IEEE SW Test Workshop
Semiconductor Wafer Test Workshop

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MPI CORPORATION

Novel Vertical Probe Card Solution for Multi-DUTs and RF Device on 3GHz Applications

June 6 to 9, 2010

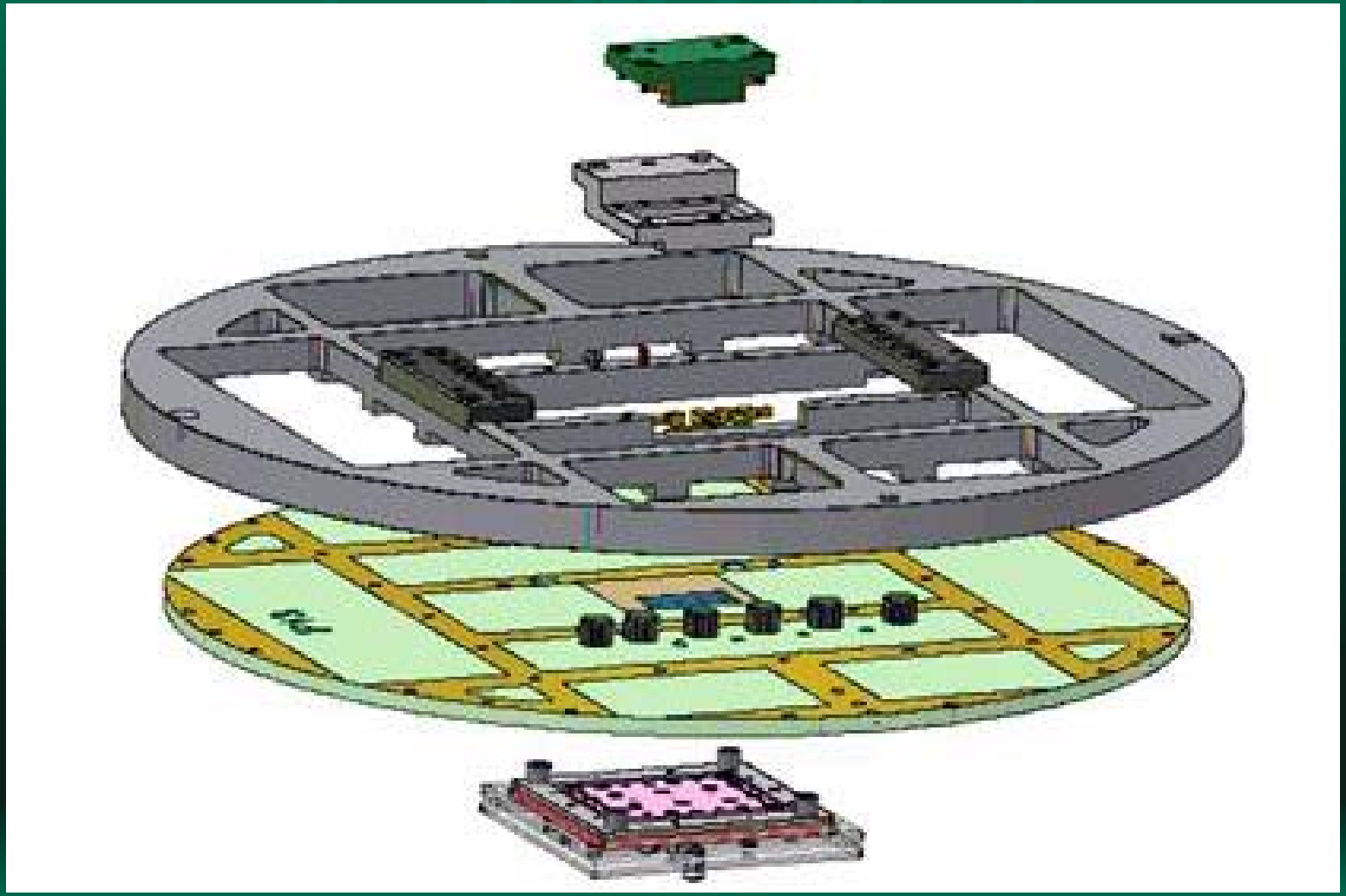
San Diego, CA USA

Overview

- VPC Structure of MPI
- RF Simulation and Modeling
- Performance on 4-DUTs RF VPC
- Summary

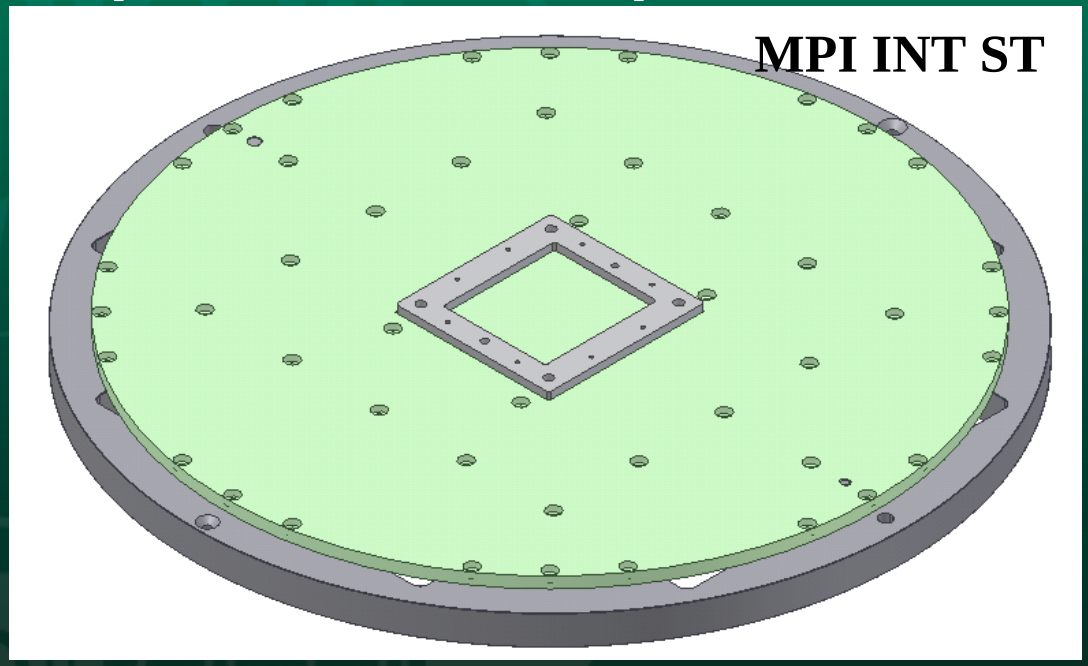
VPC Structure of MPI

- MPI INT VPC Structure (Side view)



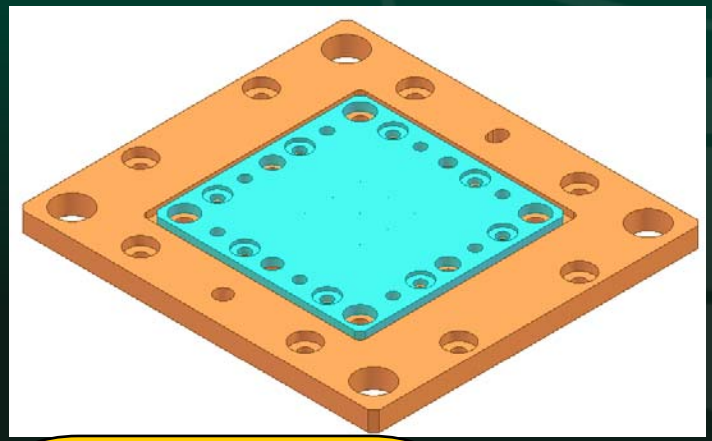
VPC Structure of MPI

☐ MPI INT VPC Structure (wafer side view)



MPI RF PH

(use 3mil Flat tip Needle)



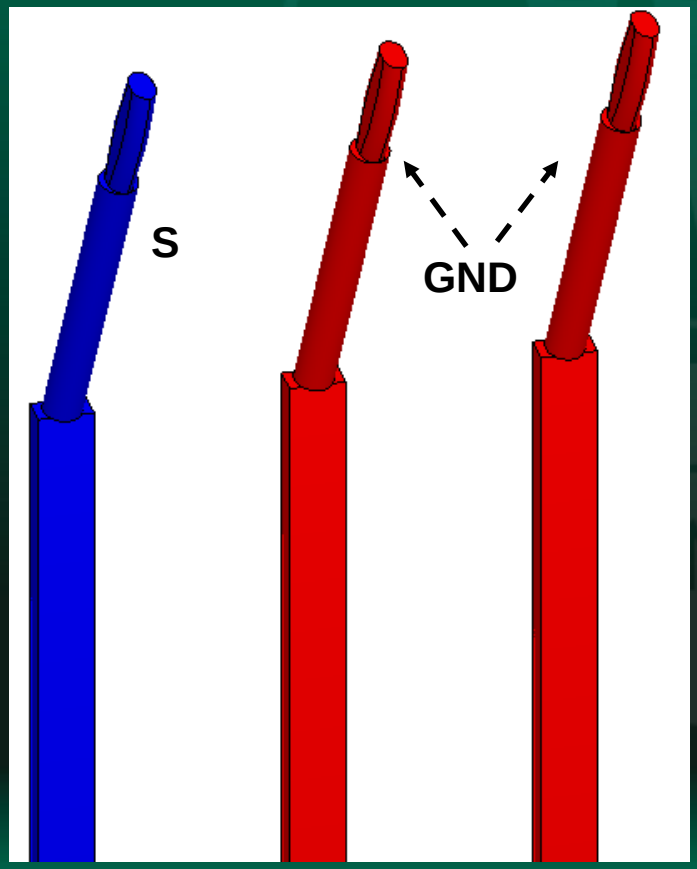
RFPH Patent Issued

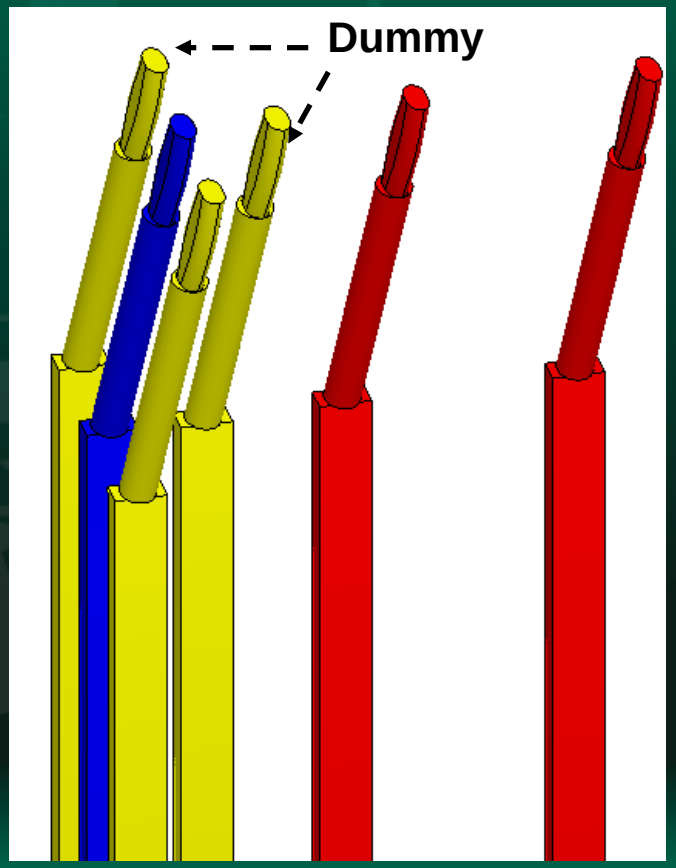
INT Patent Issued

VPC Structure of MPI

- VPC Needle Structure (Dummy Tuning)

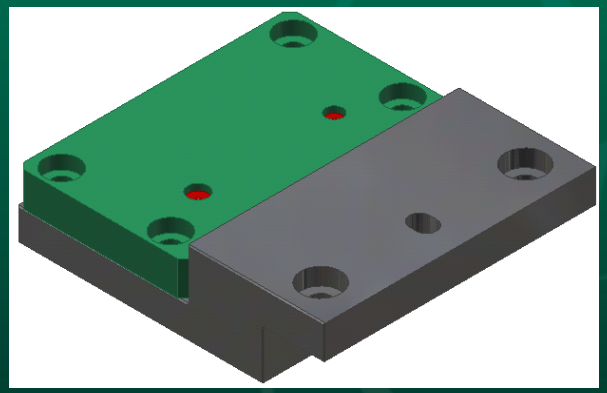
MPI applies dummy needles for 50 ohm impedance matching on VPC PH.



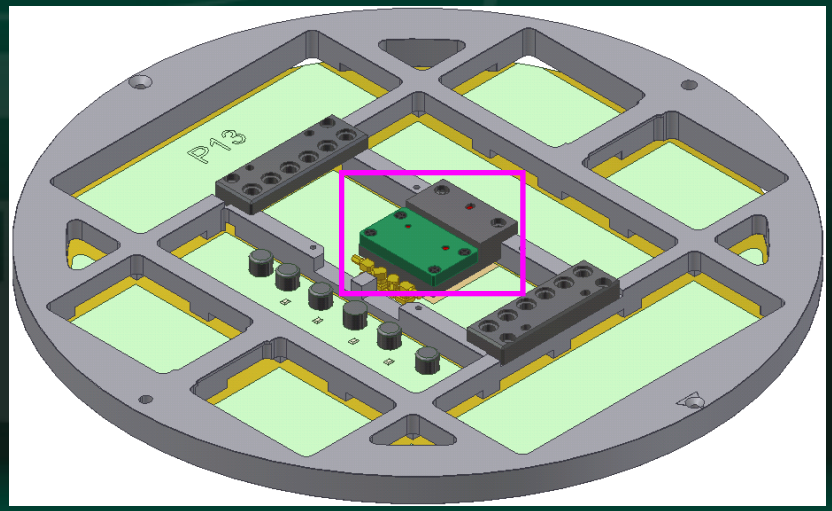


VPC Structure of MPI

☐ MPI INT VPC Structure – Matching tooling



RF matching tooling



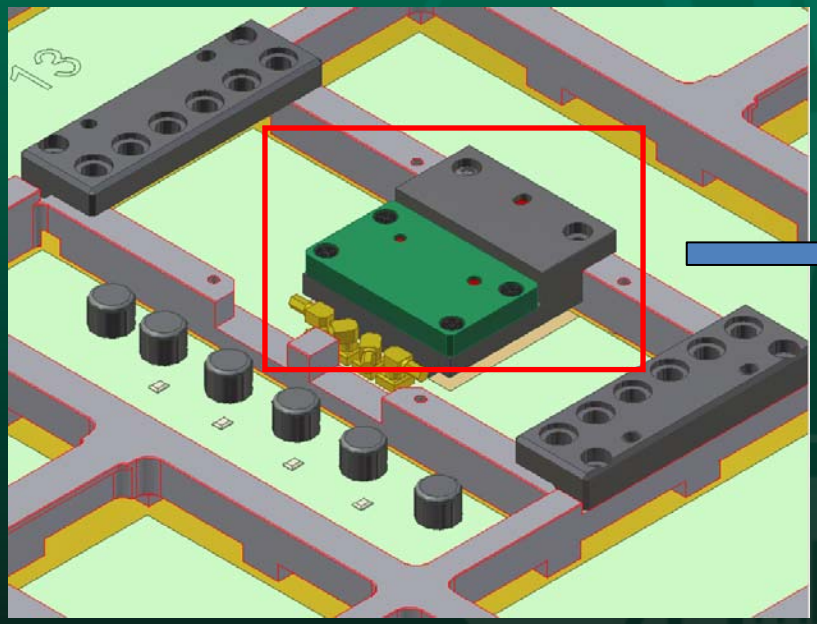
(Tester side view)

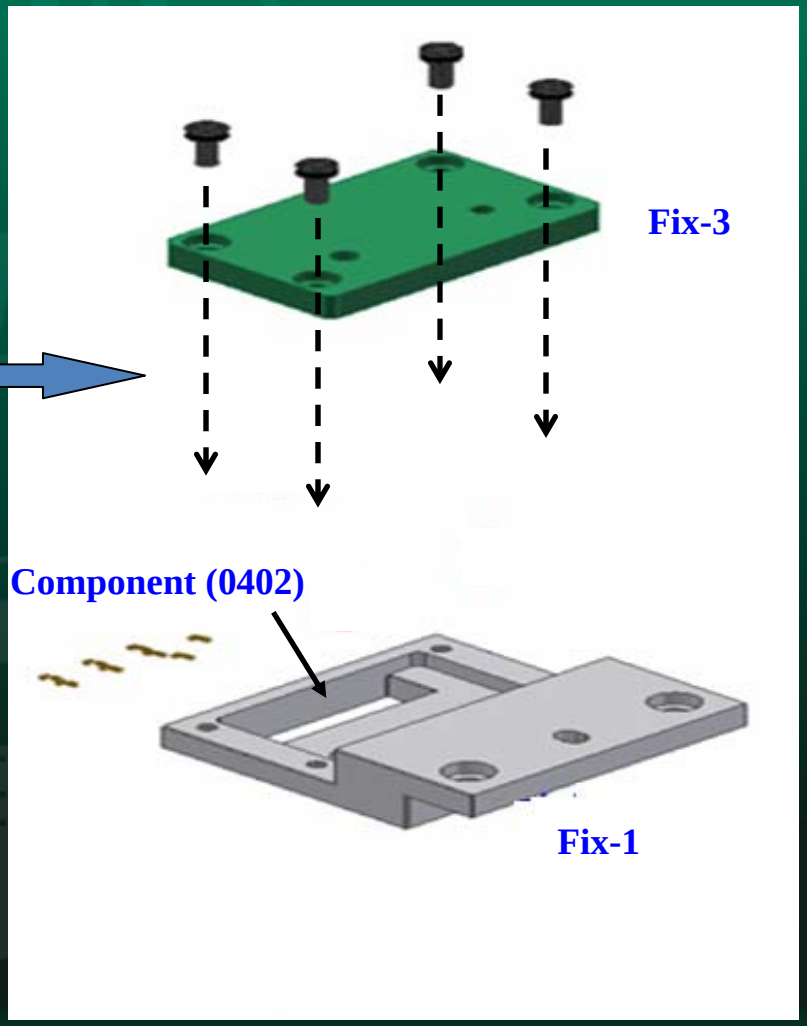
MPI Patent Pending

VPC Structure of MPI

☐ MPI INT VPC Structure

RF matching tooling tester side view





RF matching tooling assembly

Saving the engineering time from 1-hour to 10-mins in clean room !

RF Simulation and Modeling

For RF application, the electrical simulation or modeling of each element is very important for impedance matching and power optimization.

Modeling Elements:

a. The Matching Network and Tooling

b. RF trace on PCB

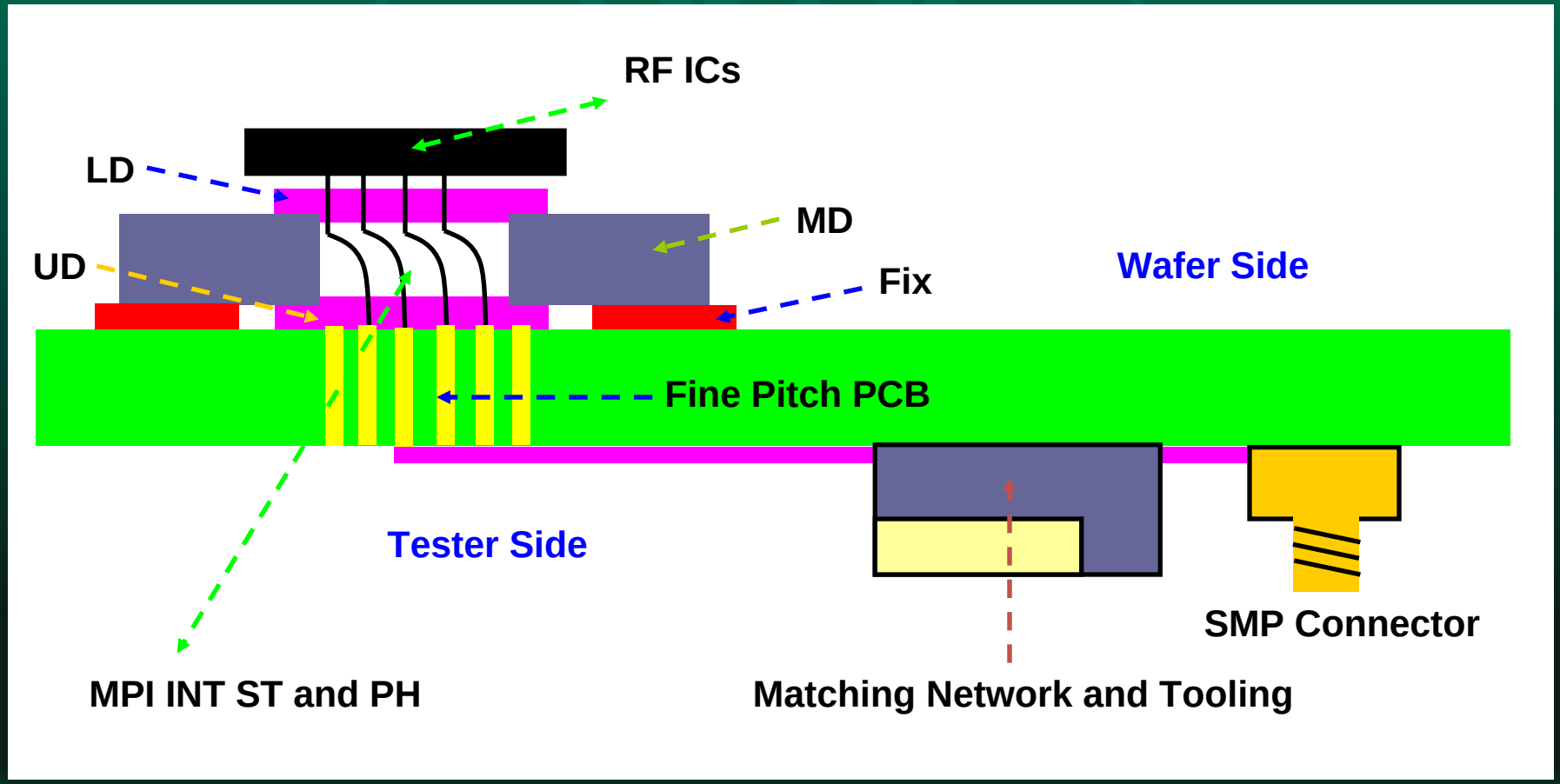
c. The Effects of Through Vias

d. RF PH

e. Chip Impedance

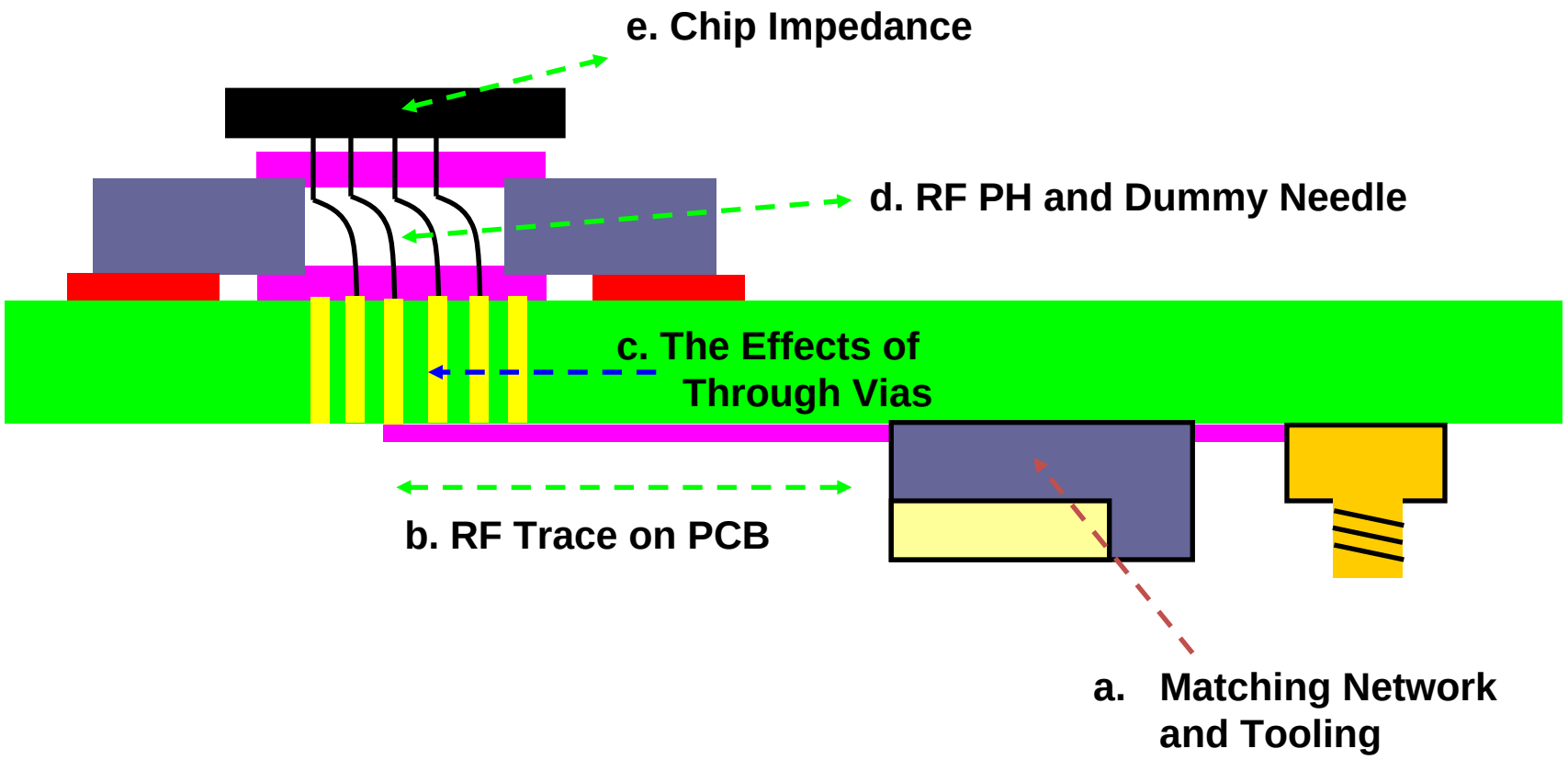
VPC Structure of MPI

☐ MPI INT VPC Structure (Side view)



RF Simulation and Modeling

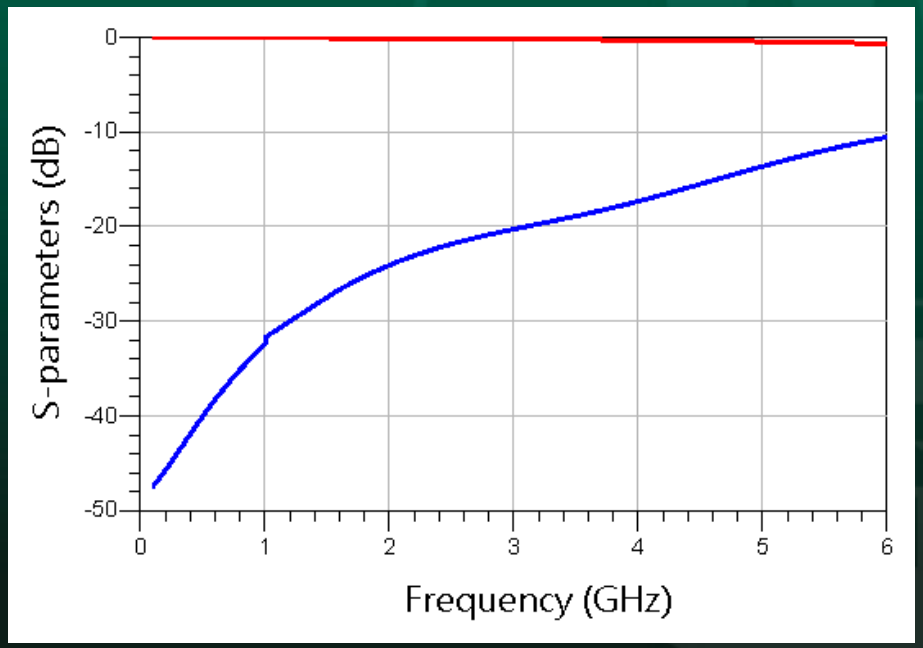
☐ MPI INT VPC Structure (Side view)

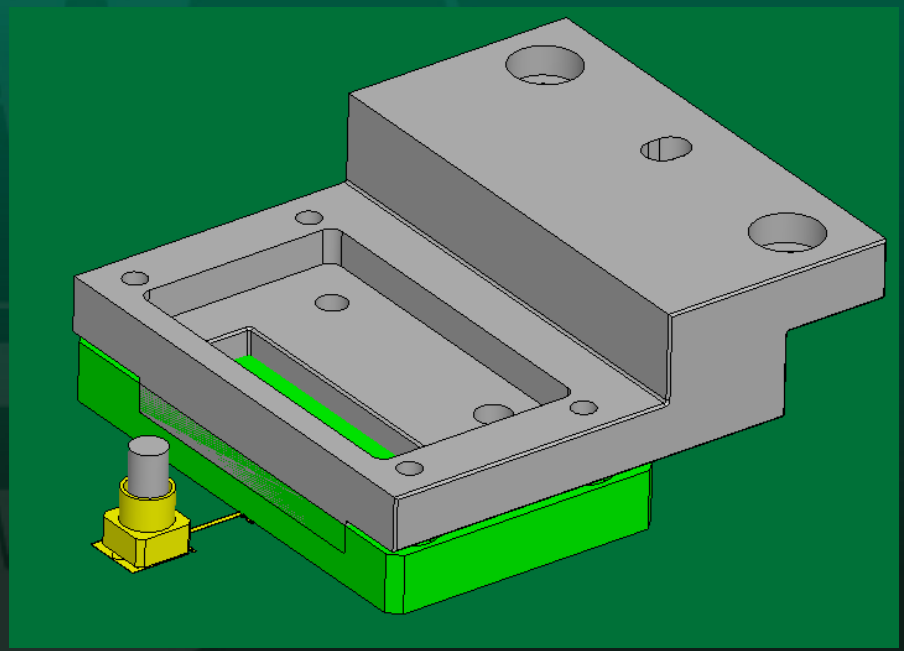


RF Simulation and Modeling

- **Simulation of PCB Traces with Matching tooling**

Matching tooling bandwidth is up to 6 GHz

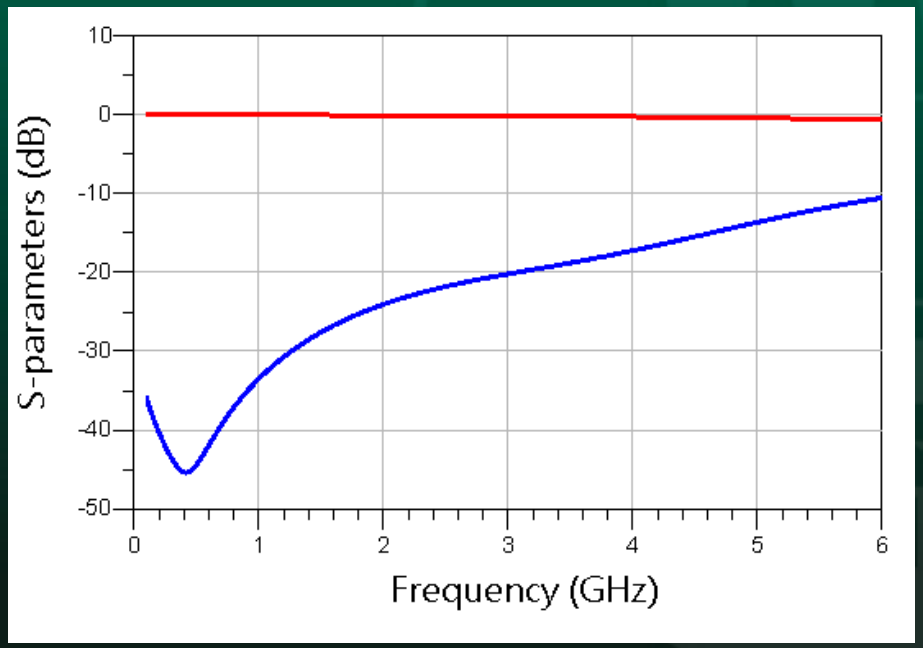


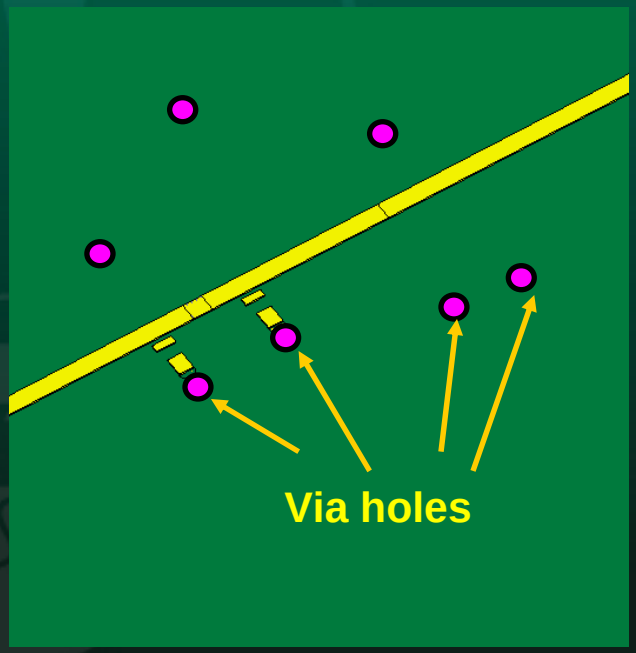


RF Simulation and Modeling

- **Simulation of PCB Traces with Via holes**

RF trace bandwidth is up to 6 GHz

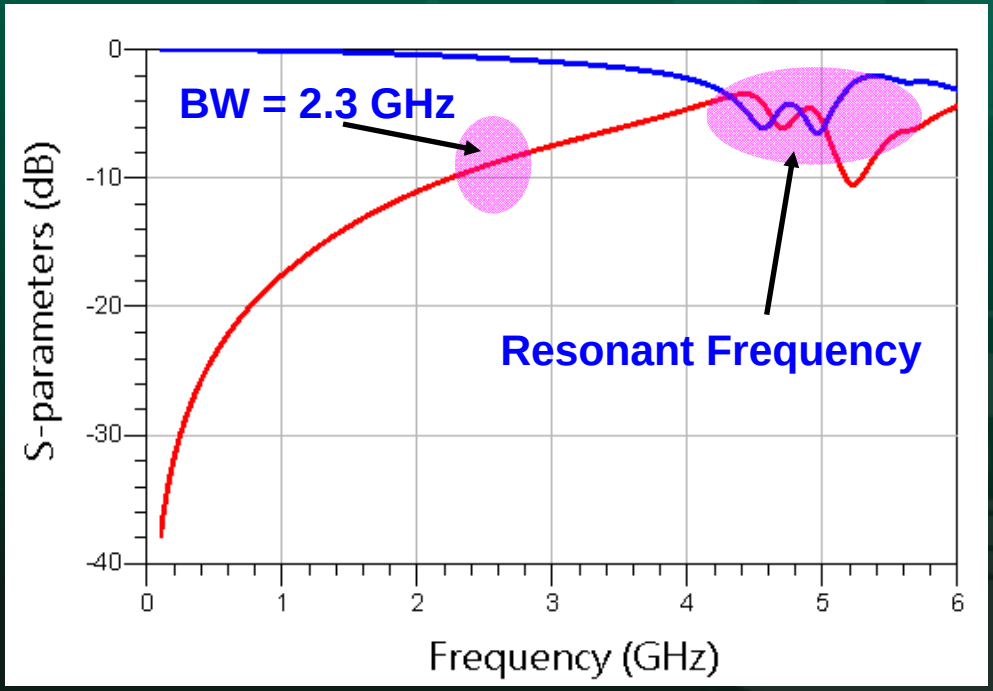


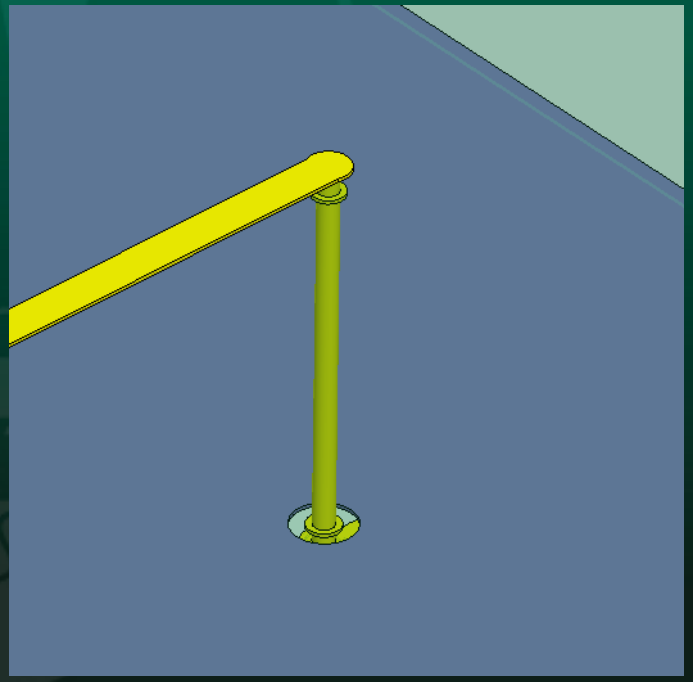


RF Simulation and Modeling

- **Simulation of Vias, coaxial Vias (1)**

The inductance effects on a through via.

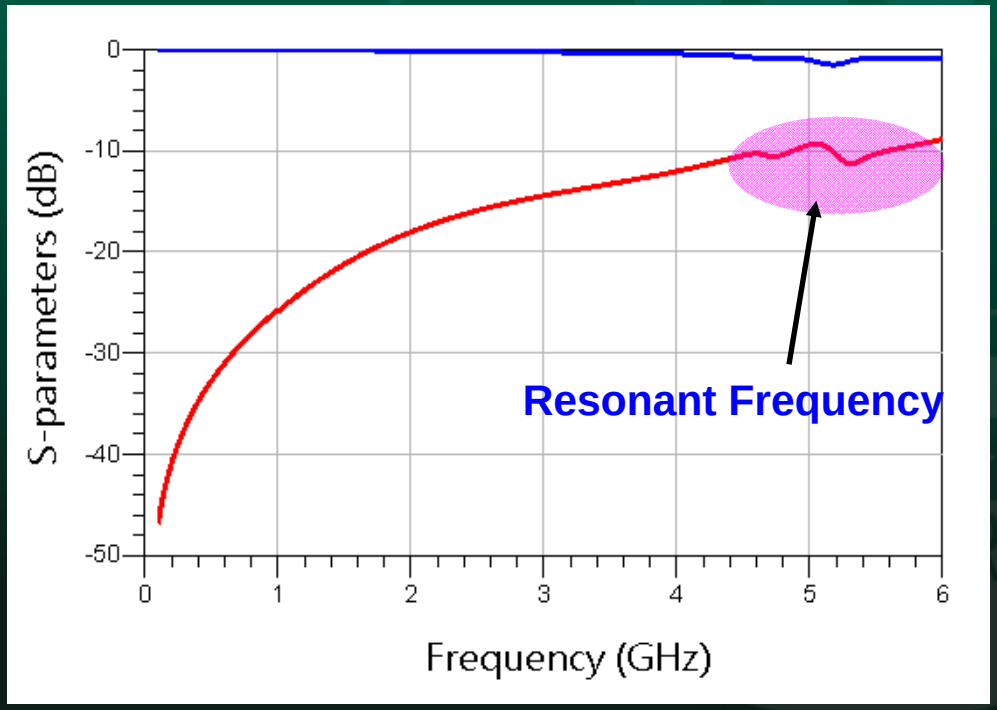


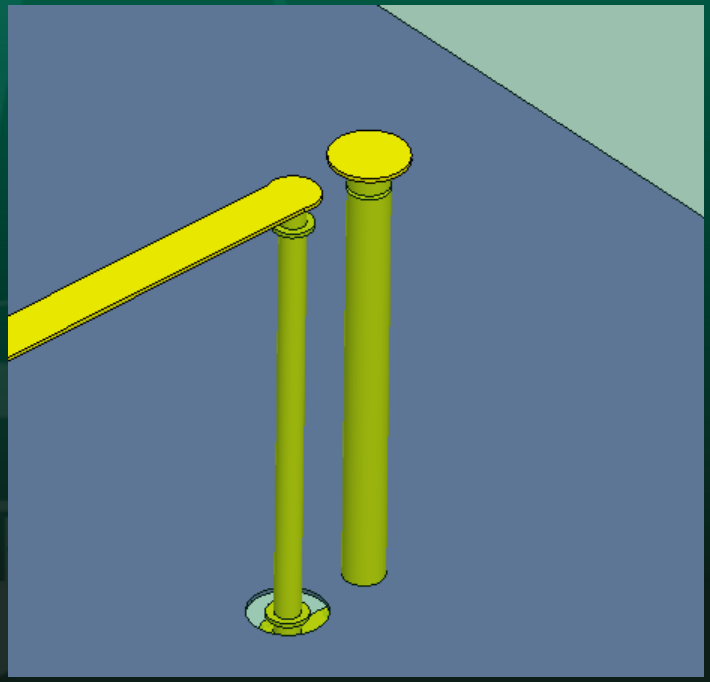


RF Simulation and Modeling

- **Simulation of Vias, coaxial Vias (2)**

Coaxial via improves the bandwidth to 4.5 GHz

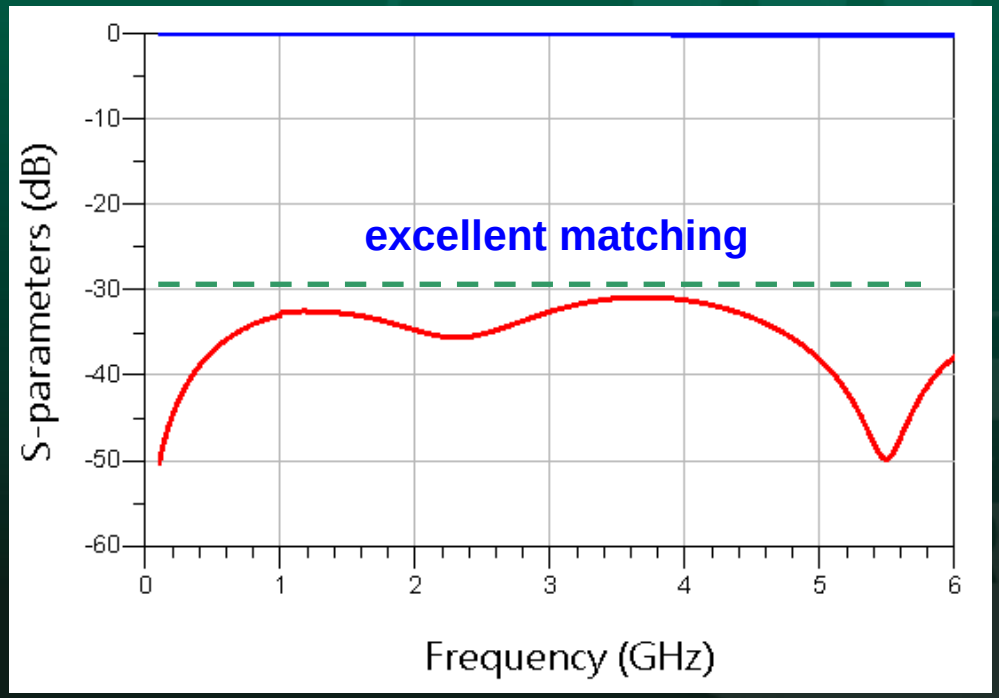


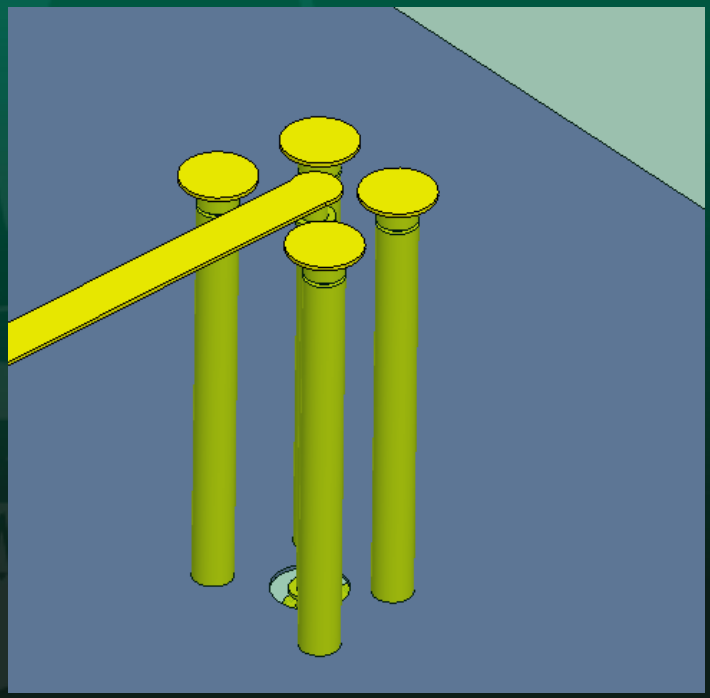


RF Simulation and Modeling

- Simulation of Vias, coaxial Vias (3)

Optimization of coaxial vias could remove the resonant frequency.

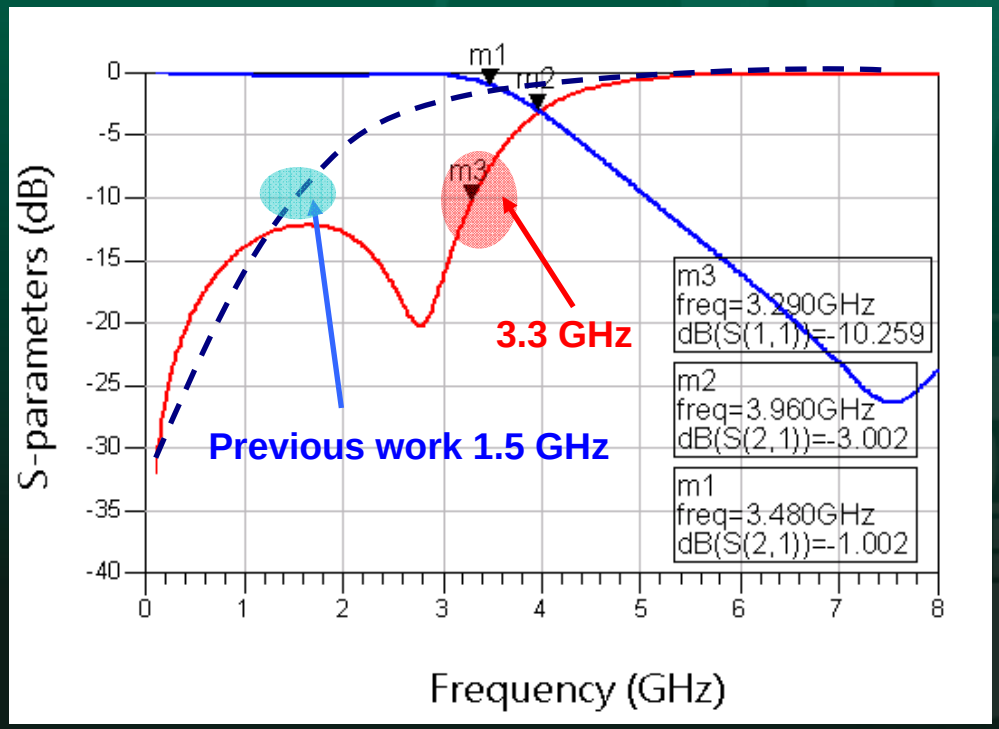


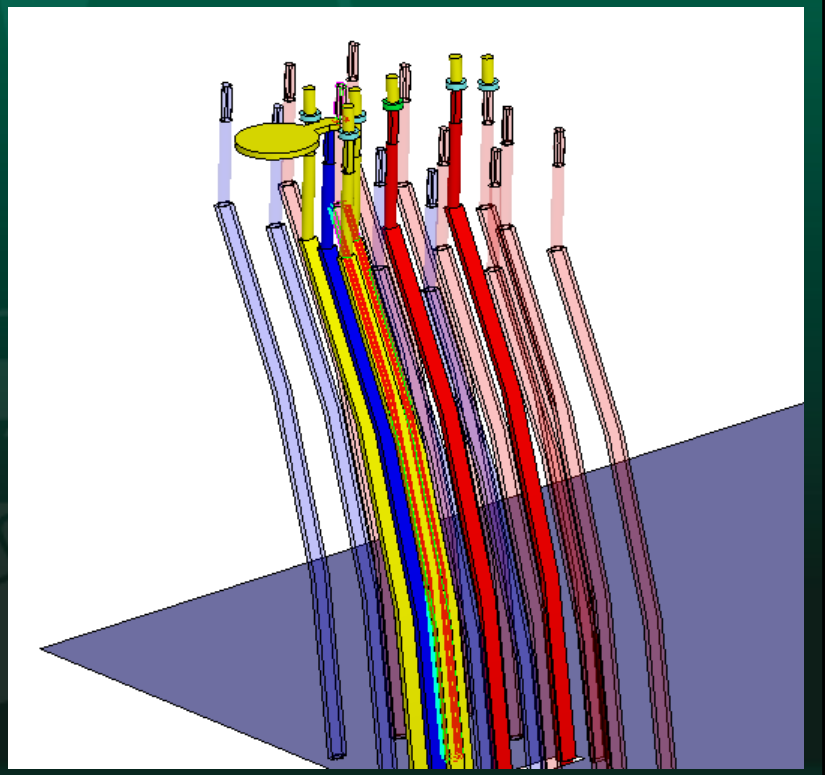


RF Simulation and Modeling

- Simulation of Signal and Dummy Needles

The bandwidth characteristic of MPI vertical PH structure.

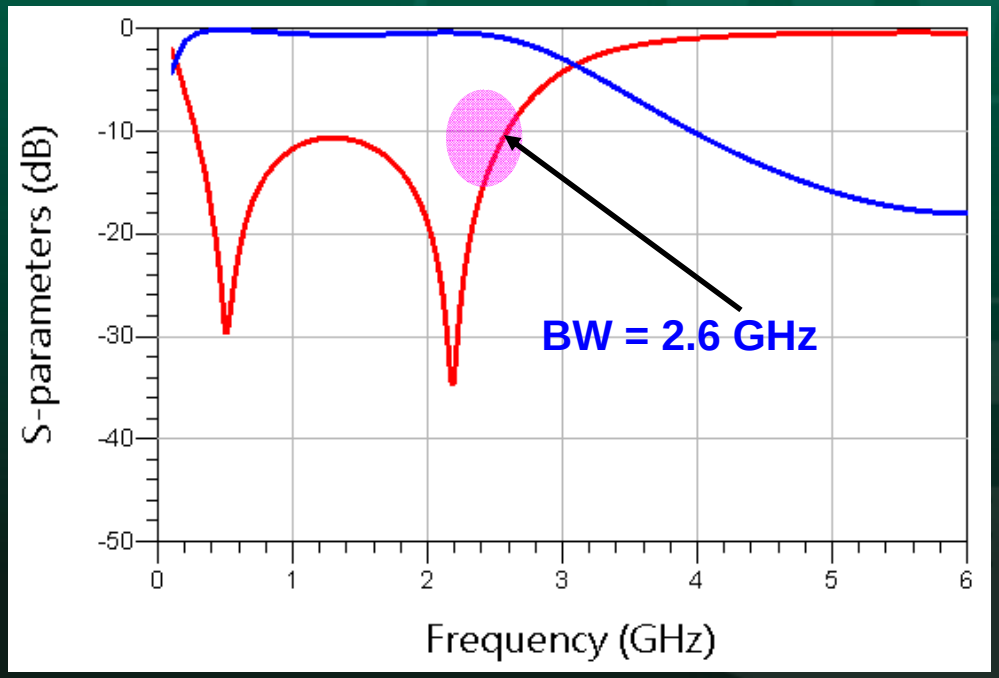


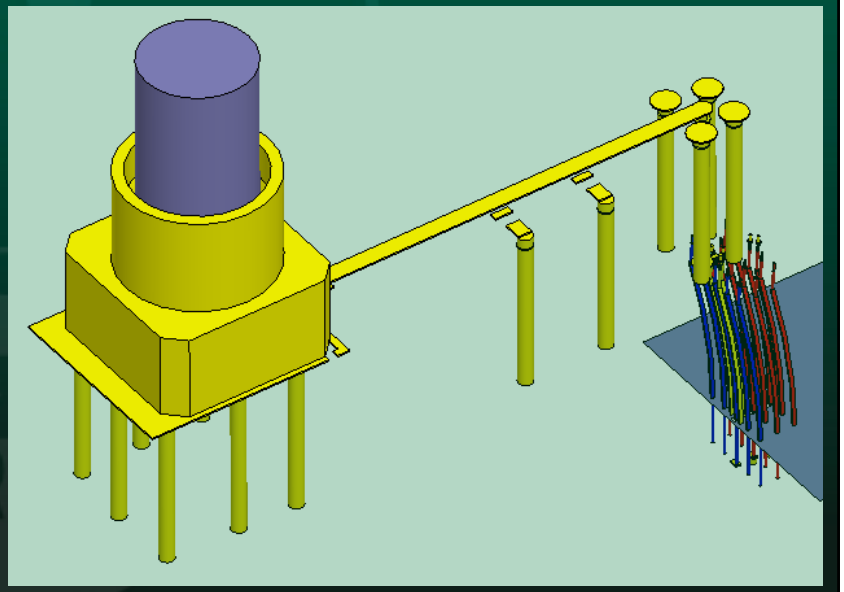


RF Simulation and Modeling

- Simulation of Total RF Path

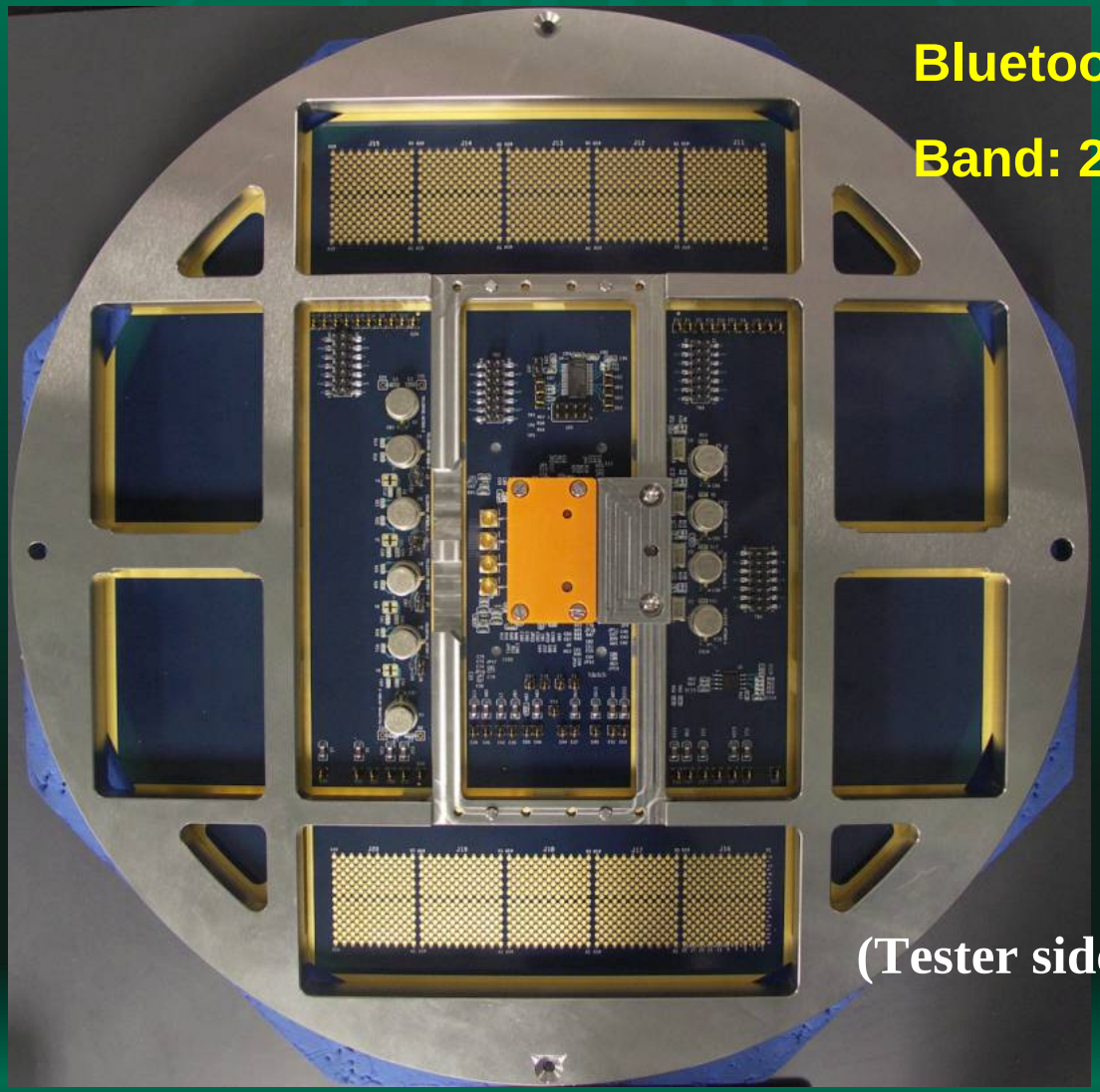
RF bandwidth of total transmission paths is about 2.6 GHz





Performance on 4-DUTs RF VPC

- MPI INT VPC Photo



Bluetooth Application

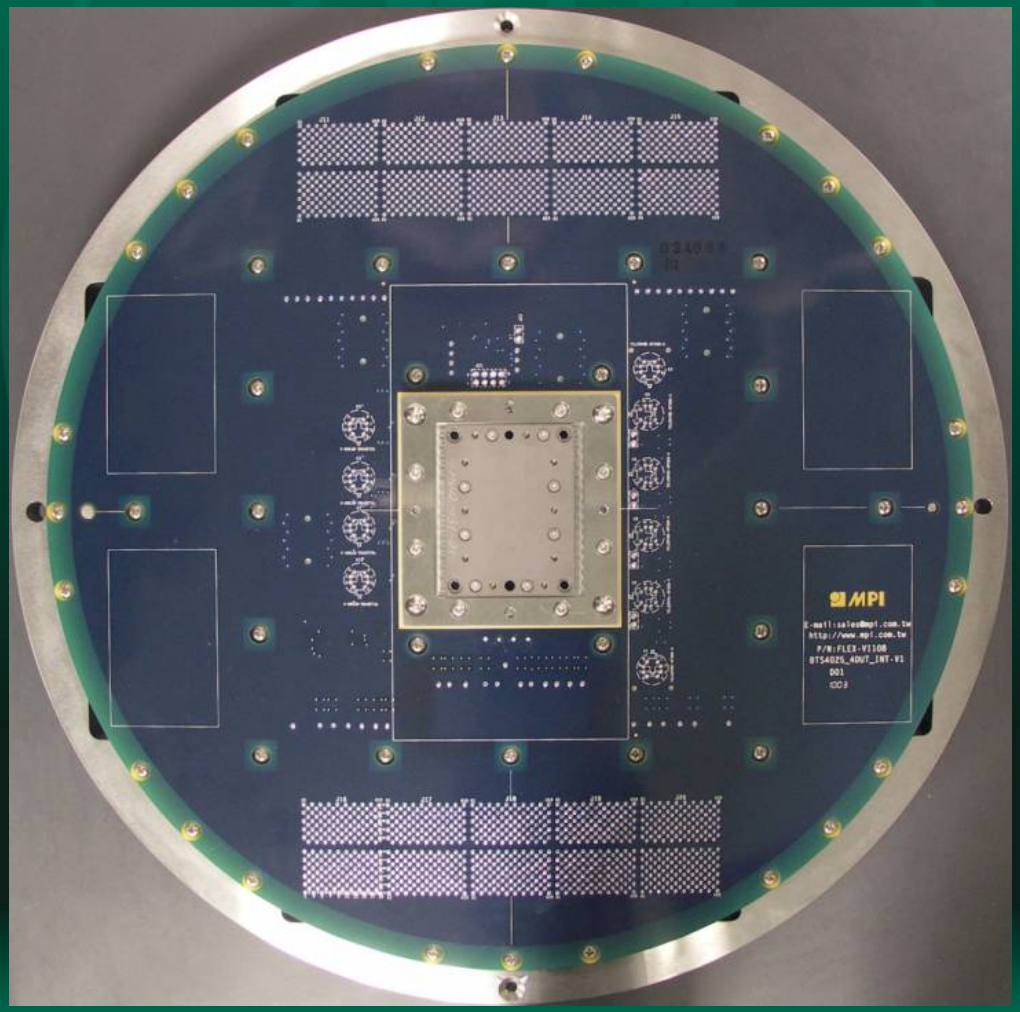
Band: 2400~2500 MHz

(Tester side view)

Performance on 4-DUTs RF VPC

- MPI INT VPC Photo

(Wafer side view)



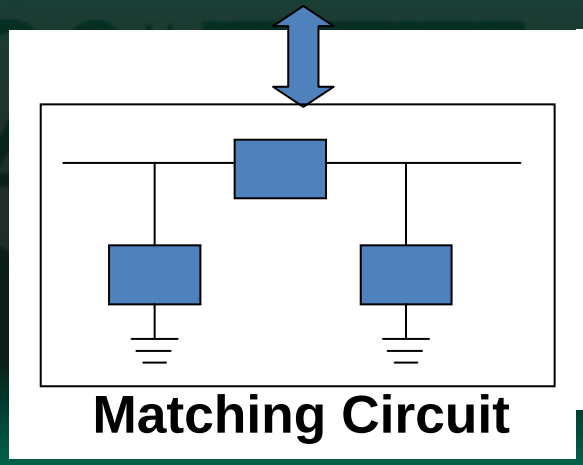
Performance on 4-DUTs RF VPC

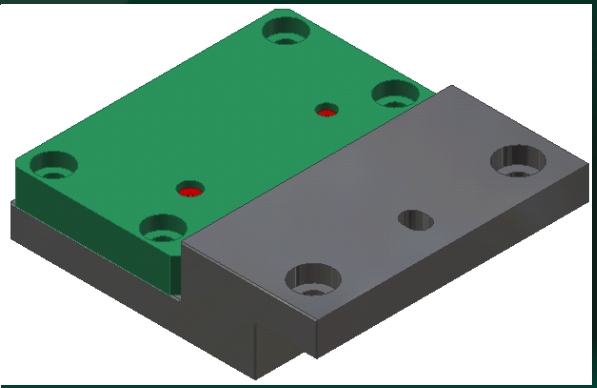
Impedance Measurement Using ENA

Initial NB

Prober

ENA



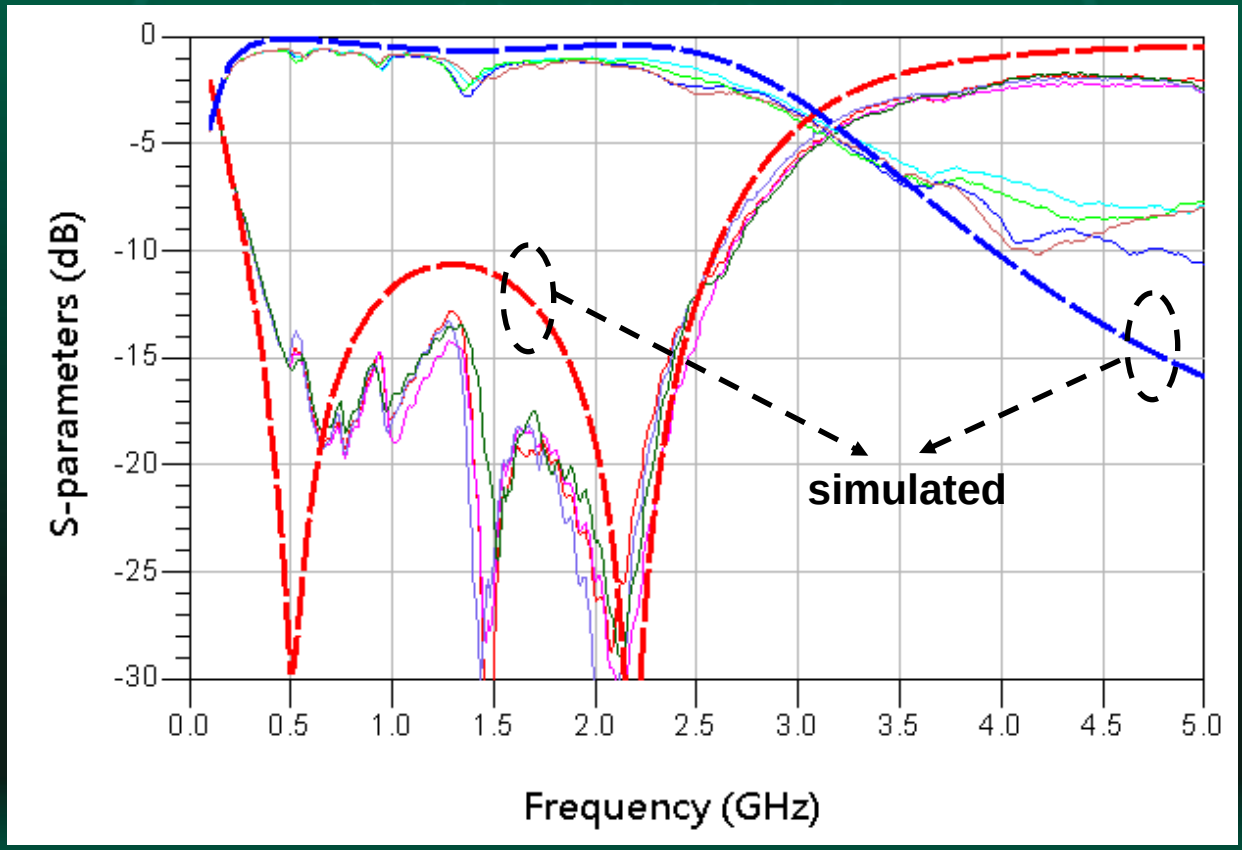


RF matching tooling

RF Simulation and Modeling

Performance of each site using 50 ohm test board.

Measured SITE #0~3 vs Simulated



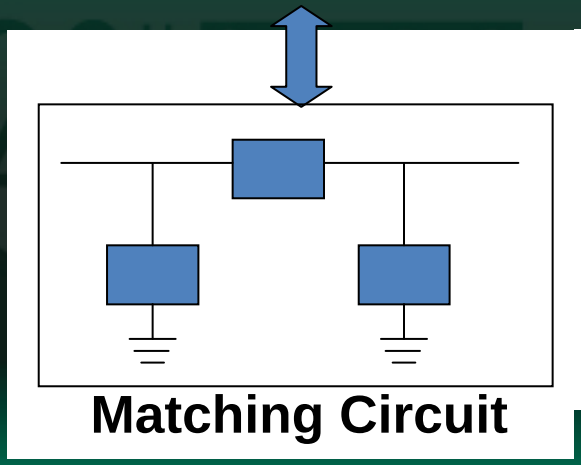
Performance on 4-DUTs RF VPC

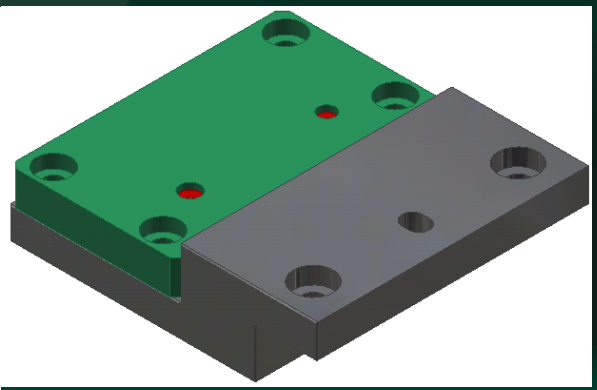
Power Measurement Using EXA

Initial NB

Prober

EXA



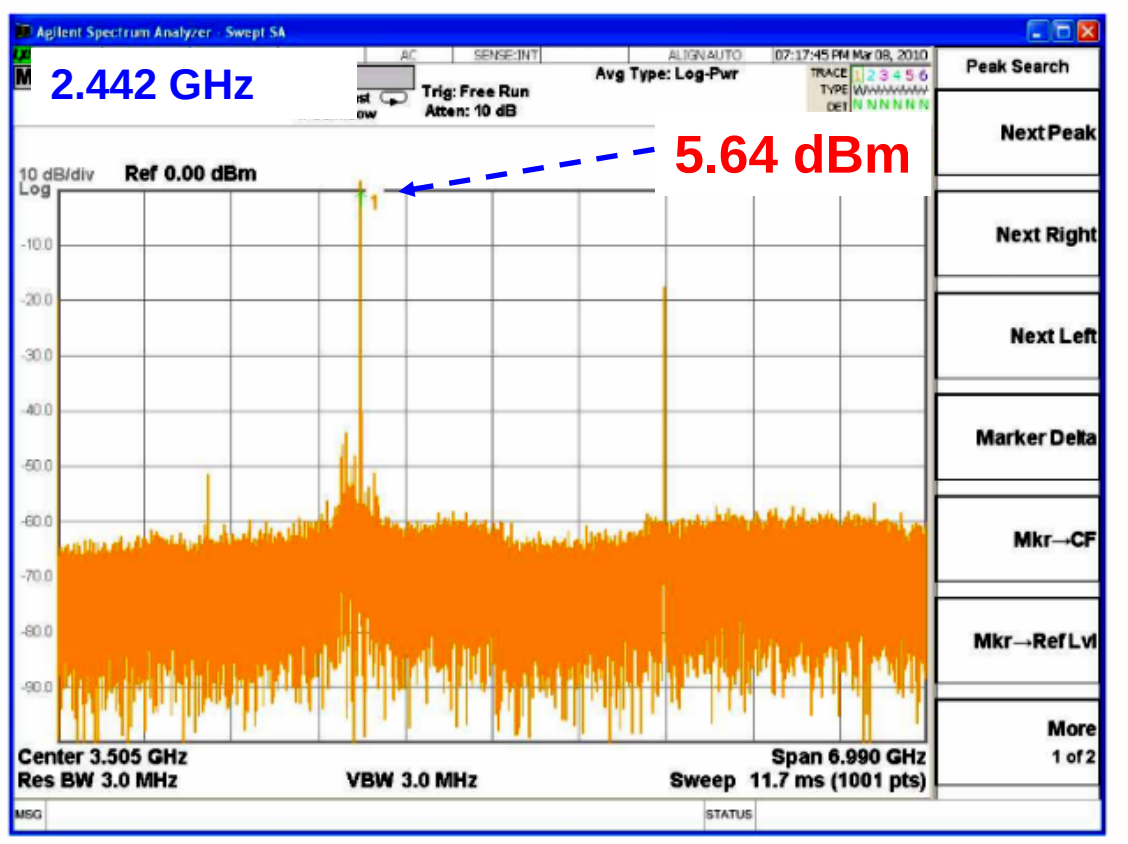


RF matching tooling

Performance on 4-DUTs RF VPC

- Power level of Contacting the Bluetooth Chip

Is there room for power level improvement ?

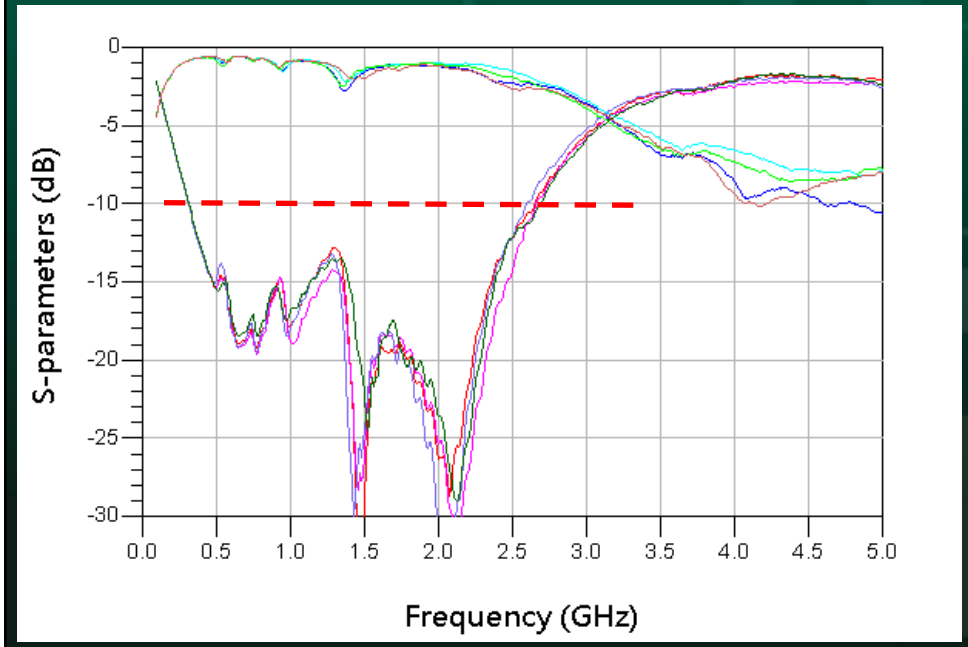


Performance on 4-DUTs RF VPC

- **The Frequency Characteristic**

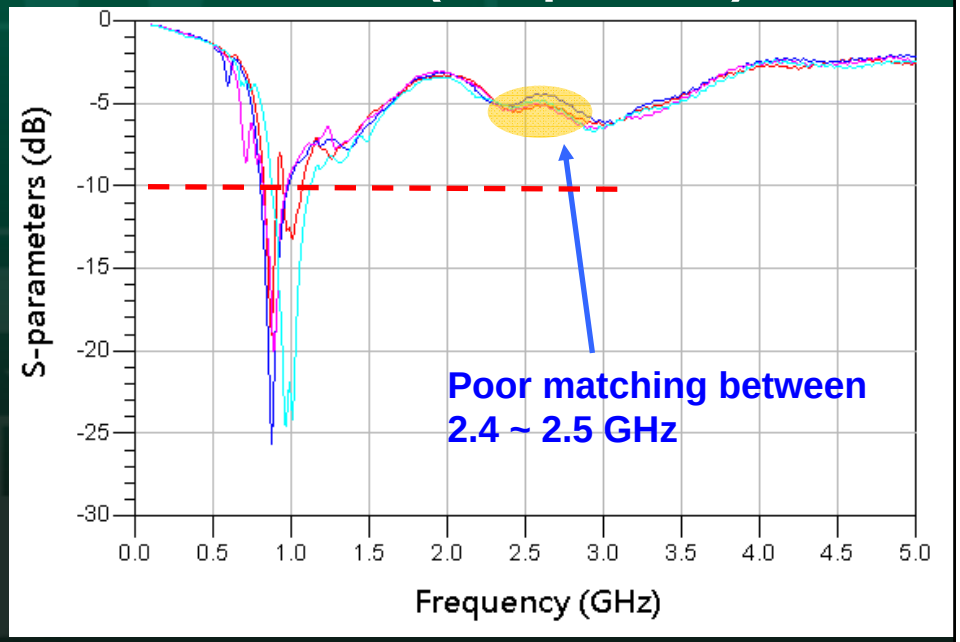
Poor return loss due to the realistic IC impedance

SITE # 0~3 (50 Ω Load)



Contact standard test board

SITE # 0~3 (Chip Load)

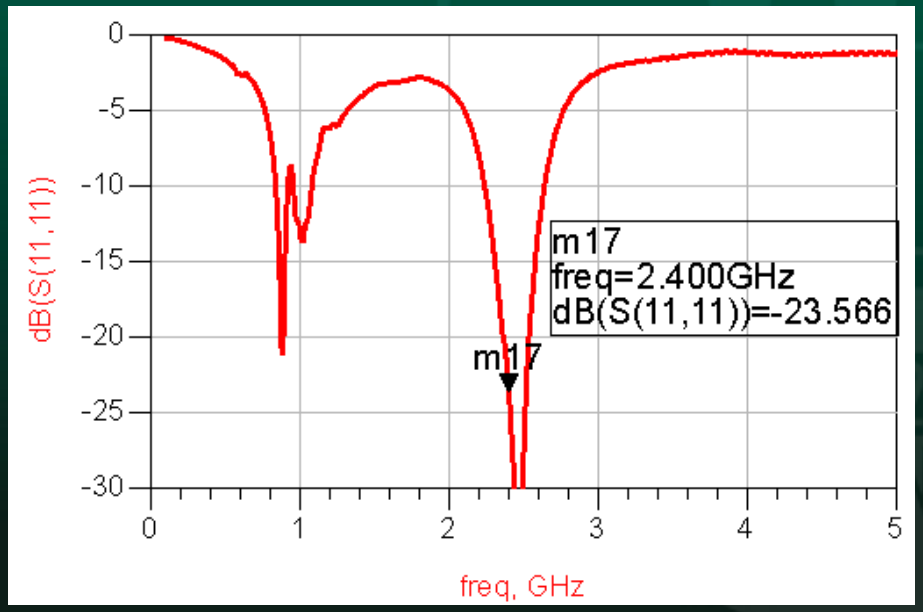


Contacting RF chip

Performance on 4-DUTs RF VPC

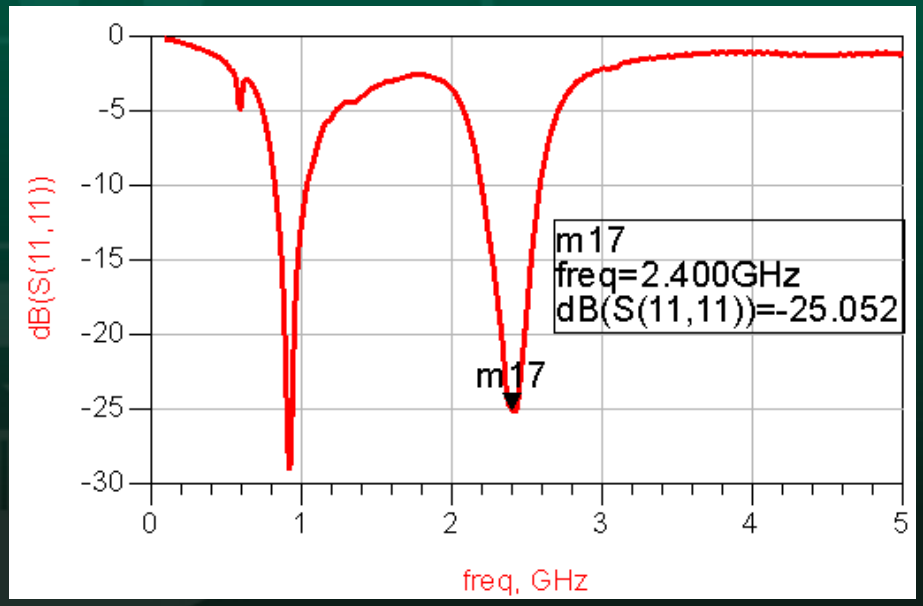
- The Frequency Characteristic (after re-matching)

SITE # 0 , Chip Load



Contacting RF chip

SITE # 1 , Chip Load

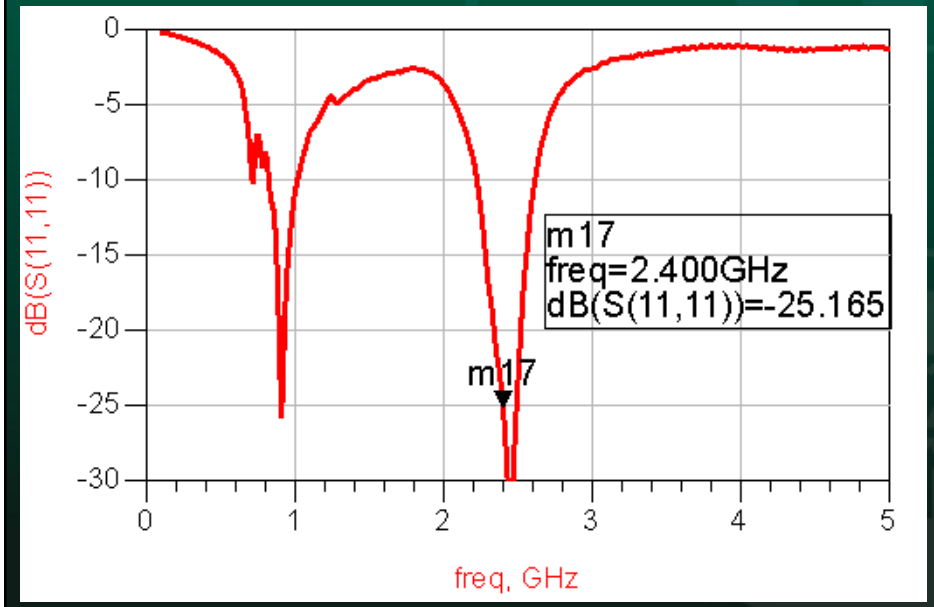


Contacting RF chip

Performance on 4-DUTs RF VPC

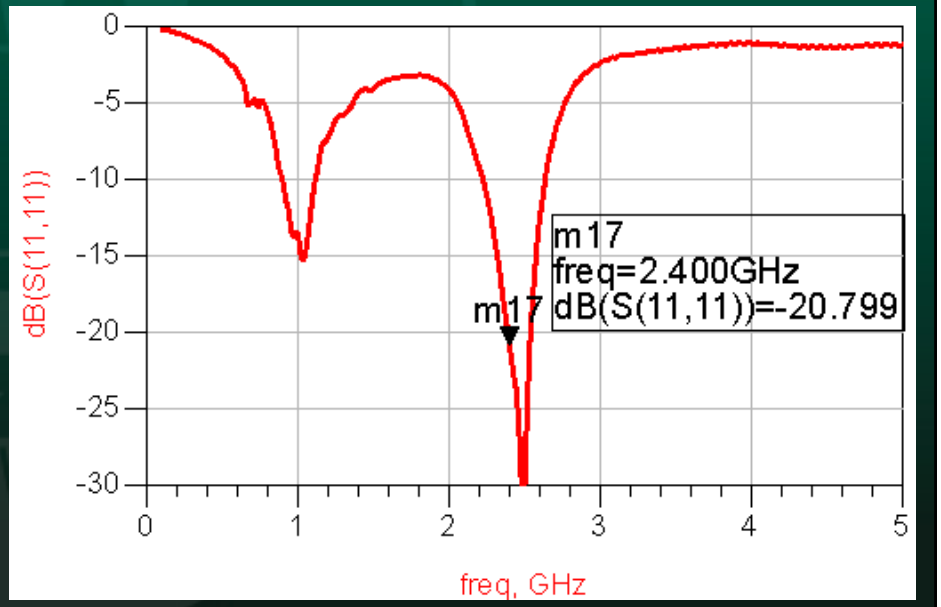
- The Frequency Characteristic (after re-matching)

SITE # 2 , Chip Load



Contacting RF chip

SITE # 3 , Chip Load

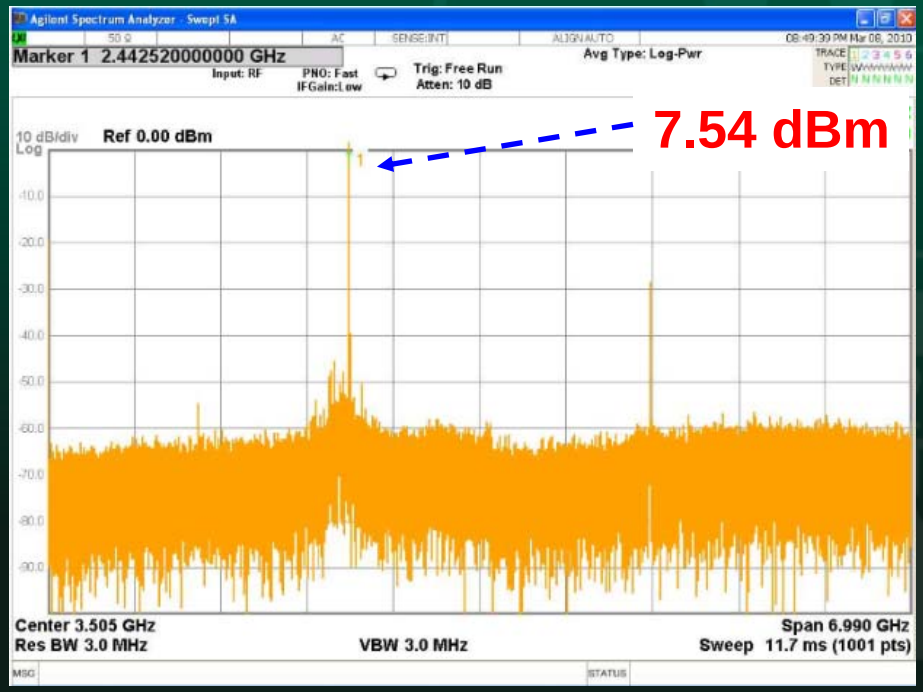


Contacting RF chip

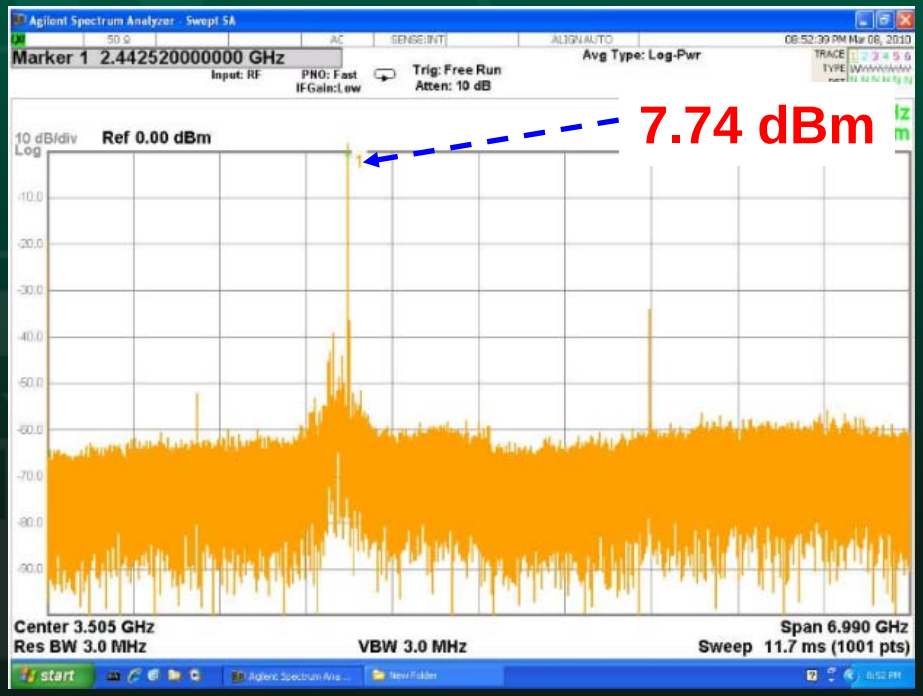
Performance on 4-DUTs RF VPC

- Power Level for All DUTs

SITE # 0



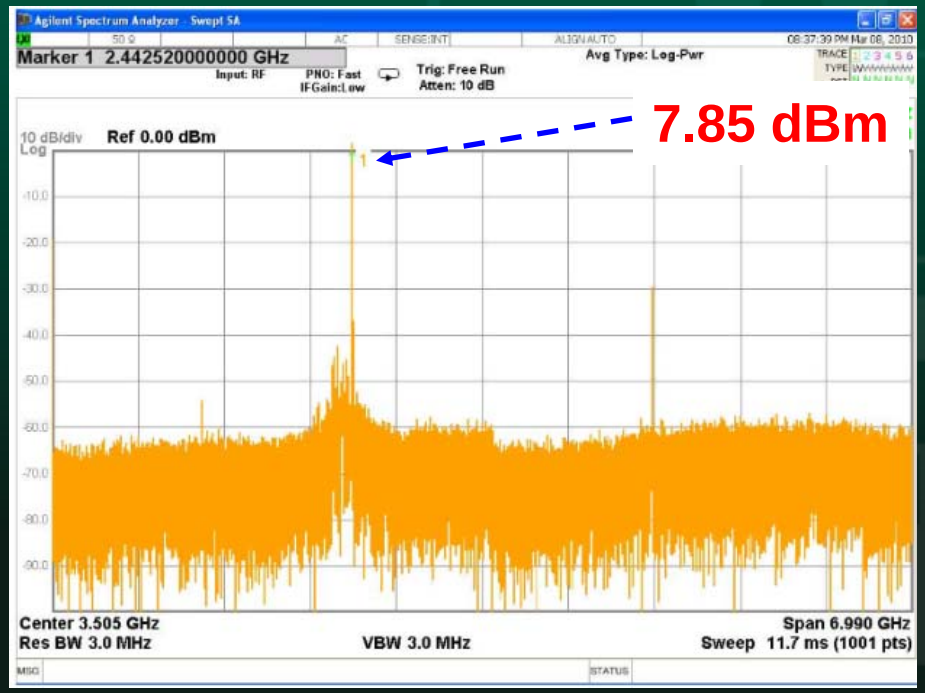
SITE # 1



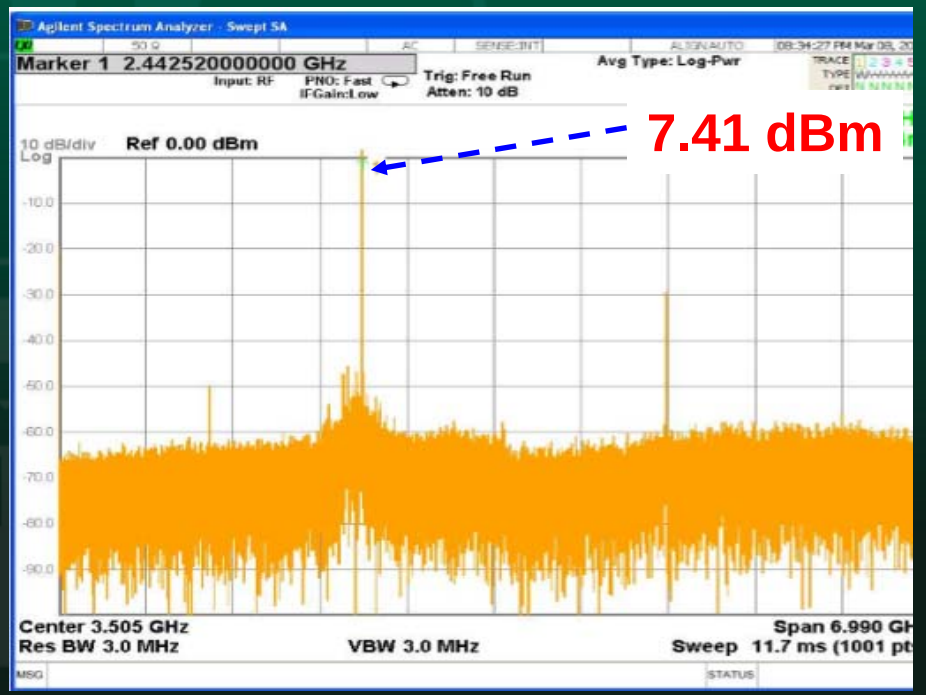
Performance on 4-DUTs RF VPC

- Power Level for All DUTs

SITE # 2



SITE # 3



Performance on 4-DUTs RF VPC

- Power Level for All DUTs

Input testing signal is 9dBm

	Power (dBm)	S11@2.45 G (dB)	Bandwidth (GHz)
Site 0	7.54	-33	2.24G ~2.63
Site 1	7.74	-23	2.2G ~ 2.58
Site 2	7.85	-31	2.23G ~ 2.61
Site 3	7.41	-24	2.23G ~ 2.63

The measured results depict the power loss of total RF signal path is around 1.5 dB , and the bandwidth characteristic could satisfy the Bluetooth (BT) application at 2.4 GHz .

Summary

- **Further improvement of VPC RF bandwidth.**

  ➔ Upgrade BW from 3 GHz to 5 GHz

- **8-DUT RF Vertical Probe Card**

  ➔ 2010 4-DUTs release.

  ➔ 2011 8-DUTs release.

Acknowledgements

Great thanks to teamwork :

Ariel Shih, Thompson Hsu, Yong Feng Lin, Eason Chen,
Jr Ping Huang (United Microelectronics Corporation)

Morgan Ku, Phil Hsieh, Anderson Huang, Joey Wu, Cahris Lin, Maureen Tsai
(MPI Corporation)

Thank you very much .