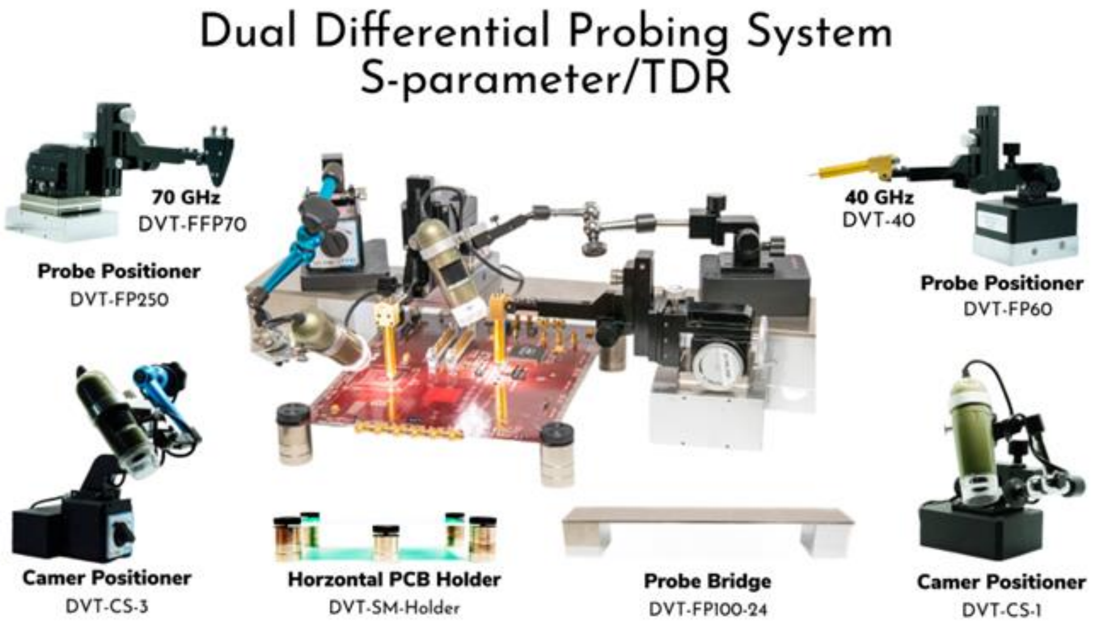
DVT Solutions PCB vs Wire-based probes FAQ

Configurable
Desktop Probe Systems



DC to 110 GHz RF
True Differential
PCB-based probes

US Patents 10852322, 11175311 (Other patents pending)

DVT-FFPNN

40 GHz, 50 GHz, 70 GHz, 110 GHz

Since 2005
A world leader in true differential probes and systems

Brian Shumaker

Email: sales@gigaprobes.com Phone: 650-743-5660 Web: gigaprobes.com Sarasota, FL USA

The Important Role of True **Differential Probes** in PCB Design and *Quality Improvement*

***Software* Simulation Engineering**

PCB Design

- **PCB trace layout**
- **Optimize: - PCB trace loss/impedance**

PCB manufacture

Prototype PCB

- Short Run: 15–20 Boards

Signal Integrity Test Engineering

Prototype PCB Verification

Using Time-and Frequency-Domain Measurements

- **Select VNA/TDR** instruments and **compatible Probes: True Differential (90%)** and SE (10%)
- **Probe Measurements:** True odd-mode SDD11/21 Differential, Impedance and S-parameter bandwidth

Process Flow

- **Create netlists** for probe-based measurements
- **Validat**e passive **interconnect electrical performance** and design compliance through measurement
- **Generate** prototype **failure analysis and rework reports** for SI simulation and PCB manufacturing corrective action

Signal Integrity Differential Probe Measurements Testing Summary

- **Verify** differential trace **bandwidth** and **impedance** targets
- Visually **correlate measurements** with **simulation models**
- **Confirm prototype PCB performance** before **production release**
- **Validate manufacturer capability** for **volume production**

PCB Prototype Design, Verification, Testing (DVT) Improvement Loop

Prototype Rework Report *Example*

Issued to PCB Manufacturing and SI Simulation to Correct Process Errors from Prototype Test Failures

Net SI Failure Analysis Test Report Example

- Measured **bandwidth performance was below specification**
- Measured differential **impedance** was **outside specification limits**

Building a Probe System

- **90% of all PCB traces are Differential**
- **First, Define the Differential Probe Needed**
- ***Then Build the Probe System Around It!***

DVT Solutions Recommends
DVT-FPPNN PCB-Based Differential Probes

Optimized for accurate differential impedance and S-parameter measurements from 40 GHz to 110 GHz

PCB-Based Differential Probe Features and Benefits

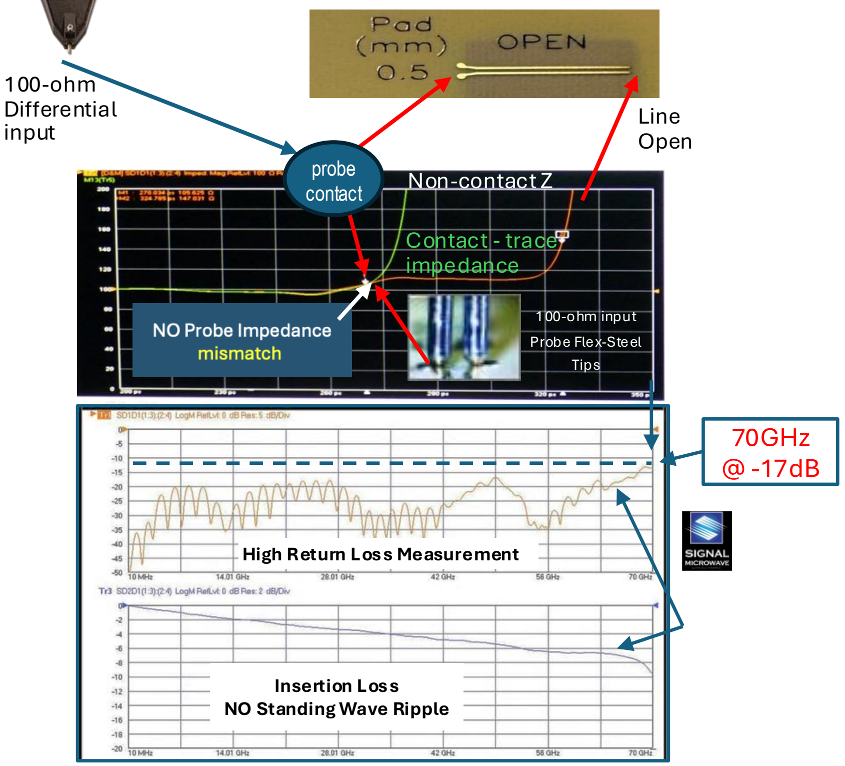
- **~100 Ω differential input matched to ~92 Ω DUT traces** — reduces probe-to-trace mismatch reflections and improves signal launch accuracy
- **Optional 85 Ω differential input version with NRE** — can be optimized for Intel PCIe platforms that use 85 Ω differential traces
- **PCB-based true differential architecture** — delivers smooth, linear insertion loss with minimal standing-wave ripple and improved return loss
- **True differential structure, not two independent 50 Ω cable paths** — provides a more accurate representation of DUT differential behavior
- **Stable bandwidth across wide pad-pitch ranges** — supports PCB wide-pitch probing from 0.35 mm to over 1.0 mm with fewer probe changes (i.e. one DVT-FPPNN .6mm probe can contact all test pad pitches from .35 mm to 1 mm)
- **Serialized S4P de-embedding file included** — simplifies setup and improves corrected DUT measurement accuracy without requiring SOLT substrate calibration
- **Rugged self-planarizing steel probe tips** —contact non-planar or bumped PCB pads without probe tip damage
- **Extended 1-year warranty** — lowers lifetime ownership cost and reduces replacement risk

DVT-FPPNN PCB-Based Probes Reveal More of the DUT’s True Signal Integrity Performance

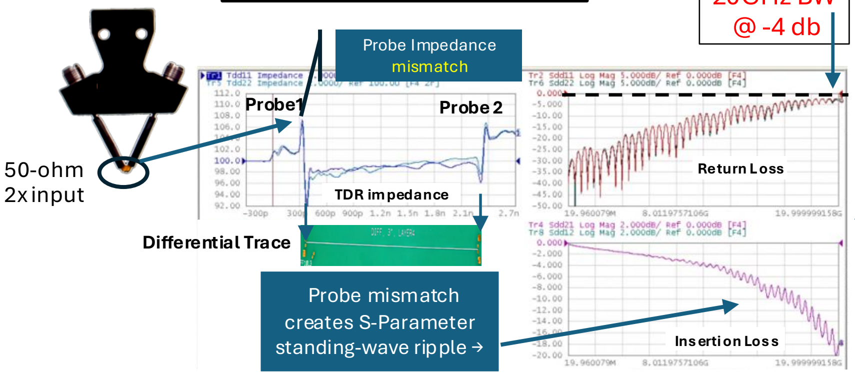
PCB-Based vs. Wire-Based Differential Probe Architectures

Impact on impedance discontinuity, return loss, and differential S-parameter fidelity

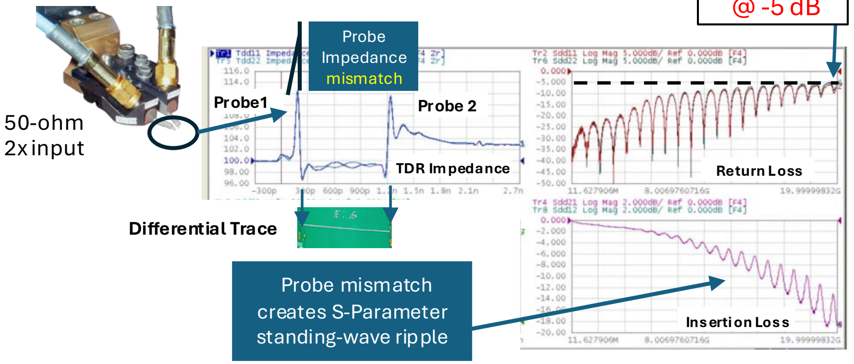
DVT Solutions
DVT-FPNN 40GHz to 110GHz PCB-Based True Differential Probes (SS)



Example 1
Wire-Based probe (SS)



Example 2
Wire-Based probe (GSSG)



50-ohm 2x input

Wire-Based probe Manufacturers
GGB, ind., Form Factor, MPI, Giga Test, Keysight, and more..

Return Loss to Power Transfer Table

Return Loss (dB)	Reflected Power (%)	Transmitted Power (%)
0	100%	0%
1	79.40%	20.60%
2	63.10%	36.90%
3	50.10%	49.90%
4	39.80%	60.20%
5	31.60%	68.40%
6	25.10%	74.90%
7	20.00%	80.00%
8	15.80%	84.20%
9	12.60%	87.40%
10	10.00%	90.00%
12	6.30%	93.70%
14	4.00%	96.00%
15	3.20%	96.80%
16	2.50%	97.50%
18	1.60%	98.40%
20	1.00%	99.00%
25	0.32%	99.68%
30	0.10%	99.90%
40	0.01%	99.99%

(-17dB)
DVT-FPP70 70GHz
PCB-based differential
100-ohm input probe impedance

Measurement errors start at the probe tips for wire-based probes

Architecture Comparison

True Differential PCB-Based vs. Wire-Based SS Probes

Probe architecture directly affects differential SI measurement accuracy

Return Loss to Power Transfer Table		
Return Loss (dB)	Reflected Power (%)	Transmitted Power (%)
0	100%	0%
1	79.40%	20.60%
2	63.10%	36.90%
3	50.10%	49.90%
4	39.80%	60.20%
5	31.60%	68.40%
6	25.10%	74.90%
7	20.00%	80.00%
8	15.80%	84.20%
9	12.60%	87.40%
10	10.00%	90.00%
12	6.30%	93.70%
14	4.00%	96.00%
15	3.20%	96.80%
16	2.50%	97.50%
18	1.60%	98.40%
20	1.00%	99.00%
25	0.32%	99.68%
30	0.10%	99.90%
40	0.01%	99.99%

−20 dB return loss corresponds to **~99% of incident power is delivered to the DUT** (~1% reflected). This represents **excellent probe performance**.

−10dB/-17 dB return loss (typical of PCB-based probes such as DVT-FPPNN) corresponds to **~98% power delivered** (~2% reflected), indicating **very high transmission efficiency**.

−4 to −5 dB return loss (typical of wire-based probes) corresponds to **~60–68% power delivered** (~32–40% reflected), resulting in **significantly reduced measurement fidelity** compared to higher-return-loss PCB probes .

Wire-Based SS Probes

Datasheet: SS differential probe, **50 ± 2 Ω** input

Architecture: Two separate internal conductors with internal ground/shield reference

Electrical behavior: Two **50 Ω single-ended paths**

Not *a true 100 Ω balanced differential structure*

Time domain: poor to significant mismatch impedance reflections at probe tips

Frequency domain: Insertion-loss contains standing wave ripple which lowers return loss (~4dB) measurements

VNA Measurements: Odd-mode S-Parameters

Probe de-embedding file: Often not included, requiring additional software, a 2xThru board, and extra customer time to create them.

Probe tips: fixed pitch: One probe may be required to each unique test pad pitch, increasing cost and setup time.

DVT-FPPNN PCB-Based SS Probes

Datasheet: True differential 100 Ω input impedance

Architecture: Tightly coupled, fully balanced internal PCB differential trace

Electrical behavior: One **controlled true differential transmission structure**

Time domain: No mismatch Impedance reflections

Frequency domain: Linear insertion loss, no standing wave ripple, High return loss (-10dB/-17dB)

VNA Measurements: Odd mode S-Parameters

Probe de-embedding file: included with probe, no extra software required

Unique probe tips design: Enables one 0.6 mm DVT-FPPNN probe to contact >10 differential test pad pitches from 0.35 mm to 1.0 mm for complete prototype PCB characterization without multiple fixed-pitch probes.

A wire-based SS probe can measure differential signals, but a PCB-Based DVT-FPPNN probe is designed to preserve differential signal fidelity.

One DVT-FPPNN 0.6 mm Probe Covers 0.35 mm to 1.0 mm Pad Pitches

Reducing the Need for Multiple Fixed-Pitch Probe Purchases

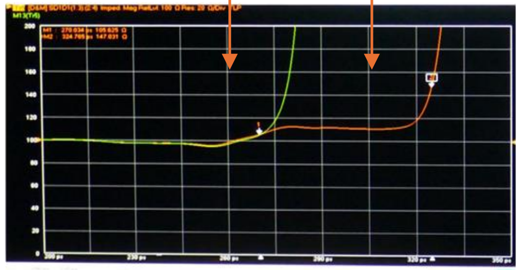
Test Coverage Procedure: *Probe contact was verified using a 70 GHz VNA in low-pass time-domain mode with an approximately 14 ps equivalent TDR rise time. A **DVT-FPP70 with a 0.6 mm probe-tip pitch** was used on a controlled differential test board containing ten pad geometries from **0.35 mm to 1.0 mm** pitch. At each structure, contact quality was confirmed by correlating the TDR measurement with camera images of the probe tips contacting the pads. The TDR responses showed little to no impedance mismatch at probe contact, indicating a well-matched transition that supports **low-ripple insertion loss** and **high return loss measurements**. For the full set of ten measurements, request the application note, **"A Single DVT-FPPNN Probe covers 0.35 to 1mm pad pitches 03-20-26R.pdf."***

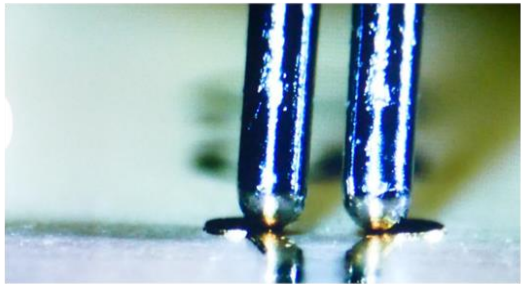
- **100 Ω differential probe input** reduces 14ps TDR impulse probe-to-trace impedance mismatch
- Wide pad-pitch coverage with fewer probe changes, reduces test times
- One 0.6 mm probe can contact test pad pitches from 0.35 mm to 1.0 mm

Board with **1.0mm** pads Pitch and 0.5mm dia,pads

Probe tips

Line open



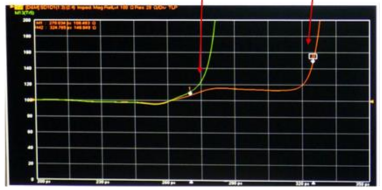


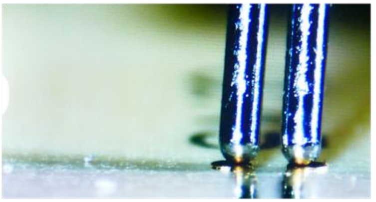
FPP70-0.60-001 SN 2083 Probe with 0.60mm pitch probe tips

Board with 0.8mm pads pitch and 0.45mm diameter pads

Probe tips

Line open



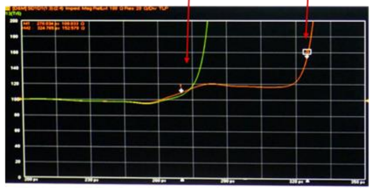


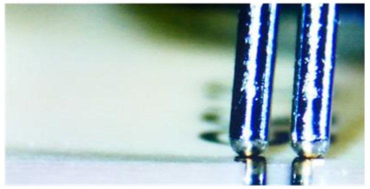
FPP70-0.60-001 SN 2083 Probe with 0.60mm pitch probe tips

Board with 0.6mm pads pitch and 0.4mm diameter pads

Probe tips

Line open



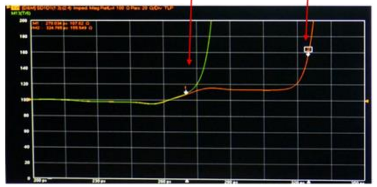


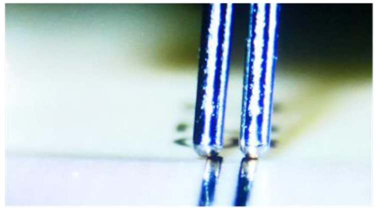
FPP70-0.60-001 SN 2083 Probe with 0.60 mm pitch probe tips

Board with 0.5mm pads pitch and 0.25mm diameter pads

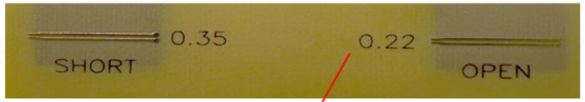
Probe tips

Line open





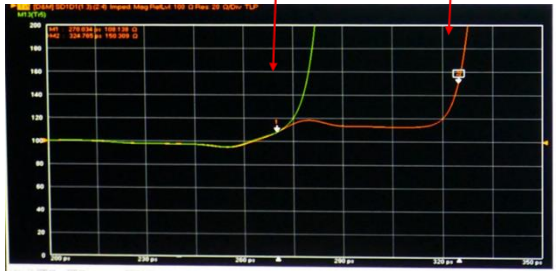
FPP70-0.60-001 SN 2083 Probe with 0.60 mm pitch probe tips

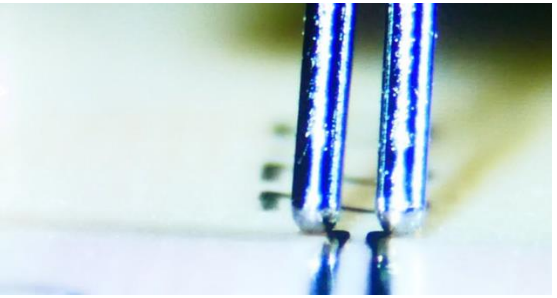


Board with **0.35.0mm** pads Pitch and 0.5 mm dia. pads

Probe tips

Line open





FPP70-0.60-001 SN 2083 Probe with 0.60 mm pitch probe tips

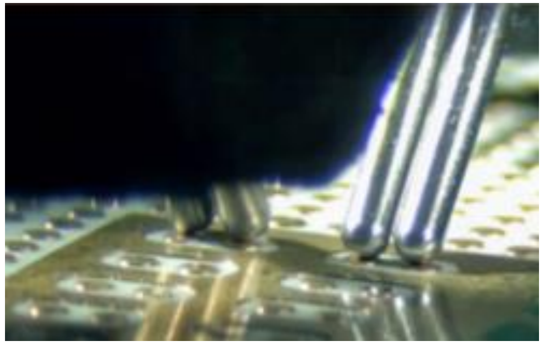
DVT-FPPNN PCB-Based Differential Wide-Pitch Probe
SUMMARY

(2018 prototype) Differential PCB-based *prototype* probe design

(2026) DVT-FPPNN (40-110 GHz) differential PCB-Probe
US Patents 10852322, 11175311

Mechanical Design

- **PCB-based** design
- Fixed pitches: **0.6 mm, 0.8 mm, 1.0 mm**
- **0.6 mm** probe covers **0.35 mm to 1.0 mm** pad pitches
- Replaces up to **20 fixed-pitch probes**
- **Rugged flexible steel probe tips**



Measurement Performance

- Measures **true differential S-parameters** and **impedance**
- Frequency range: **40 GHz to 110 GHz**
- **100 Ω PCB-based differential input** impedance
- Smooth TDR transition from **probe tips to DUT pads**
  - Reduces Impedance **mismatch reflections**
- Minimizes **return-loss degradation** (>-10dB) and no Insertion loss **standing-wave ripple**

Customer Value

- Serialized **S4P de-embedding file** included
- One **0.6 mm** probe covers multiple pad pitches
  - Reduces the need for multiple **fixed-pitch probes**
- **1-year unconditional warranty**
  - Lower **total cost of ownership**

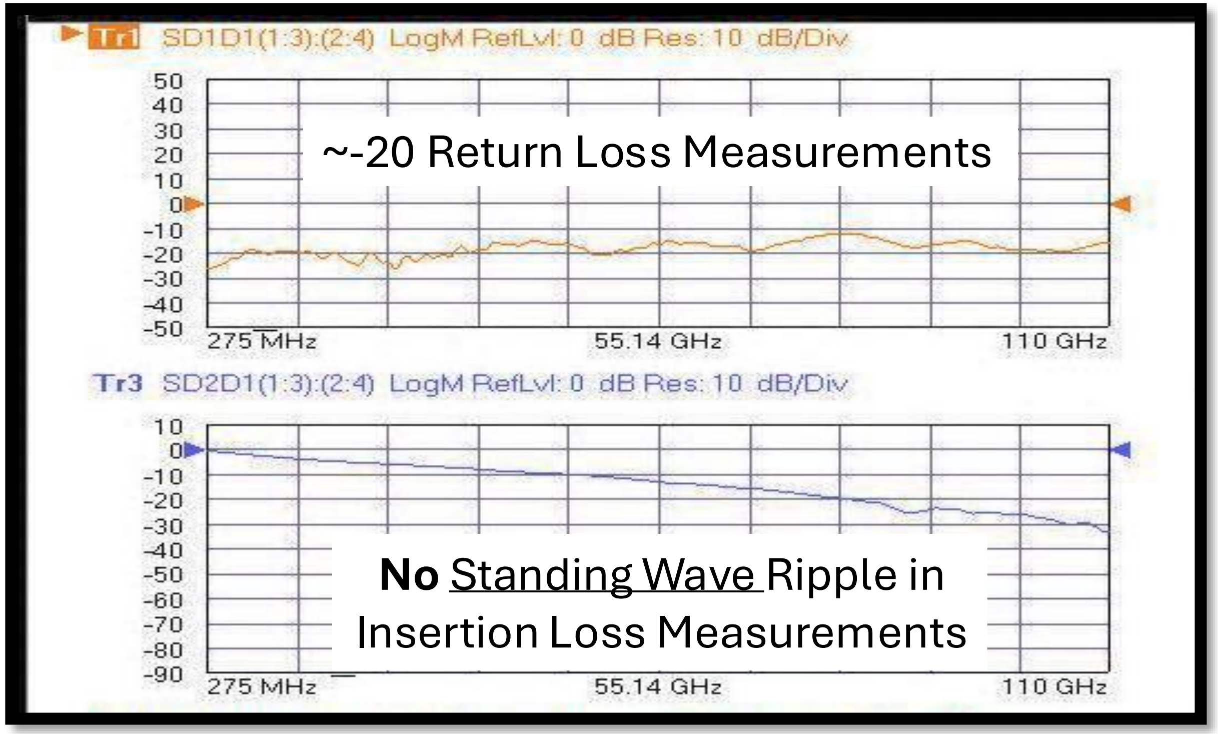
Bottom line

100-ohm differential Probe Input impedance = linear ripple-free insertion and high return loss measurements

110 GHz PCB-Based Differential Probe Performance

Reveal More of the DUT's True Signal Integrity Performance

- DVT-FPP110: 110 GHz PCB- Based True Differential Probe
- Rugged, self-planarizing flexible steel probe tips
- 100-ohm differential input impedance
- .35mm – 1mm probe range



Measured on the ISB110 110 GHz test board

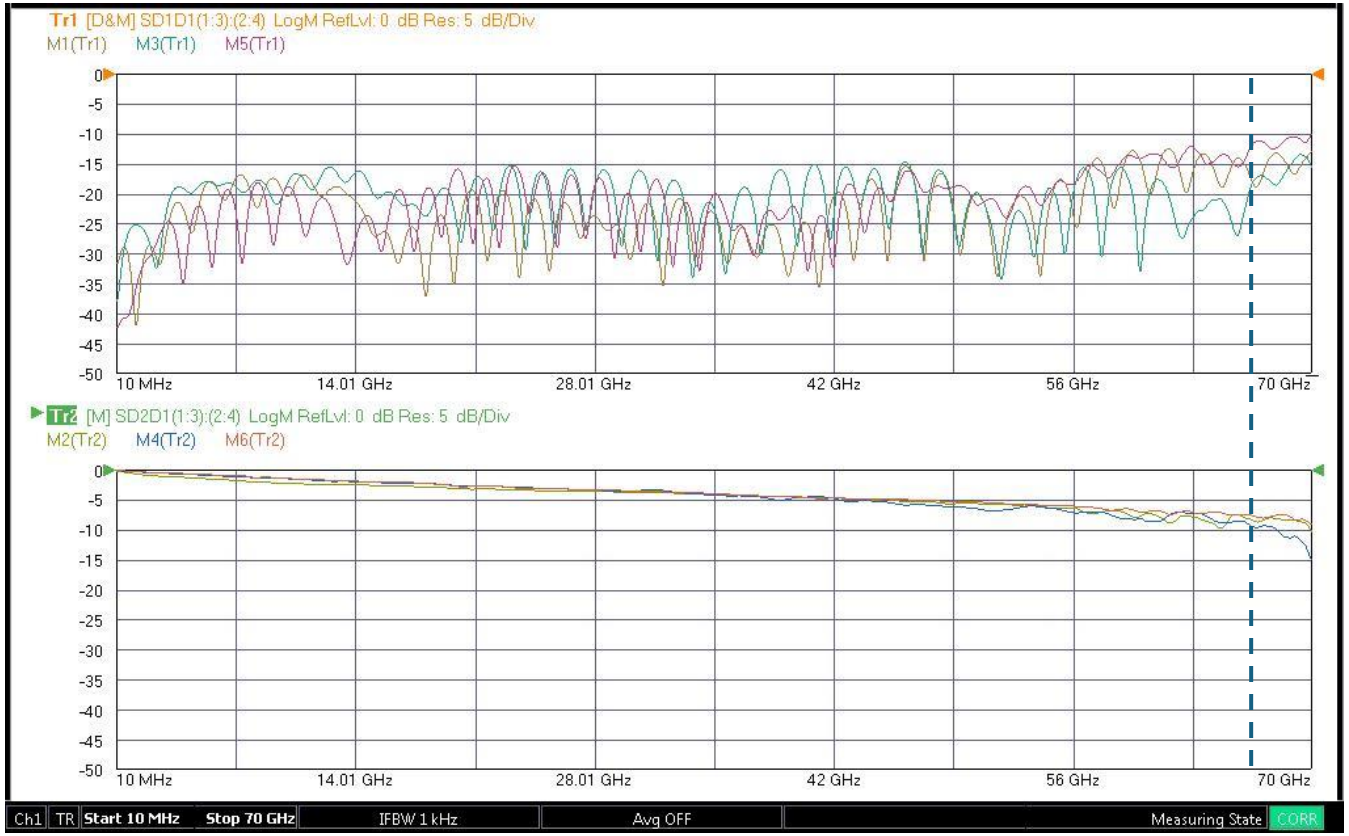
High return loss and ripple-free, linear insertion loss performance to 110 GHz

DVT-FPP70 70 GHz Wide-Pitch Bandwidth Performance

Measured with **0.6 mm, 0.8 mm,** and **1.0** mm Probe Pitches

- Linear insertion loss at 0.6 mm, 0.8 mm, and 1.0 mm probe pitches
- Bandwidth is independent of probe pitch
- No standing-wave ripple in insertion loss
- High return loss: -25 dB to -10 dB from 10 MHz to 70 GHz

110 GHz bandwidth is maintained across 0.6 mm and 0.8 mm rated probe pitches. One DVT-FPP110 .6 mm probe can contact 10+ differential test pad pitches from 0.35 mm to 1.0 mm (although it is not bandwidth-rated at a 1.0 mm pitch).

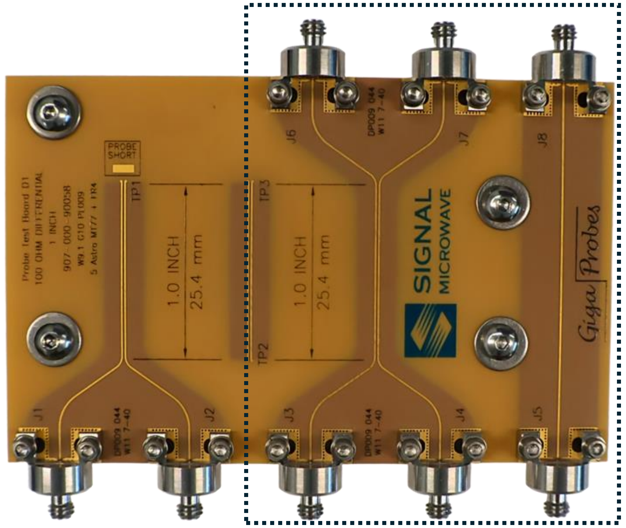


Note: These raw probe insertion loss measurements were made using a 70 GHz VNA sweep with 1.85 mm RF connectors rated to 67 GHz. On this plot, 67 GHz is slightly to the right of the midpoint between 63 GHz and 70 GHz.

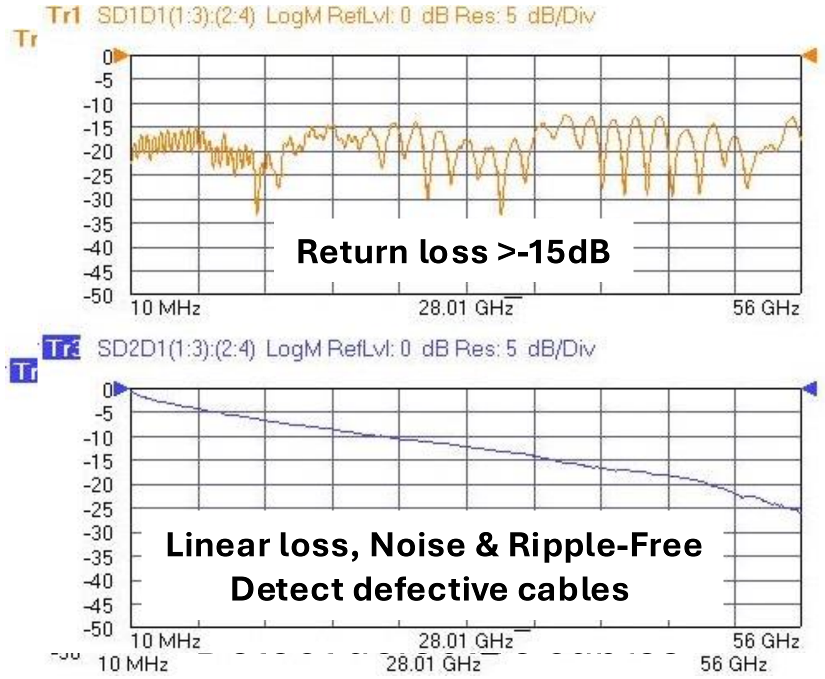
Optional ISBNN VNA Test Verification Boards

40 GHz to 110 GHz connectorized "Golden Reference" traces
The benchmark for detecting cable defects missed by SOLT

Verify VNA measurement system accuracy, including all cables, with one "golden reference" trace insertion loss measurement after SOLT calibration and before DUT measurements.



"Golden Reference" differential and single-ended traces

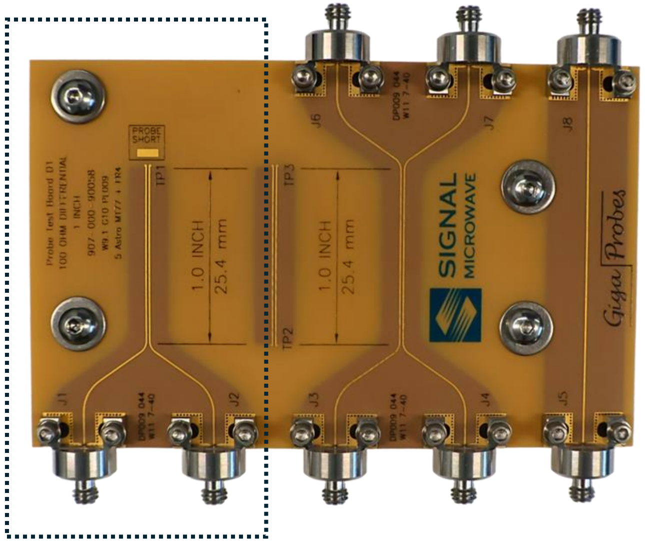


- Full system bandwidth **test VNA measurement accuracy**
- **Detect faulty cables** and setups not found by calibration alone
- Check for **correct port assignments** before making probe measurement
- Establish a repeatable golden-reference measurement baseline, **useful for troubleshooting faulty VNA setups**
- **Improve confidence in DUT measurements** and de-embedding results

Golden reference trace measurements verify VNA and cable integrity for accurate DUT measurements.

Initial 40 GHz to 110 GHz VNA Probe Setup

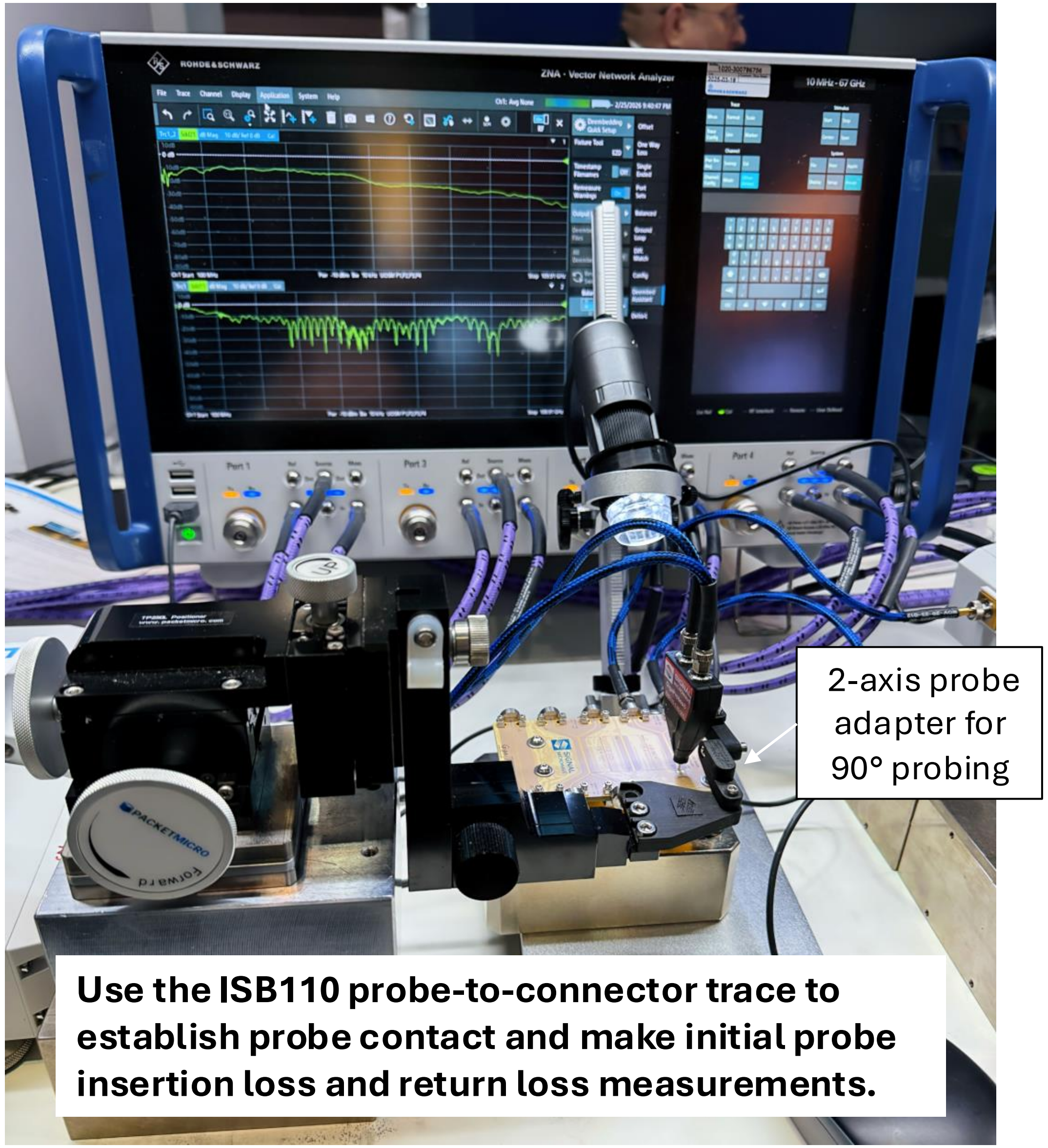
Using the ISBNN Probe-to-Connector Trace



Probe to connector trace

Process: Connect probe in situ to the **ISBNN probe-to-connector trace** and **VNA differential ports**

1. Make a **reference insertion loss measurement**
2. Verify **probe measurement accuracy**
3. Practice probe **tip to test pad planarization**
4. Confirm correct **VNA port assignments**
5. Set up **time- and frequency-domain measurements**
6. Optimize **camera placement** of probe tip on test pads
7. Verify **probe de-embedding measurement accuracy**

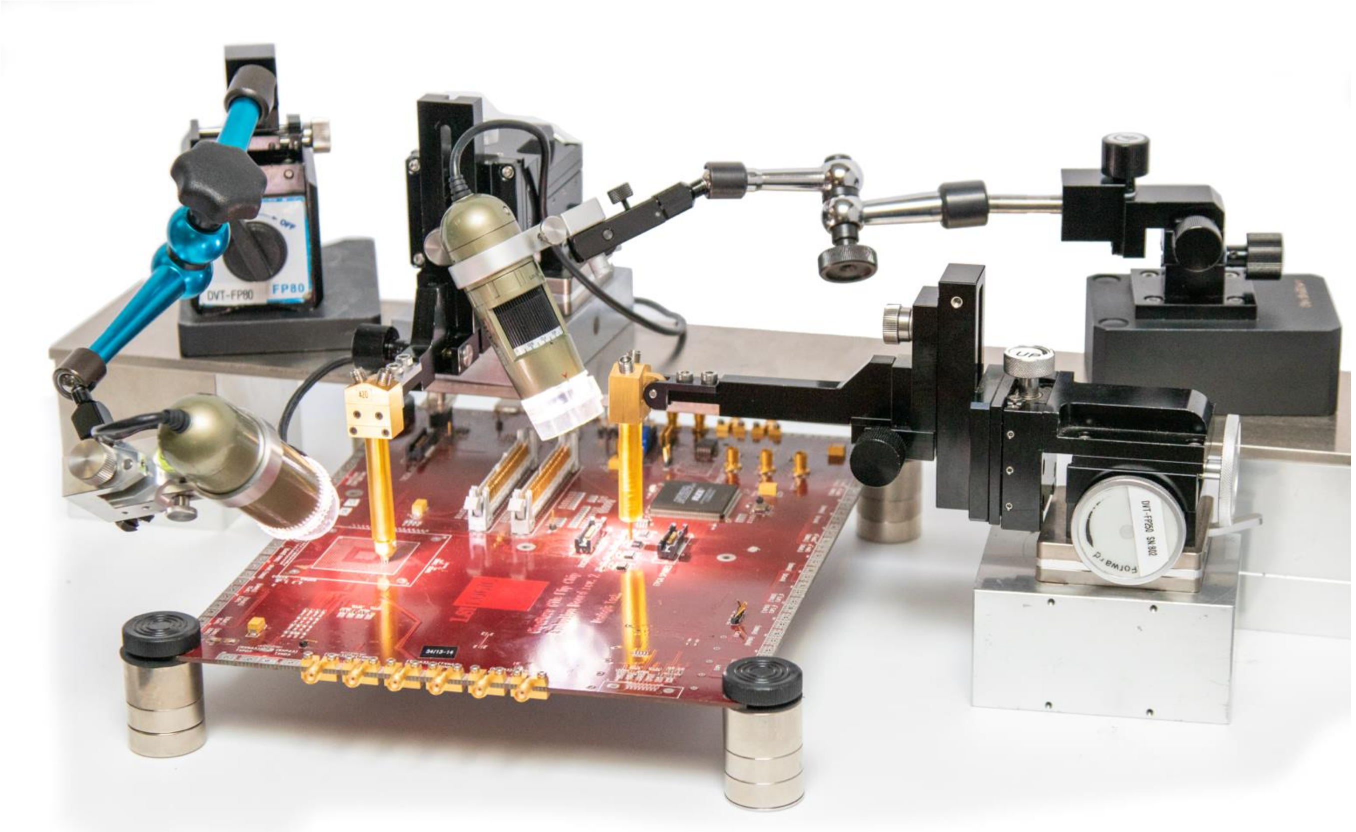


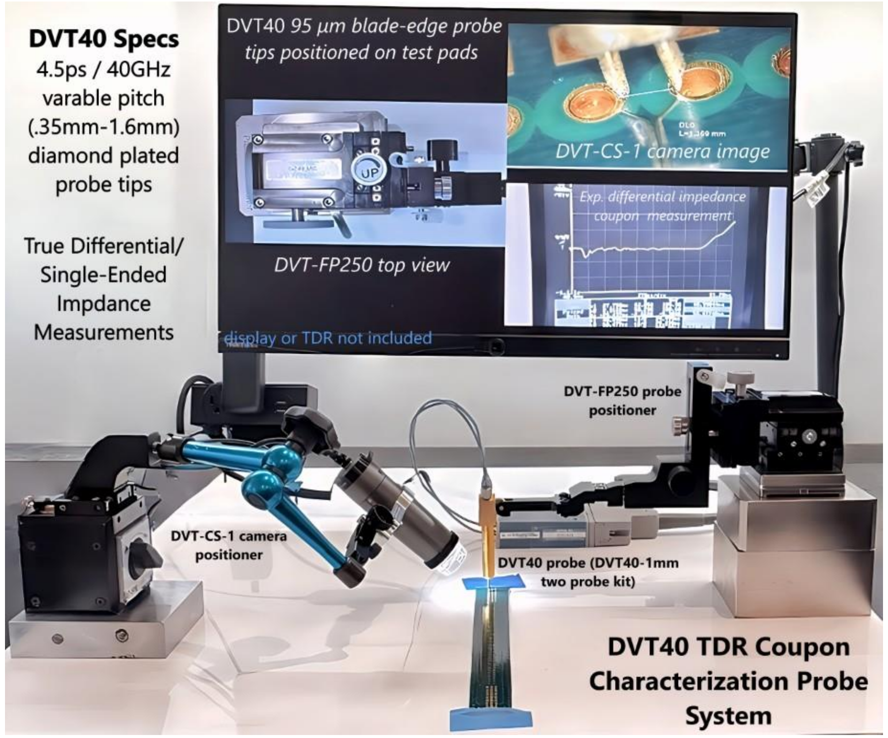
Vertical and Horizontal Probe Systems

For use with DVT-FPPNN, DVT40, DVT30 differential, third party single-ended, and wafer(um) probes

Horizontal Probe System Configurations

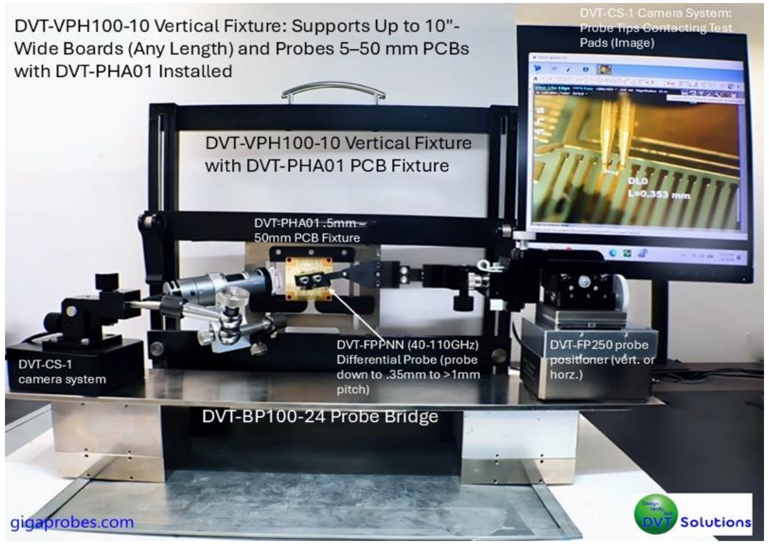
Assembled from **Standard Modular Probe System** Components





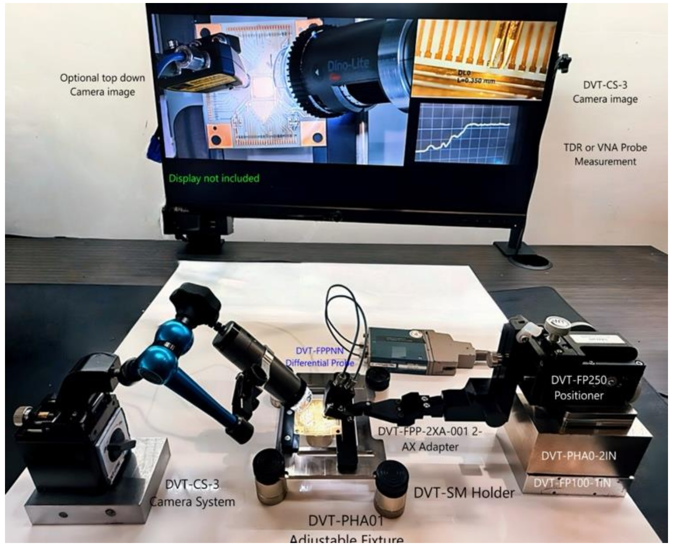
Vertical Probe Systems

Assembled from **Standard Modular Probe System Components**



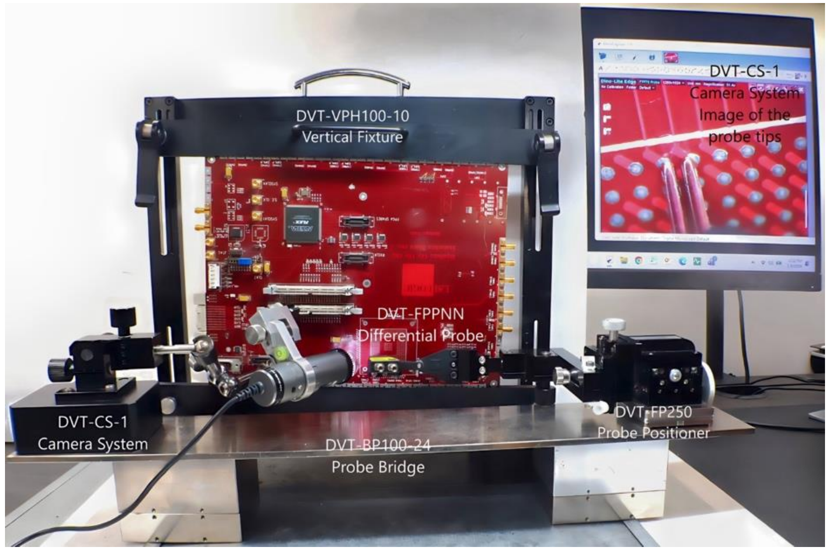
Vertical Backside Probing

For Packages and PCBs
***5 mm** to **50 mm** devices*
and PCBs up to 18 in



Horizontal Probing

For Packages and Small PCBs
5 mm to 50 mm devices
and small PCBs

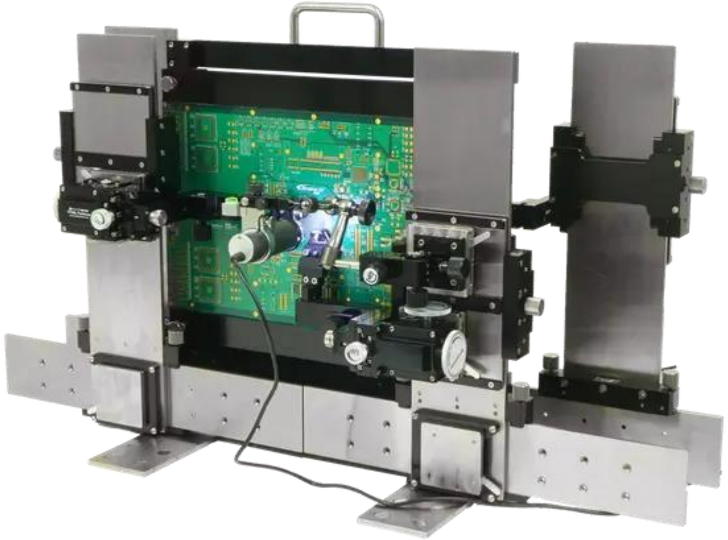


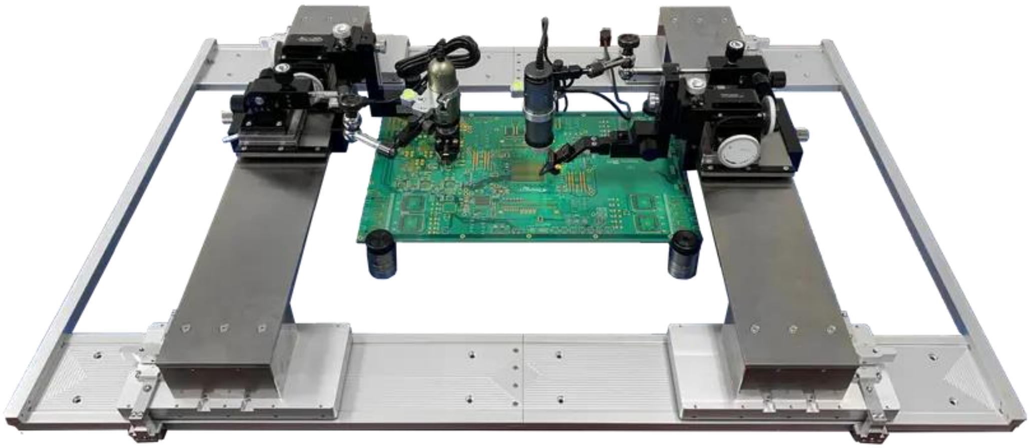
Vertical Front/Back Side Probing

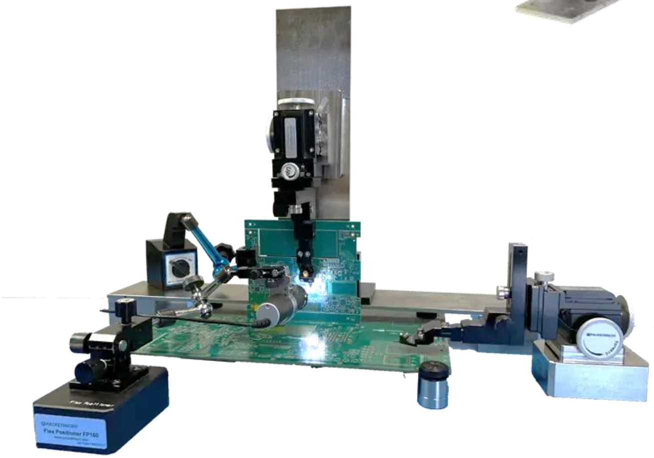
18” PCBs

2026 High-Frequency PCB Probe System (40–110 GHz)

Horizontal & Vertical Probing for Large PCB SI Characterization





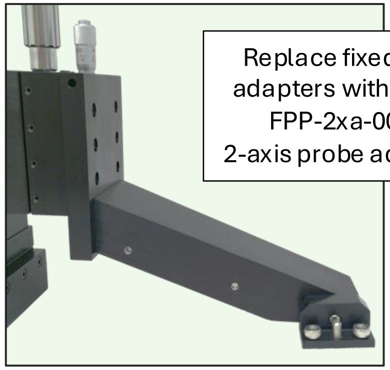


DVT-FPPNN PCB-Based Differential Probes for Wafer Probe Systems

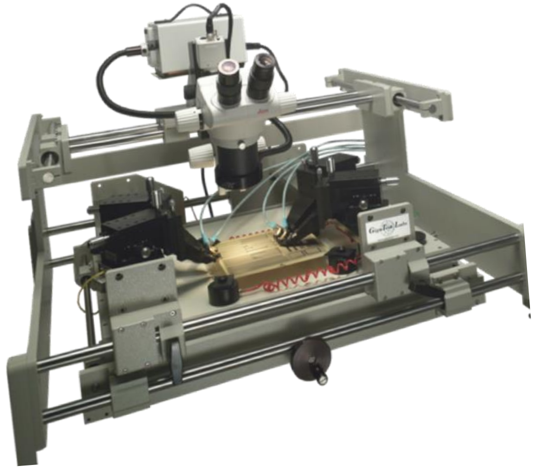
40–110 GHz measurements on non-planar, wide-pitch differential pads

All DVT-FPPNN probes come with a 2-axis probe adapter

- ±90° horizontal and vertical rotation
- 15+ probe positions for setup flexibility
- Eliminates separate fixed 90° arm adapters
- Supports continuous multi-position testing
- Fits standard 3-hole probe positioners

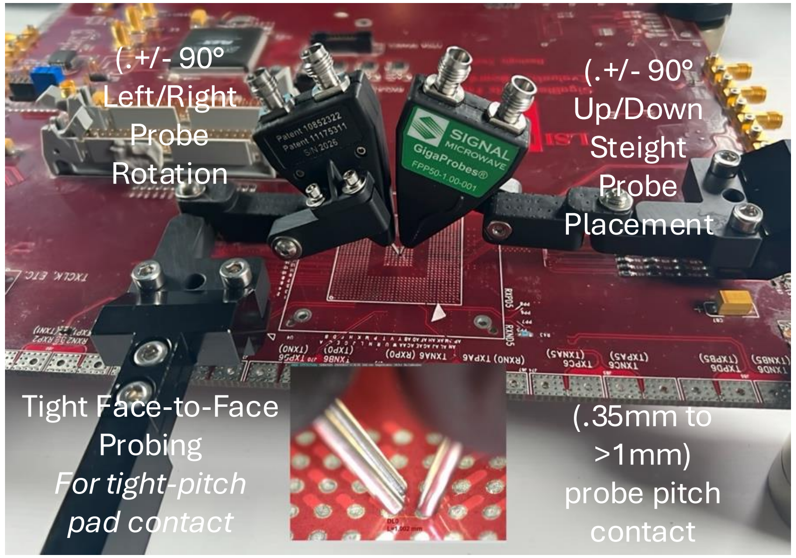


Replace fixed 90° adapters with DVT-FPP-2xa-001 2-axis probe adapter



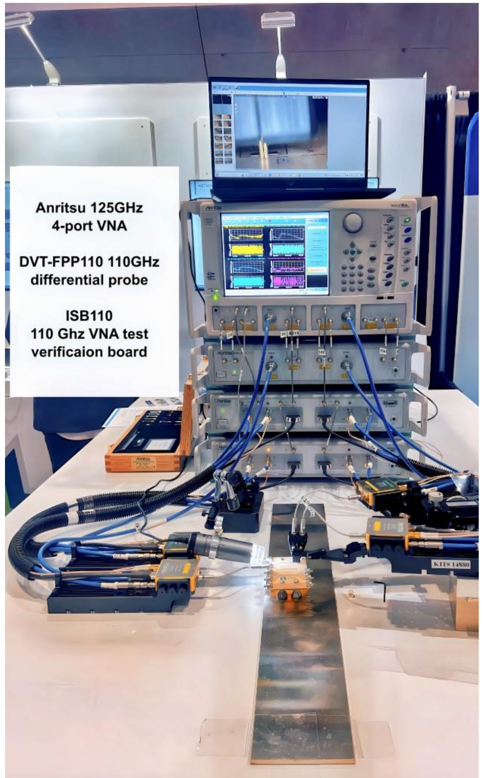
Probe Up/Down and Left/Right

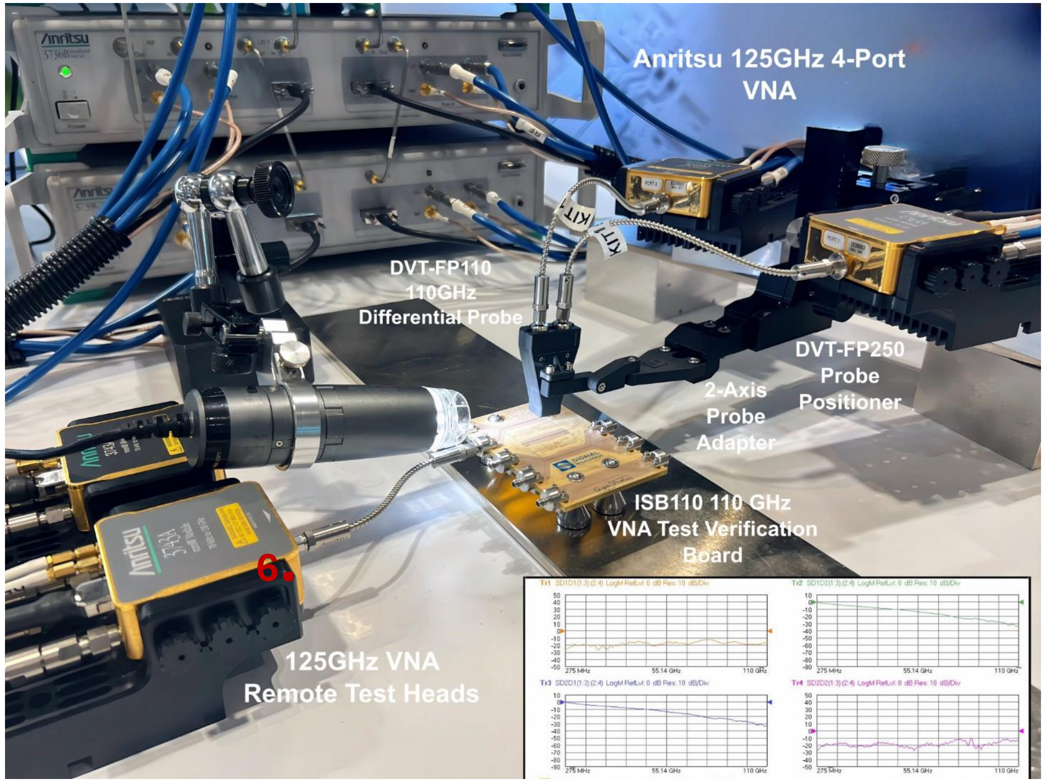
2-Axis Probe Adapter for 90°



DVT-FPP-2xa-001

Fixturing Considerations
for 110 GHz Probe Systems with Remote Sampling Heads





1. Use short cables (6–12 in.)
2. Avoid sharp bends
3. Mount test heads inline with the DUT connectors
4. Elevate test heads above the probe connection
5. Maintain a gradual downward cable sweep to the probe
6. When possible, put test head in line with DUT connectors

DVT Solutions, LLC

GigaProbes®

Brian Shumaker

President, DVT Solutions

Desktop Probe Systems

DC to 110 GHz RF Differential Probes

Since 2005, the world leader in true differential probes and systems

Sales - Technical Support – Service

Worldwide Availability

Email: sales@gigaprobes.com
PH: 650 743-5660

Web: gigaprobes.com
Sarasota, Florida USA