UBM

PCB Probing for Signal-Integrity Measurements

Richard Zai, PacketMicro

SPEAKER

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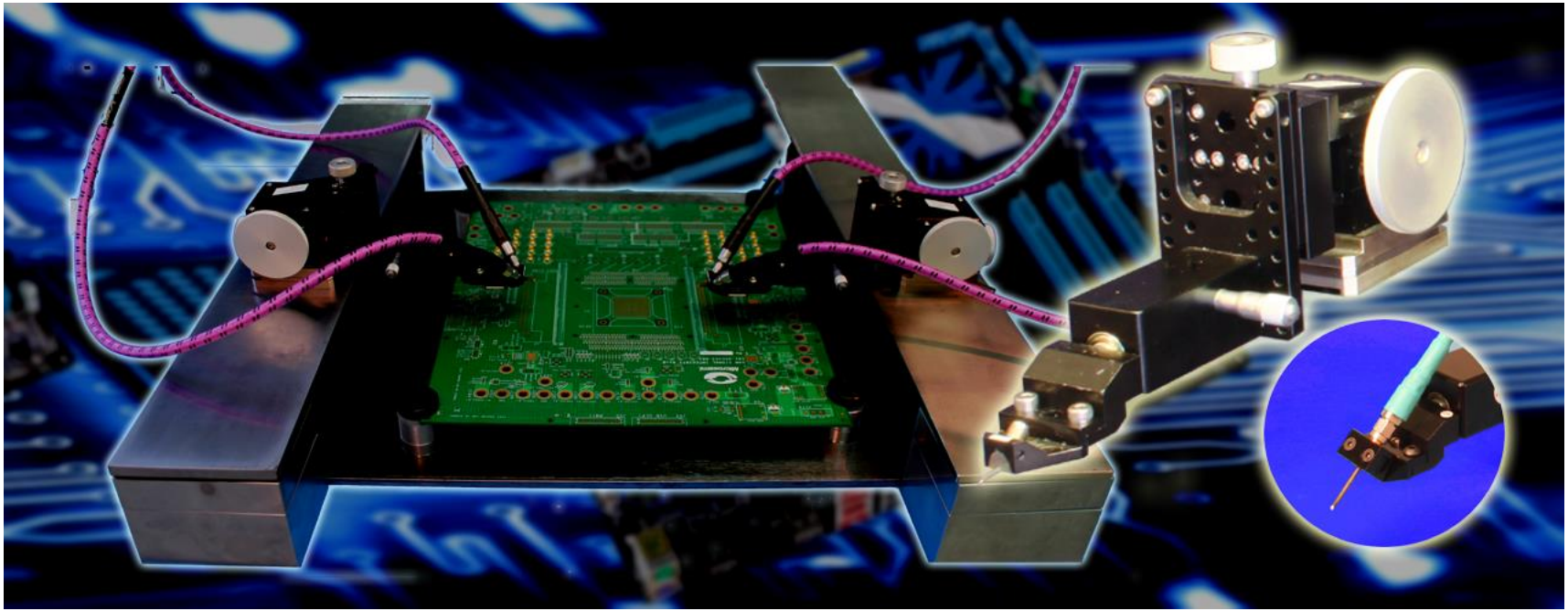
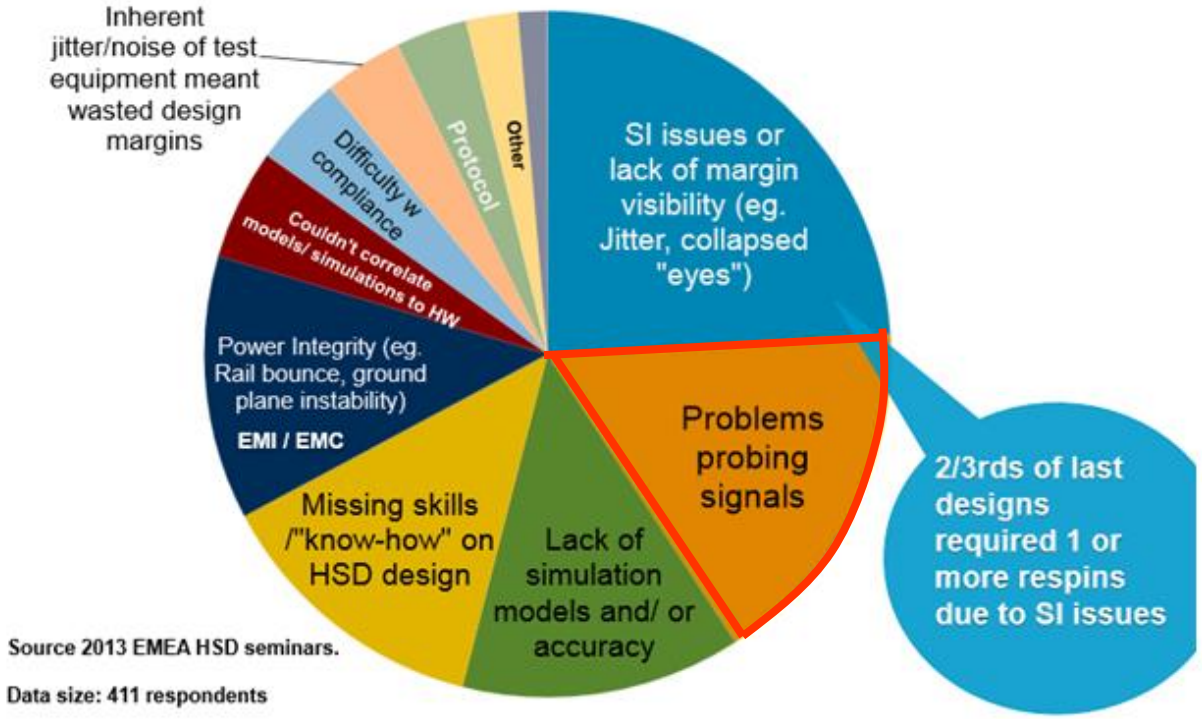
Dr. Richard Zai is PacketMicro CTO and has more than 25 years of experience in architecting and delivering technology solutions in the areas of RF and signal integrity probing, wireless sensor networks, and radio frequency identification (RFID). In 1987, he joined IBM Watson Research Center as a research staff member and manager, where he pioneered in the development of RFID and high-speed robotic technologies. After leaving IBM in 1997, Richard co-founded start-up companies in Silicon Valley. Most recently, he has been leading the development of rugged 20-GHz test probes and patented probe stations that have been used by many Fortune 100 companies. Richard receives his Ph.D. degree from the University of Wisconsin-Madison and holds 15 US patents.

PCB PROBING FOR SIGNAL INTEGRITY MEASUREMENTS



CHALLENGES IN HIGH SPEED PCB DESIGN

What were the HSD Challenges on Your Last Design?

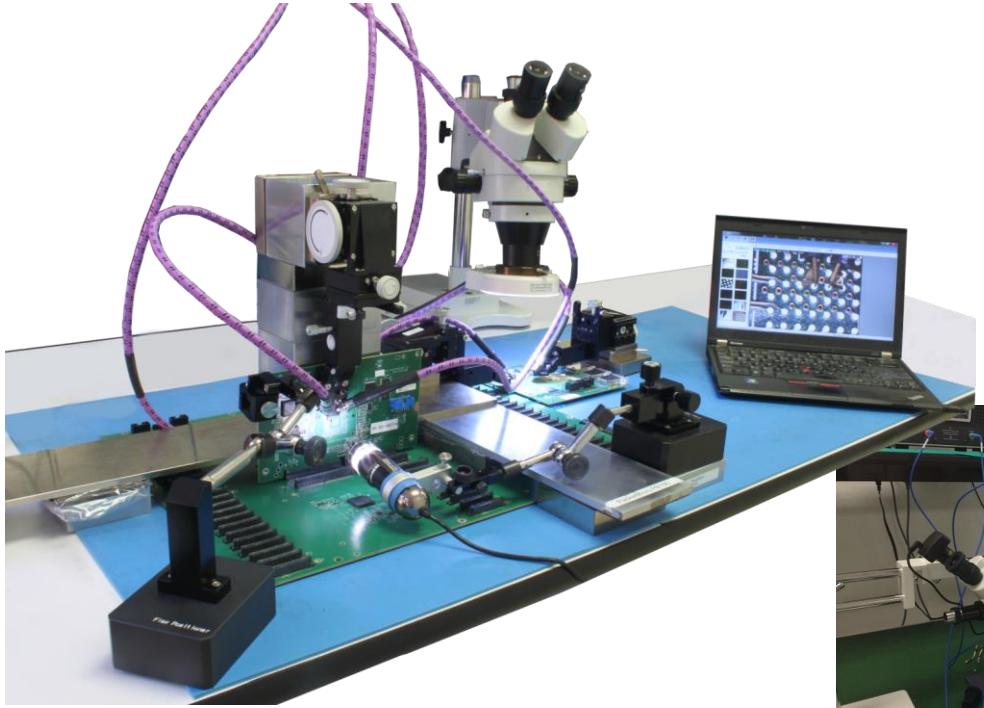


CHALLENGES IN PCB PROBING

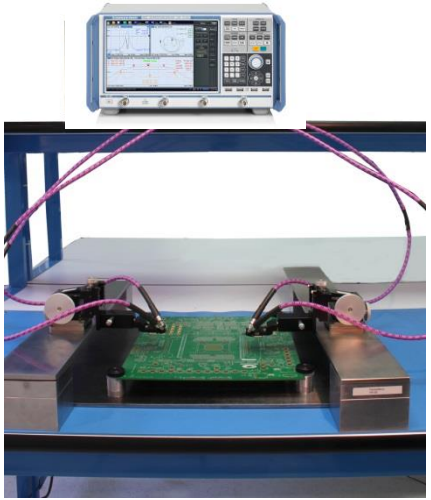
- **Diverse Form Factors:**
  - PCBs, unlike silicon wafers, have many different sizes and shapes.
- **Various Test Configurations:**
  - Single-sided, double-sided, daughter boards on motherboard, boards on a backplane, etc.
- **Different Test Pad Orientations:**
  - Ground pads are sometimes not in the convenient locations.
- **Robustness of Test Probes:**
  - Microprobes are good for probing wafers but too fragile for probing PCBs.

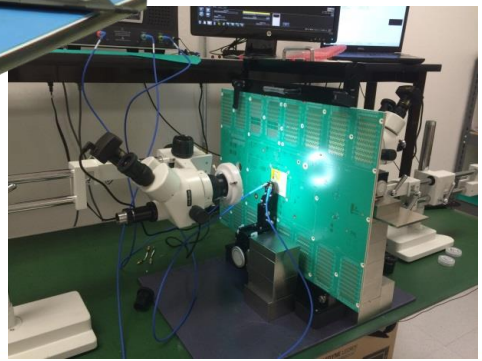
VARIOUS TEST CONFIGURATIONS

Mother/Daughter Board Probing



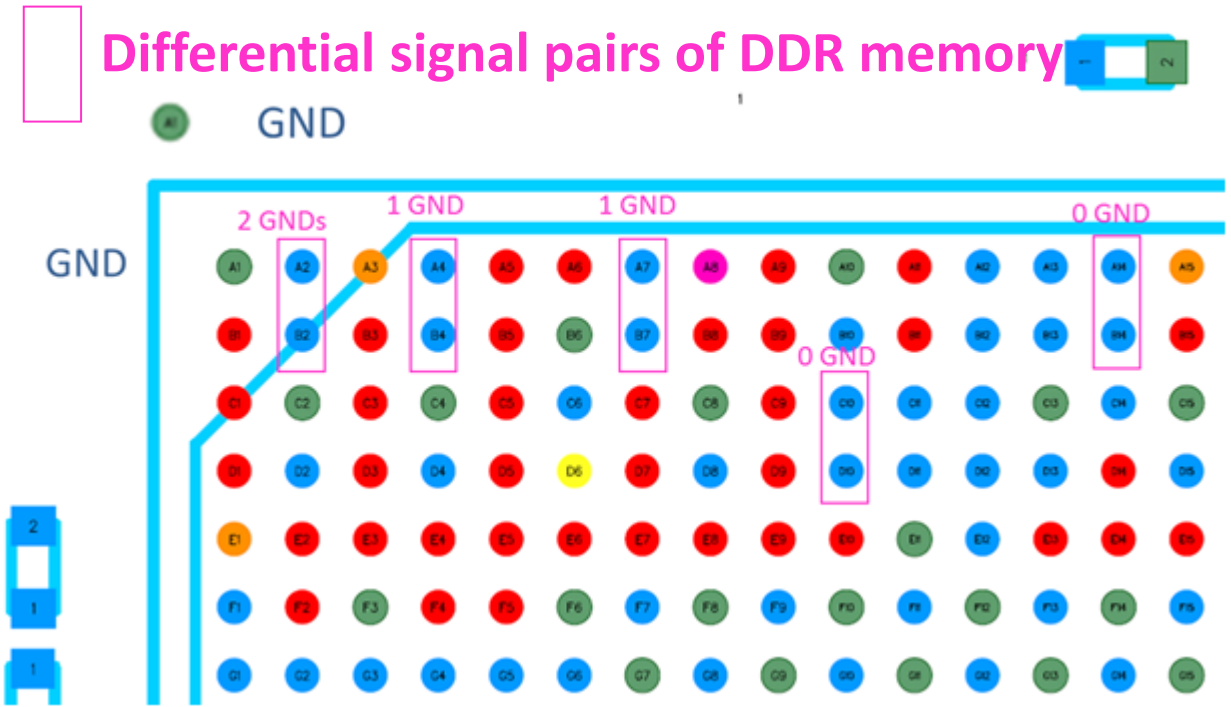
Large PCB Probing





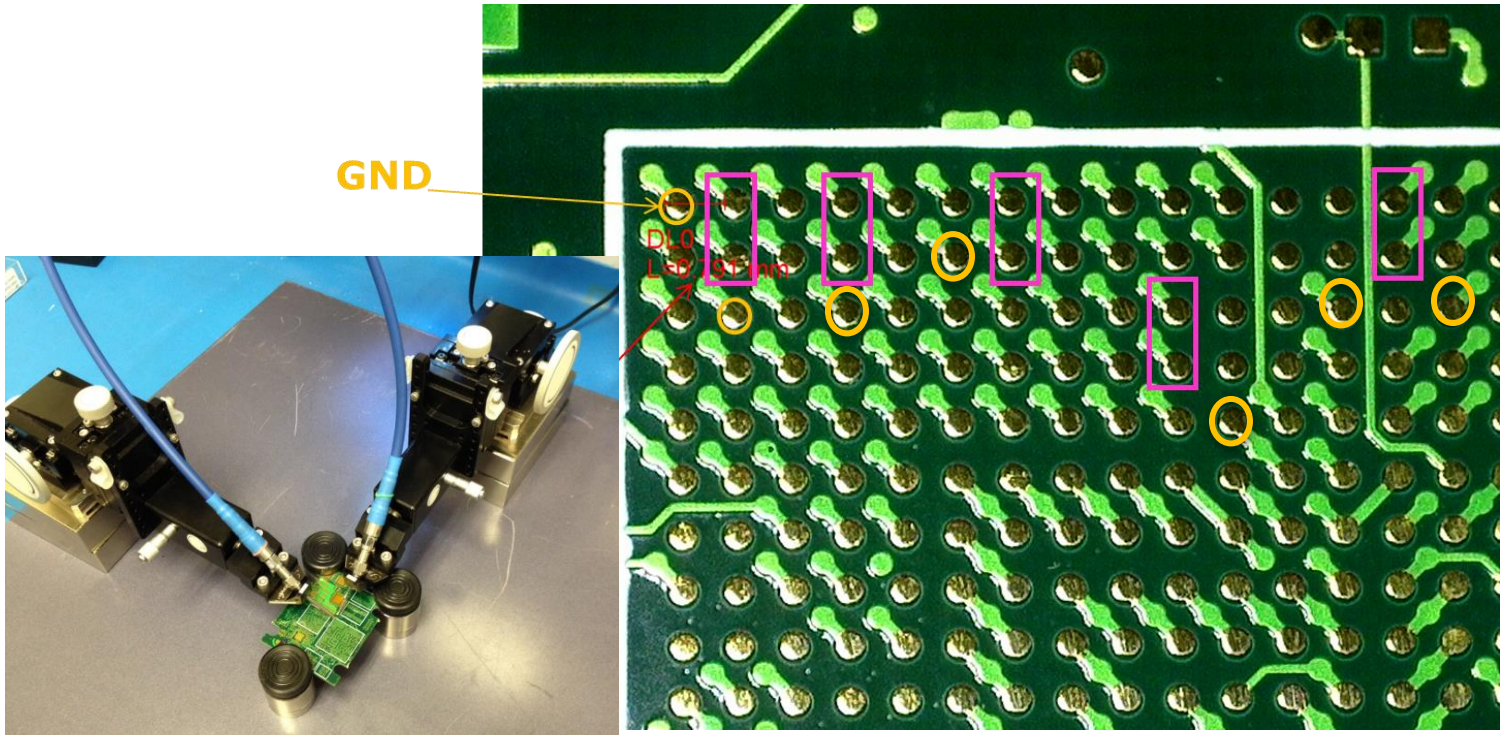
Vertical Probing

DIFFERENT TEST PAD ORIENTATIONS



Not all the differential signal pads have adjacent GND pads

DDR MEMORY BOARD LAYOUT

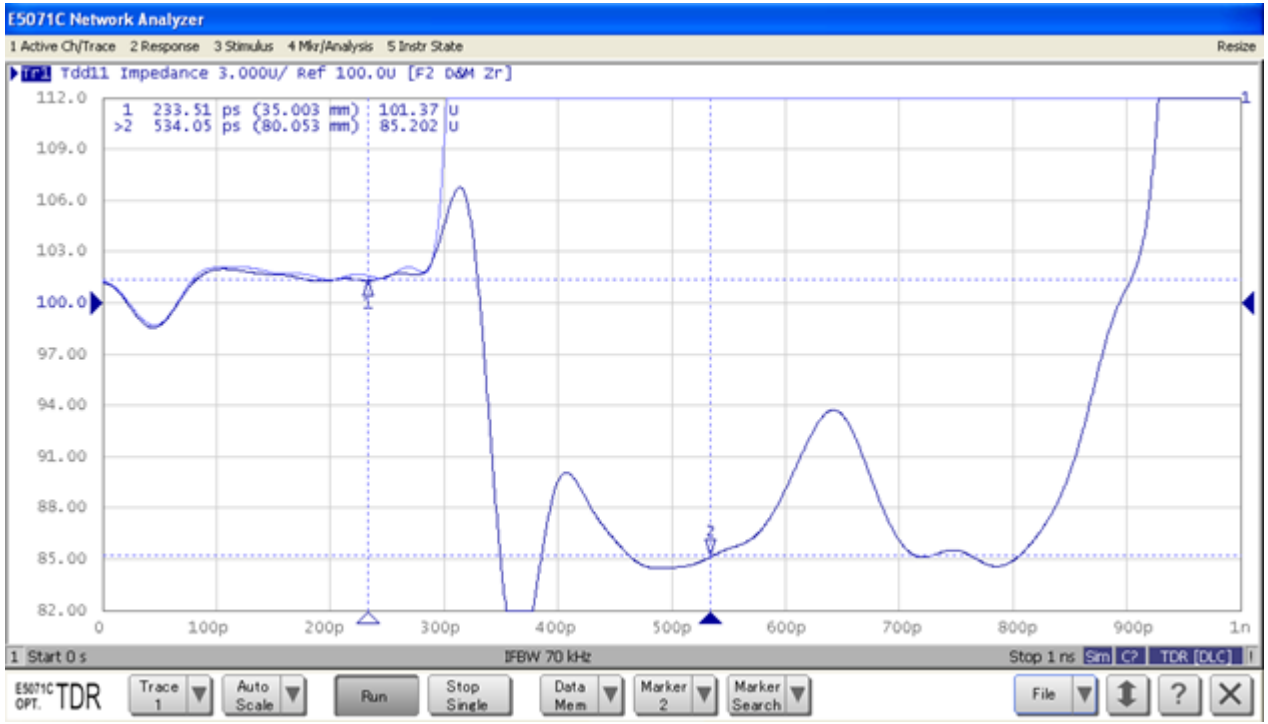


Only 1 out of 5 differential pairs can be probed with GS & SG microprobes.

DIFFERENTIAL SIGNAL-SIGNAL PROBE

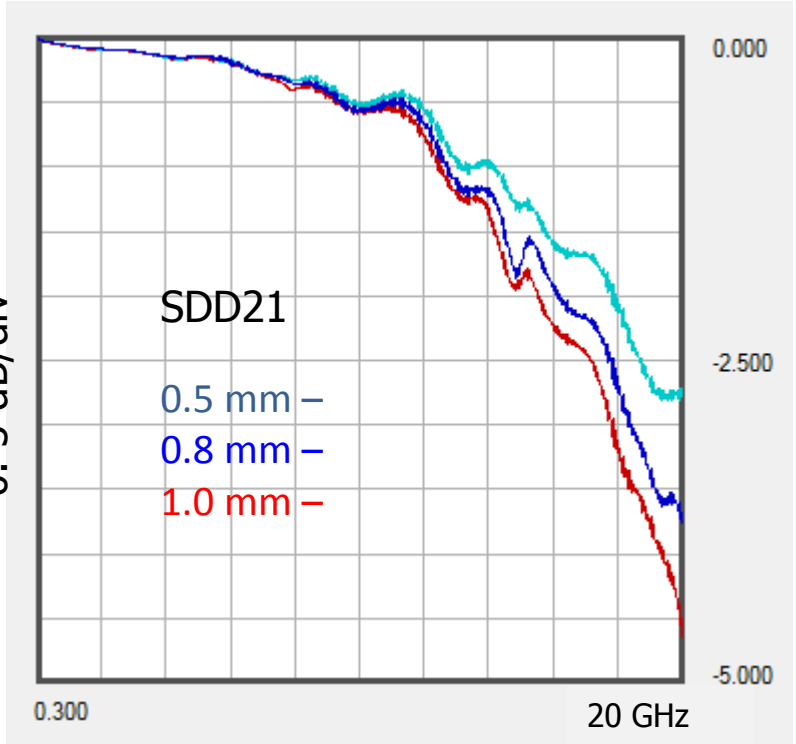
- **Robust :**
  - Signal-Signal only D-Probe and de-embedding tool offer an easy, robust solution for PCB characterization.
- **Accurate :**
  - 18-GHz D-Probe and 40-GHz differential GGB40A microprobe provide comparable measurement accuracy up to 18 GHz.
- **Versatile:**
  - D-Probe with 2 signal-signal tips can probe differential pads without neighboring GND pads as required by microprobes with 4 GSSG tips.

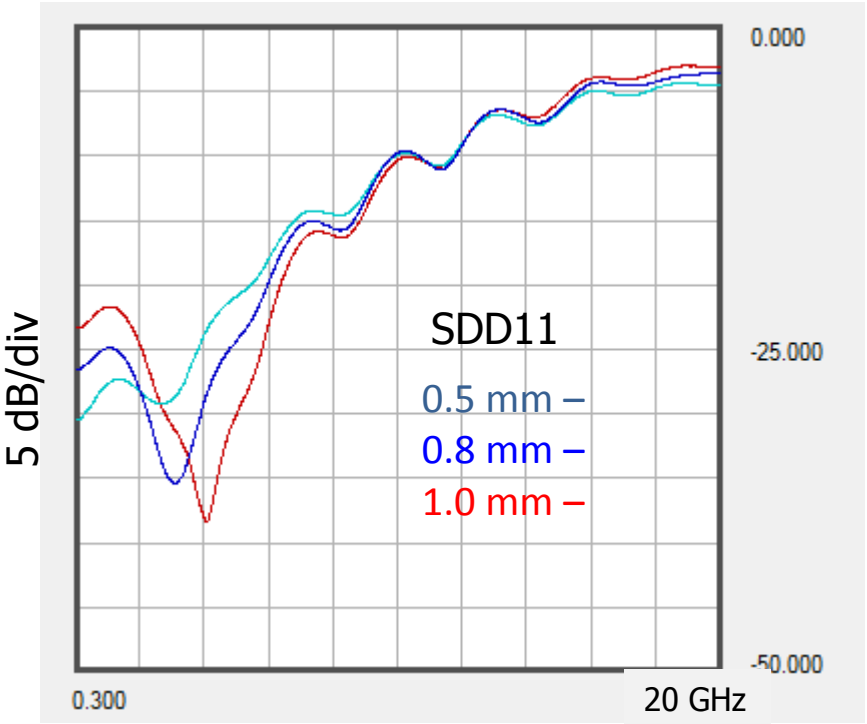
DIFFERENTIAL TDR MEASUREMENT WITH D-PROBE



5 out of 5 differential pairs can be probed with signal-signal D-Probe.

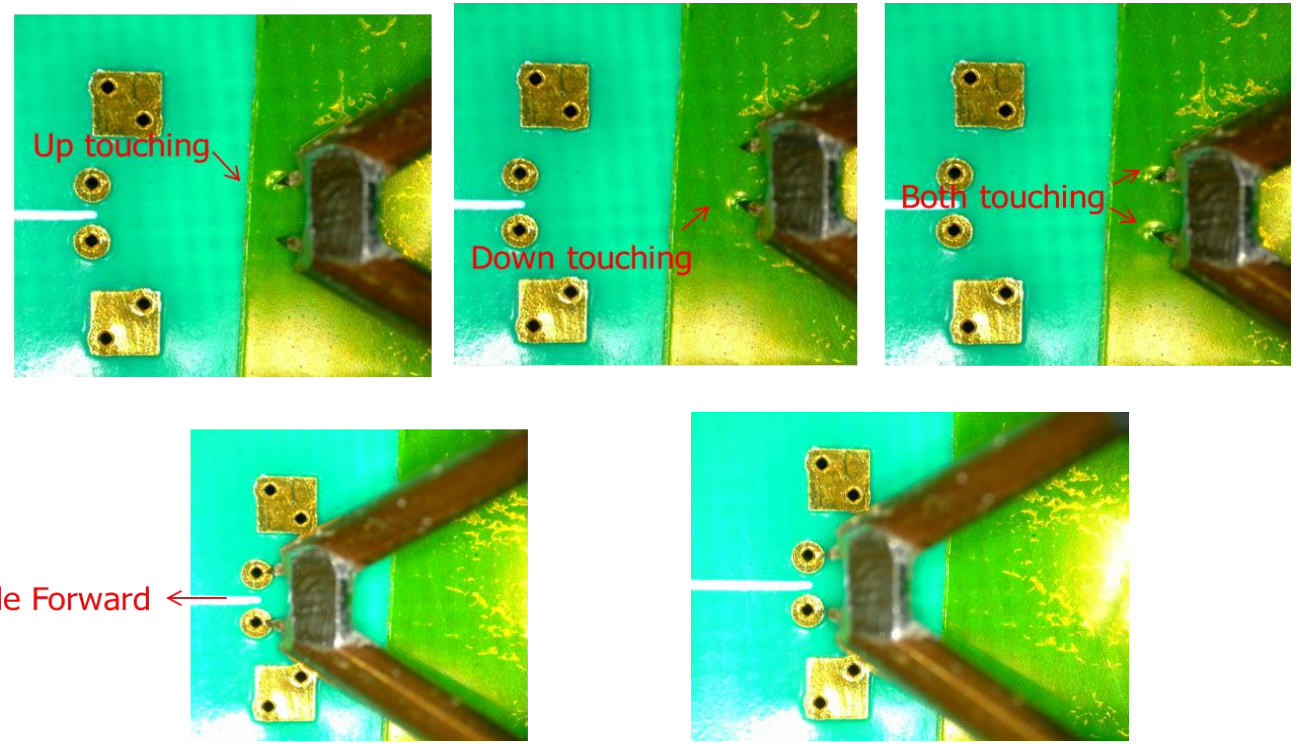
D-PROBE SDD21 & SDD11





D-Probe S4P extracted from probe-thru-probe by SFD de-embedding tool.

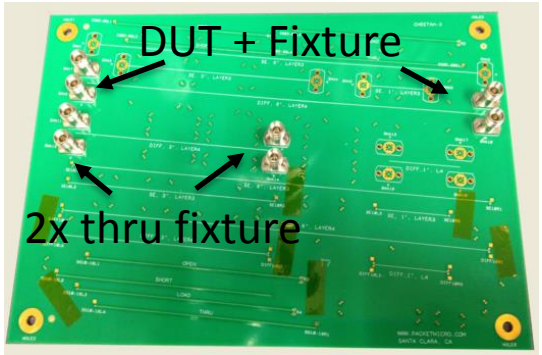
PROBE PLANARIZATION WITH MYLAR TAPE

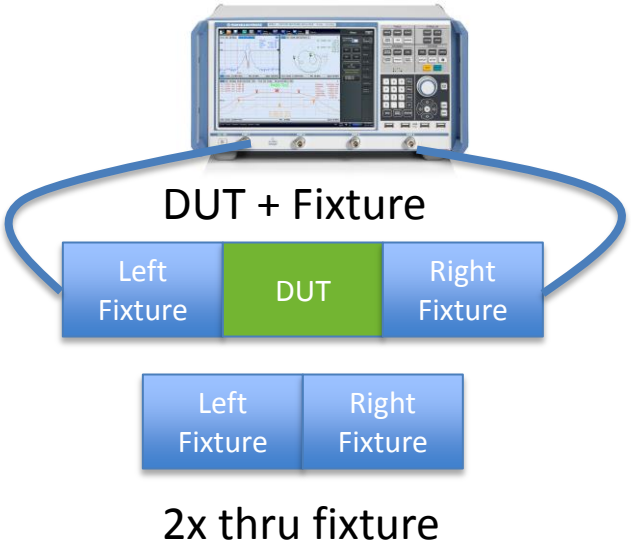


Quick and easy probe planarization procedure.

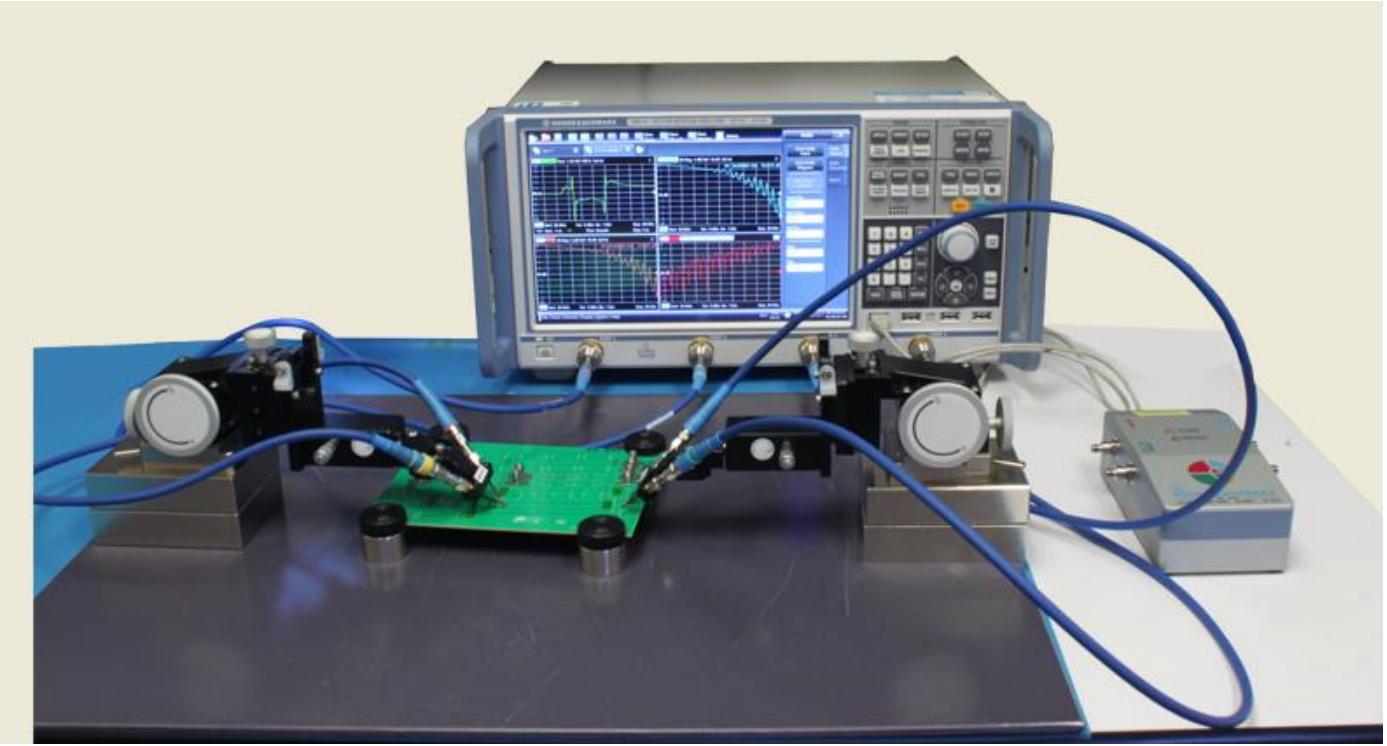
PCB CHARACTERIZATION

- **2X-Thru De-embedding Method:**
  - Accurate: comparable accuracy to traditional TRL technique
  - Simple: only one 2x thru fixture is needed
- **De-embedding Tools:**
  - EMStar Smart Fixture De-embedding (SFD) Tool
  - AtaiTec In-Situ De-embedding (ISD) Tool
  - Keysight Automatic Fixture Removal (AFR) Tool



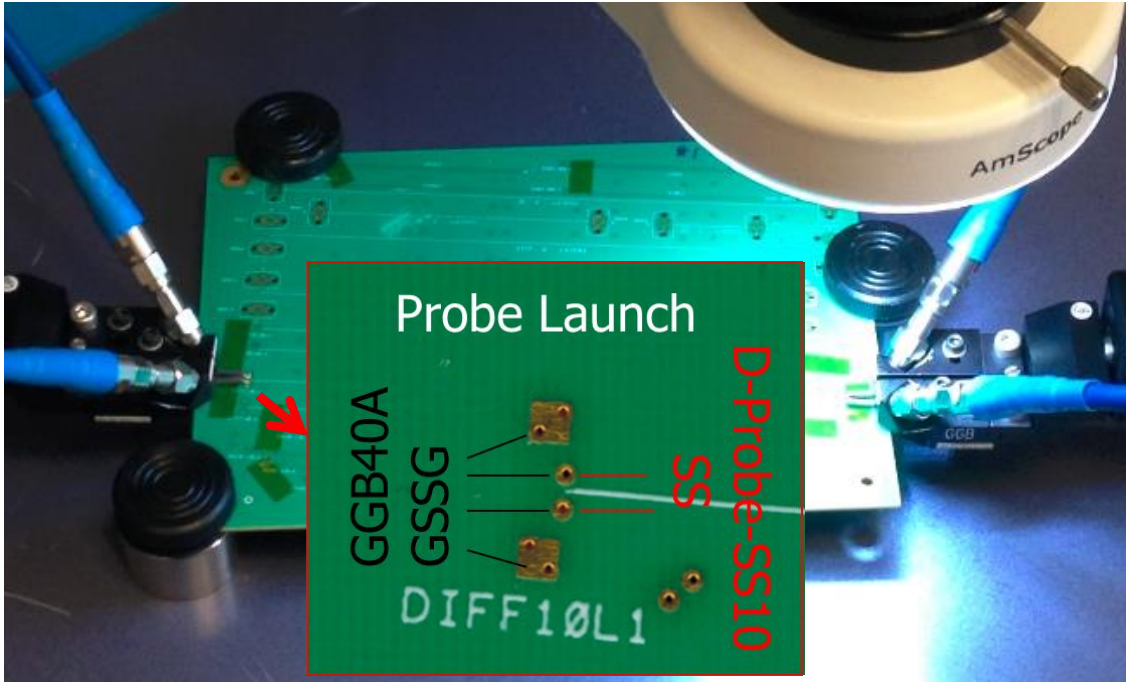


PCB PROBING WITH R&S ZNB20 VNA



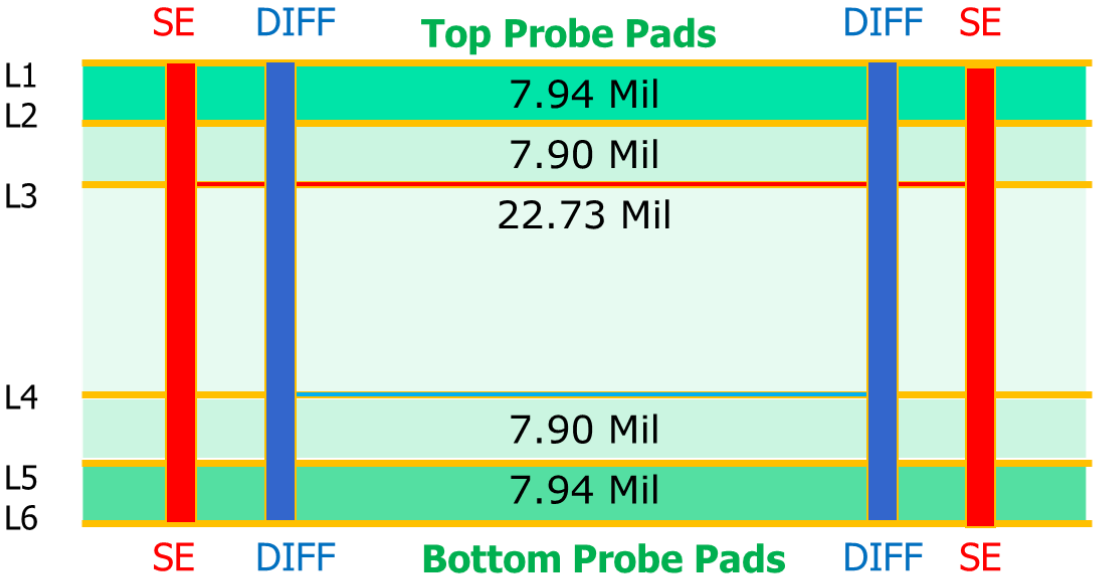
R&S ZNB20 VNA is ideal for S-parameter and TDR measurements.

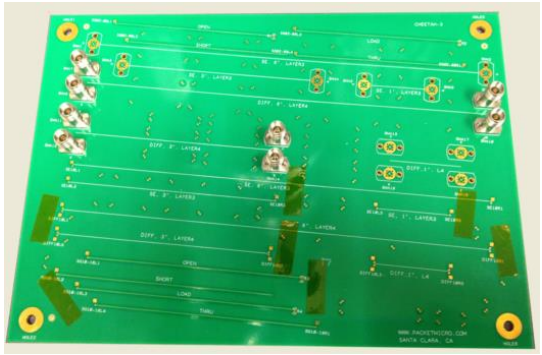
TEST SETUP FOR D-PROBE VERIFICATION



Probe launch allows D-Probes and microprobes to measure the same trace.

TEST BOARD STACKUP

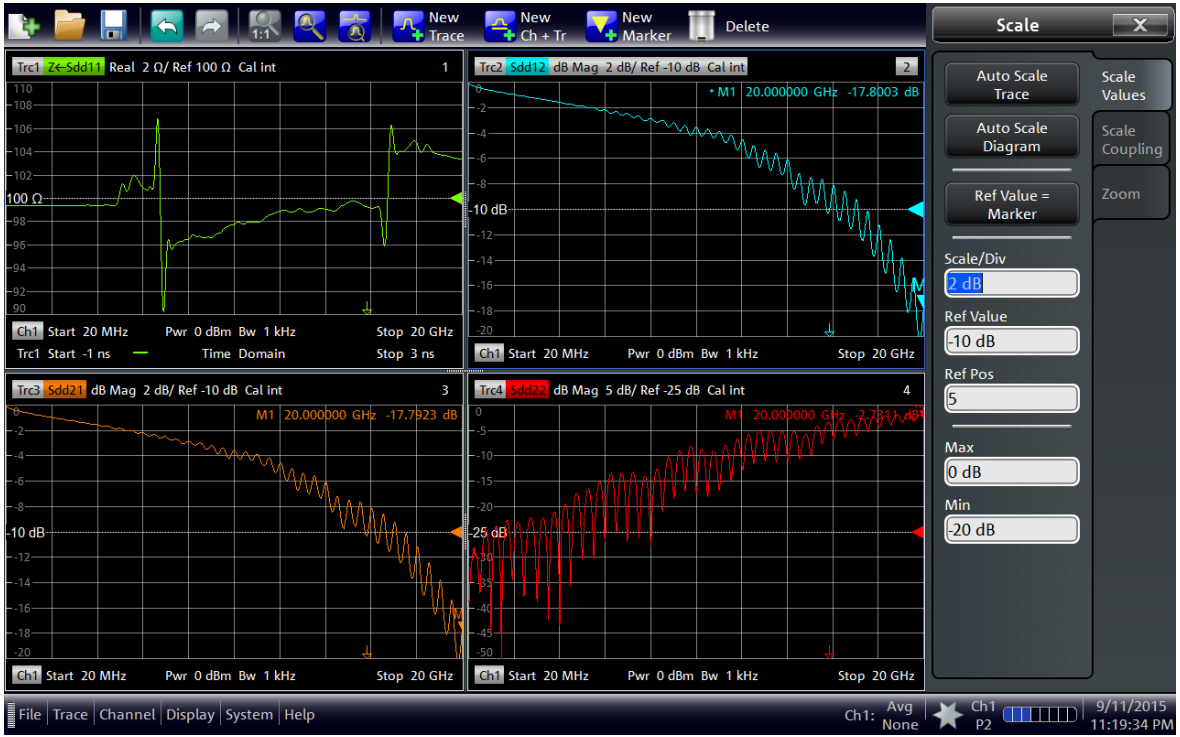




Layer 3: Single-ended striplines, Layer 4: Differential striplines

	Top Probing	Bottom Probing
SE Striplines	39.97-mil Stub	16.54-mil stub
DIFF Striplines	16.54-mil stub	39.97-mil Stub

SDD & TDD (6” STRIPLINE)

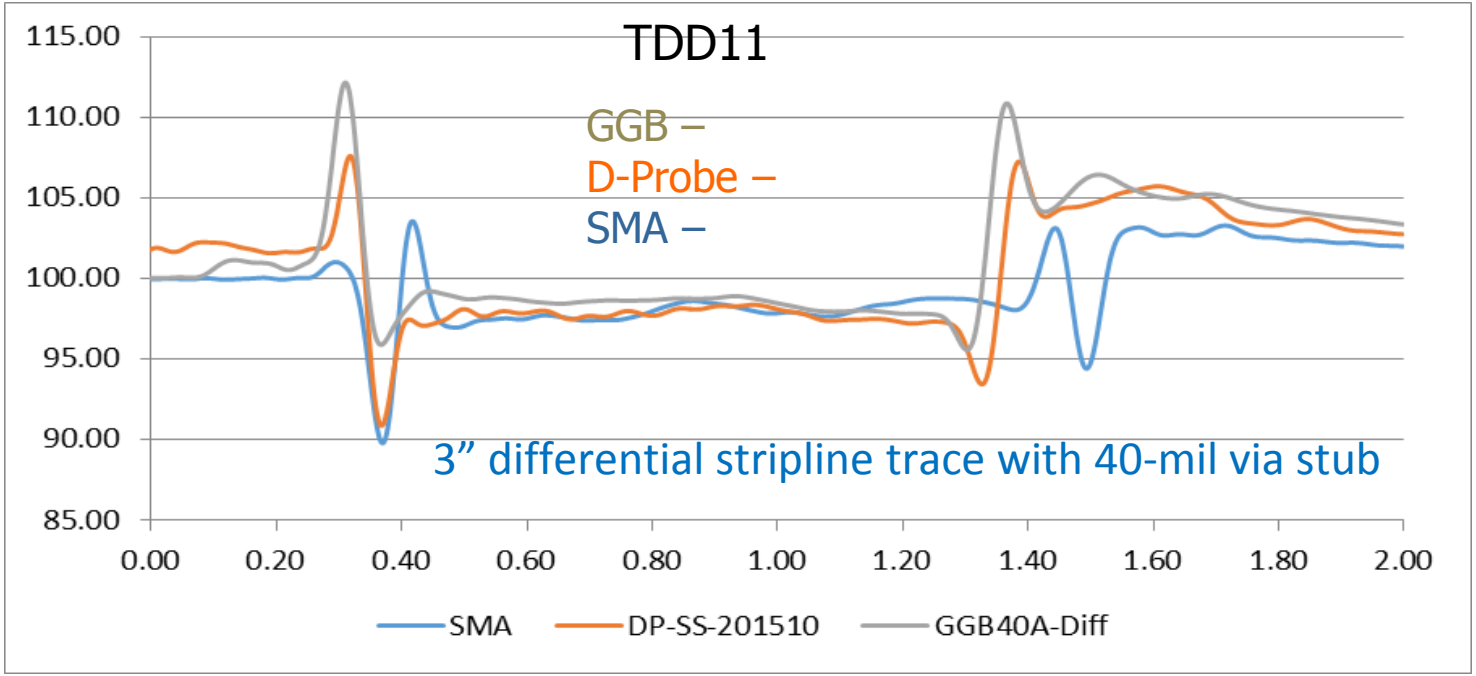


D-Probe measurement of a 6” differential stripeline trace with a 40-mil stub

SDD & TDD (3” STRIPLINE)

D-Probe measurement of a 3” differential stripeline trace with a 40-mil stub

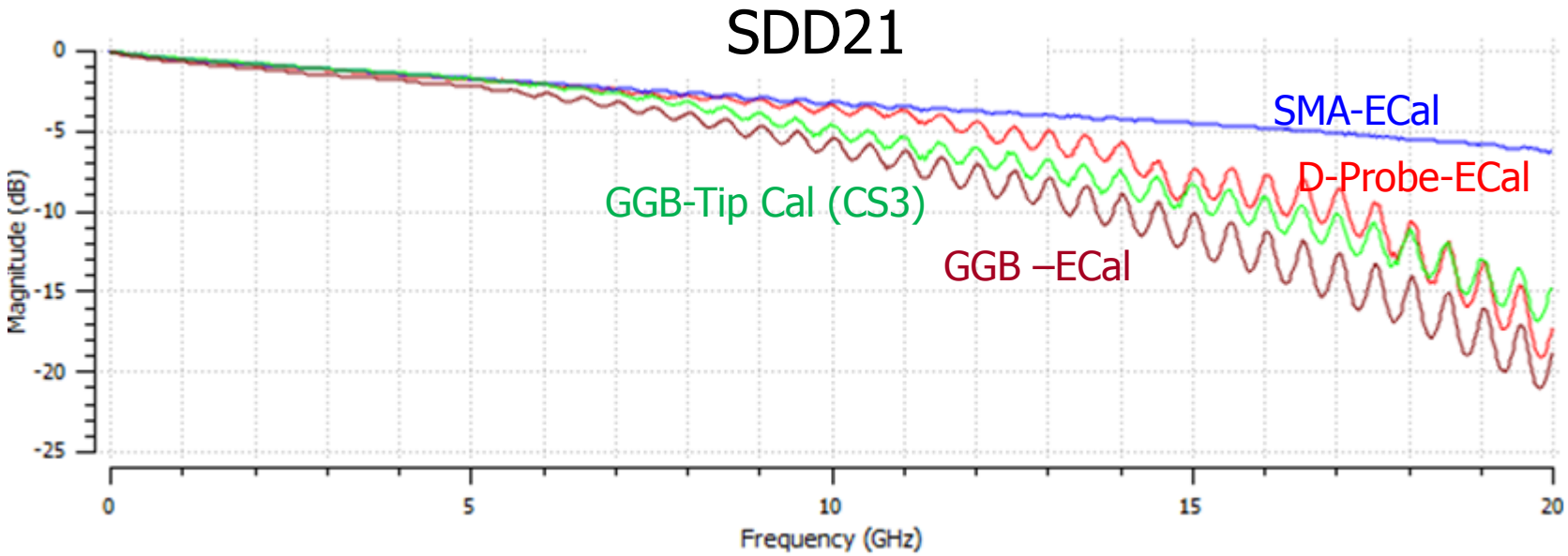
TDR MEASUREMENT, D-PROBE vs. MICROPROBE



D-Probe and microprobe provide comparable TDR accuracy.

* 40 GHz GGB dual microwave probe (Model 40 A) is used in the comparison.

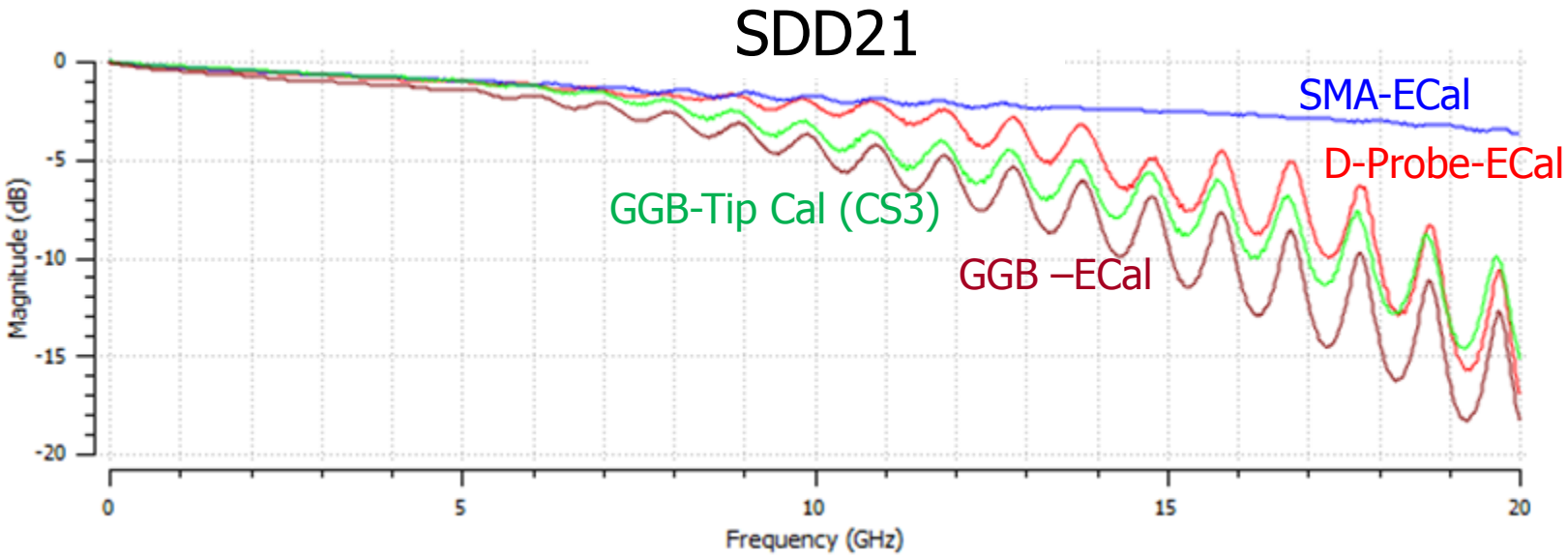
SDD21, D-PROBE vs. MICROPROBE (6” TRACE)



D-Probe shows low insertion loss with a simple ECal.

* SMA with 16-mil via stub is used for the comparison.

SDD21: D-PROBE vs. MICROPROBE (3” TRACE)

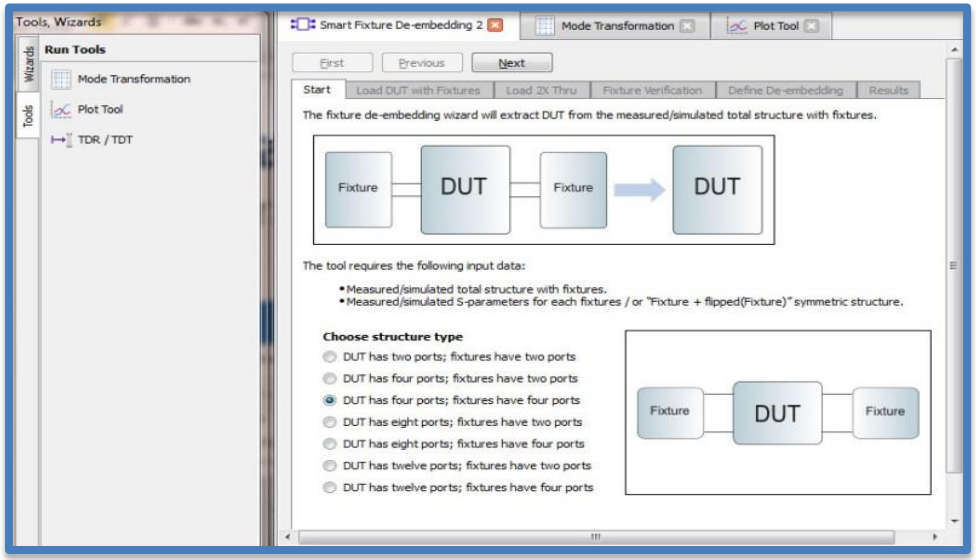


D-Probe shows low insertion loss with a simple ECal.

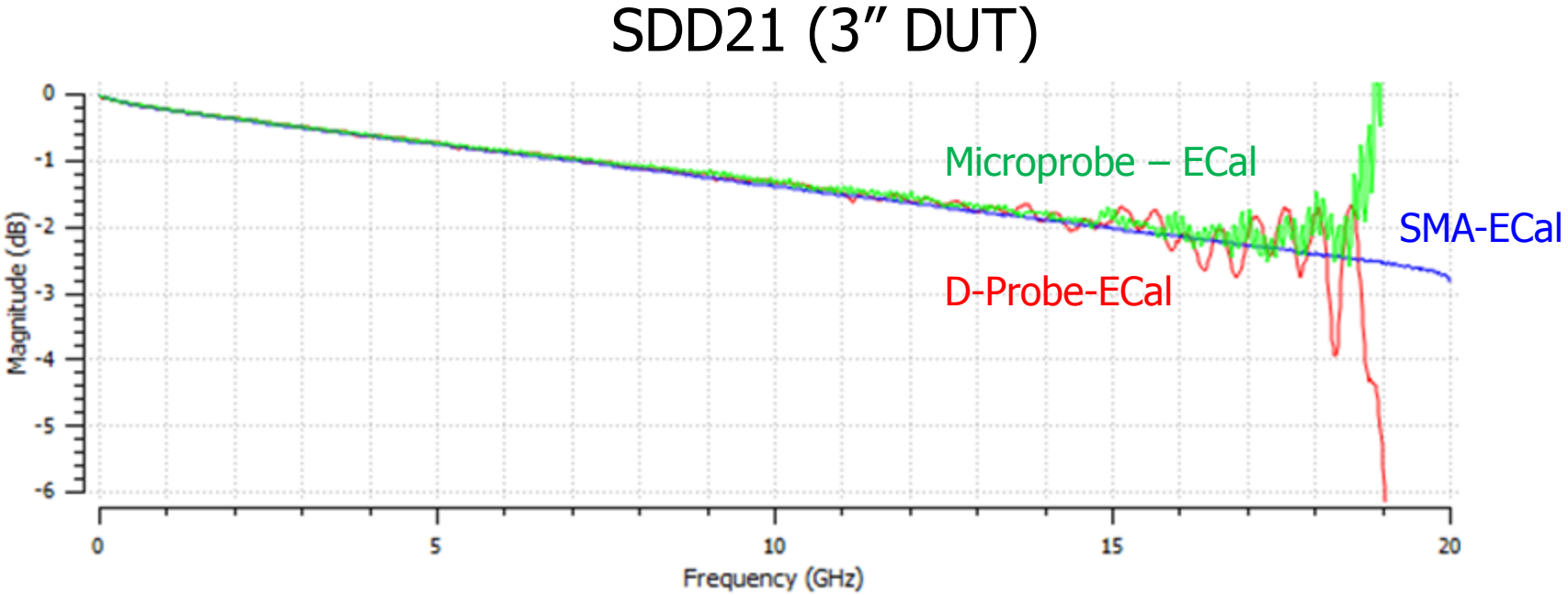
* SMA with 16-mil via stub is used for the comparison.

EMSTAR SFD TOOL

- **Versatile:**
  - Multiport fixture de-embedding for single-ended and differential devices with support of fixture with some asymmetry
  - S-parameters and T-parameters conversion
  - Mode transformation
  - Powerful plotting tool
- **Accurate:**
  - Comparable to Keysight ADS accuracy
- **Easy-to-use:**
  - User-friendly interface
- **Fast:**
  - Fast runtime with simple installation

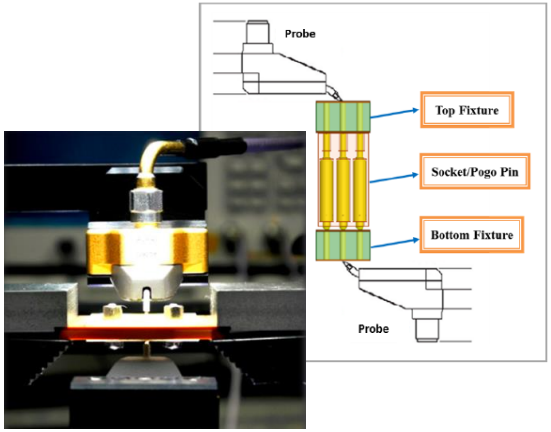


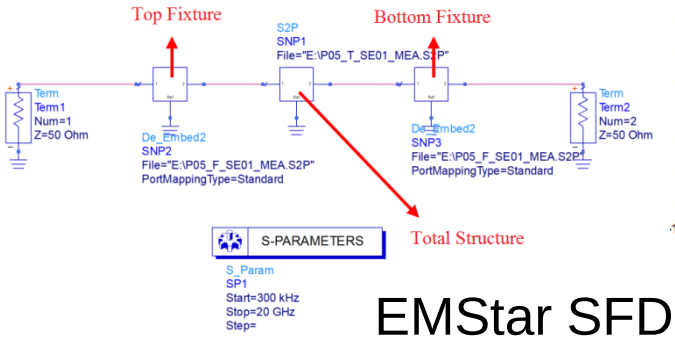
SDD21, D-PROBE vs. MICROPROBE (SFD)

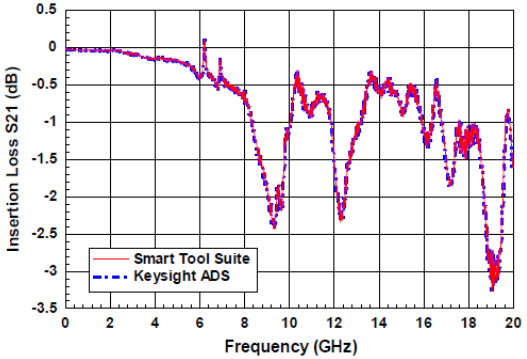


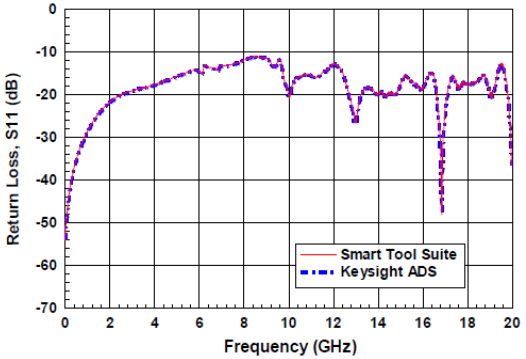
- Probes and SMA have comparable de-embedded results
- D-Probe and GGB probes have similar accuracy up to 18 GHz

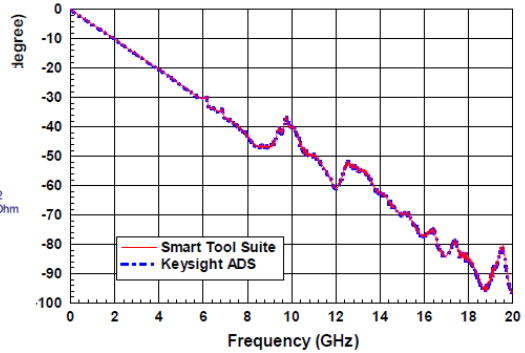
SMART FIXTURE DE-EMBEDDING (SFD) TOOL

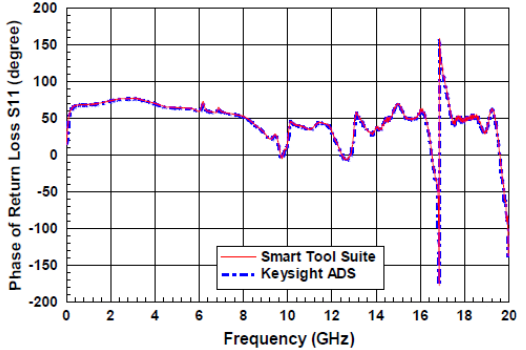










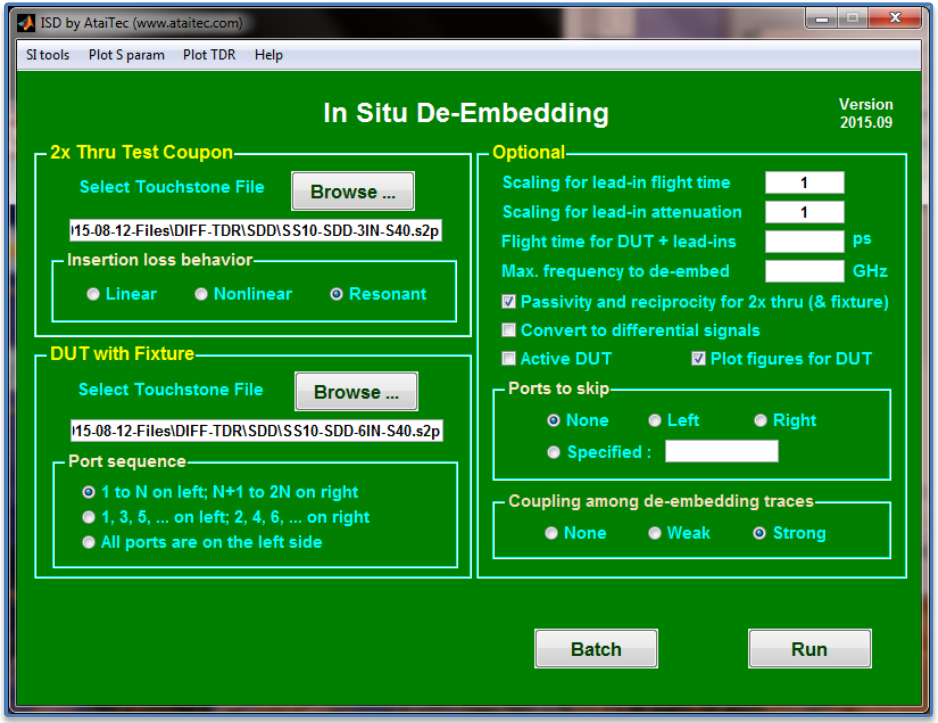


EMStar SFD and Keysight ADS have comparable accuracy.

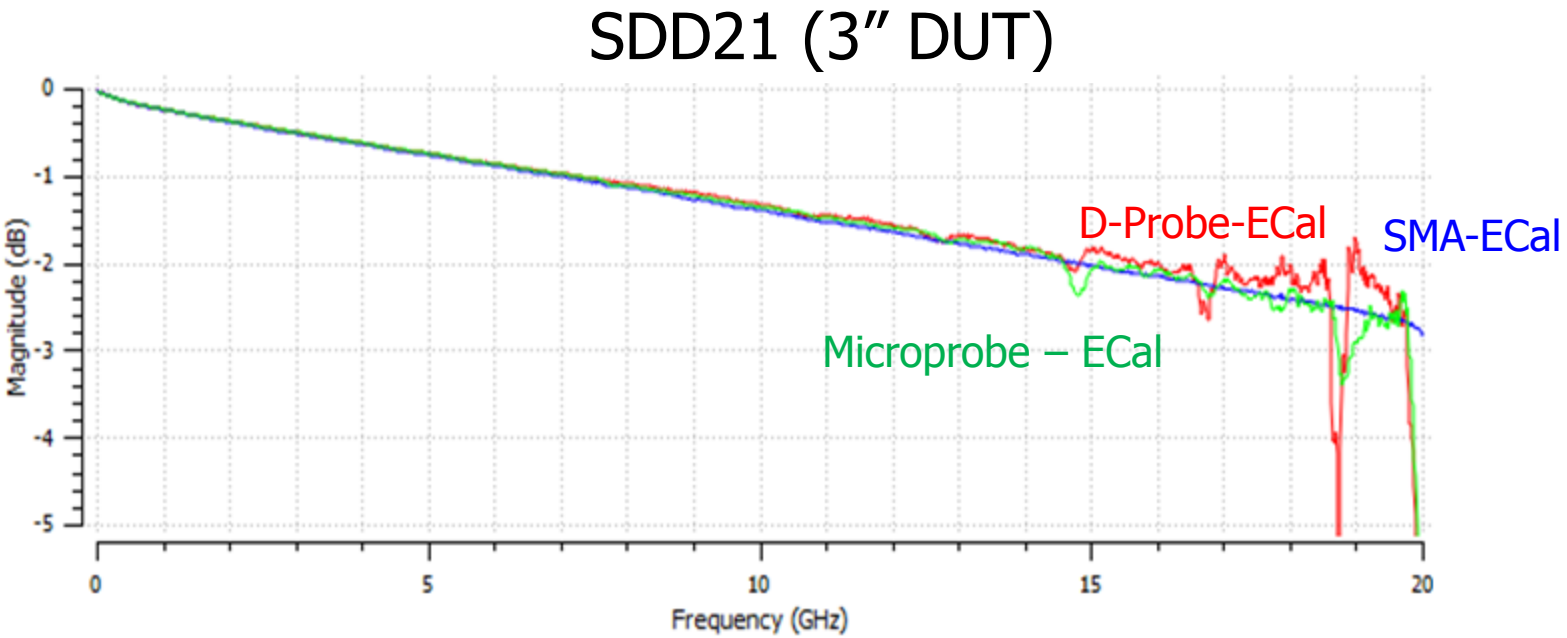
* Comparison was performed by Jthink Technology

ATAITEC ISD TOOL

- **Versatile:**
  - Multiport fixture de-embedding for single-ended and differential devices with support of asymmetrical fixture configuration
  - S-parameters and T-parameters conversion
  - Mode transformation
- **Simple user interface:**
  - Data entry on one page



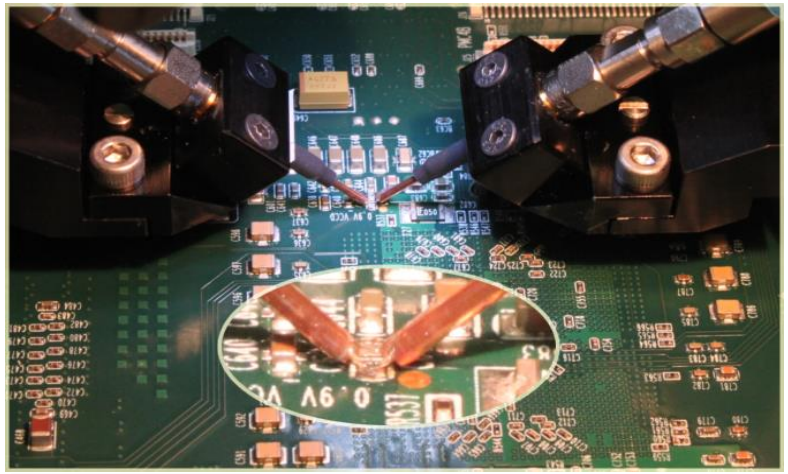
SDD21, D-PROBE vs. MICROPROBE (ISD)



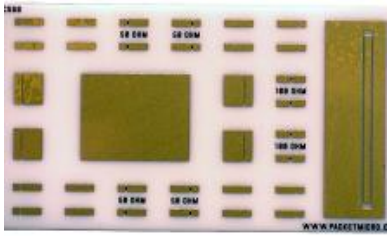
- Probes and SMA have comparable de-embedded results
- D-Probe and GGB probes have similar accuracy up to 18 GHz

RUGGED SINGLE-ENDED PROBE

- **Robust :**
  - Strong Beryllium Copper (BeCu) probe tip allows direct probing on uneven surfaces, such as solder balls.
- **Accurate :**
  - S-Probe and microprobe provide comparable measurement accuracy up to 20 GHz.
- **Easy-to-use:**
  - Mylar tape approach makes probe planarization quick and easy.

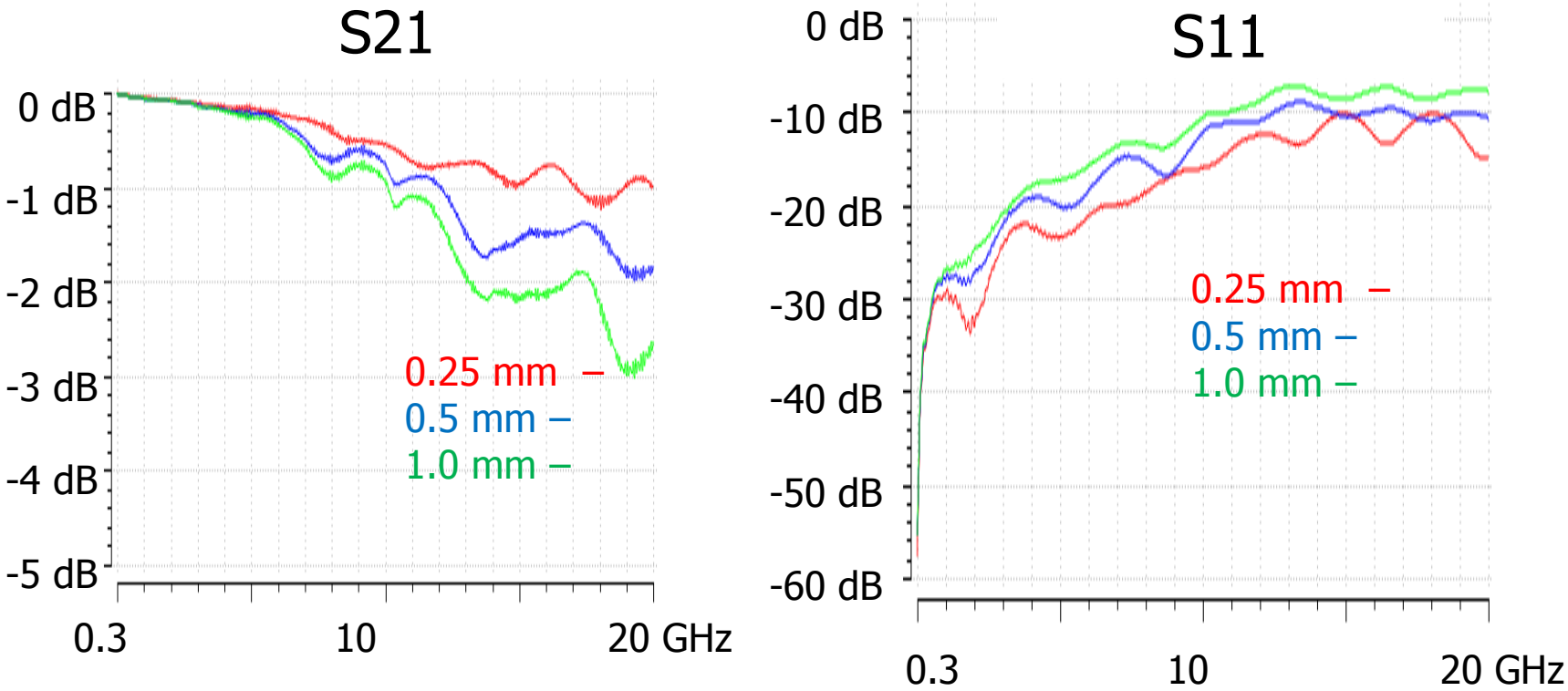


S-Probe



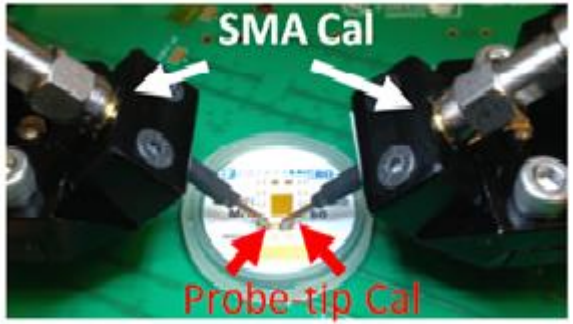
TCS60 Cal Substrate

S-PROBE S21 & S11

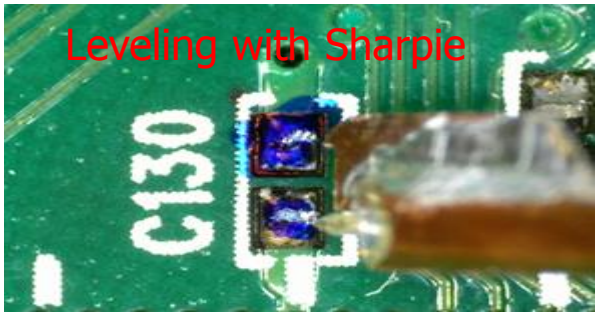


Rugged probe with 20 GHz performance

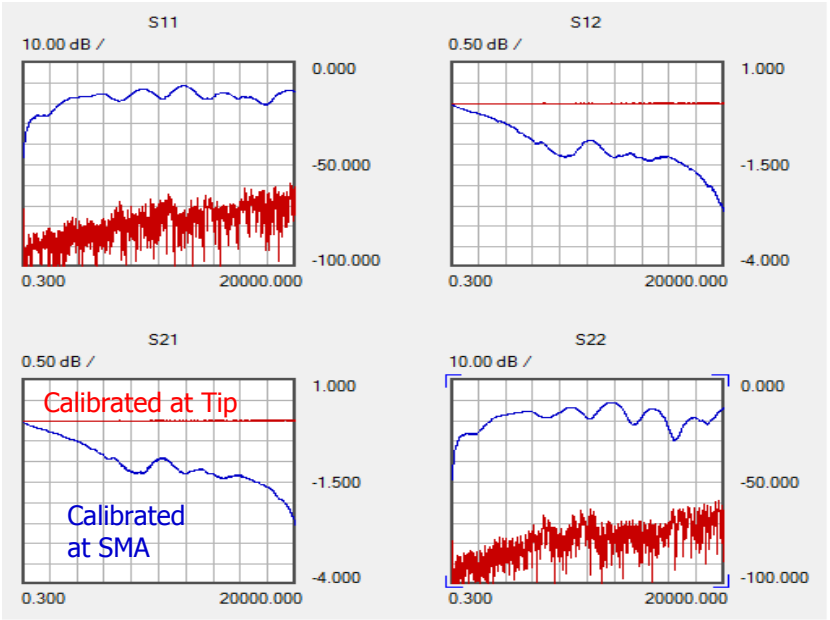
PROBE-TIP CALIBRATION OF S-PROBE



Two probe measurement of TCS60 thru.



Direct Probing on Solder Bumps!



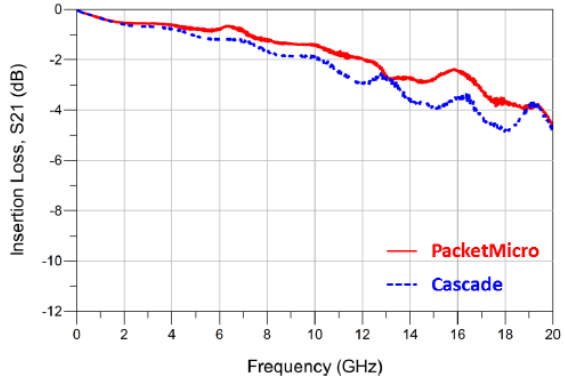
S-PROBE vs. MICROPROBE

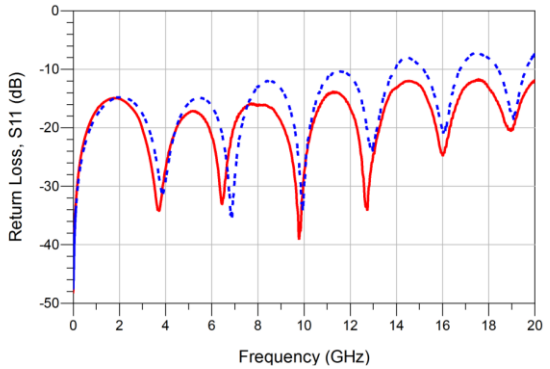
Transmission Line

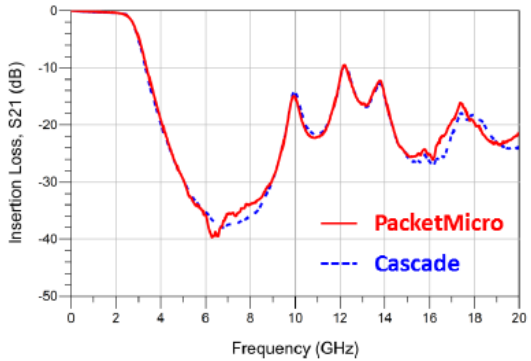
* 40 GHz Cascade ACP-40 GS/SG 550um microprobes were used for comparison

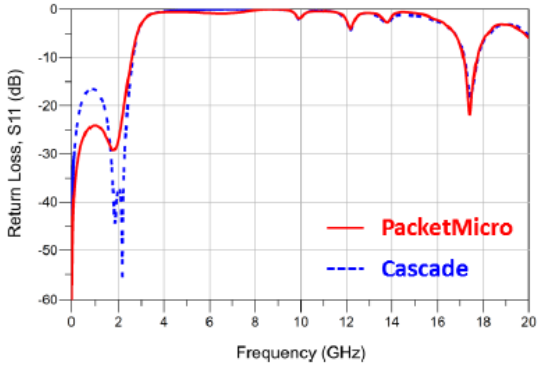
Low-pass Filter

* Comparison was performed by Jthink Technology







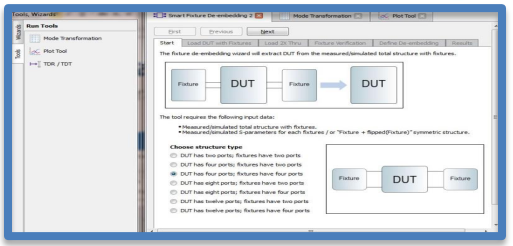


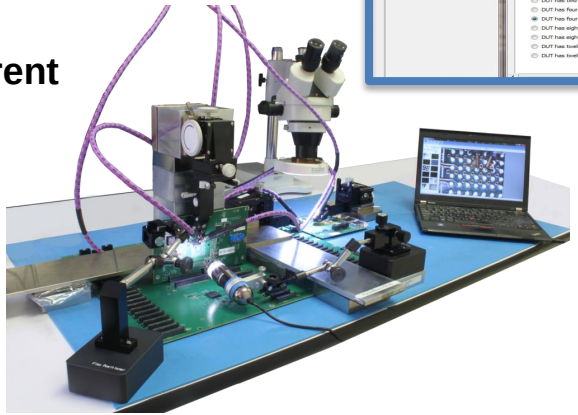
S-Probe and microprobe have comparable accuracy up to 20 GHz.

SUMMARY

PCB Probing for Signal Integrity Measurements

- **Use 2x Thru method:**
  - Simple: one 2x thru fixture
  - Accurate: comparable to TRL accuracy
- **Choose the right probes:**
  - Rugged probes ≤ 20 GHz
  - Microprobes ≥ 20 GHz
- **Select the good de-embedding tool**
- **Find the probe station meeting your current and future needs**





MORE INFORMATION

- **www.packetmicro.com**
- http://www.packetmicro.com/microwave-probes/d-probe.html
- http://www.packetmicro.com/microwave-probes/s-probe.html
- http://www.packetmicro.com/docs/RF_Probing_with_Rohde_VNA.pdf
- rzai@packetmicro.com

Thank you!

QUESTIONS?