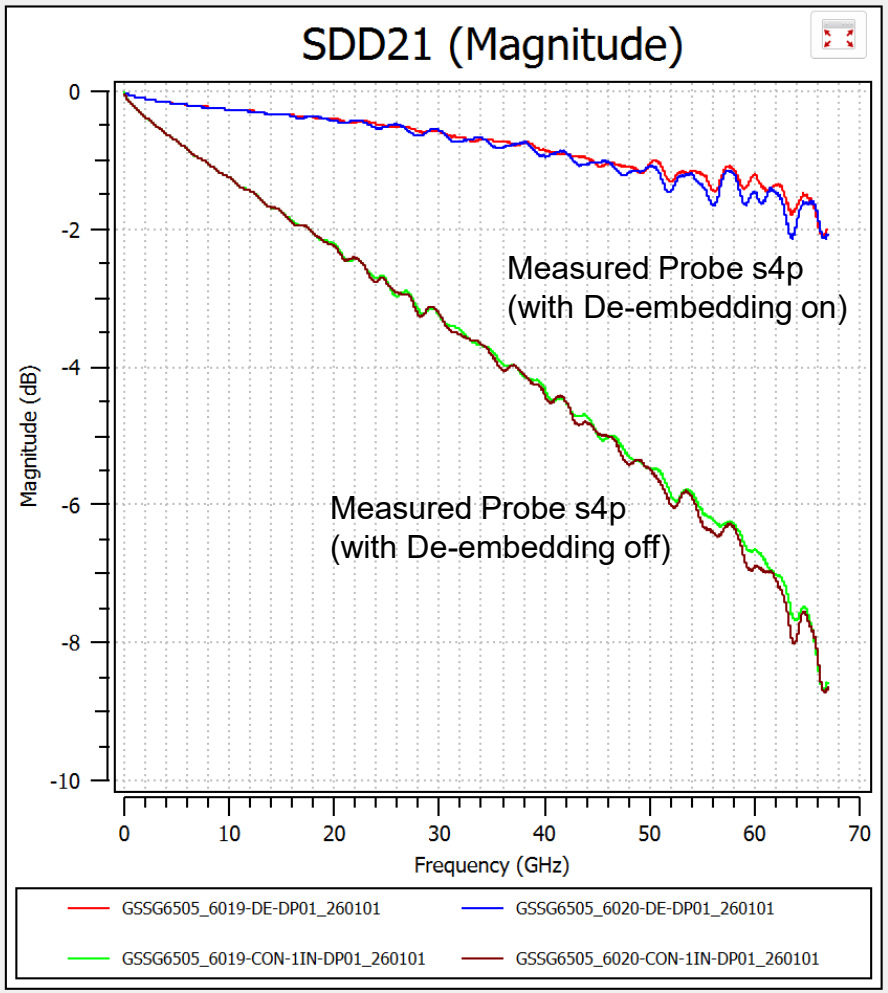
Measured Probe s4p
(with De-embedding off)



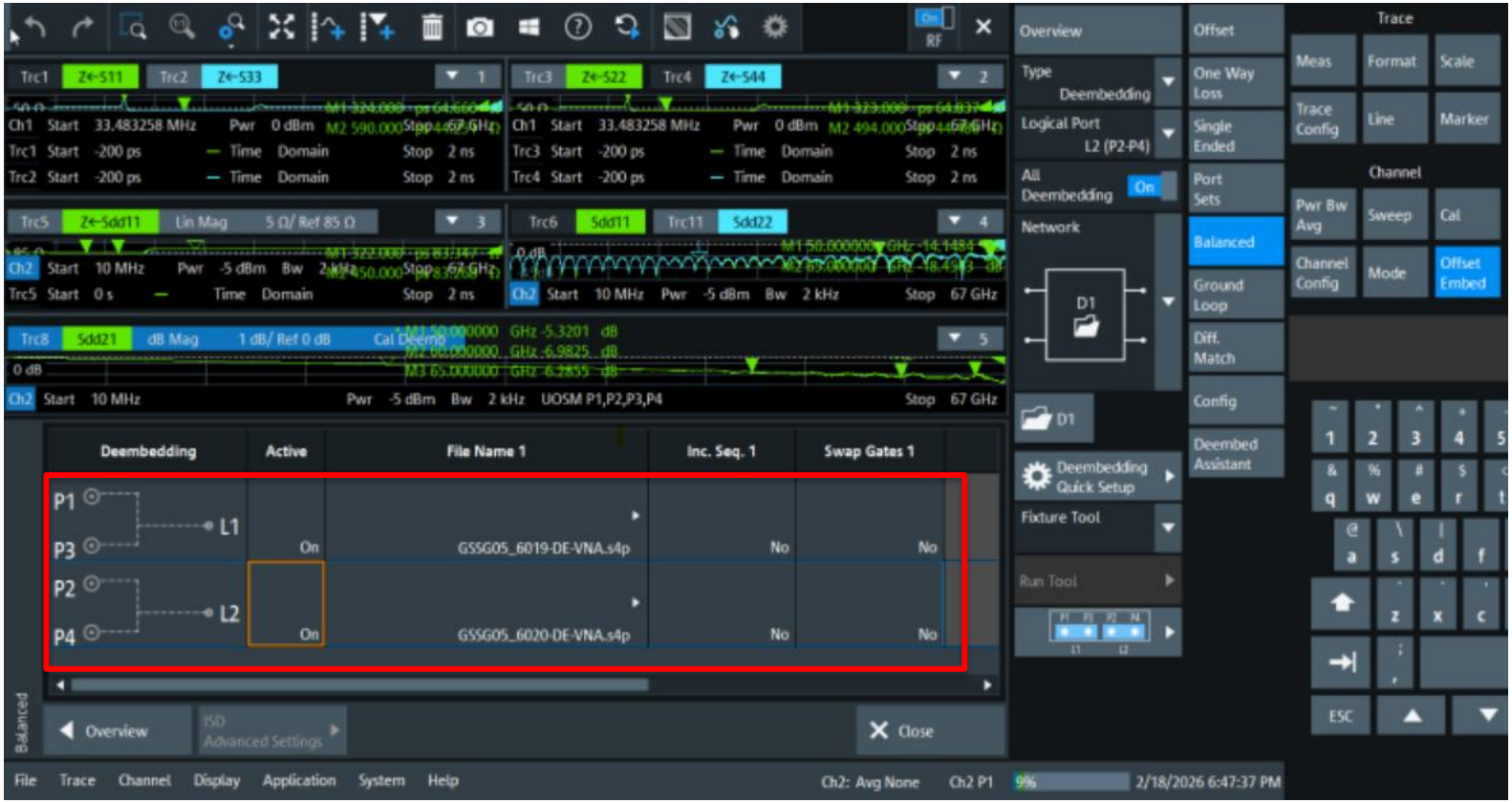
Measured Probe s4p
(with De-embedding on)

Step 5 - Continued

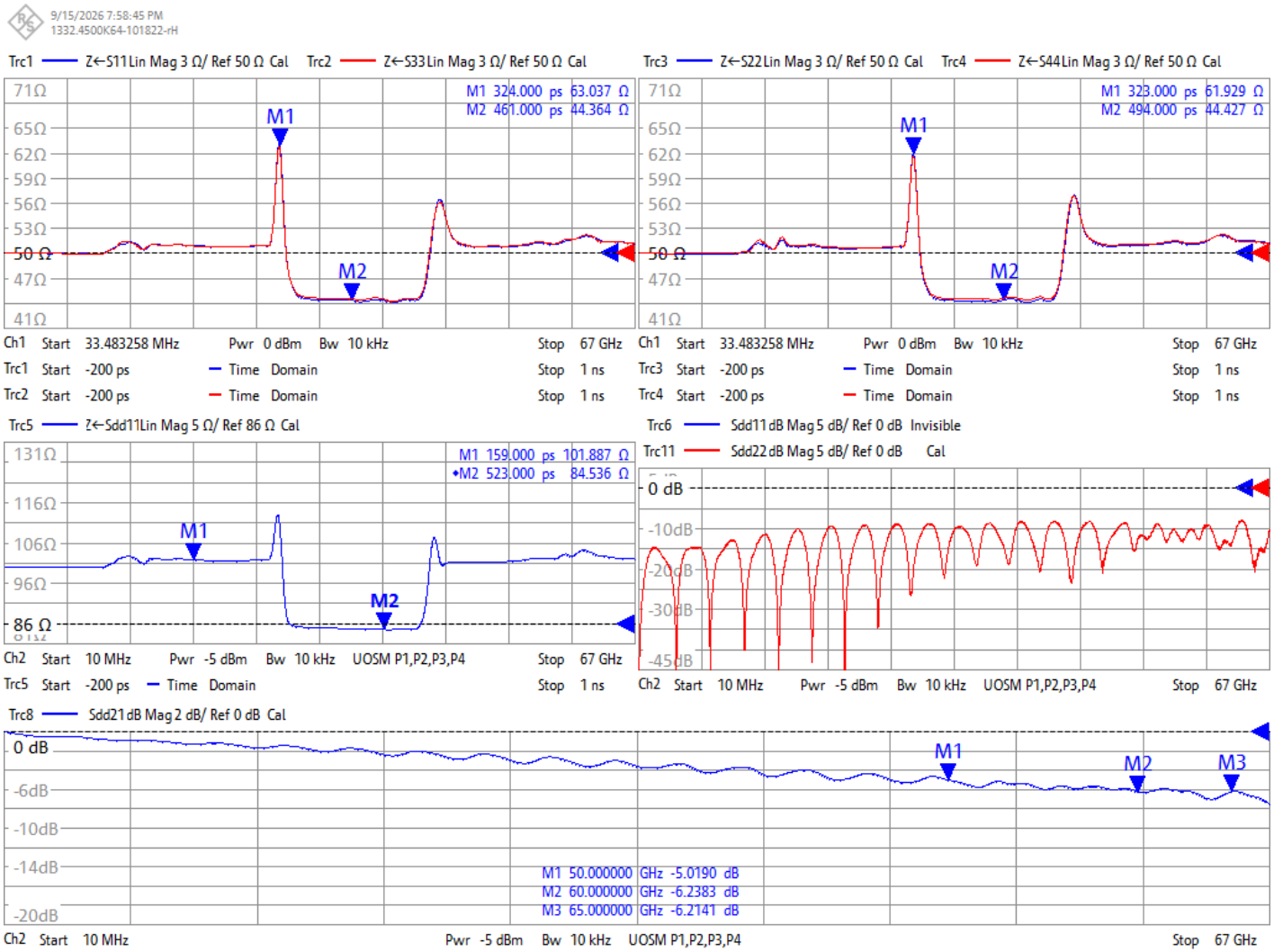




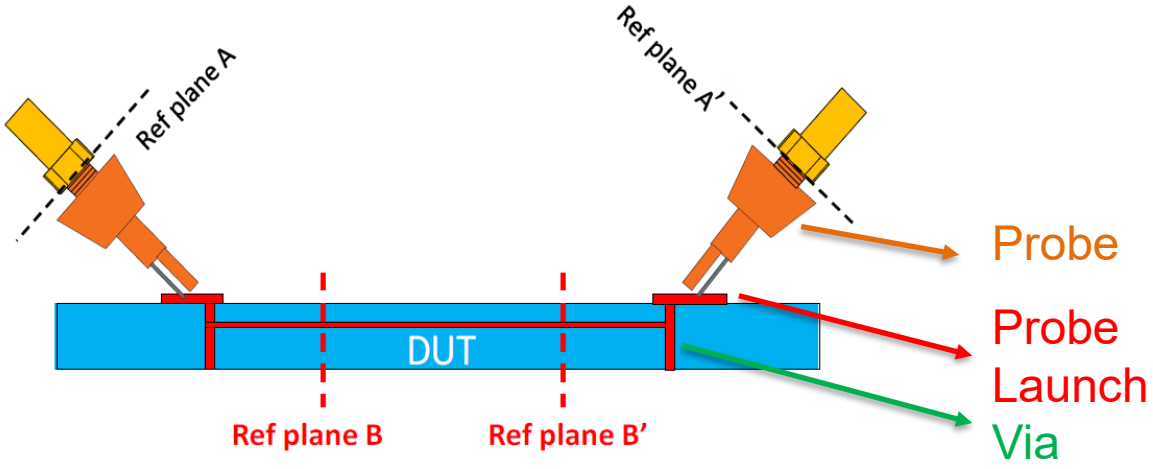
Step 6: Load Probe#1 & #2 into VNA for de-embedding



Step 7: Measure Probe#1 + 1” + Probe#2

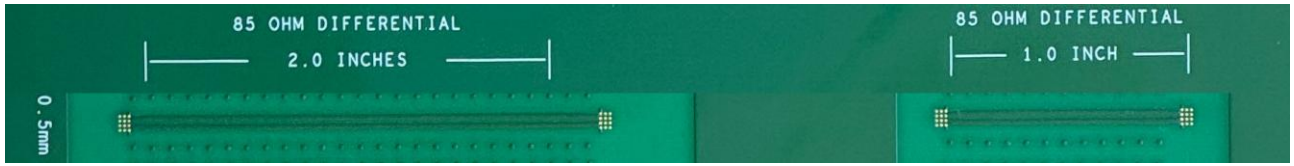


Create Reference DUT for Comparison



- **De-embedding with 2X Thru fixture**
  - Removing the effects caused by probes, probe contacts, and PCB vias.

DUT 1 IN Reference

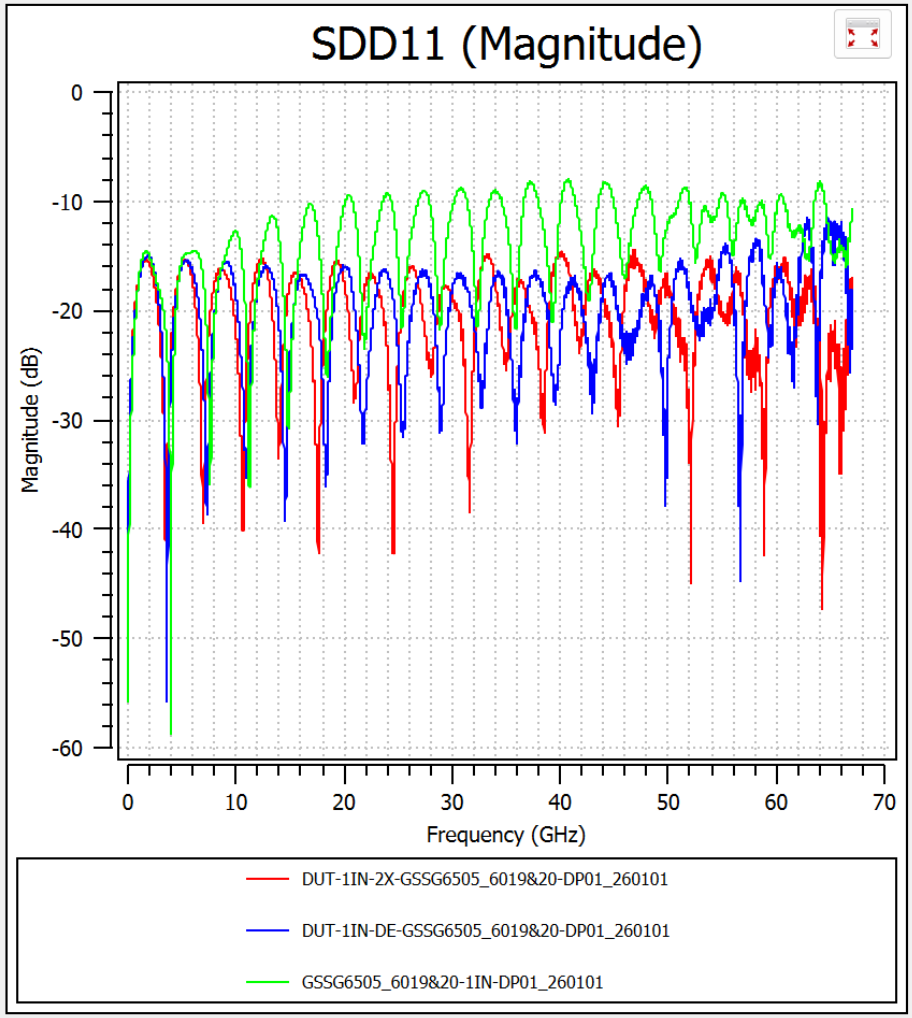


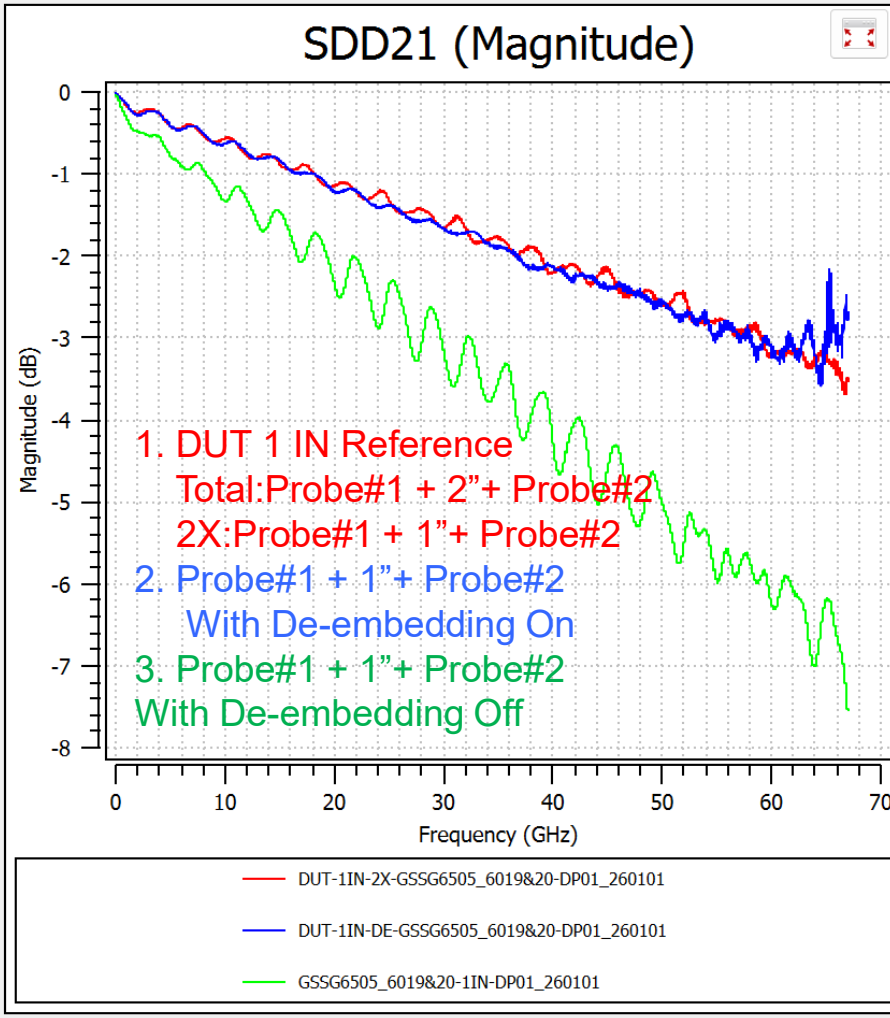
Total

2X Thru

Total= Probe 1 + 2 IN + Probe 2, 2X Thru = Probe 1 + 1 IN + Probe 2

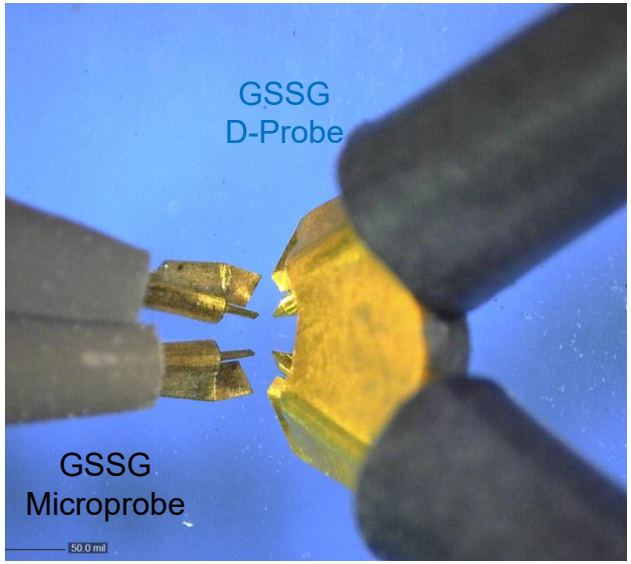
De-embedded 1 IN DUT (65 GHz GSSG Probes)

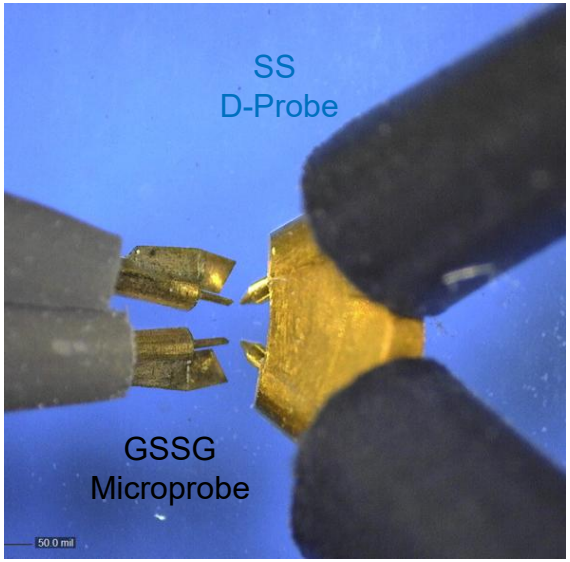




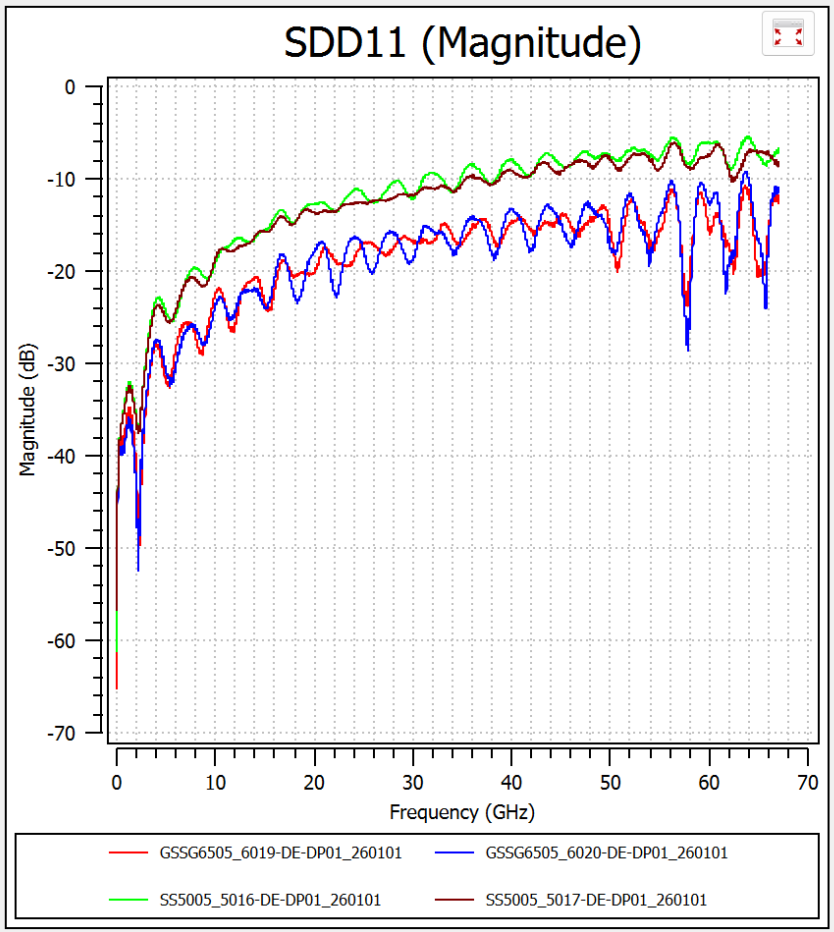
DP-GSSG vs. DP-SS Probes

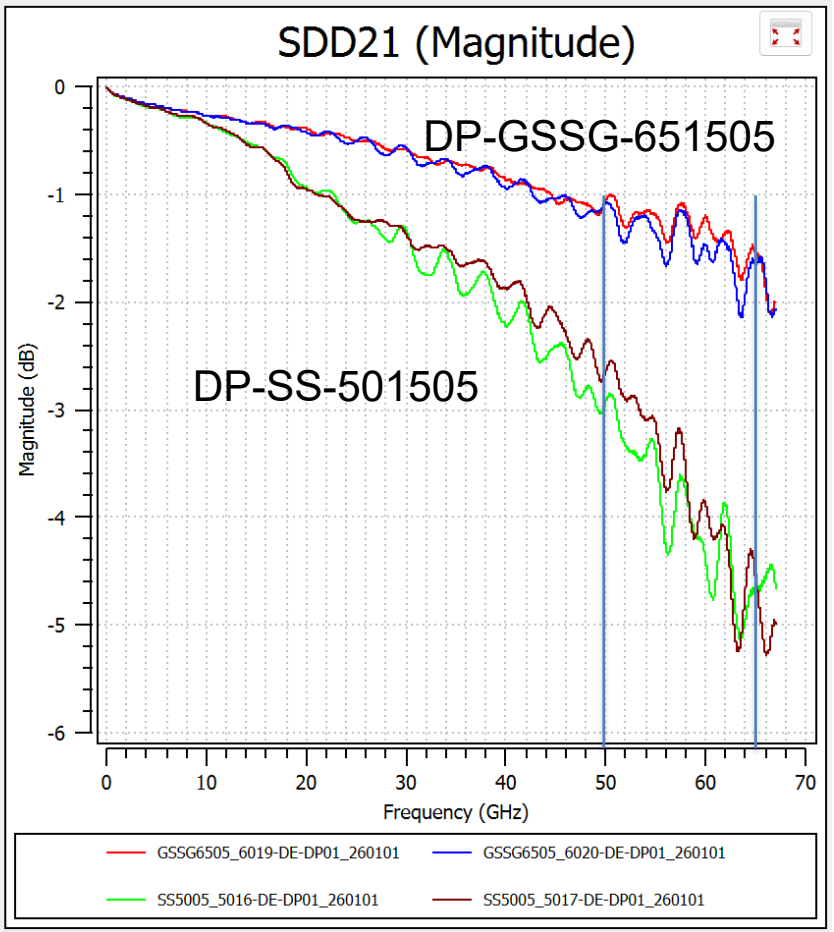
- **DP-SS series probes complement the DP-GSSG probes in use cases where there are insufficient GND pads surrounding the differential traces**



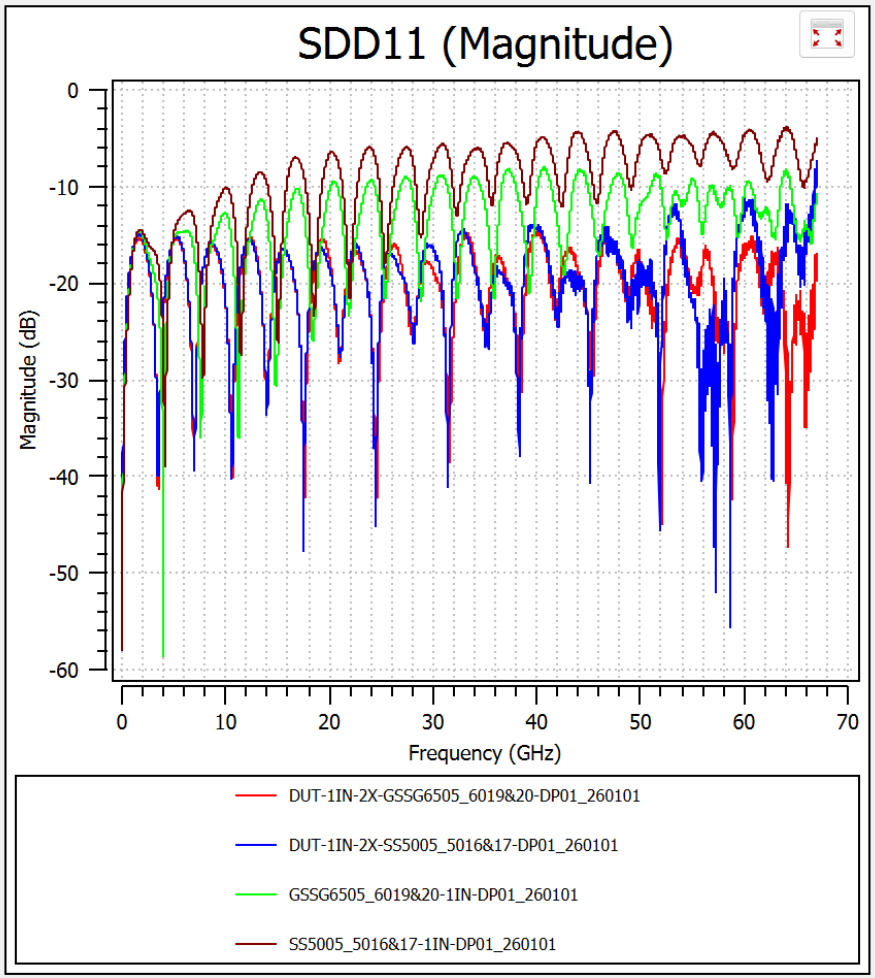


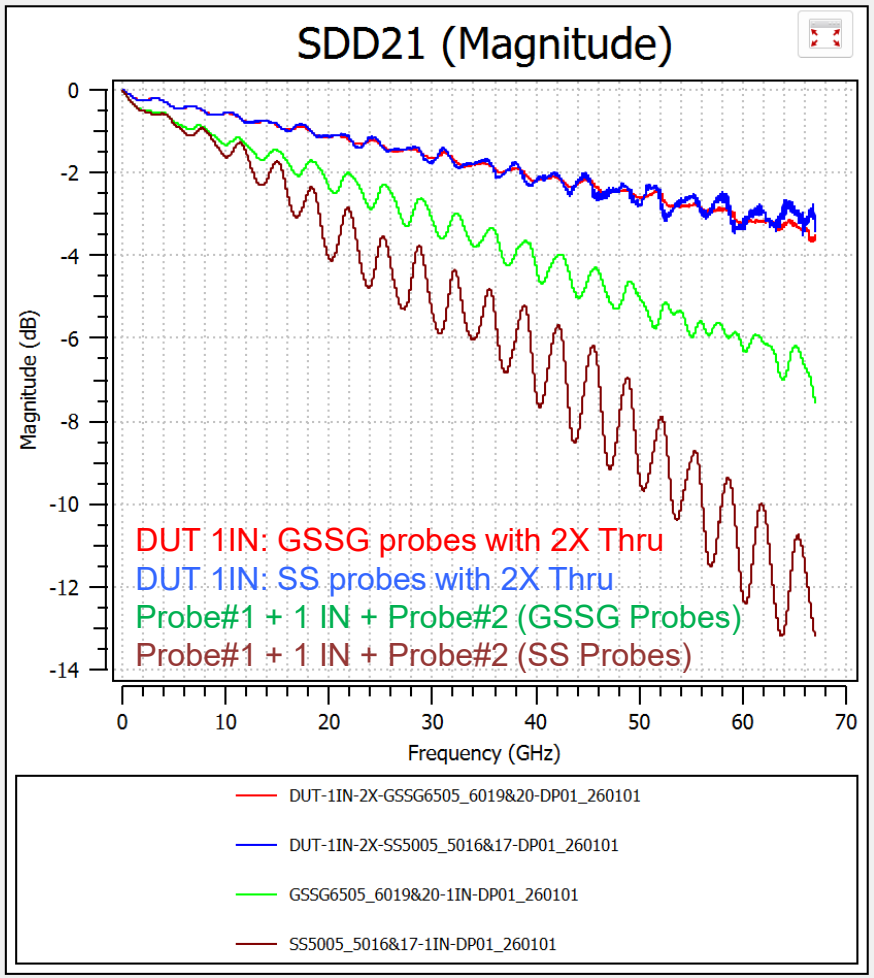
Sdd21 & Sdd11: GSSG vs. SS





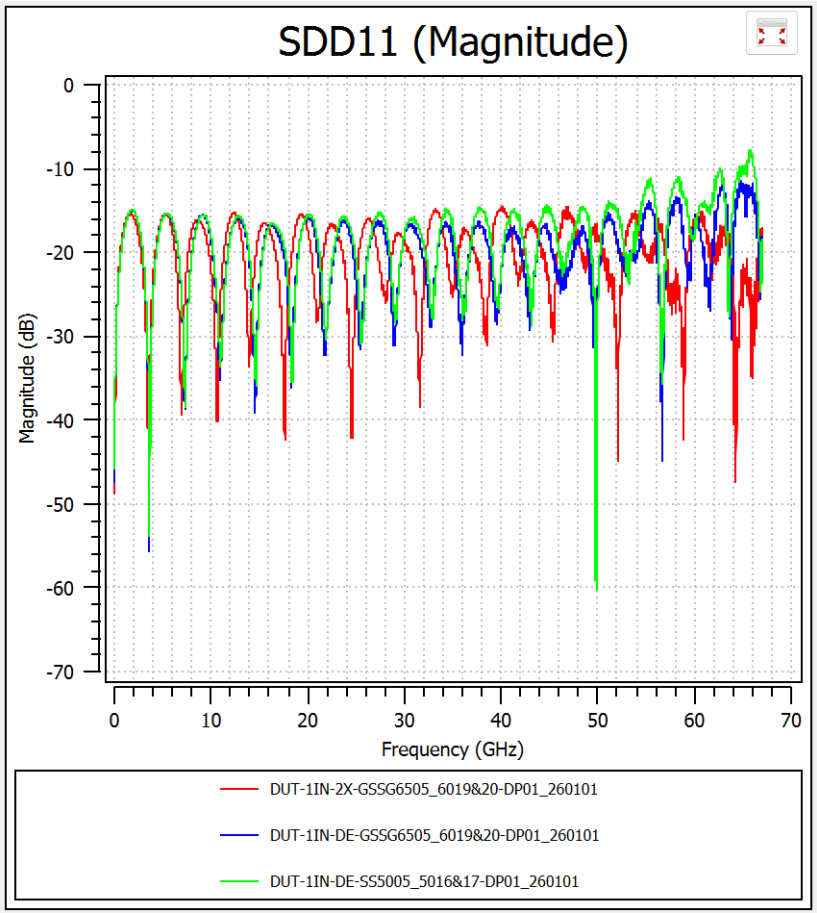
1 IN DUT with 2X De-embedding

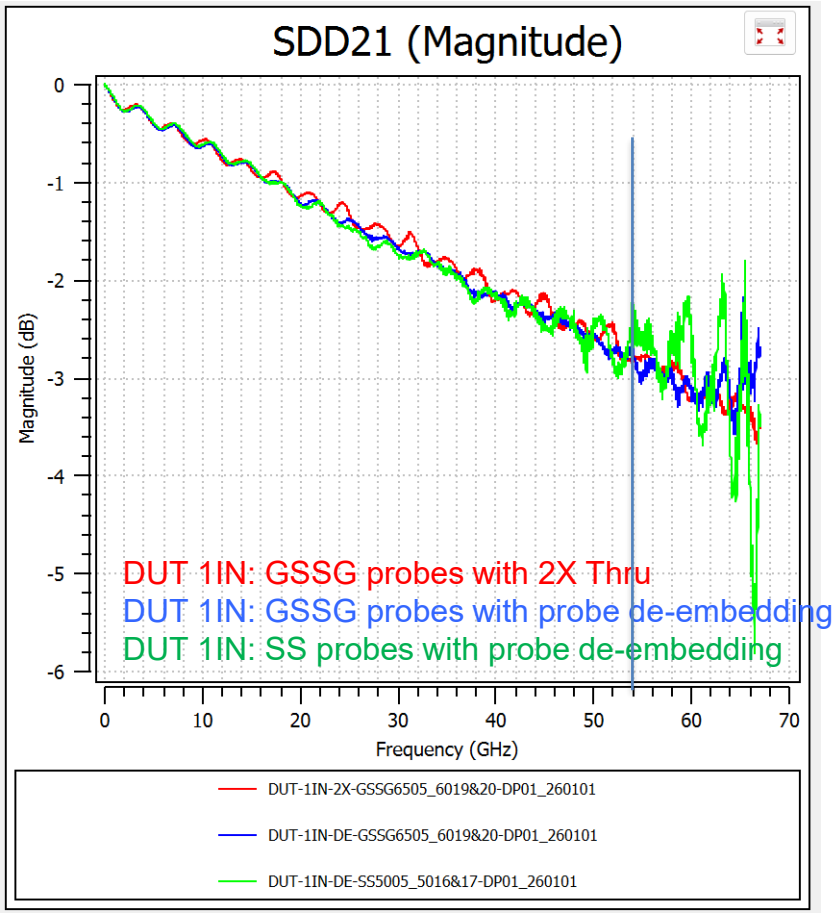




- **GSSG and SS probes yield comparable DUT results using the 2X Thru approach.**

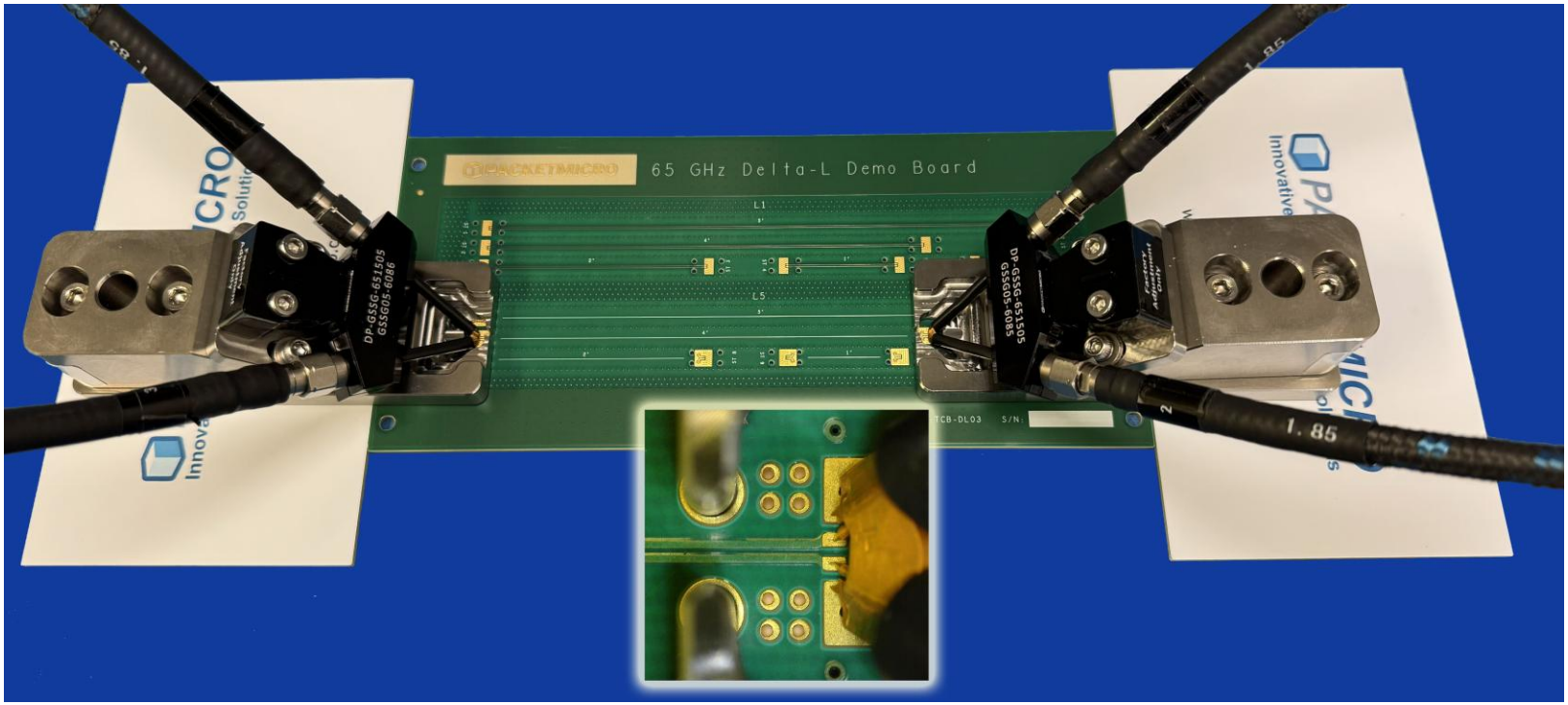
1-IN DUT with Probe De-embedding





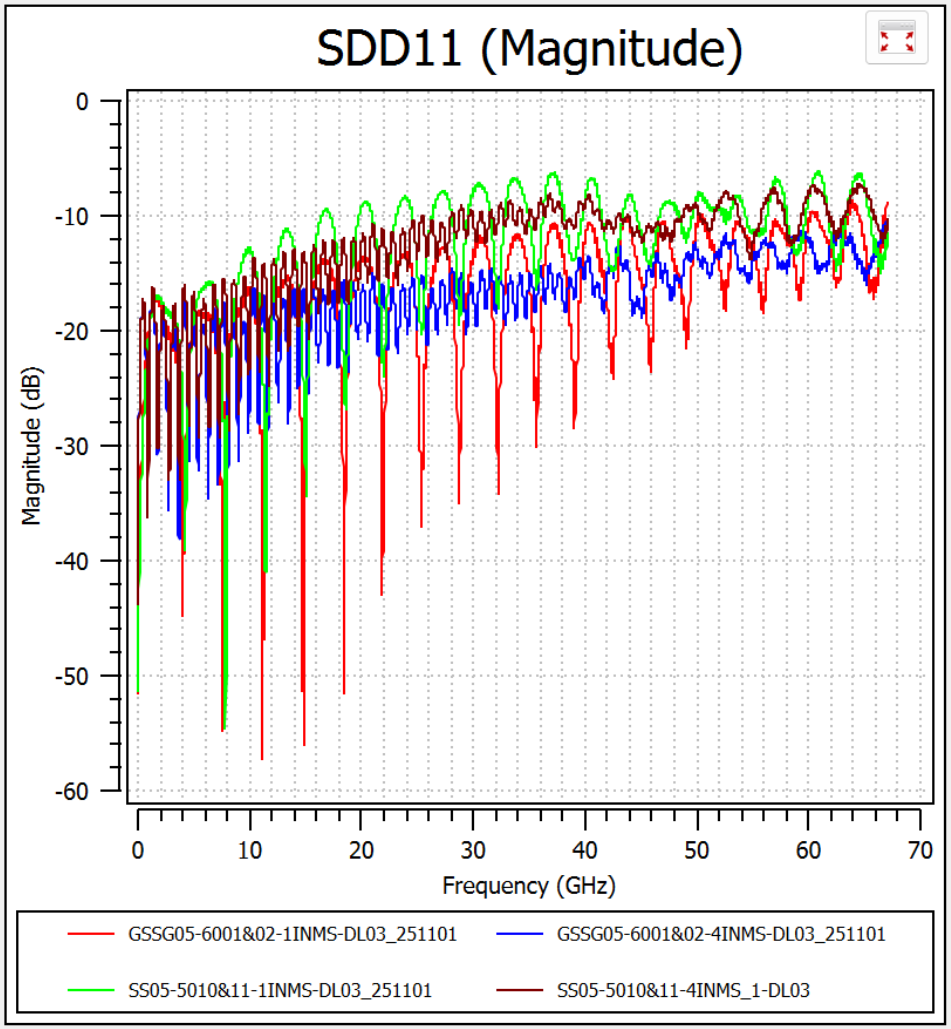
- **GSSG and SS probes yield comparable DUT results up to 54 GHz using the probe de-embedding approach.**

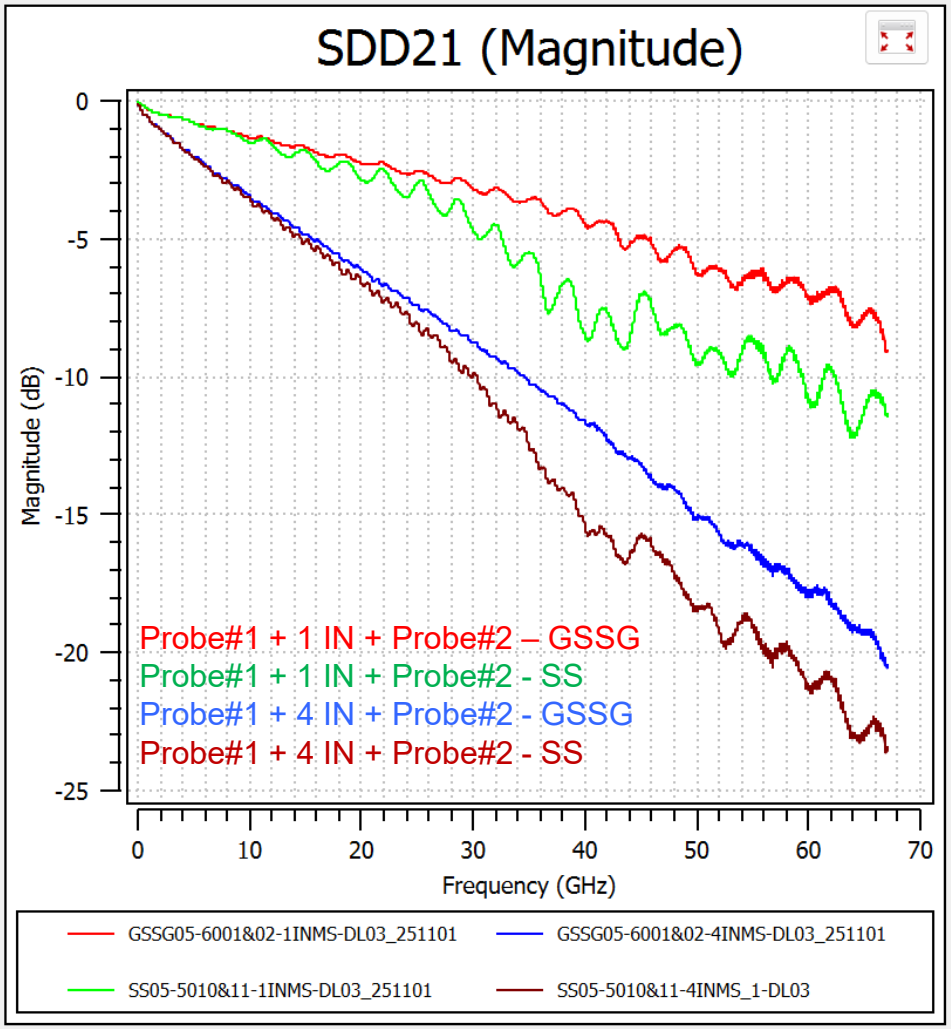
DP-GSSG vs. DP-SS Probes - Delta-L



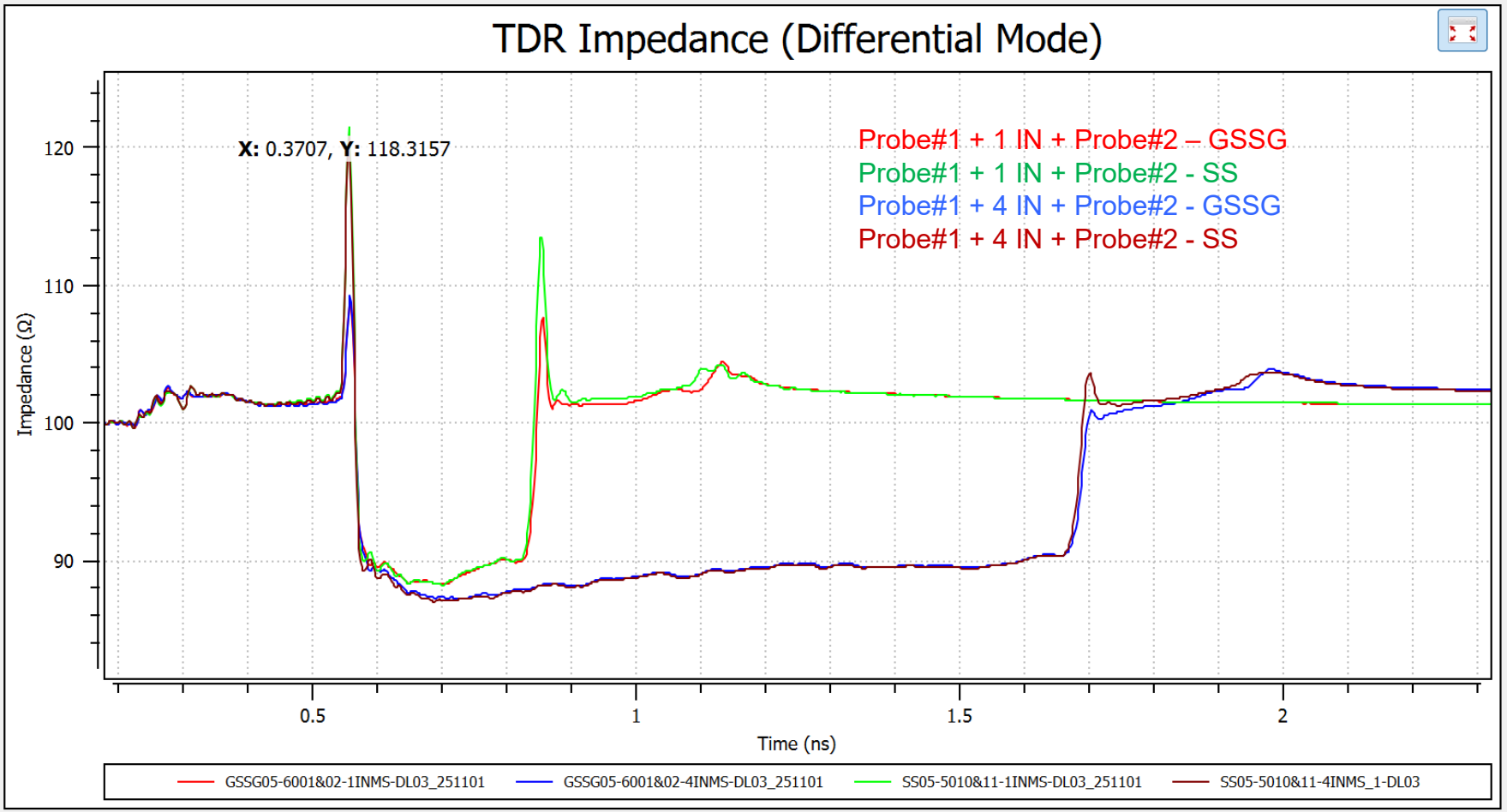
- **GSSG and SS probes also yield comparable results up to 54 GHz for Delta-L measurements.**

1 IN & 4 IN Microstrip



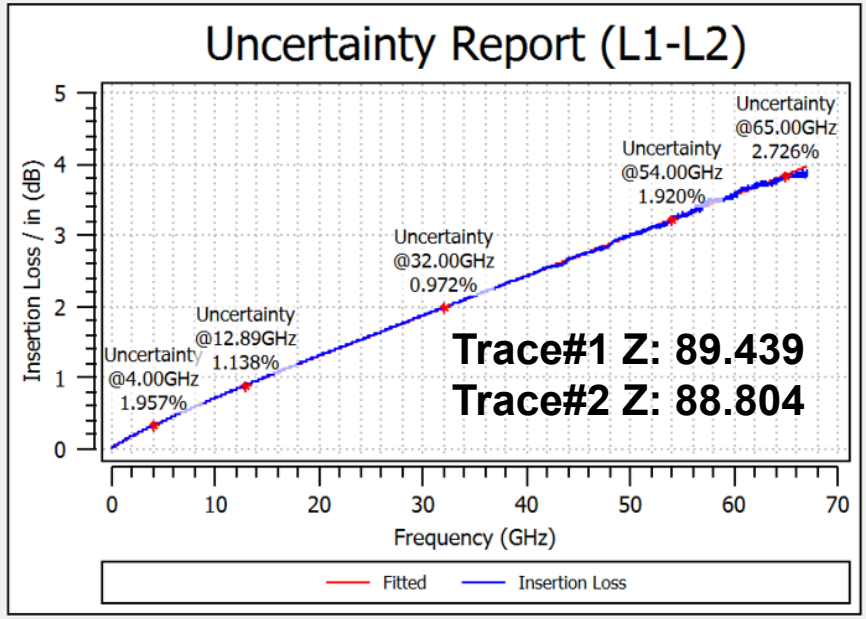


1 IN & 4 IN Microstrip



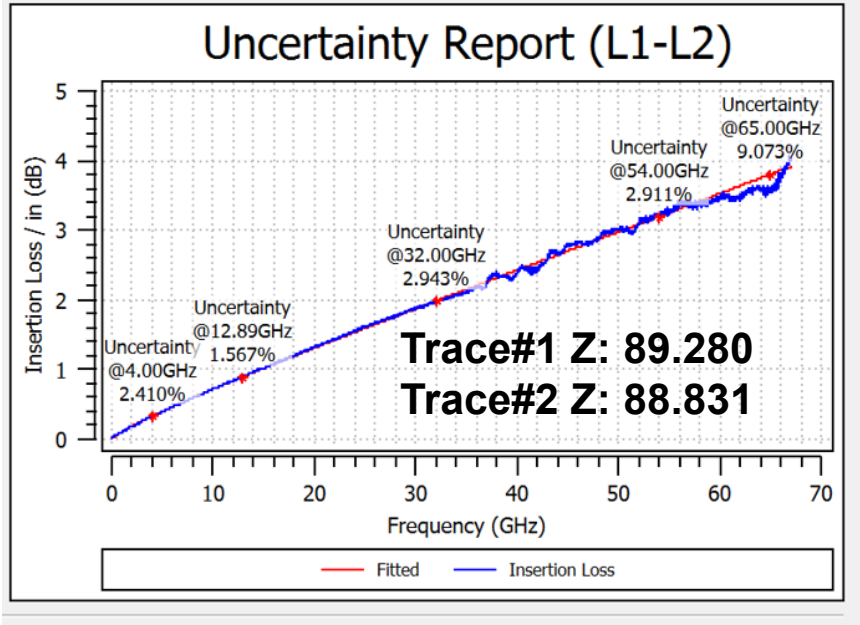
Microstrip Delta-L

DPGSSG651505



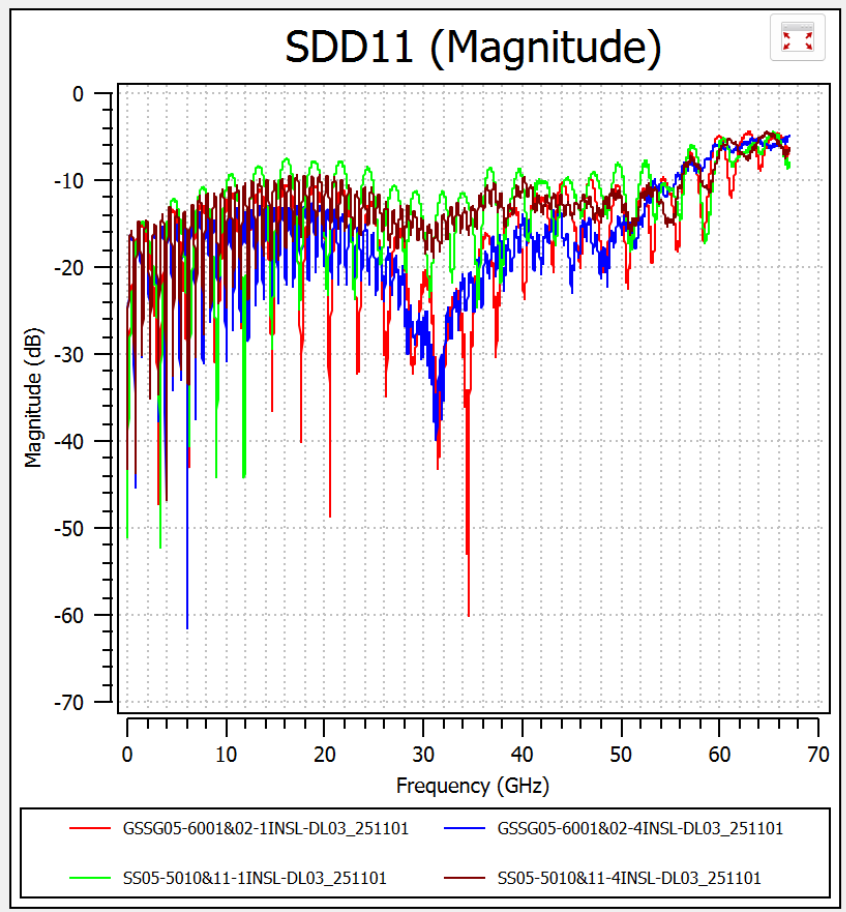
Frequency (GHz)	Uncertainty (%)	dB/in
4	1.957	0.333
12.89	1.138	0.849
32	0.972	1.985
54	1.920	3.220
65	2.726	3.848

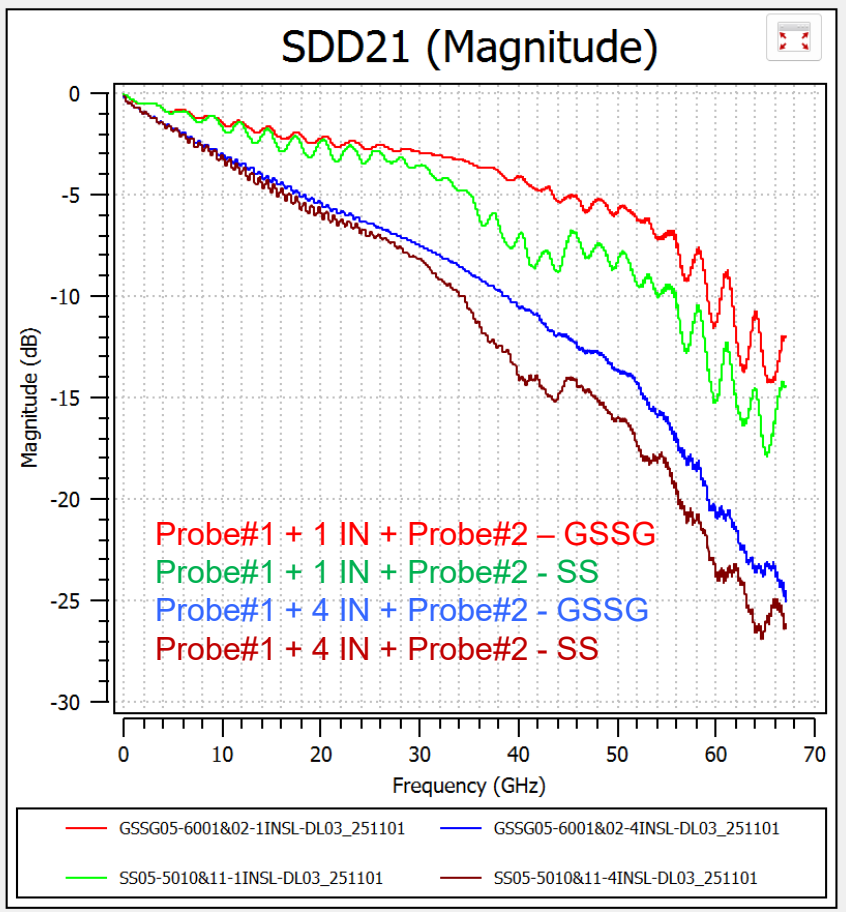
DPSS501505



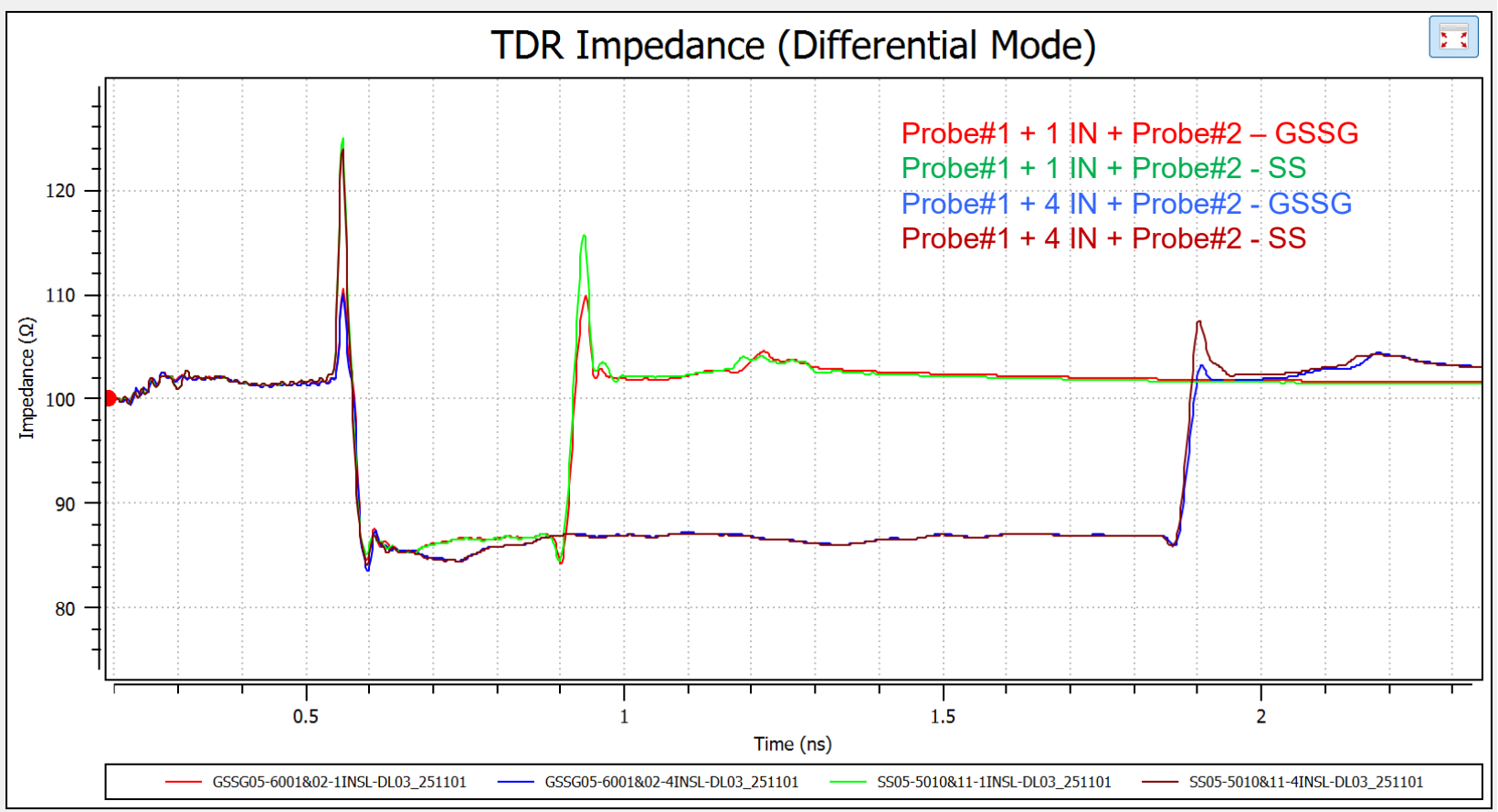
Frequency (GHz)	Uncertainty (%)	dB/in
4	2.410	0.332
12.89	1.567	0.896
32	2.943	1.986
54	2.911	3.197
65	9.073	3.803

1 IN & 4 IN Stripline



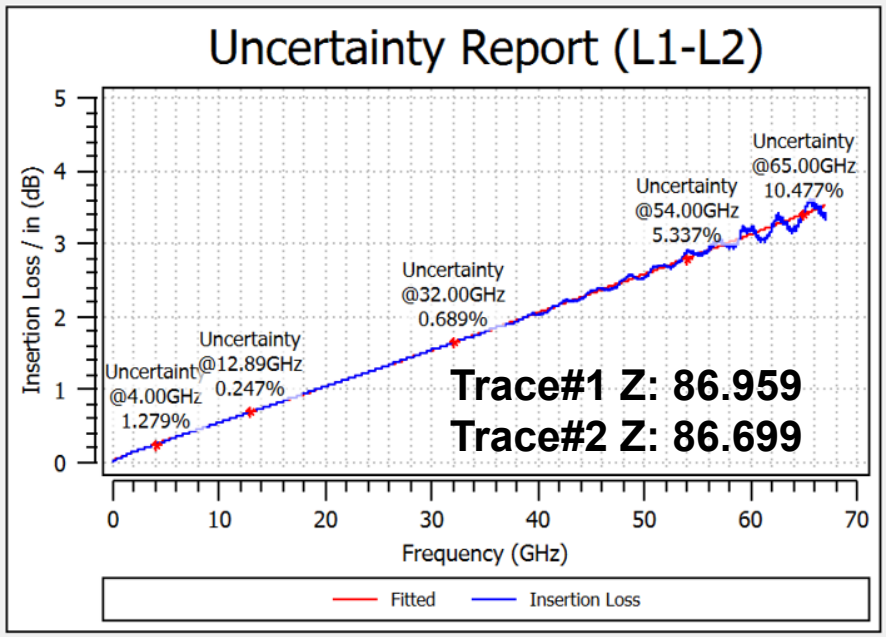


1 IN & 4 IN Stripline



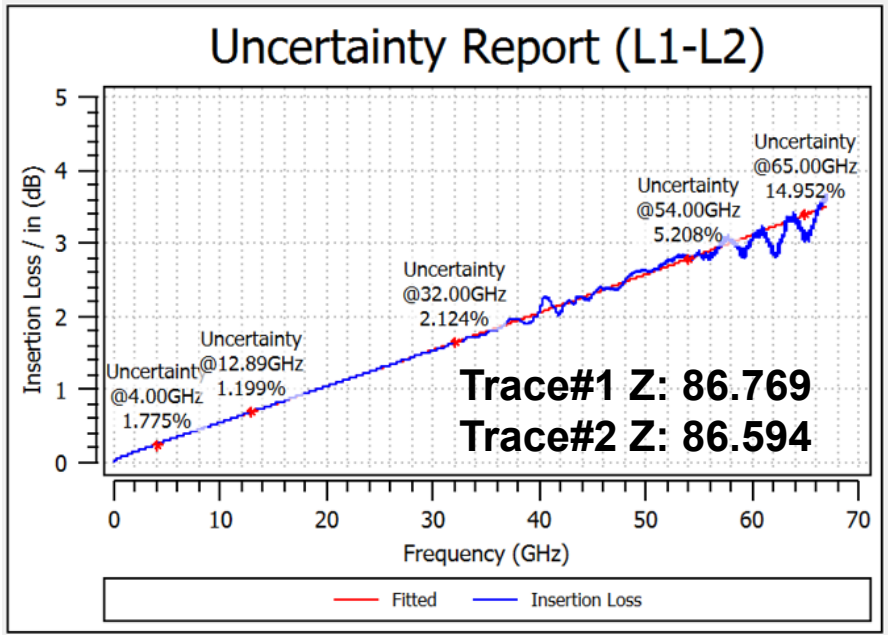
Stripline Delta-L

DPGSSG651505



Frequency (GHz)	Uncertainty (%)	dB/in
4	1.279	0.254
12.89	0.247	0.693
32	0.689	1.644
54	5.337	2.800
65	10.477	3.408

DPSS501505



Frequency (GHz)	Uncertainty (%)	dB/in
4	1.775	0.256
12.89	1.199	0.695
32	2.214	1.642
54	5.208	2.789
65	14.952	3.390

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