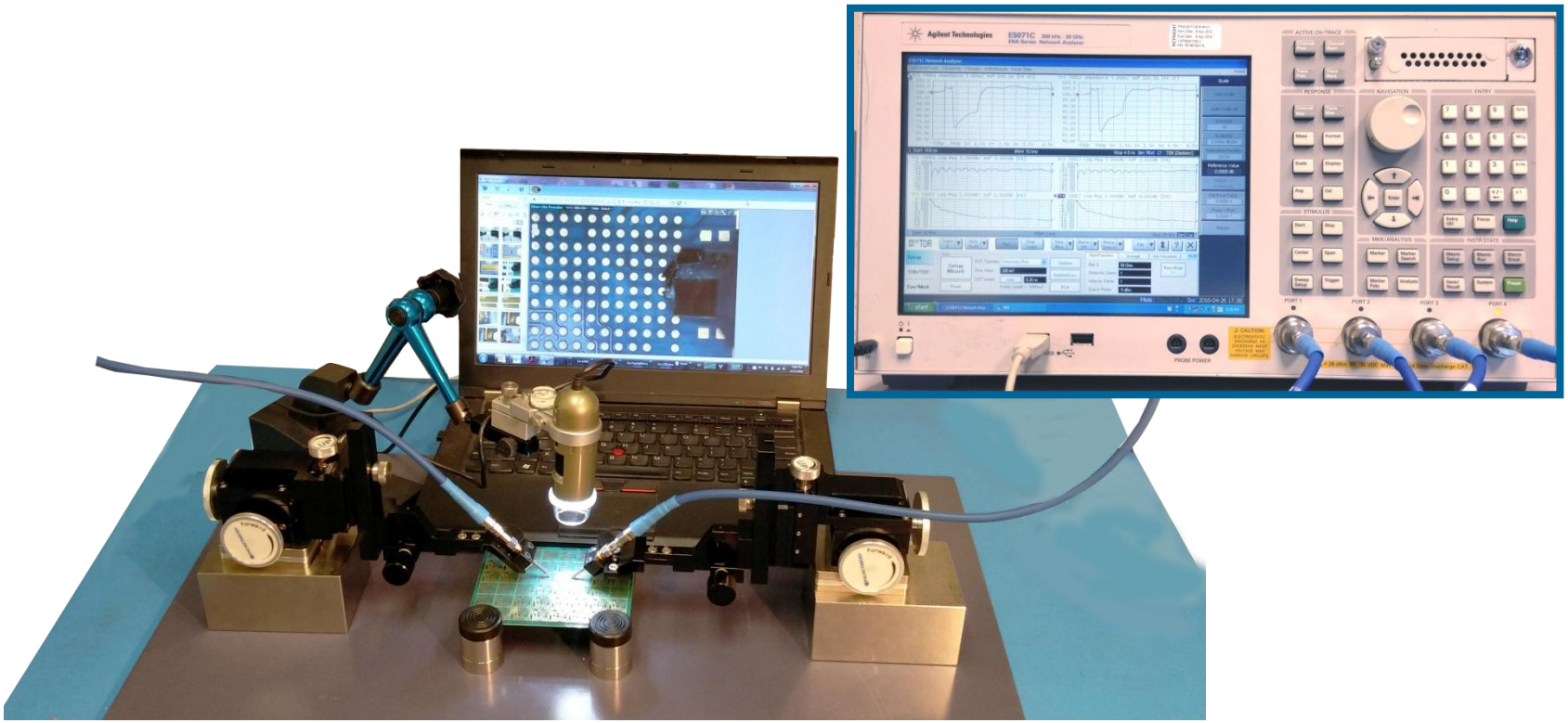
RF Probing
With
Keysight E5071C VNA

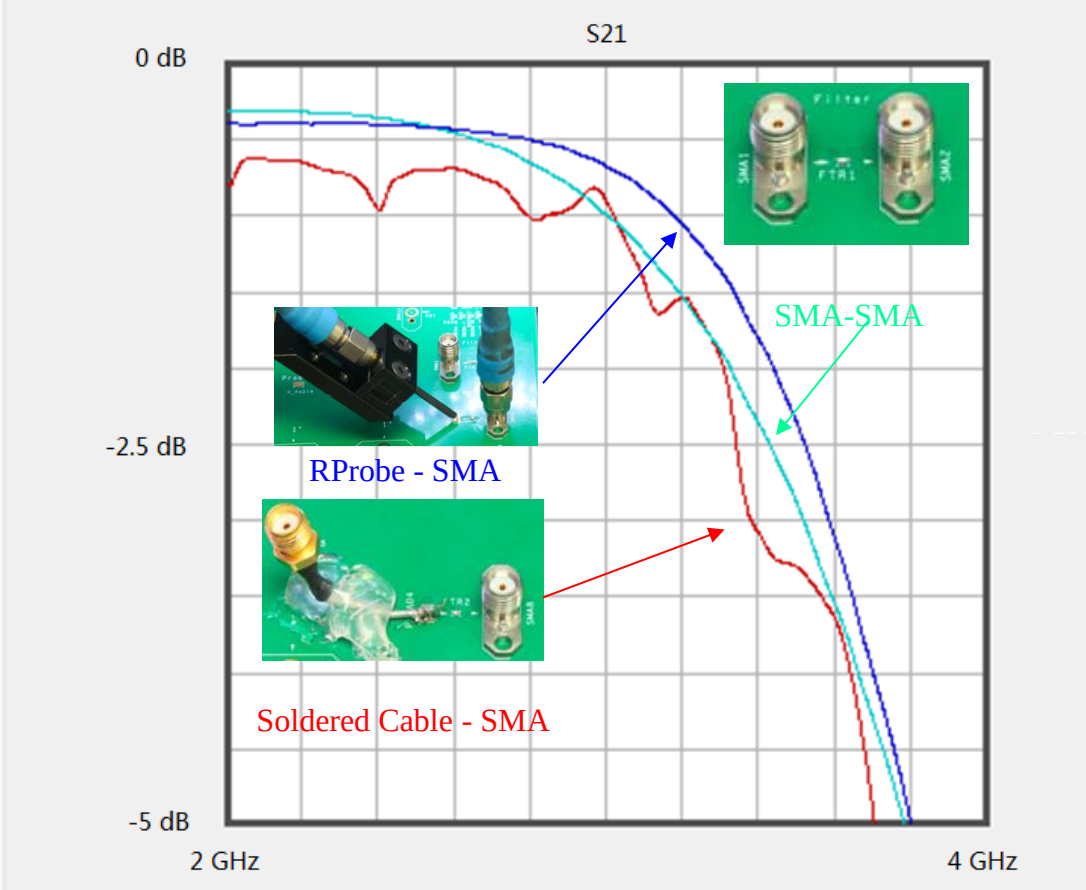


Outline

Why RF Probing?

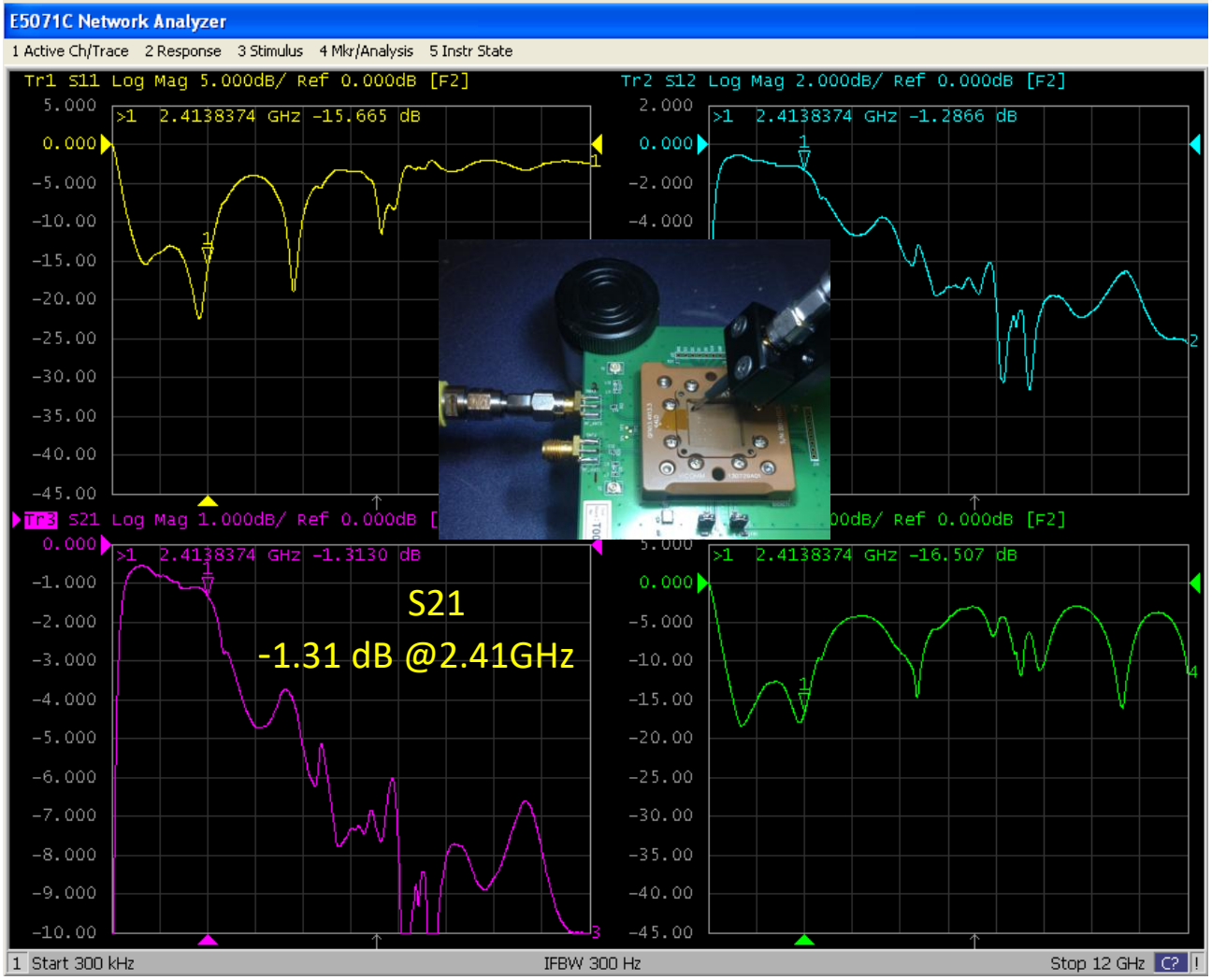
- **Necessity:** **Constant shrinking size of circuit components makes soldering semi-rigid RF cables to test gigahertz circuits impractical.**
- **Accuracy:** **RF probes and calibration substrates allow engineers to perform probe-tip calibration for accurate, repetitive measurements.**
- **Productivity:** **Any engineer can do RF measurements in minutes without the need of soldering semi-rigid cable**

Measurements of RF Low-Pass Filter

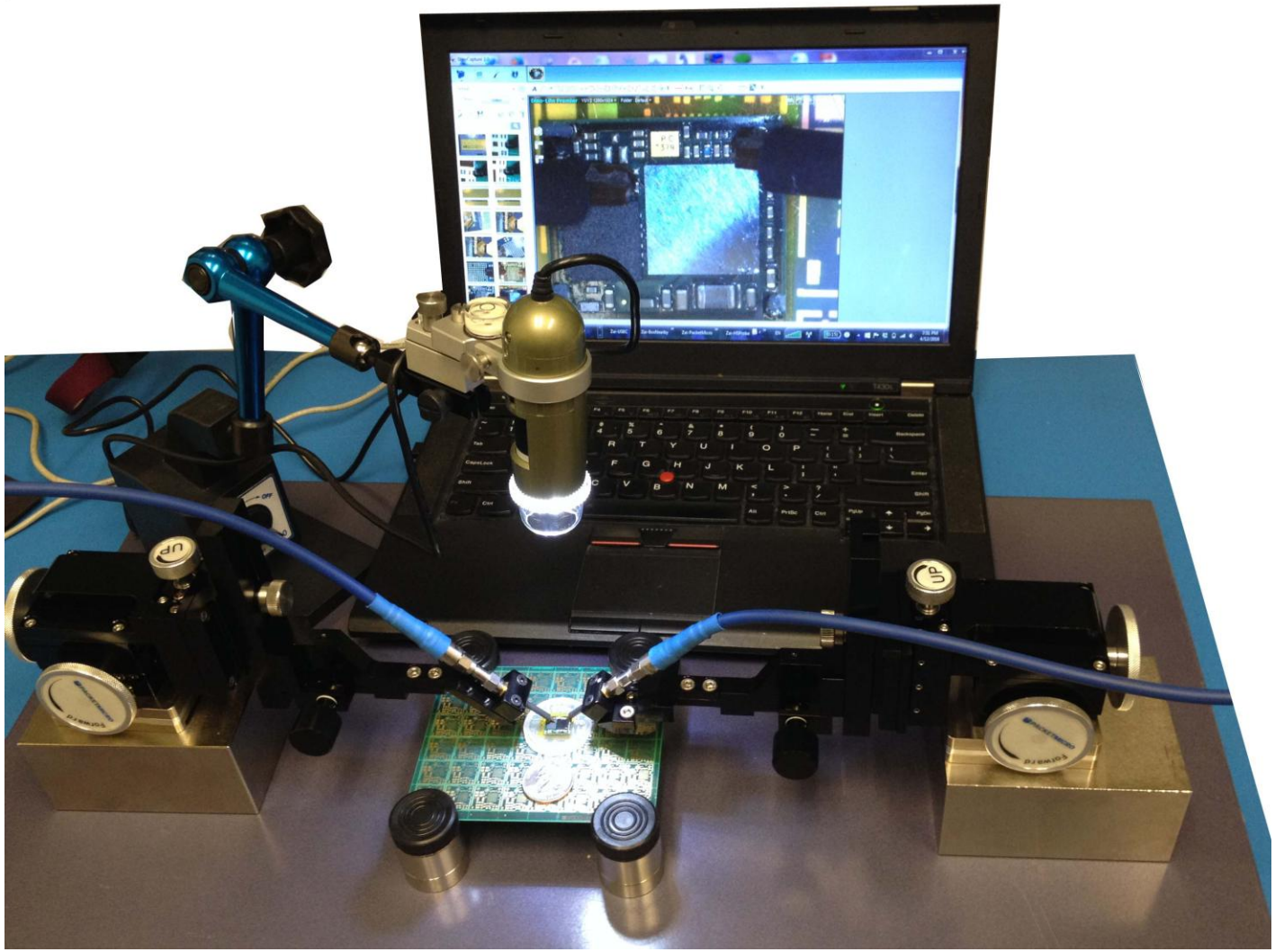


RF probe is almost as good as SMA connector!

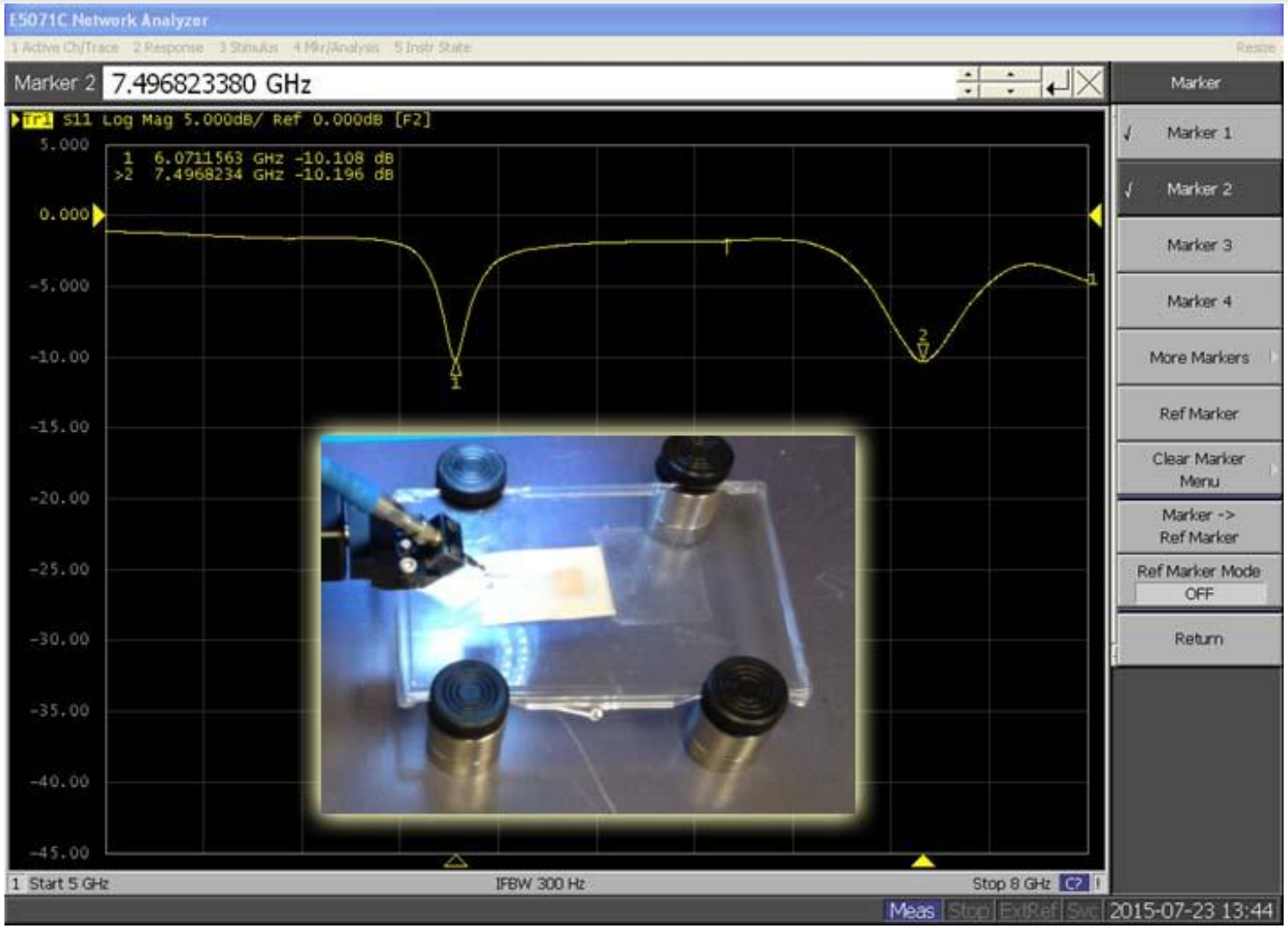
RF Fixture Testing



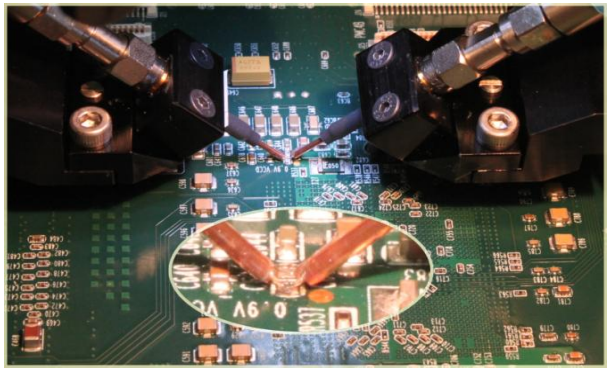
RF Module Testing



RF Antenna Testing

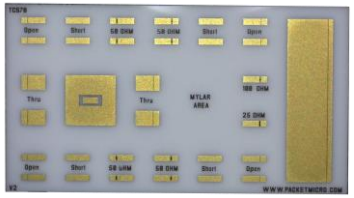


30/20 GHz S-Probe

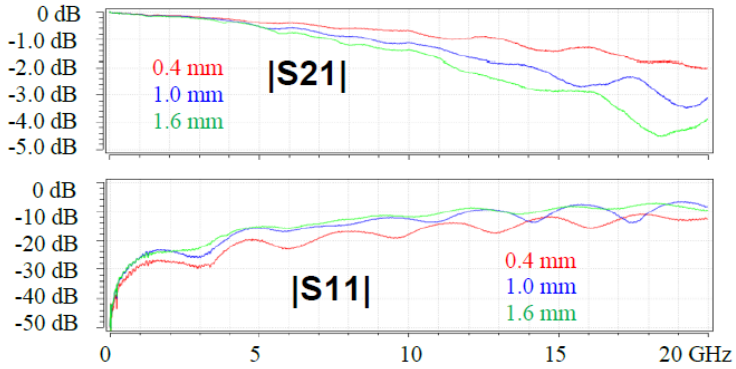


PCB Probing with S-Probe

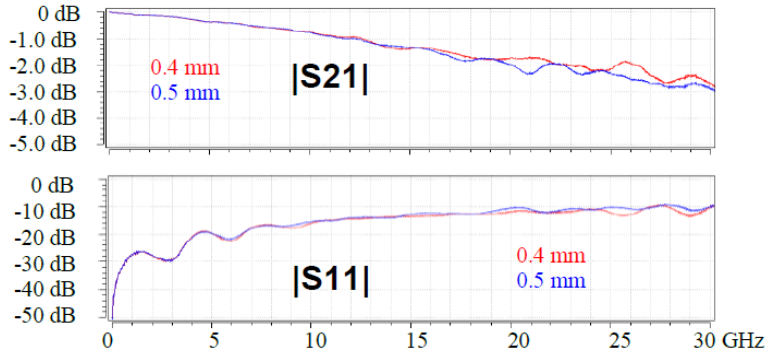
S-Probe
(1.5”x0.4”x0.3”)



TCS70 Cal Substrate
(0.7” x 0.4” x 0.025”)



30 GHz S-Probe

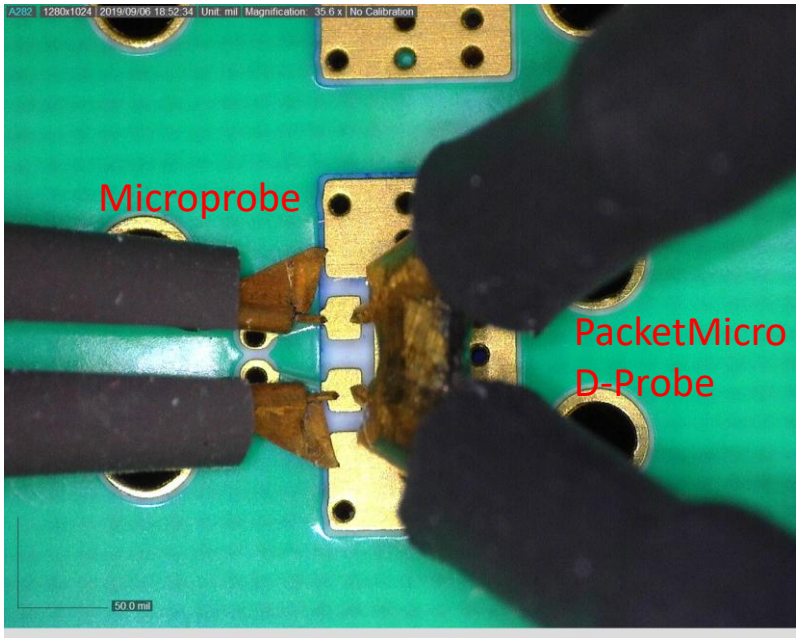


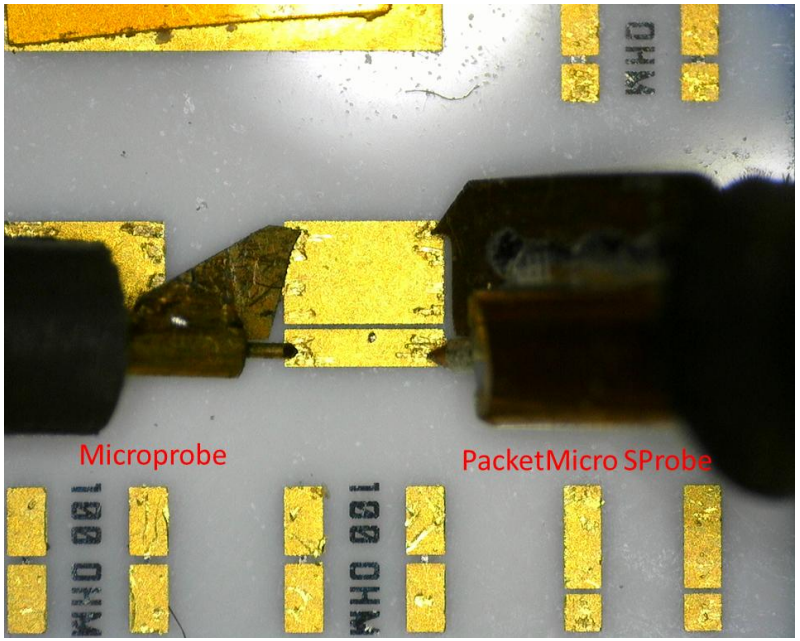
- **SP-GR-2015025** – 20 GHz, 0.25 mm
- **SP-GR-201504** – 20 GHz, 0.4 mm
- **SP-GR-201505** – 20 GHz, 0.5 mm
- **SP-GR-181508** – 18 GHz, 0.8 mm
- **SP-GR-181510** – 18 GHz, 1.0 mm
- **SP-GR-161512** – 16 GHz, 1.2 mm
- **SP-GR-161514** – 16 GHz, 1.4 mm
- **SP-GR-161516** – 16 GHz, 1.6 mm

- **SP-GR-3015025** – 30 GHz, 0.25 mm
- **SP-GR-301504** – 30 GHz, 0.4 mm
- **SP-GR-301505** – 30 GHz, 0.5 mm

Video demo:
https://packetmicro.com/Videos/PacketMicro_Probe_Planarization.mp4

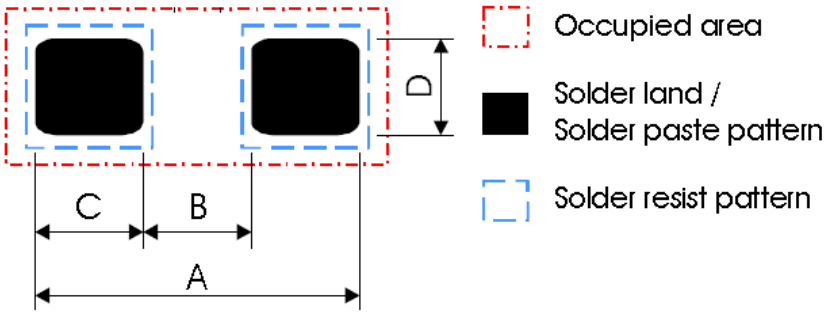
Rugged Probes vs. Microprobes





- **PacketMicro rugged probes are specifically designed for probing on test pads on uneven surfaces.**

Probe-Pitch Selection



S-Probe Part Number:

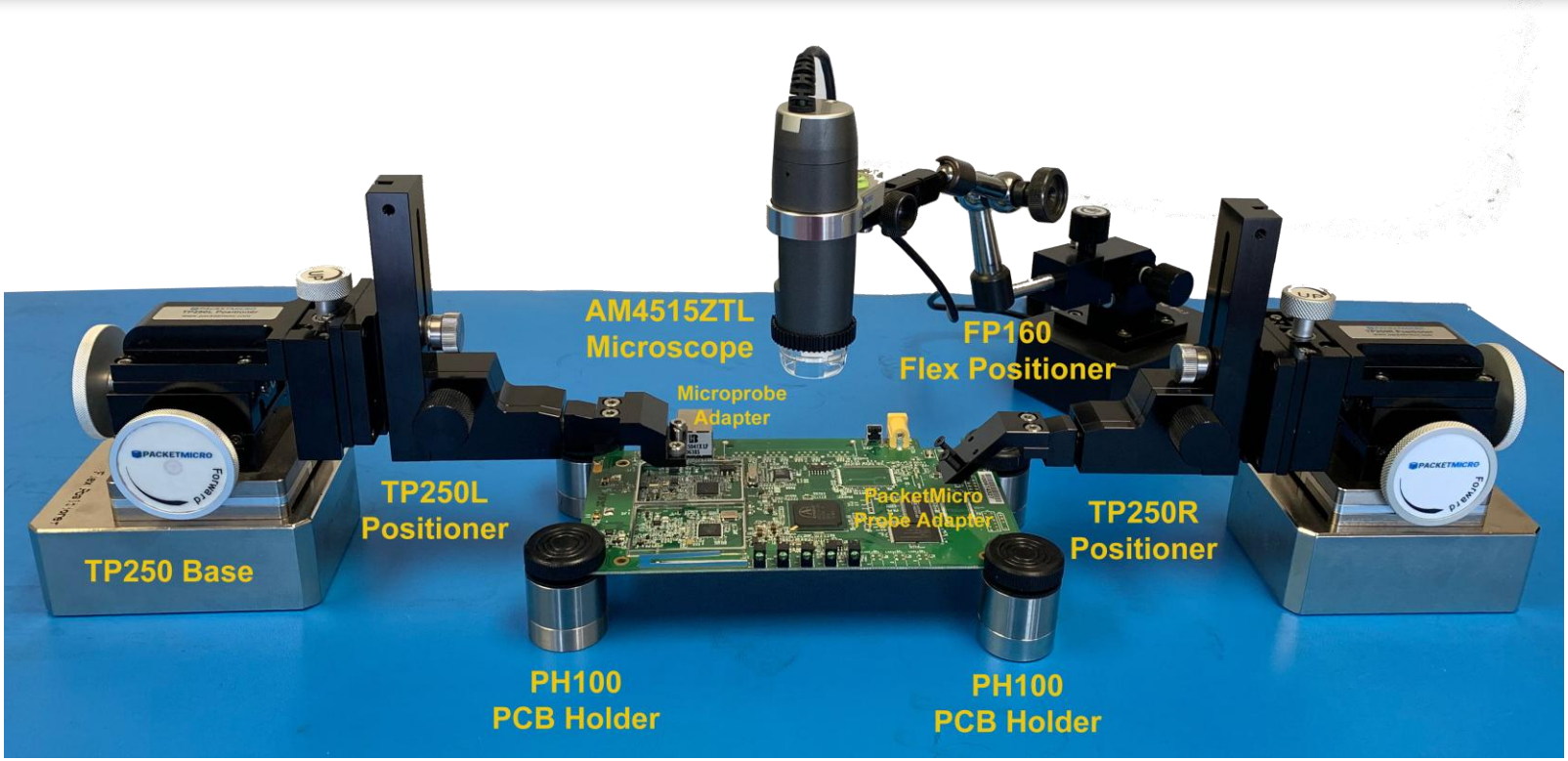
- **SP-GR-2015025** – 20 GHz, 0.25 mm/10 mil pitch
- **SP-GR-201504** – 20 GHz, 0.4 mm/16 mil pitch
- **SP-GR-201505** – 20 GHz, 0.5 mm/20 mil pitch
- **SP-GR-181508** – 18 GHz, 0.8 mm/32 mil pitch
- **SP-GR-181510** – 18 GHz, 1.0 mm/40 mil pitch
- **SP-GR-161512** – 16 GHz, 1.2 mm/48 mil pitch
- **SP-GR-161514** – 16 GHz, 1.4 mm/56 mil pitch
- **SP-GR-161516** – 16 GHz, 1.6 mm/64 mil pitch
- **SP-GR-3015025** – 30 GHz, 0.25 mm/10 mil pitch
- **SP-GR-301504** – 30 GHz, 0.4 mm/16 mil pitch
- **SP-GR-301505** – 30 GHz, 0.5 mm/20 mil pitch

Recommendation: B + 0.2 mm < Probe Pitch < A – 0. 2mm

Size	Probe Pitch	A	B	C	D	Component Size
01005	SP-GR-2015025	0.48	0.12	0.18	0.20	0.4 x 0. 2
0201	SP-GR-201505	0.75	0.30	0.30	0.30	0.6 x 0.3
0402	0.7mm < Pitch <1.3mm	1.50	0.50	0.50	0.60	1.0 x 0.5
0603	0.8mm < Pitch <1.9mm	2.10	0.60	0.90	0.90	1.6 x 0.8
0805	1.2mm < Pitch <2.8mm	3.0	1.0	1.0	1.25	2.0 x 1.25

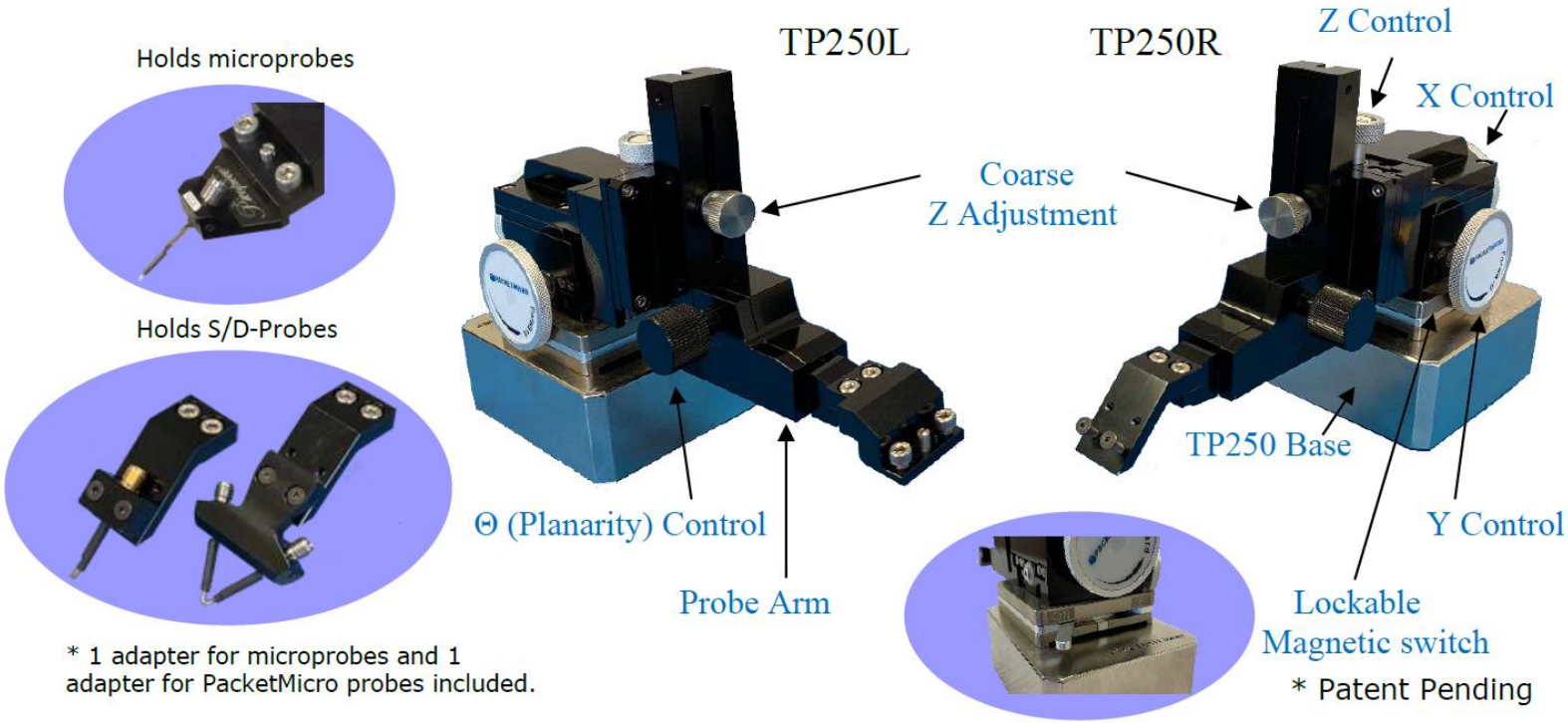
Typical Reflow Soldering Footprint and Component Size in mm

Simple DIY Probe Station



Set up your probe station in 5 minutes !

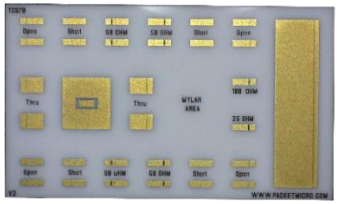
Precision Positioner – TP250



- **Precise:** XYZ stage (50 TPI, 2.5 µm resolution)
- **Versatile:** detachable θ stage
- **Easy:** lockable magnetic base

Tools - Accessories

Optical Microscope
(~ 90 x magnification)



TCS70
Calibration
Substrate

Mylar
Tape

Fine-tip
Sharpie pen

USB Digital Microscope
(~ 90 x magnification)

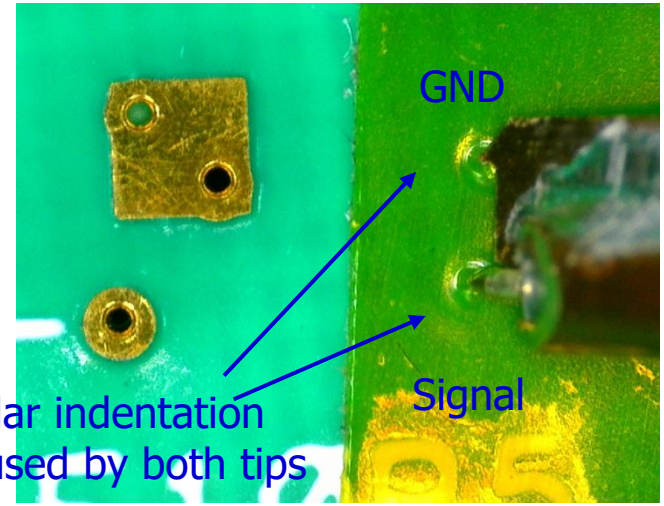
- Using a good microscope is essential.
- You might damage the probe if you cannot see its tips well.

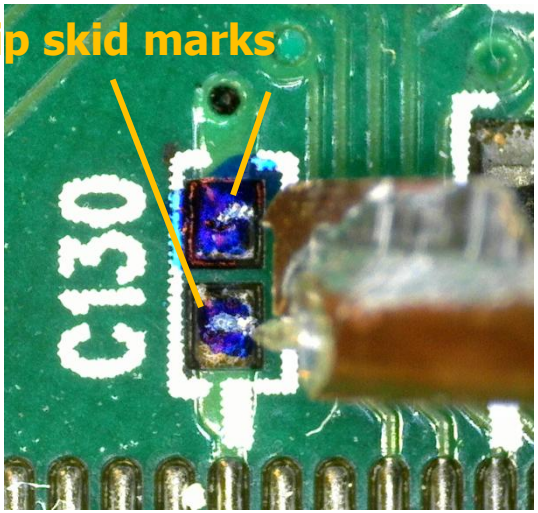
(Make sure to use a long working range (5 cm @ 90x) microscope!)

Probe Planarization Tips

- A good microscope is important. You may damage the probe if you cannot see its tips well.
- Good contact of both probe tips with the DUT is essential to accurate calibration and measurements.
- Mylar tape provides leveling guidance on flat, even surface (bare PCB).
- Color marker helps on uneven surface (solder bump).
- Probe Planarization Video:

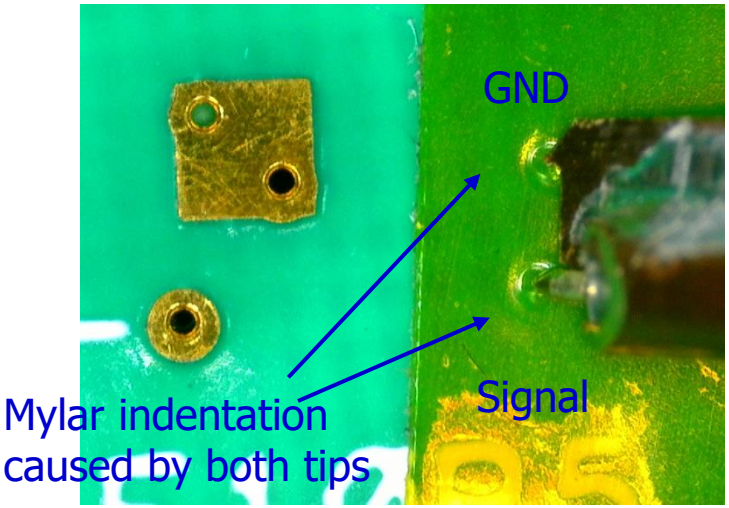
  https://packetmicro.com/Videos/PacketMicro_Probe_Planarization.mp4

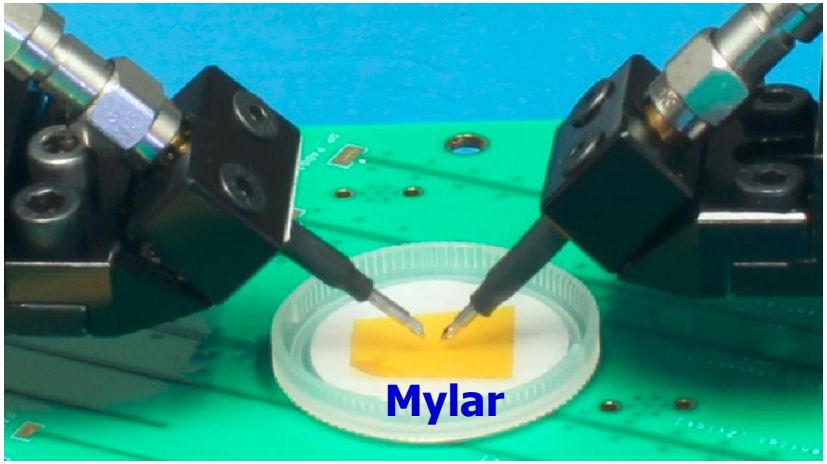




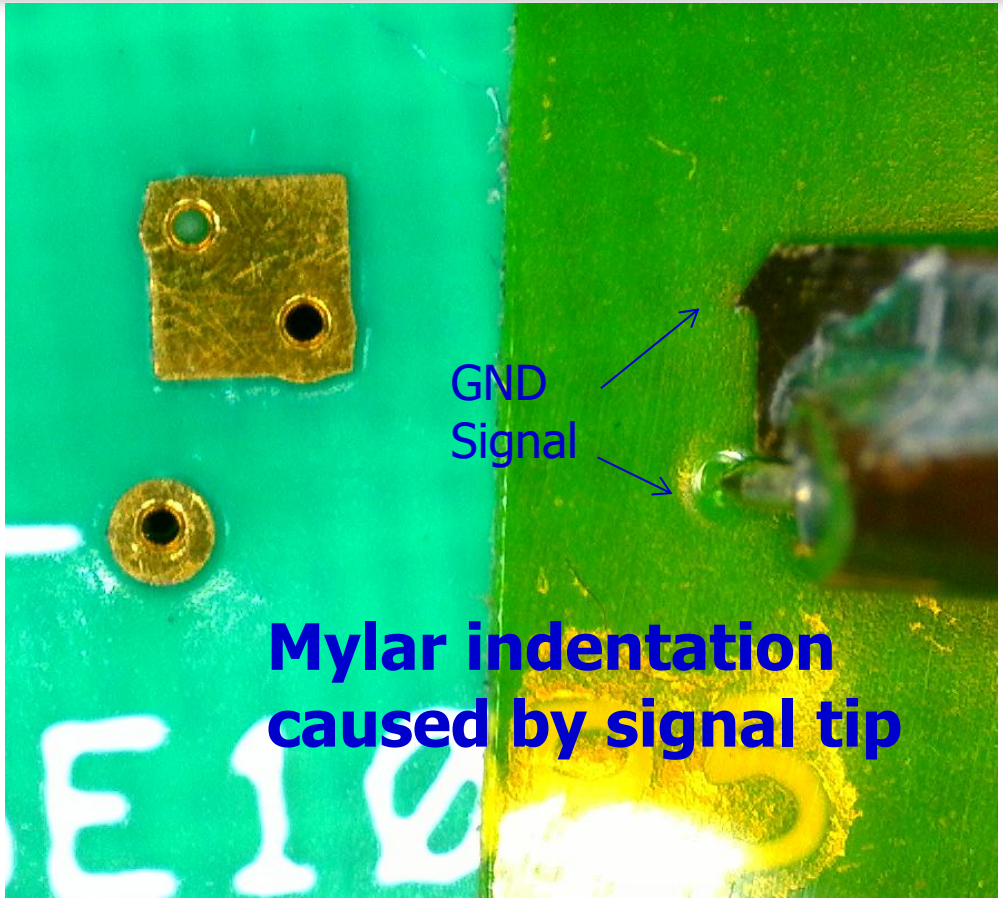
Probing Test Pads on Even Surfaces

- Use the Mylar tape on the back of the plastic cap for probe planarization by observing the indentation caused by the tips.
- Remove the plastic cap and perform probing
- Affix a Mylar tape next to test pads if there is not enough space for placing the plastic cap.





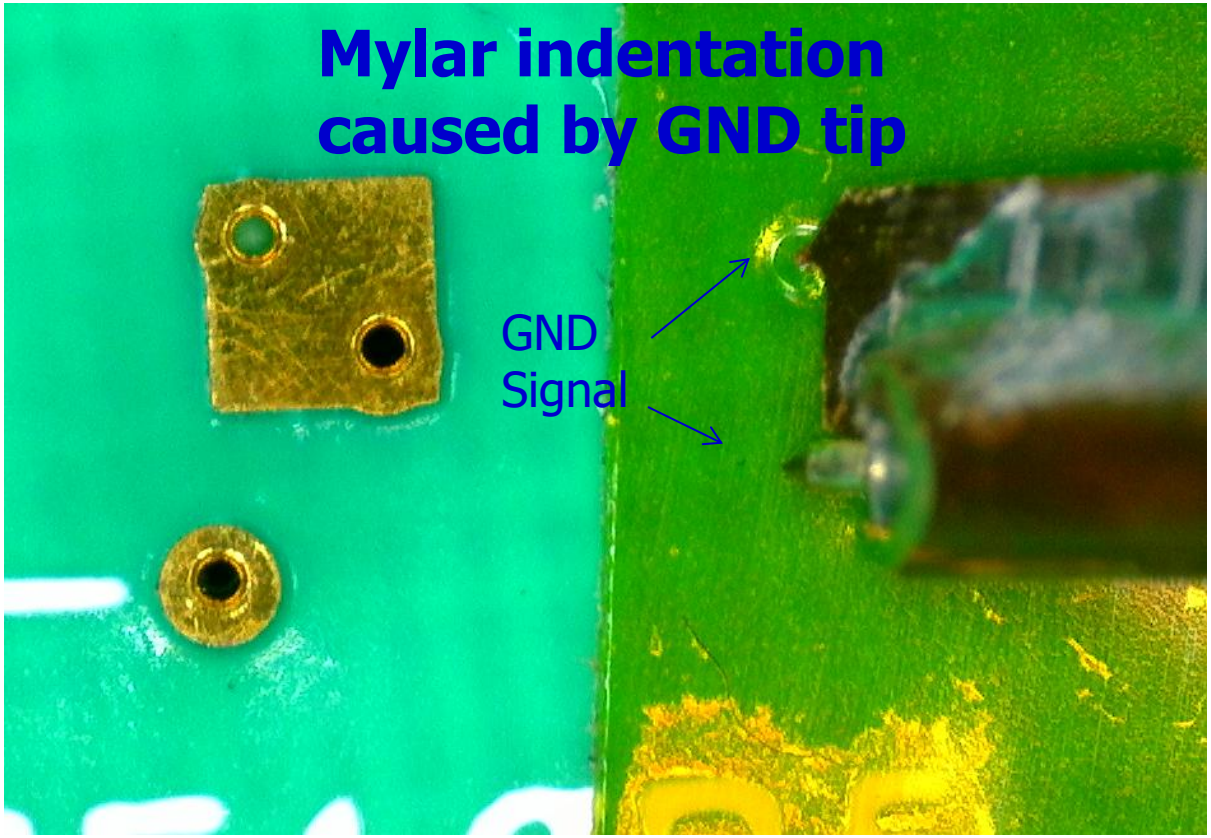
Signal tip touches down first



Step 1:

Land the probe tips on the tape and observe the probe-tip footprint. Above image shows that signal tip touches the surface first.

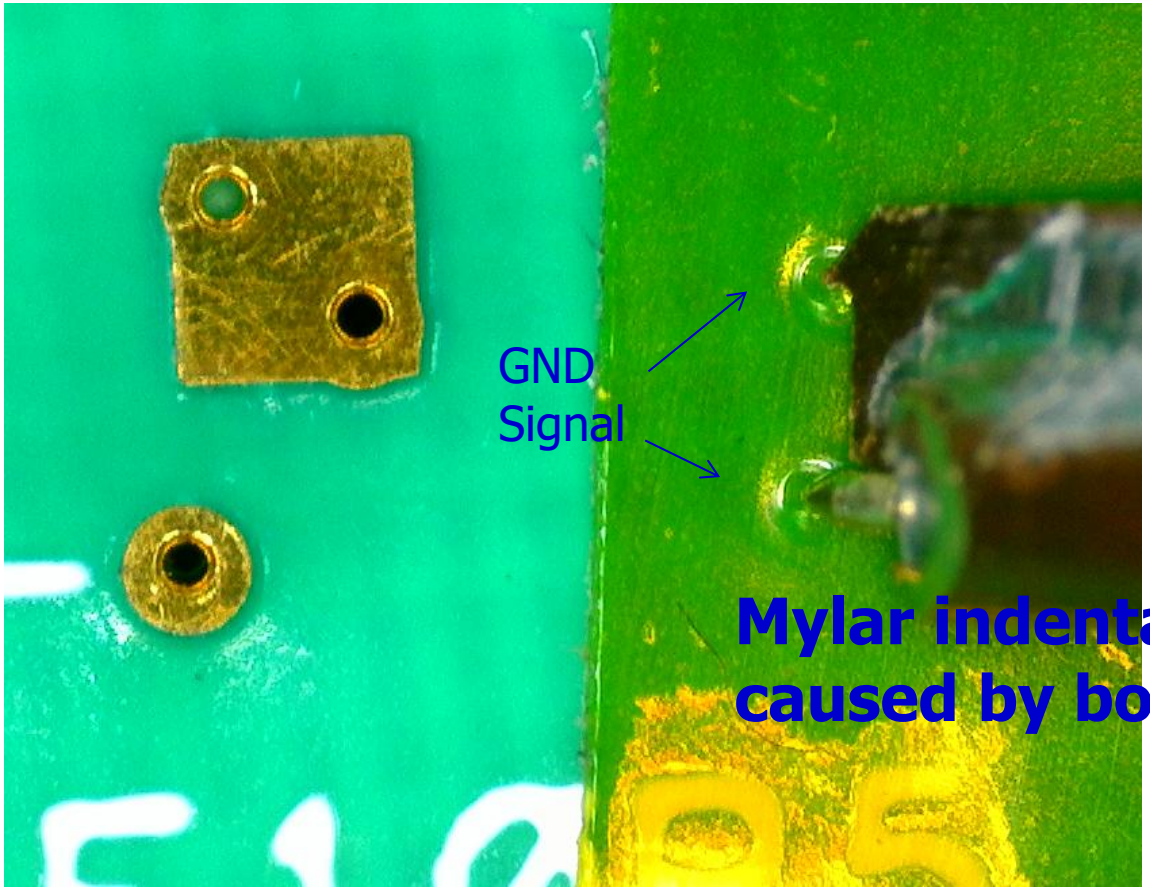
GND tip touches down first



Step 2:

Adjust the planarization knob on the TP150 positioner to lower the GND tip. Above image shows that GND tip touches the surface first.

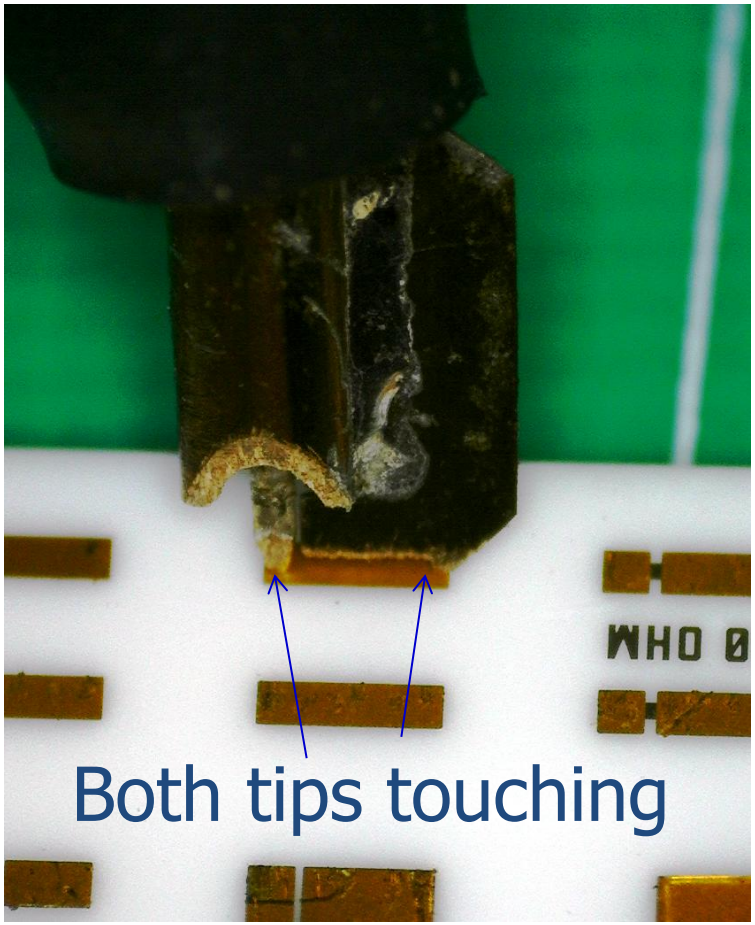
Both tips touch down simultaneously

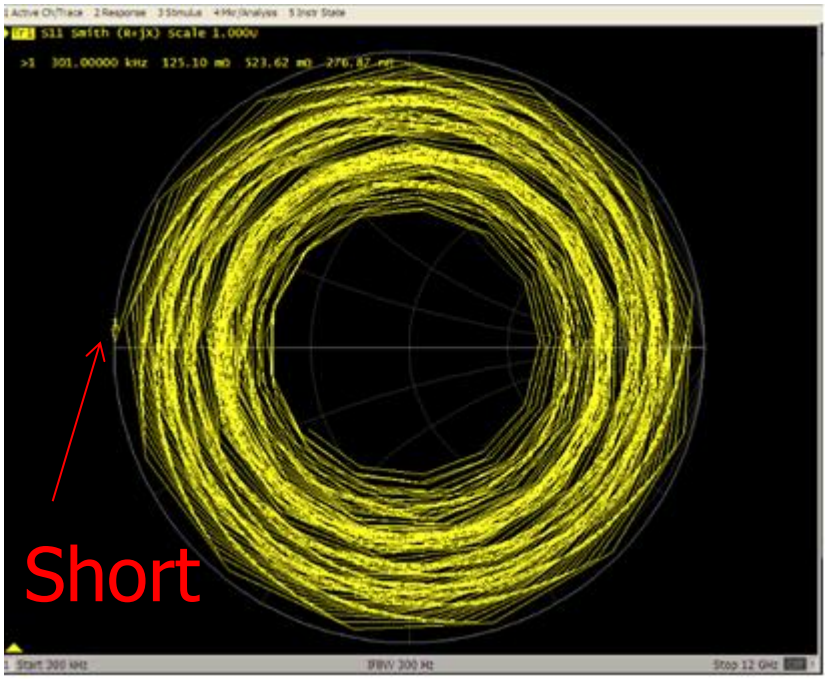


Step 3:

Adjust the planarization knob on the positioner to land both probe tips. Above image shows the two probe tips touch the surface evenly.

Use VNA to Verify Probe Contacts

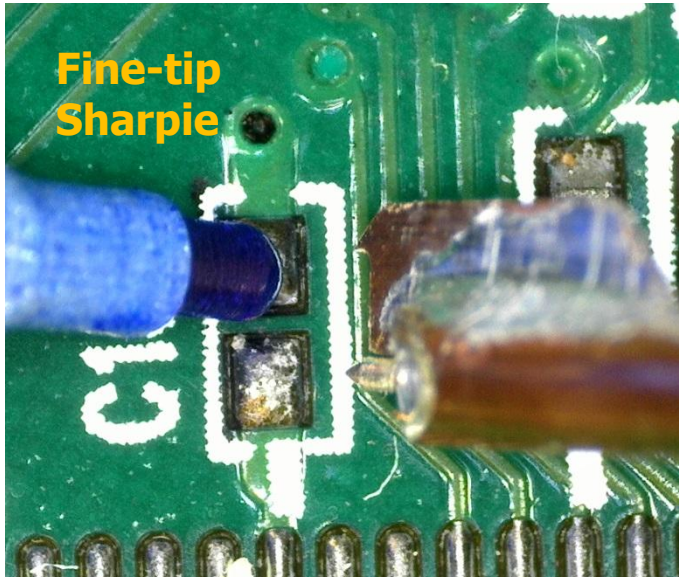


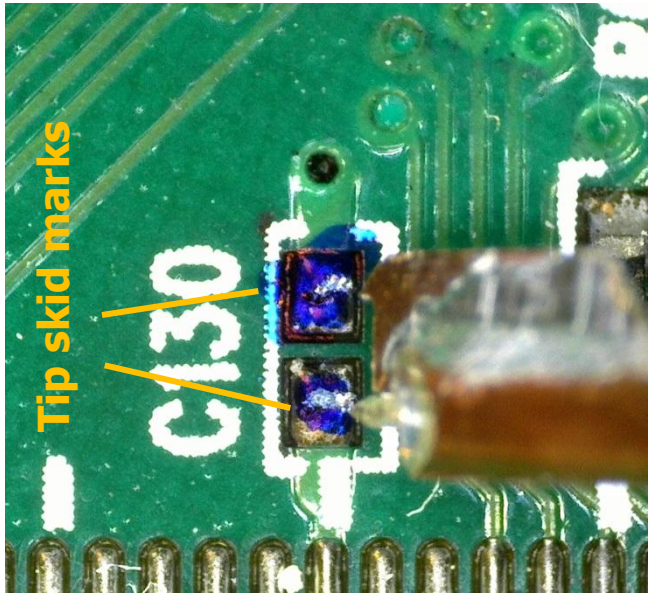


- Both tips leave light probe marks
- VNA Smith Chart shows “Short”

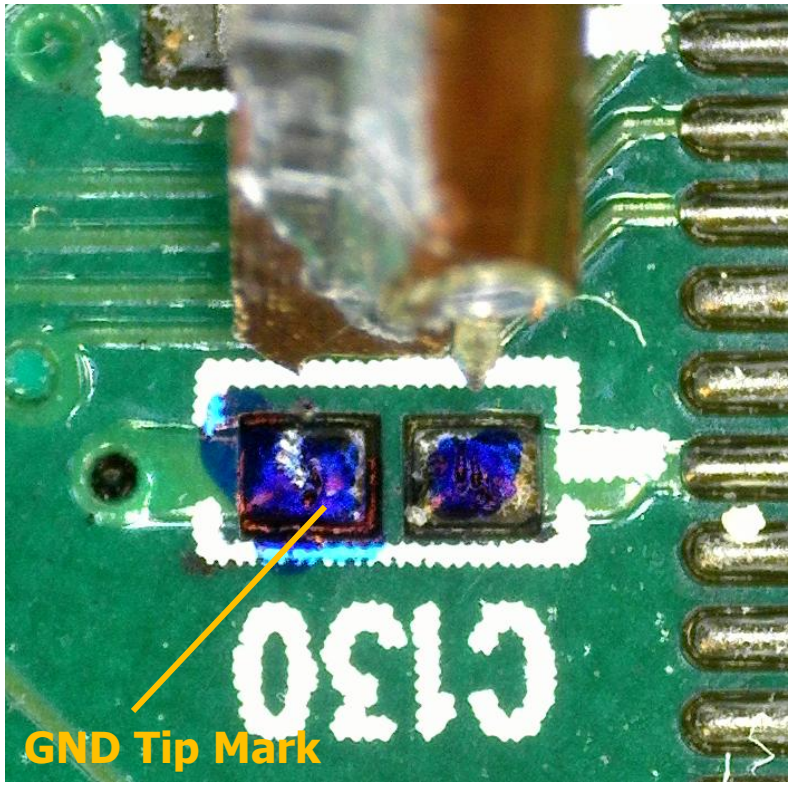
Probing Test Pads on Uneven Surfaces

- Color solder bumps with a Sharpie
- Use the probe skid marks to confirm good tip contact
- Clean up the solder bumps with industrial alcohol after probing

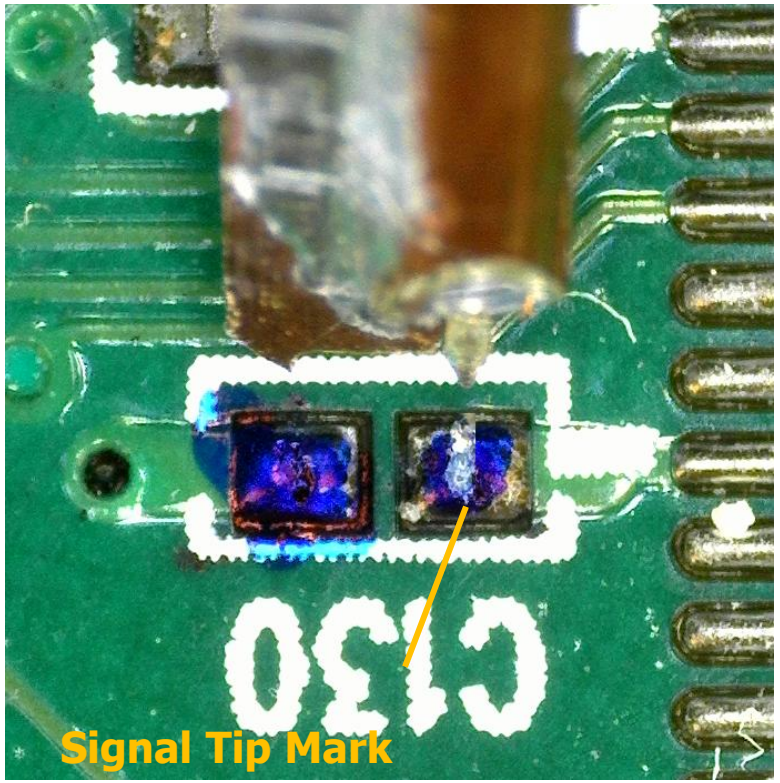




Use Probe Skid Marks on Solder Bumps

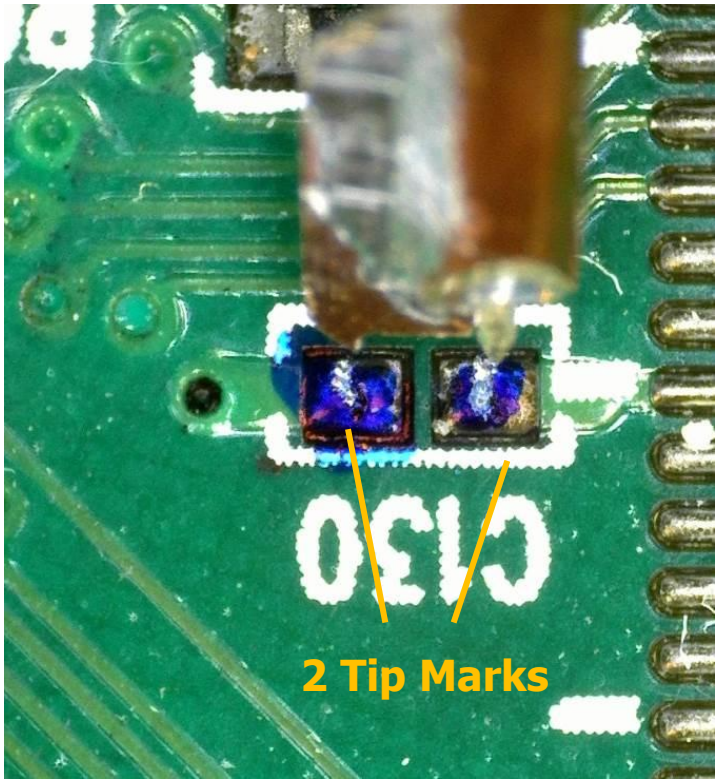


Left GND tip touches down first

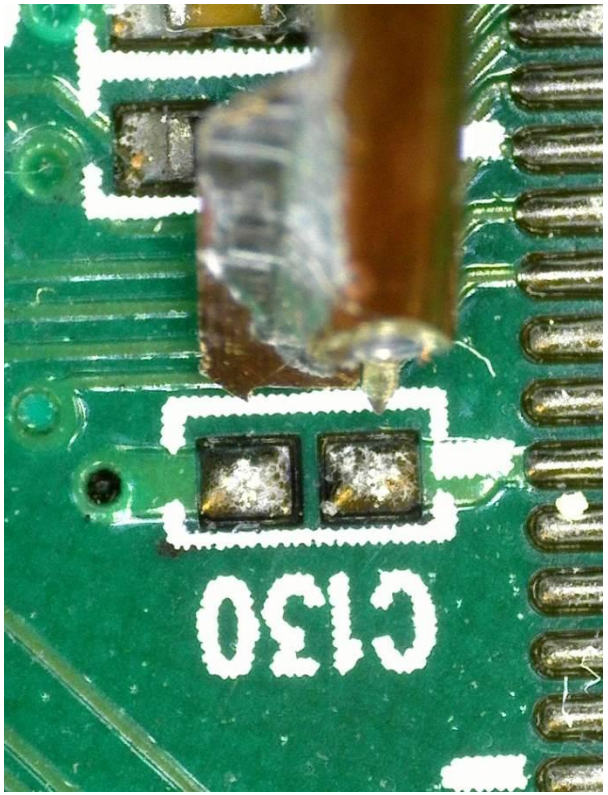


Right signal tip touches down first

Both Tips Touch Down Simultaneously



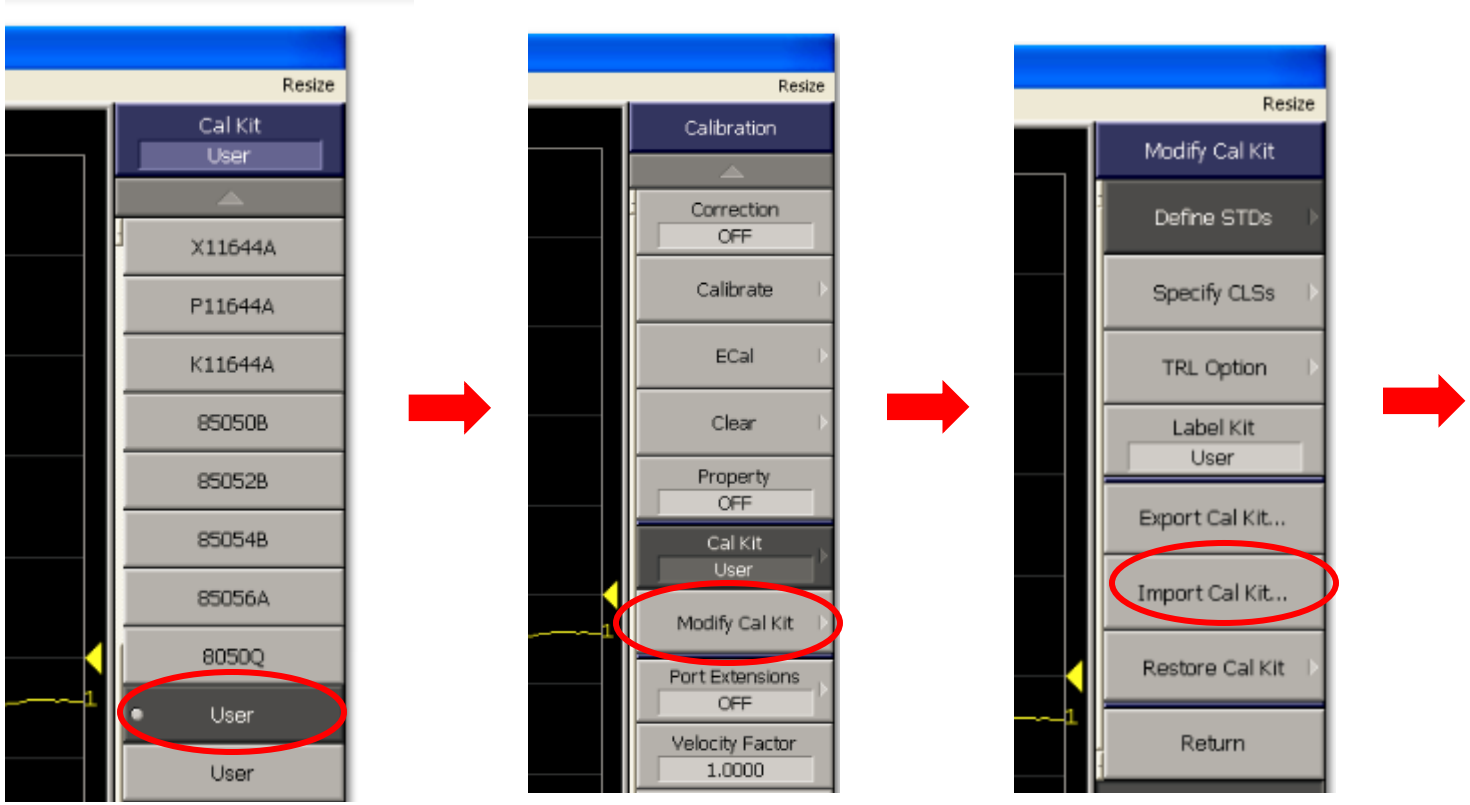
Both tips touch down simultaneously



Clean up solder bumps with industrial alcohol after probing

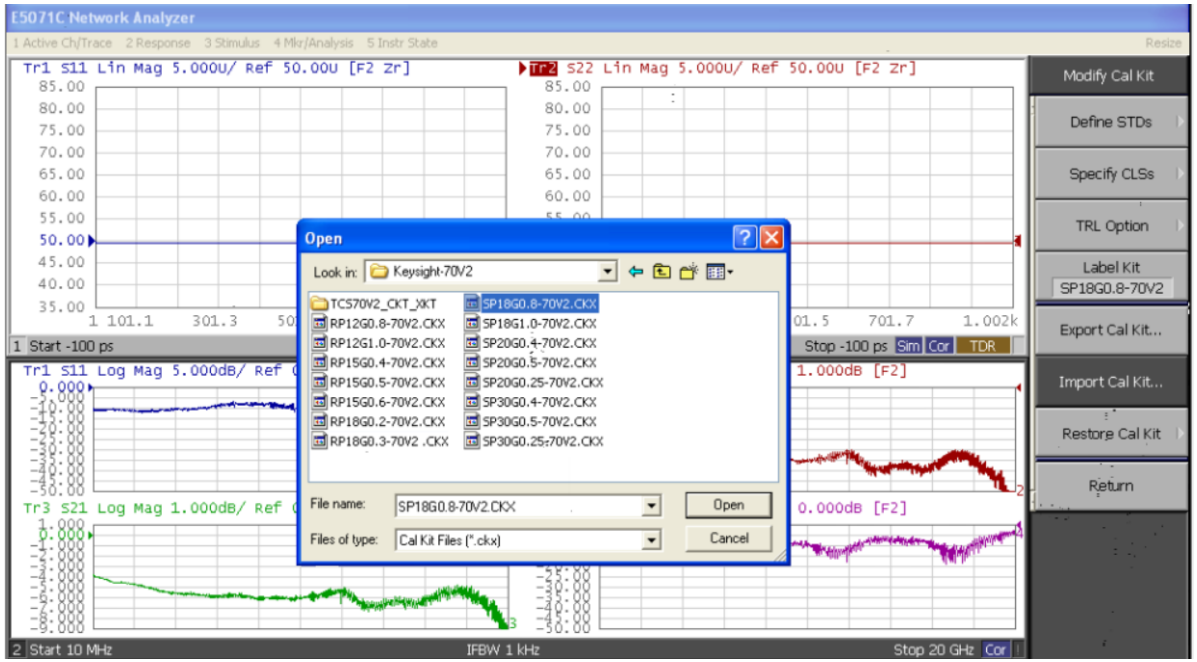
Import .CKX file for TCS50/70 Substrate

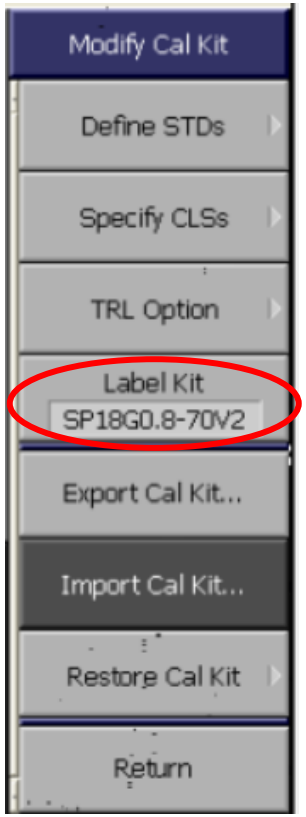
Press CAL button and choose an unused “User” kit ->



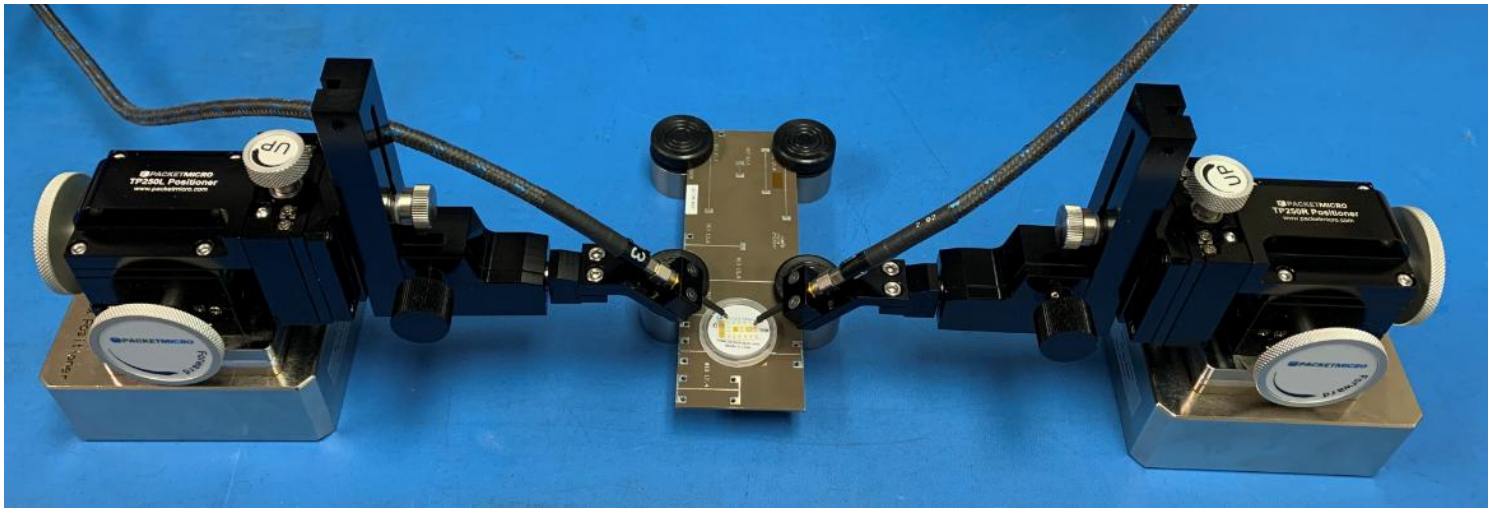
Import TCS50/70 .ckx file - Cont.

Press “Import Cal Kit” soft key ->



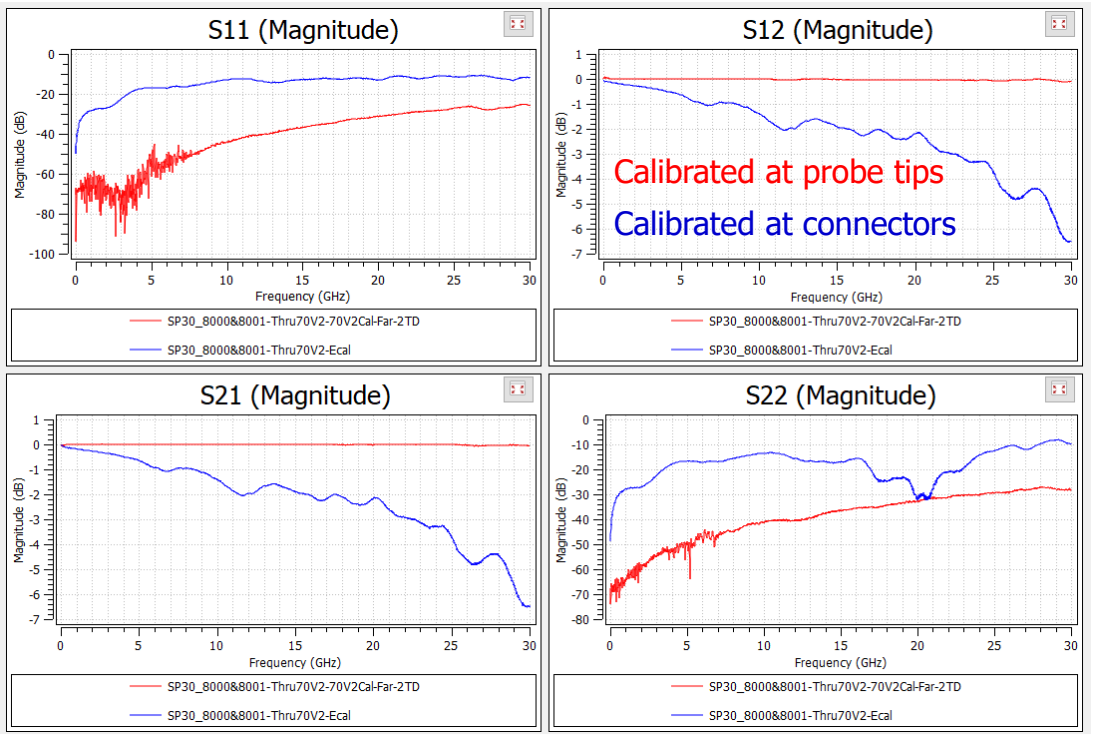


2-Port Probe-Tip Calibration Setup



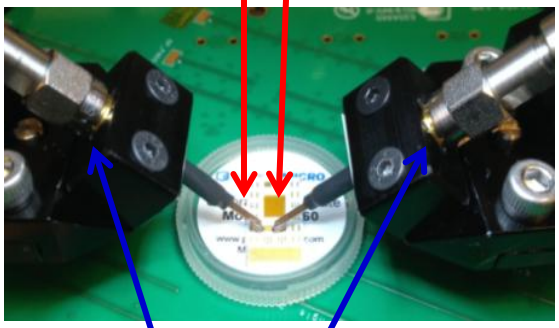
Precision TP250 Positioners with S-Probes

Thru Measurement with Probe-Tip Calibration



Thru Measurement

Calibrated at probe tips

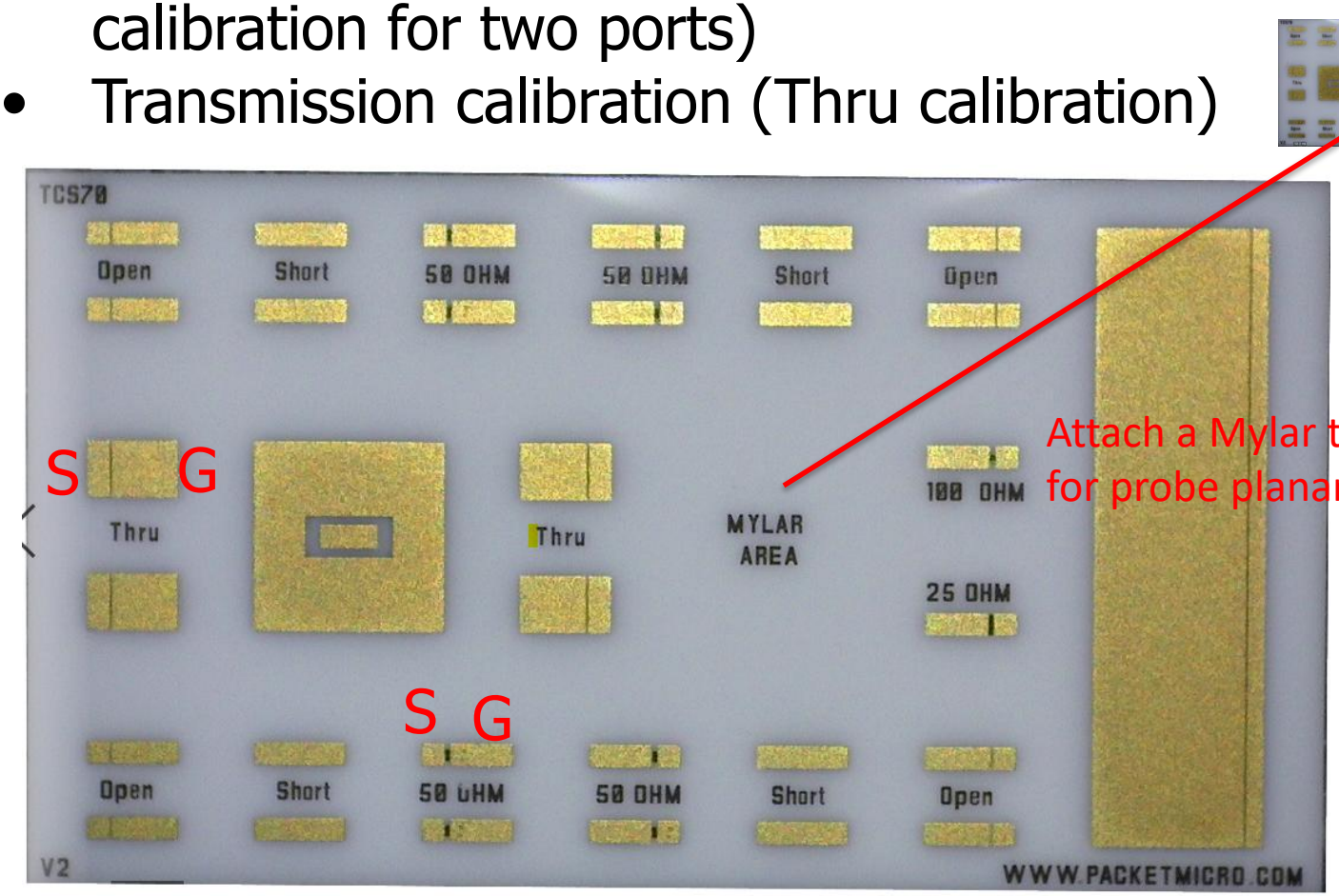


Calibrated at connectors

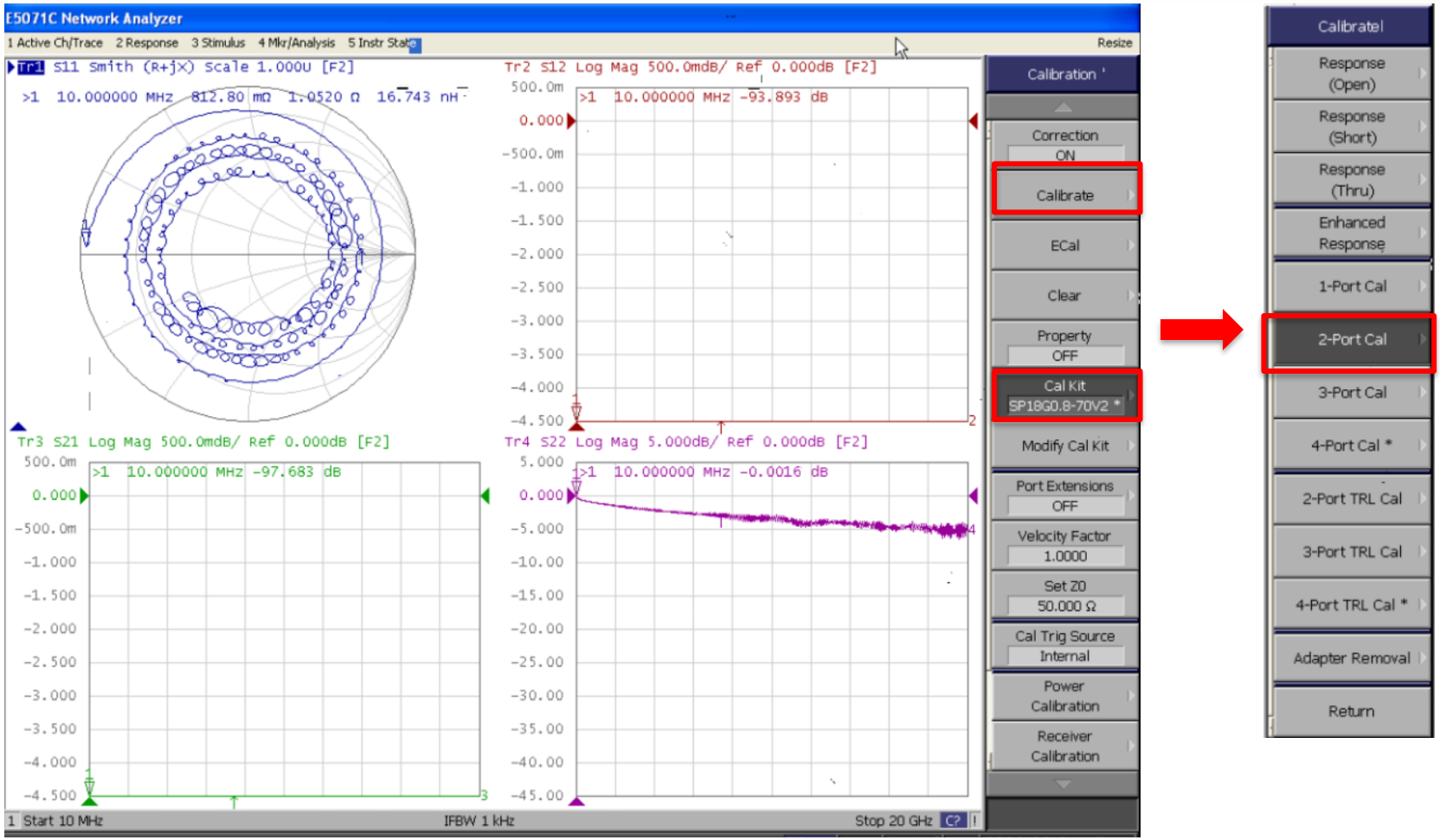
Probe-tip calibration (30 GHz 0.5 mm S-Probe)

2-Port Calibration with TCS70

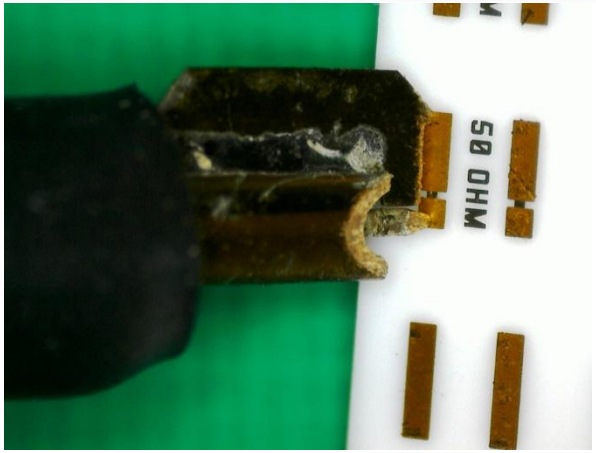
- Reflection calibration (Short, Open, Load calibration for two ports)
- Transmission calibration (Thru calibration)

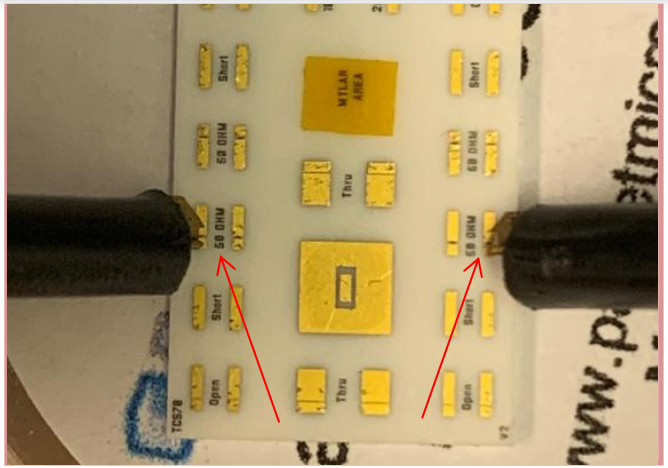


Select Probe-Specific .ckx File

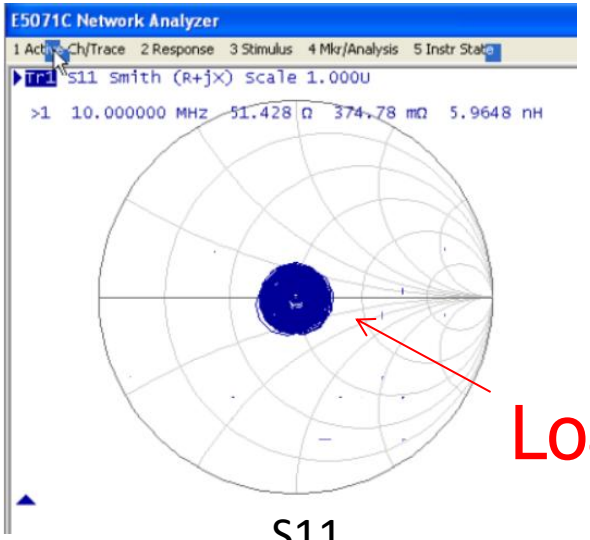


Reflection Calibration - Load



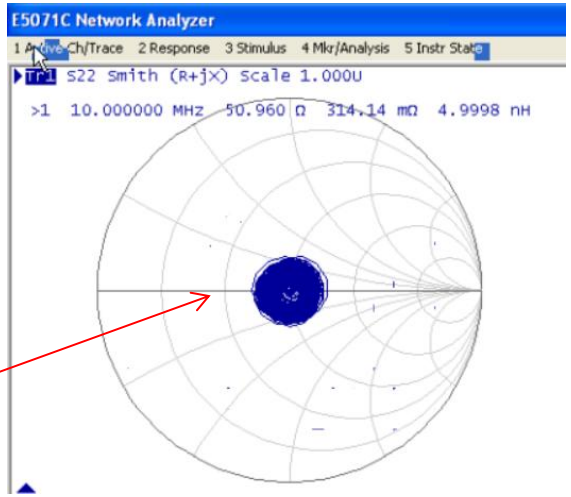


Load Pattern



S11

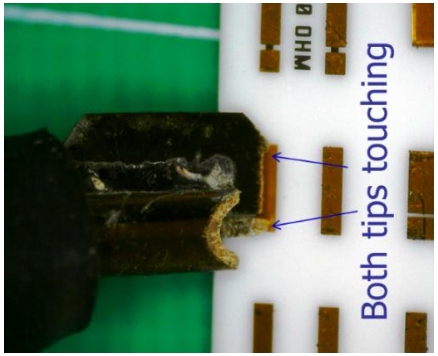
Load

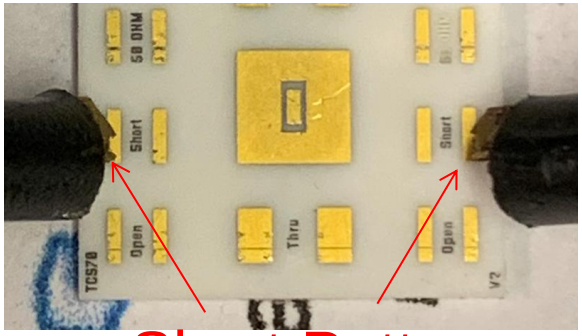


S22

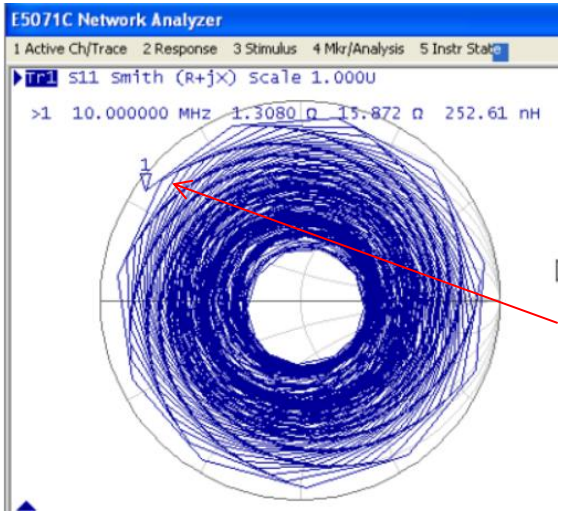
Reflection Calibration - Short

- Perform Short first to verify probe planarization



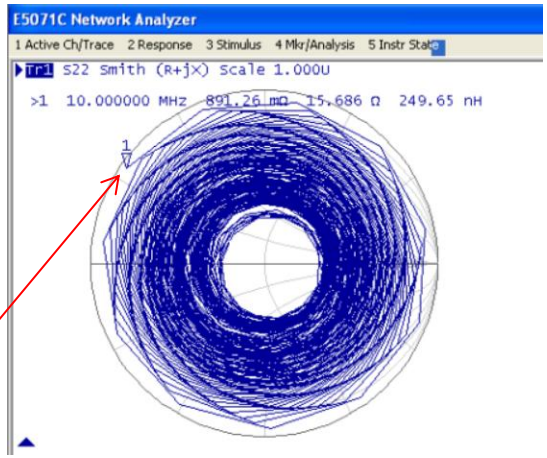


Short Pattern



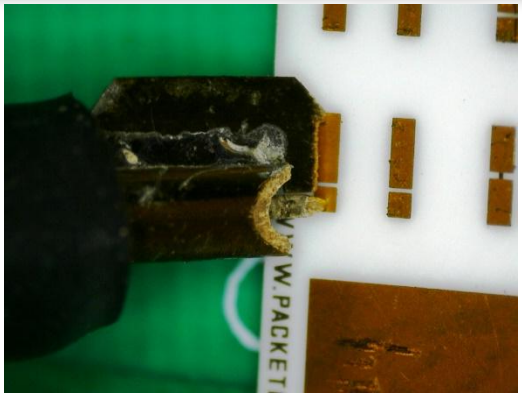
S11

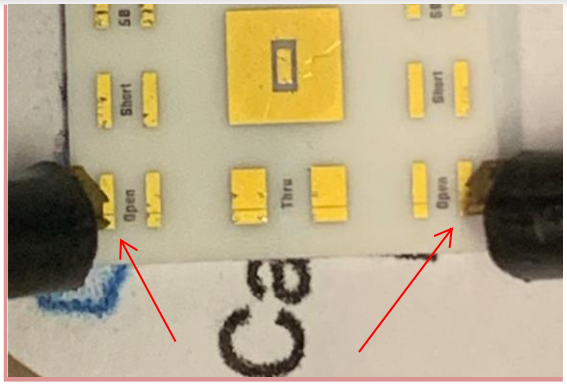
Short



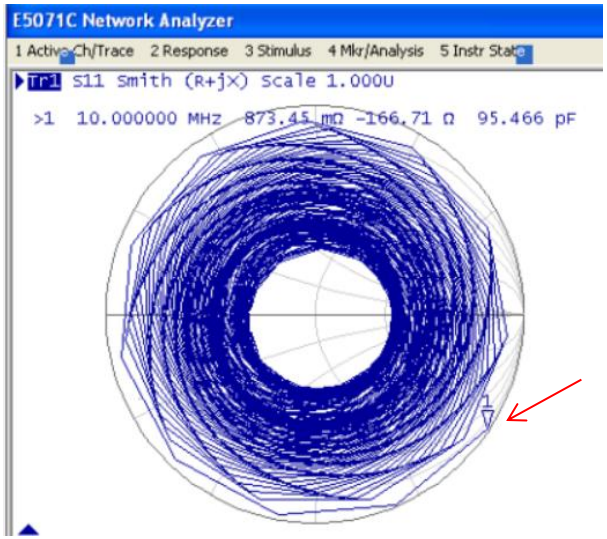
S22

Reflection Calibration - Open

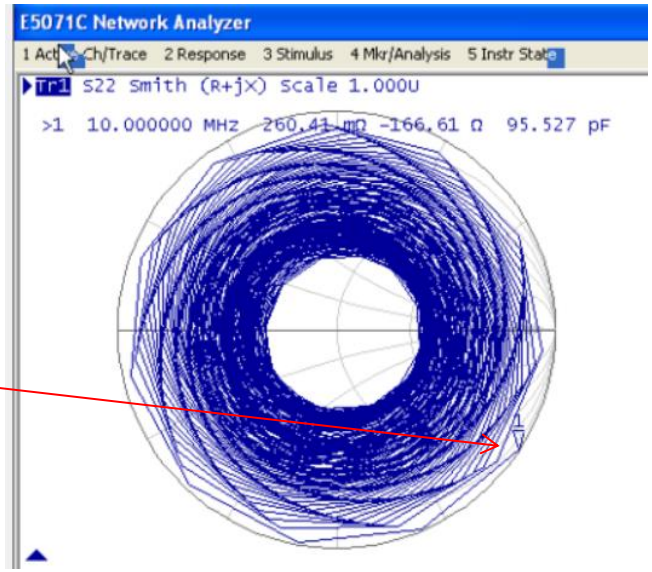




Open Pattern



Open

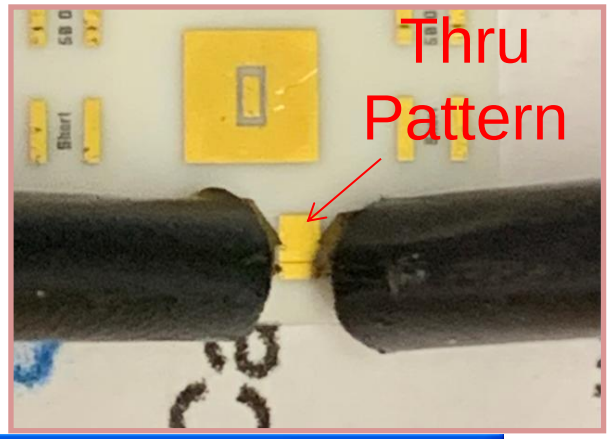


S11

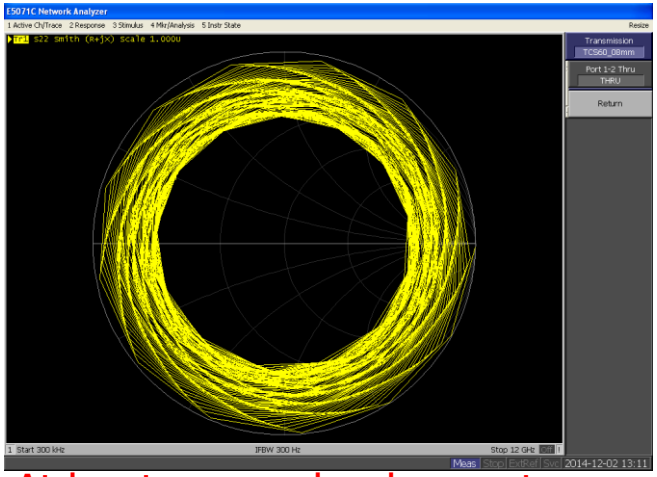
S22

Transmission Calibration - Thru

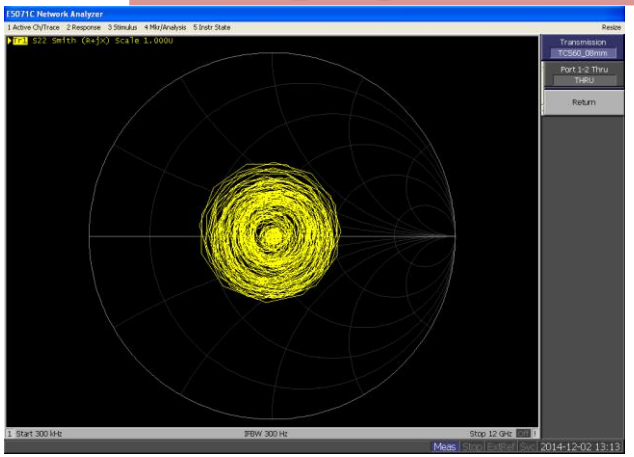
- Make sure that both probes touch down



S11 or S22

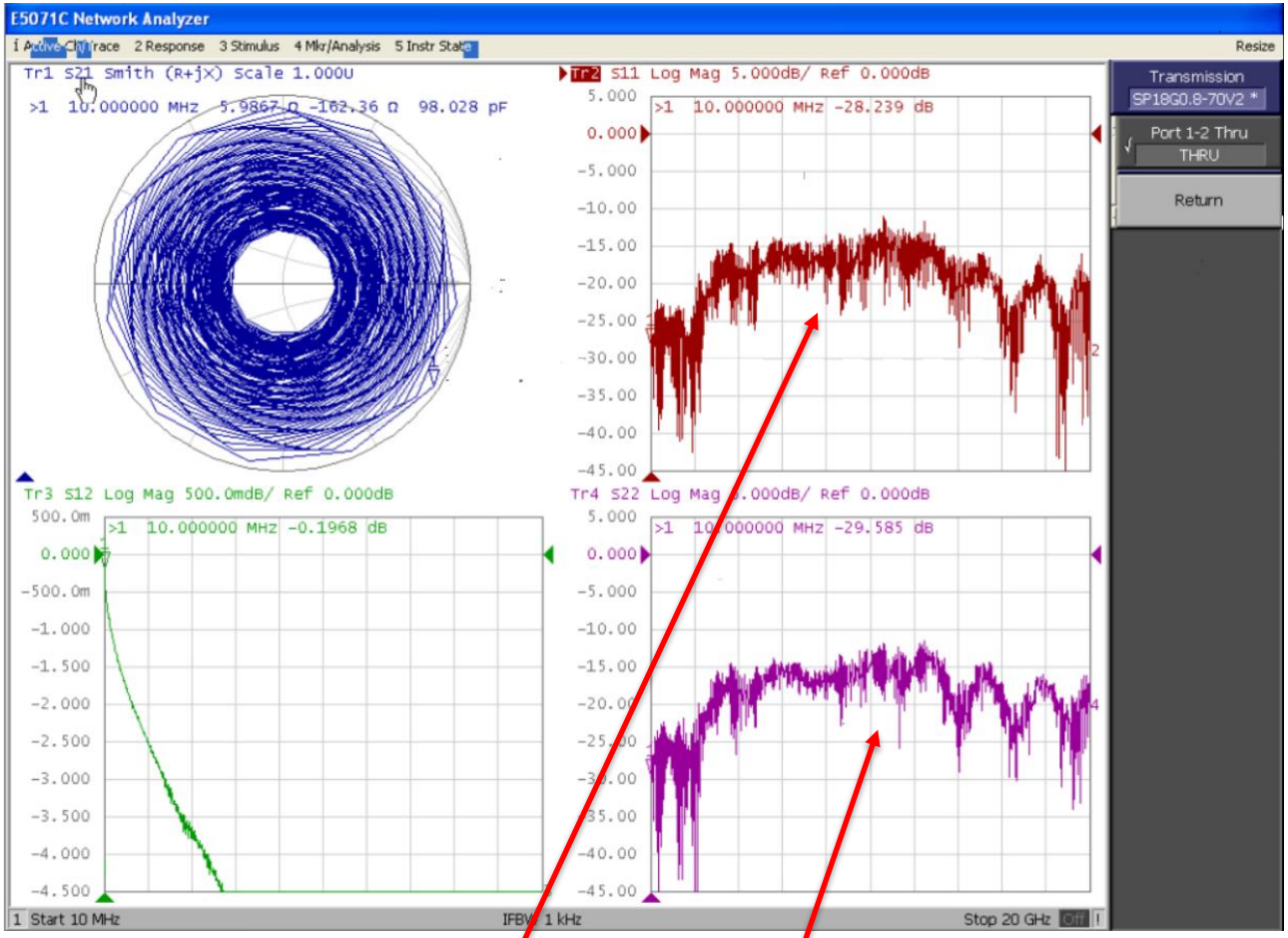


At least one probe does not touch down



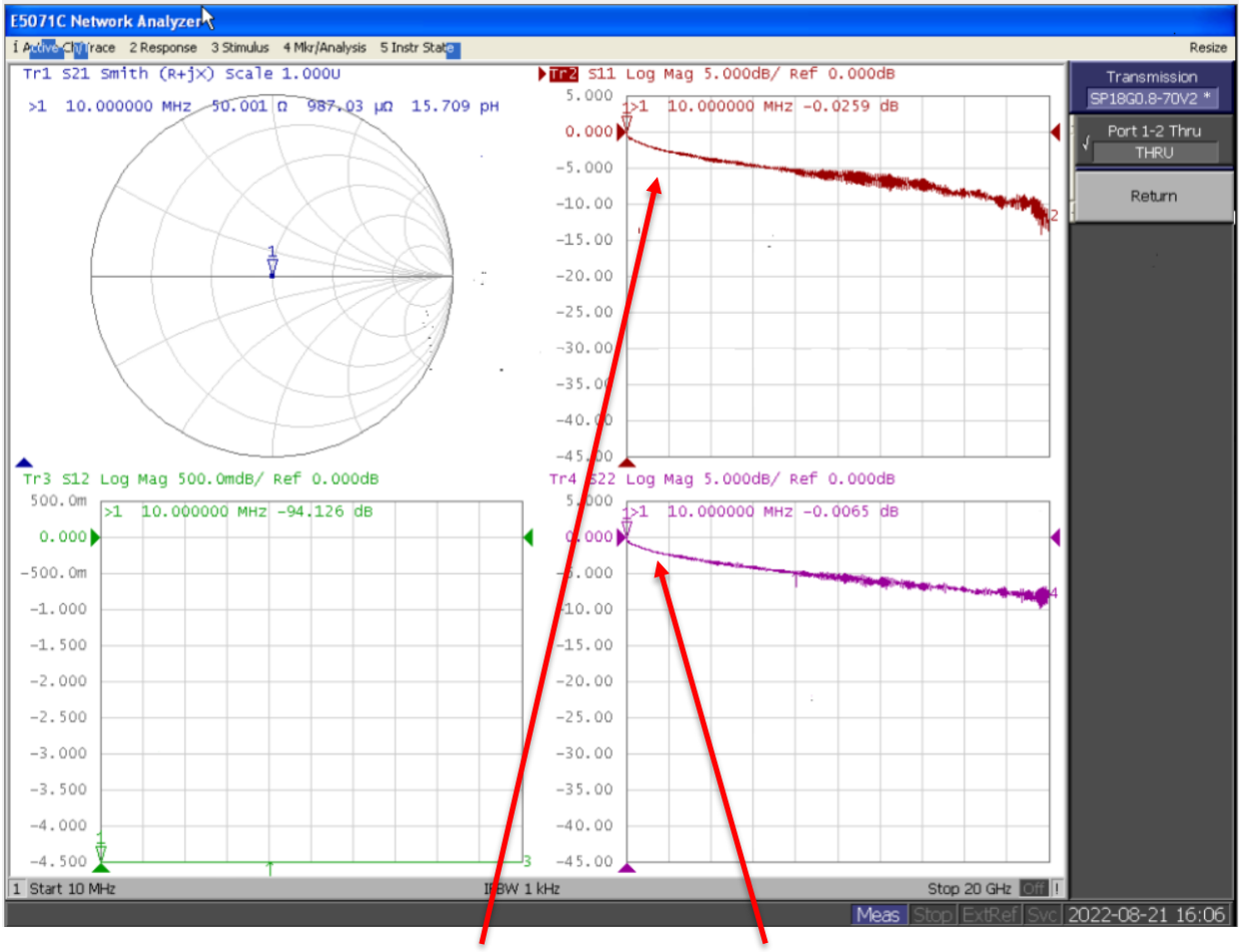
Both probes touch down

Correct Thru Calibration



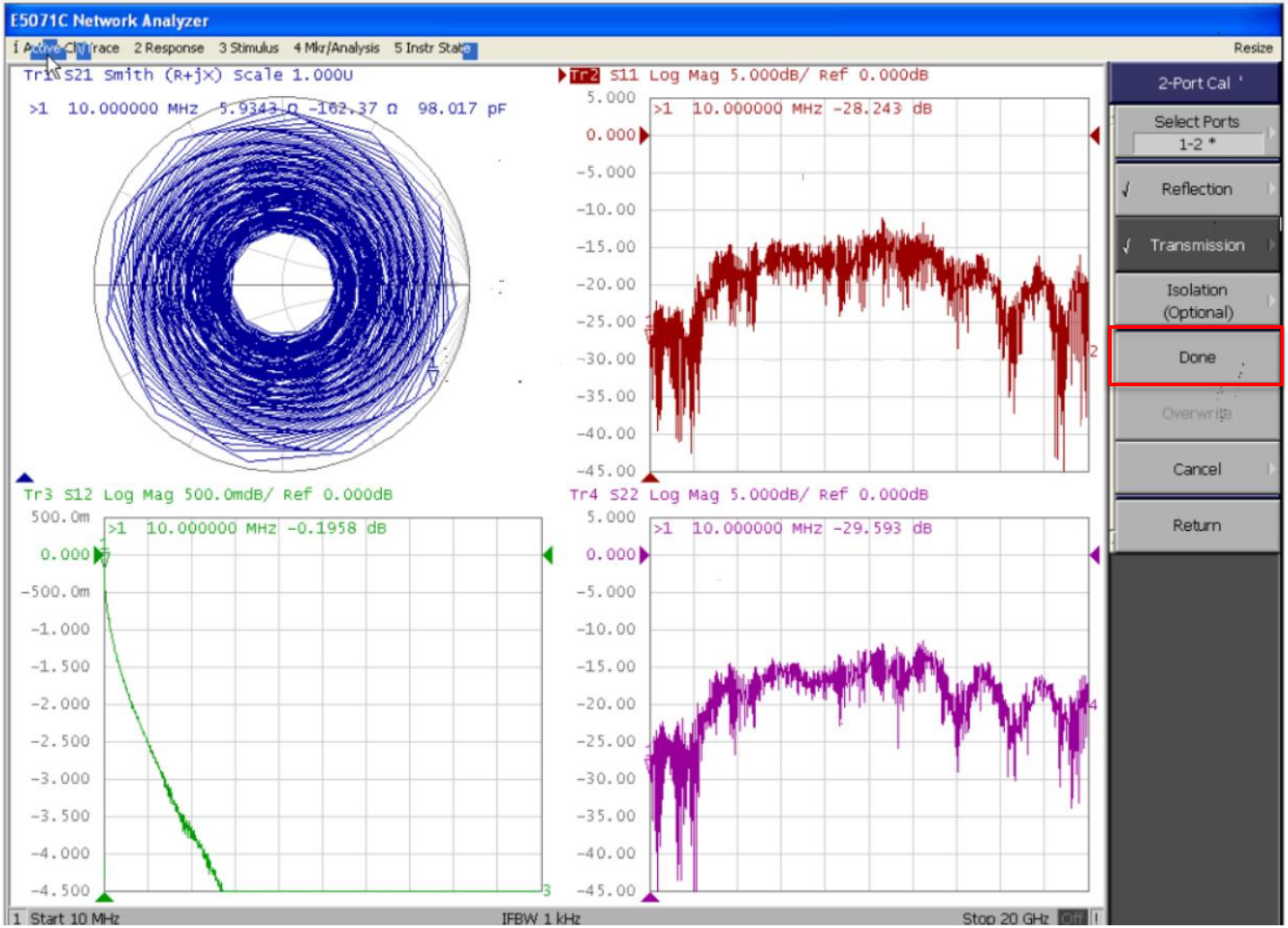
Both S11 and S22 should be < -10 dB !

Incorrect Thru Calibration

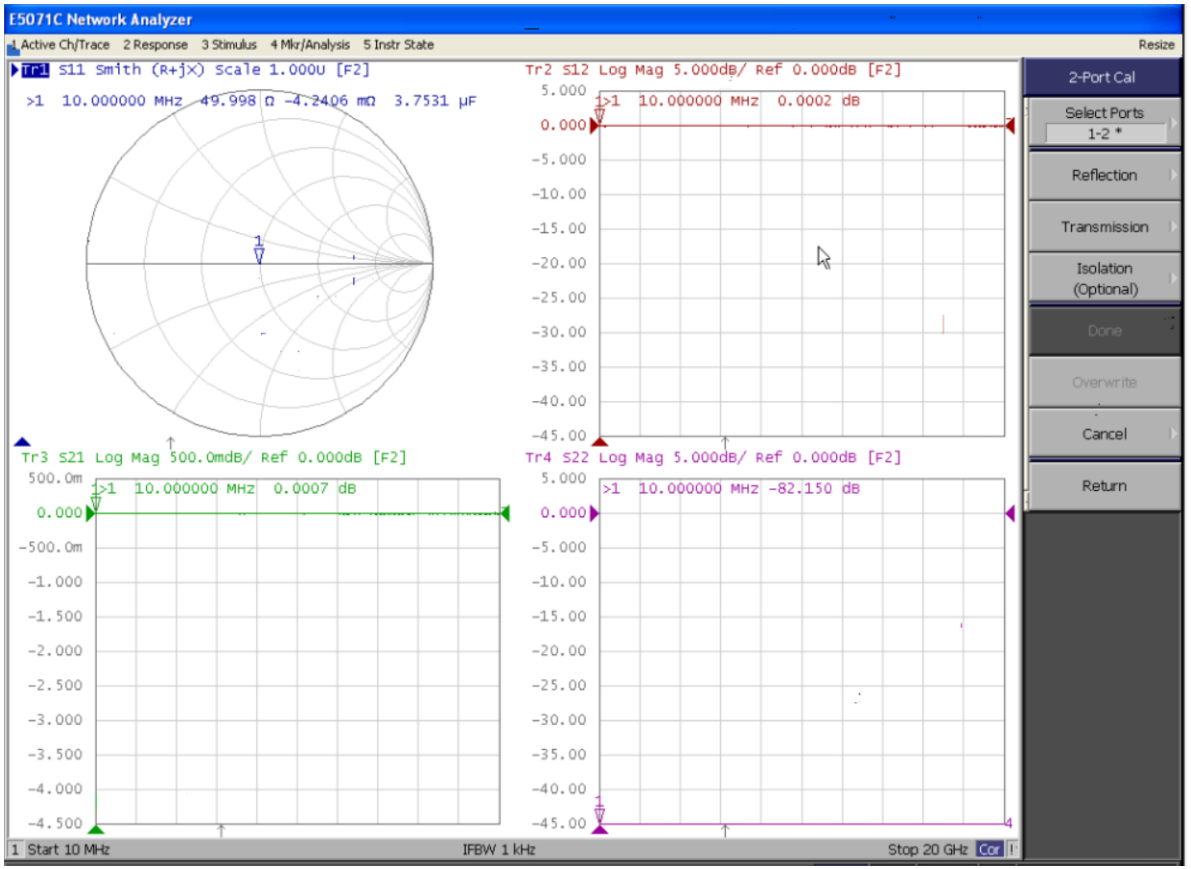


Both S11 and S22 are close to 0 dB at low frequency !

Make sure to click the “Done” button



Thru Measurement after SOLT Calibration



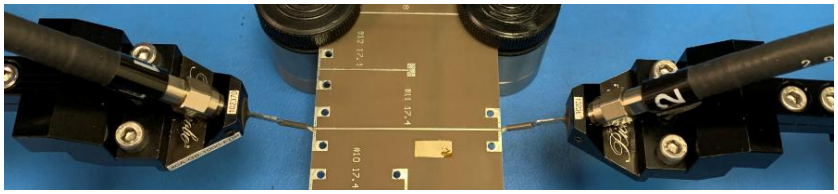
- S21 and S12 should be a flat line
- S11 and S22 should be only a dot on the Smith chart

Test Trace: 2” (5.08 mm) Microstrip

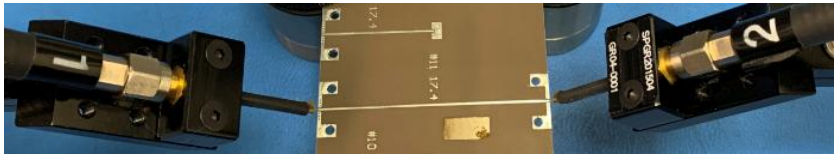
- **Compare measurements between 2.92 mm connectors and probes with probe-tip SOLT calibration**

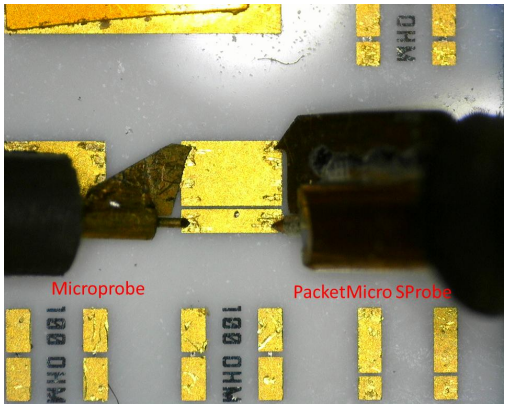
40 GHz 2.92 mm connector

40 GHz Microprobe

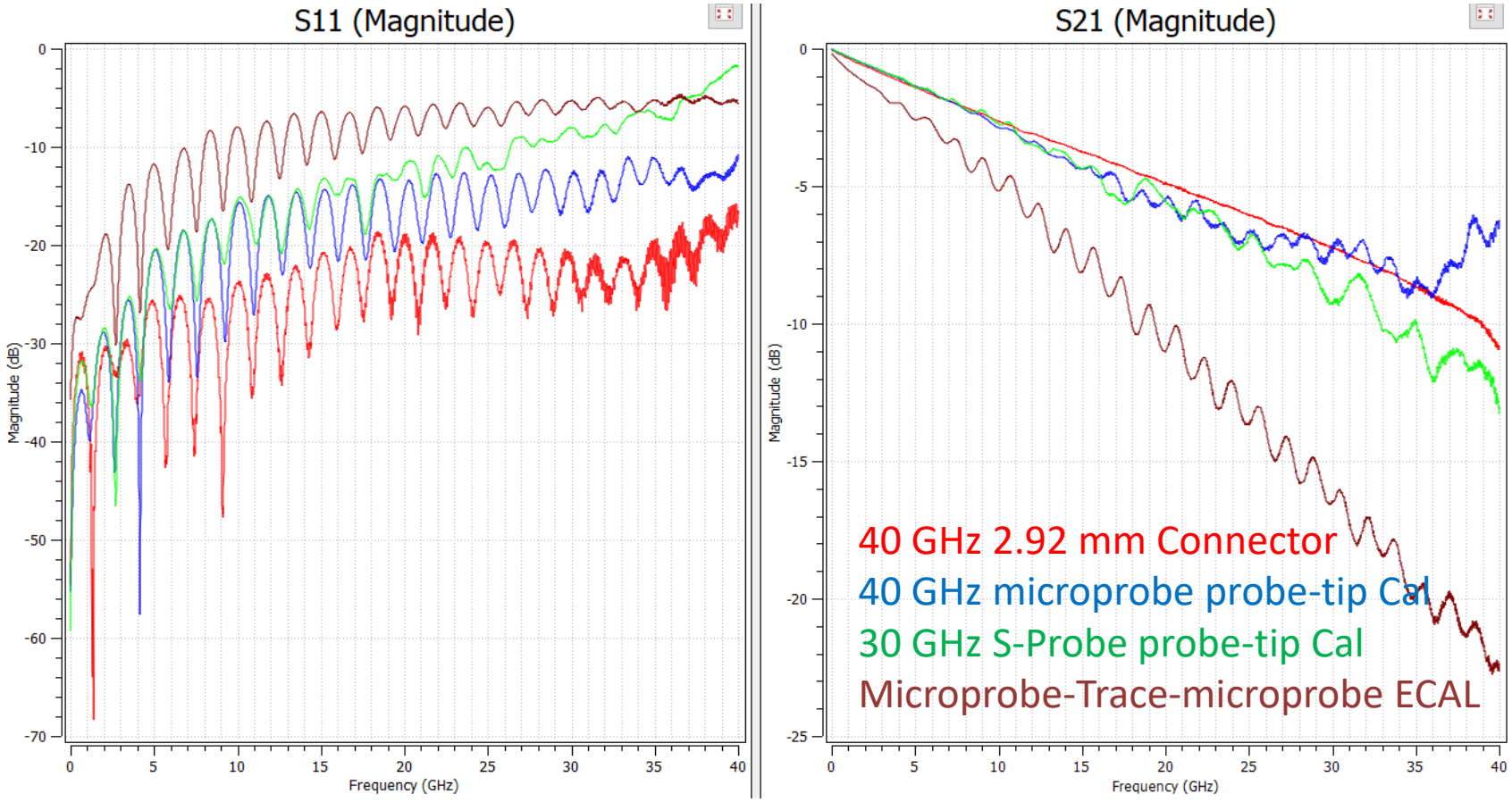


30 GHz S-Probe

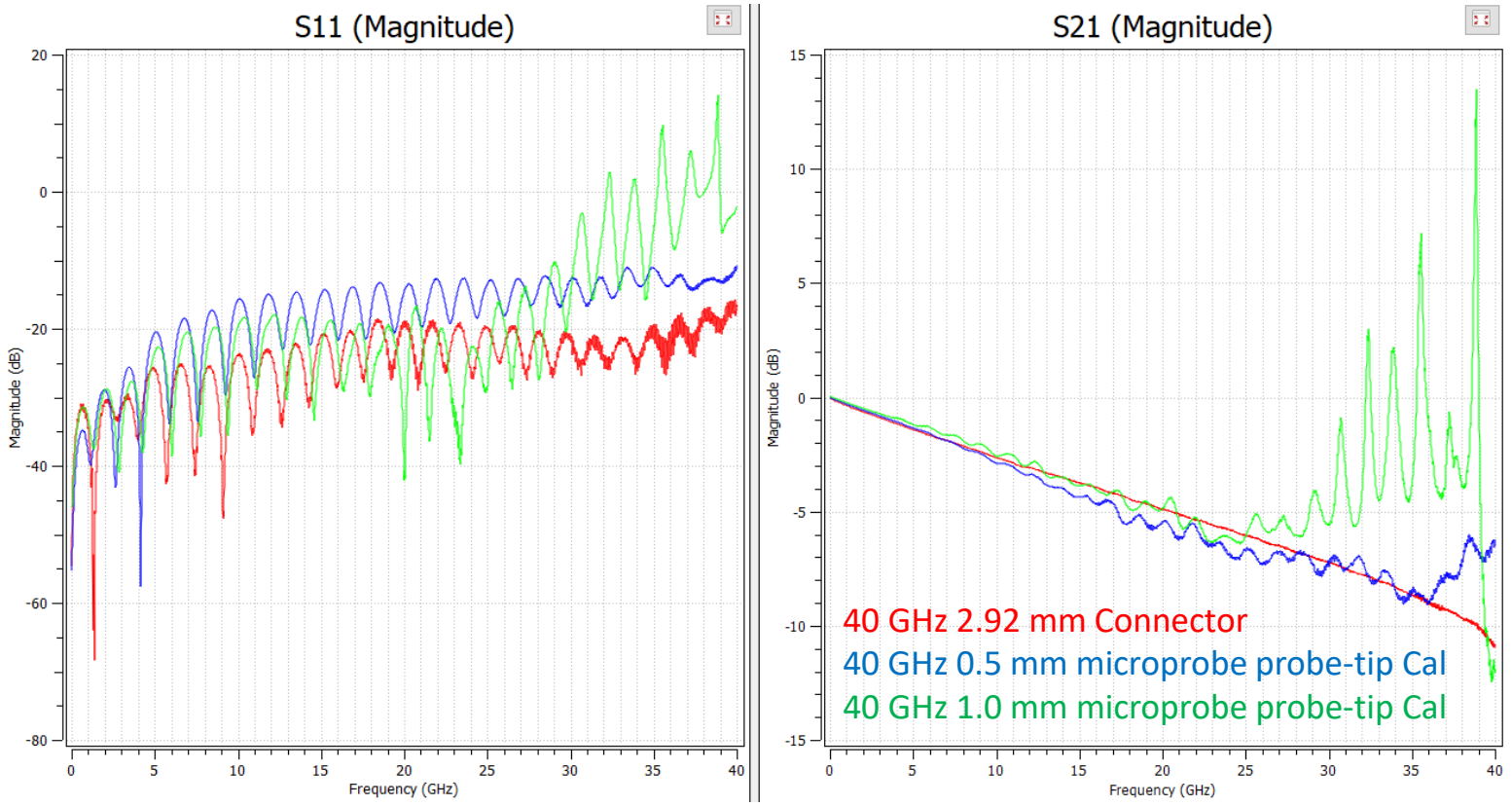




Connector vs. Probes



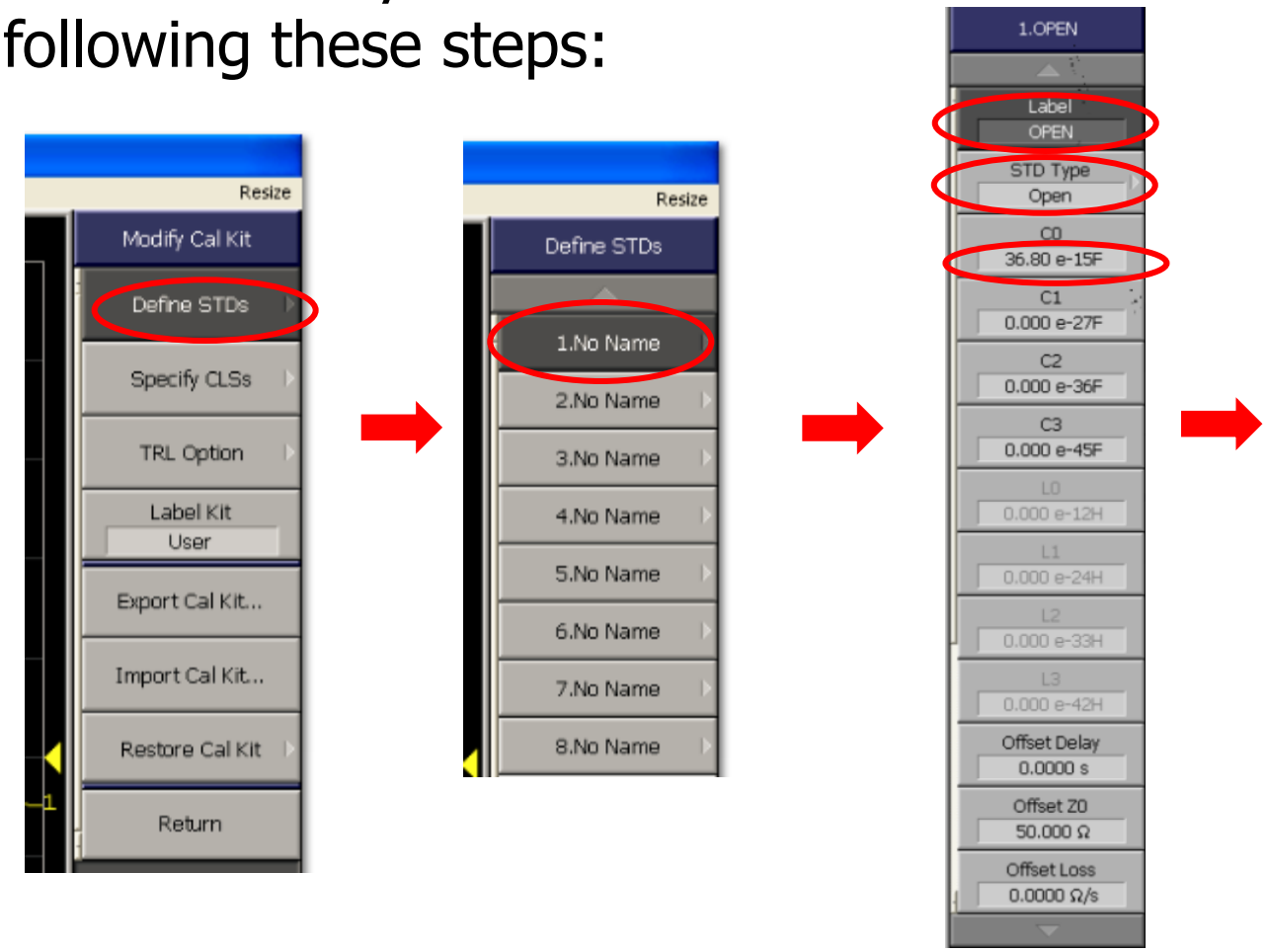
Limitation of Probe-Tip SOLT CAL



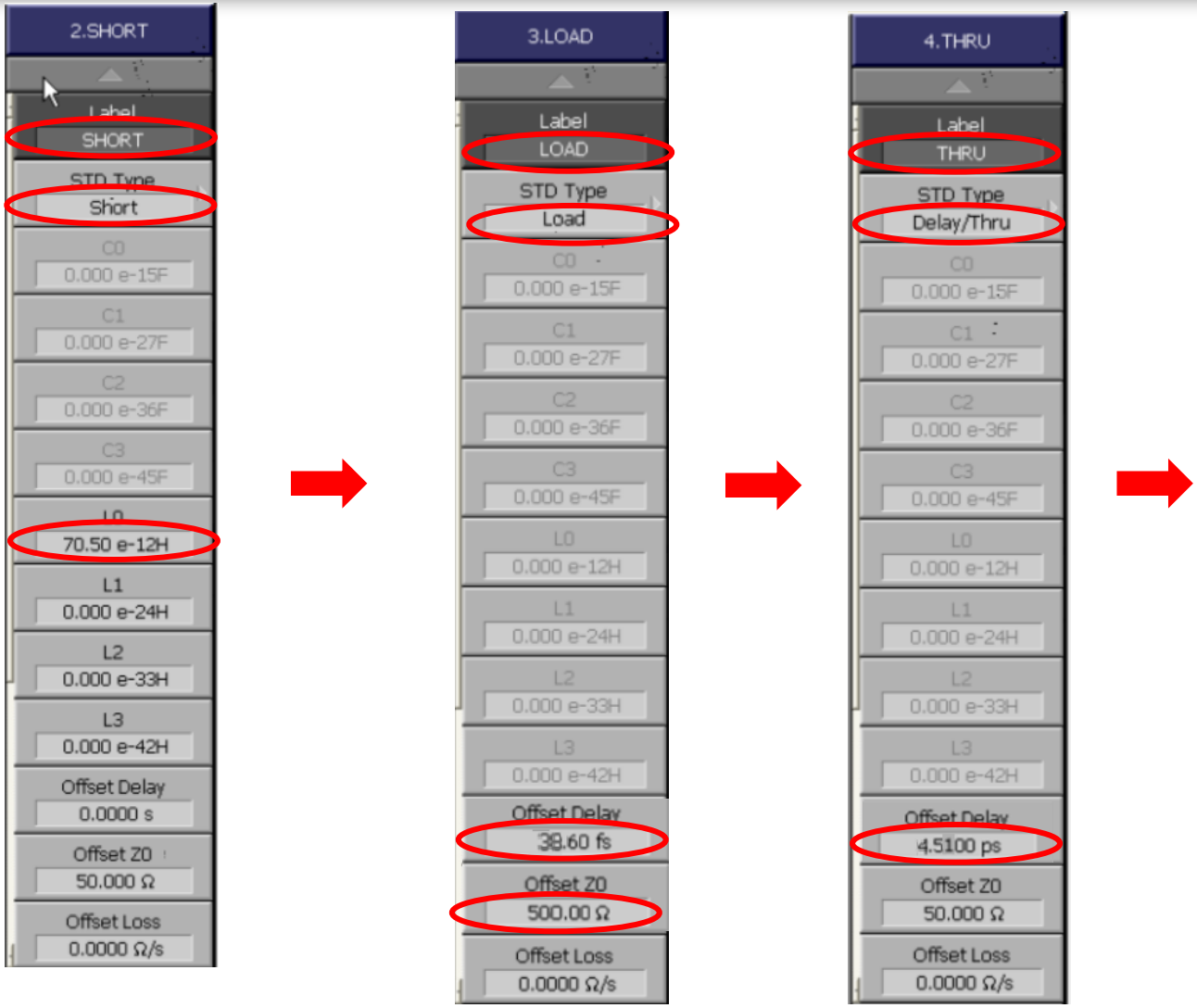
- **Typical probe-tip SOLT calibration for GS probes is accurate up to ~60% of probe bandwidth because higher order coefficients are not used due to probe contact**

Manual entry of TCS70

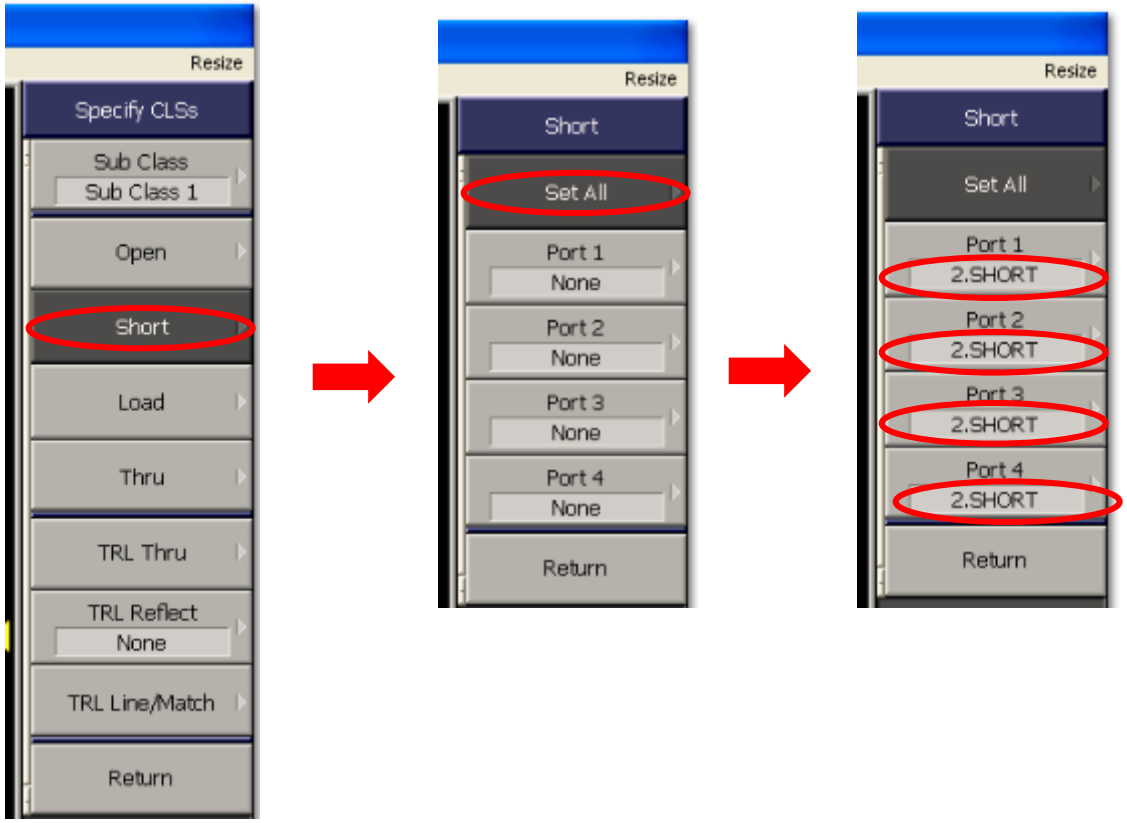
You can manually enter the coefficients of TCS70 Cal Kit by following these steps:



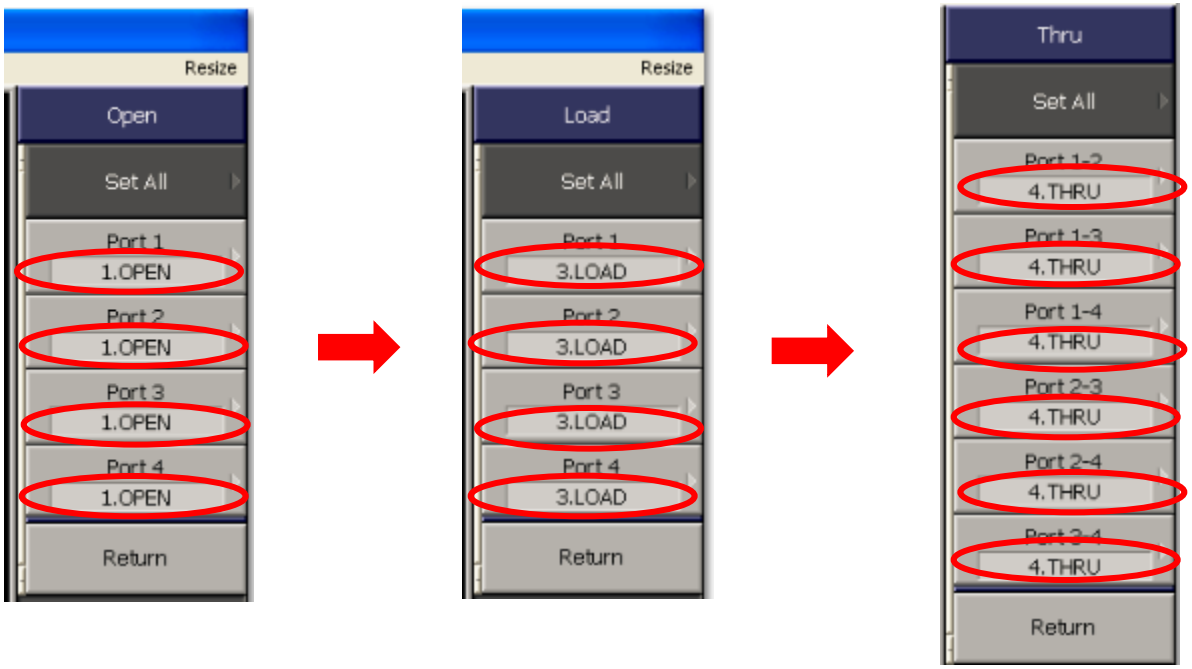
Enter SOLT – cont.



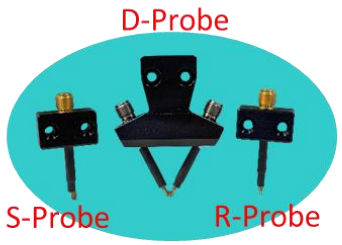
Specify CLS - Short

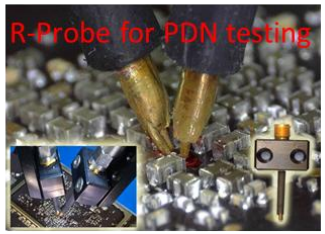


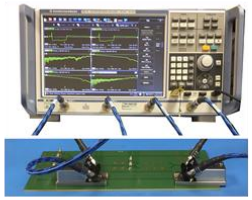
Specify CLS – Open, Load, Thru



PacketMicro Product Offering






Delta-L 4.0 Solution

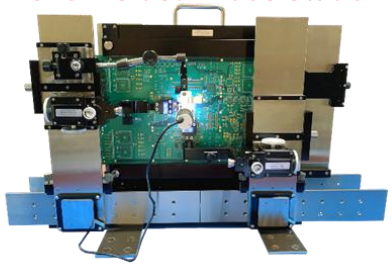

TCS70
Cal Substrate

Precision Positioners


TP250


TP150

VPS10 2-Sided Probe Station



Flex Positioners

F80

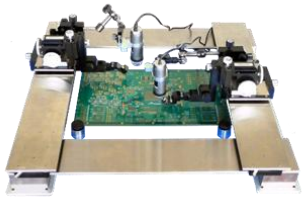

FP40

FP160MS

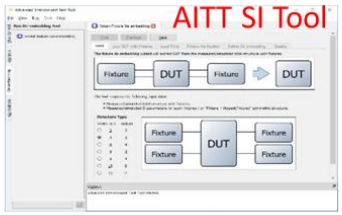

FP160

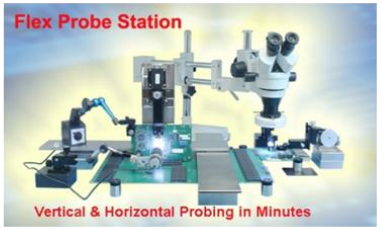
USB Type-C Fixtures

HPS24 Probe Station



AITT SI Tool





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