Design and Analysis of a High-Performance PCB Interposer for 100G PAM4 Validation

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Agenda

- Overview of PAM4 in high-speed interfaces
- Challenges of PAM4 IP validation
- Advantages of coax via PAM4 interposer
- Design of PAM4 interposer
- Manufacturing process
- Summary

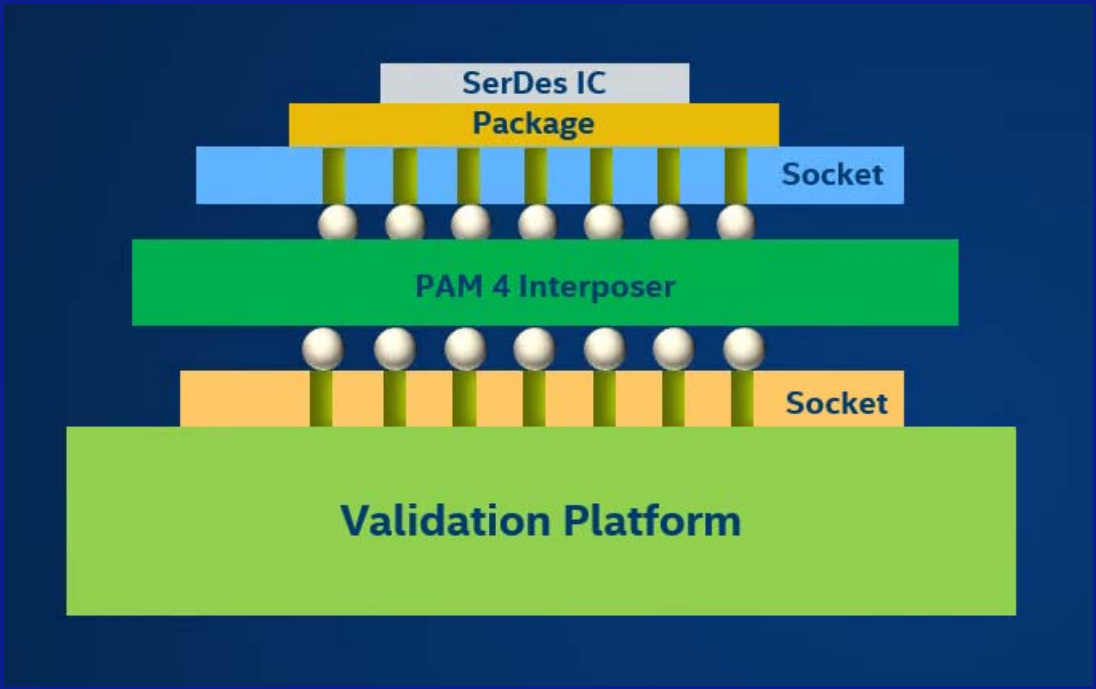
Overview of PAM4 in High-Speed Interfaces

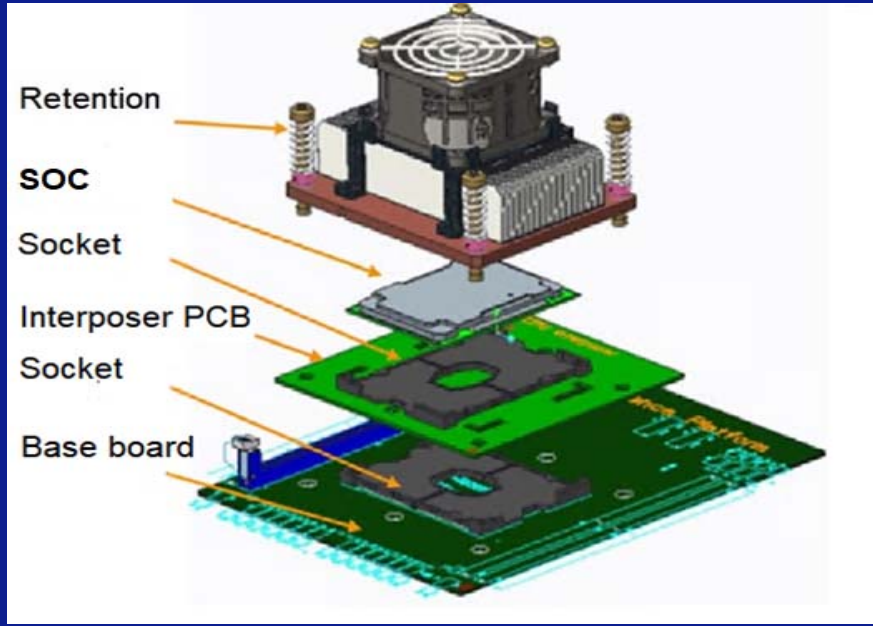
- Platform channel bandwidth bottleneck
- Transition from NRZ to PAM4
- 4-level modulation and bandwidth efficient
- Sensitive to noise and crosstalk
- Employ FEC to improve BER performance

Challenges of PAM4 IP Validation

- Very high data rate up to 100 Gb/s and beyond
- Crosstalk isolation is critical to IP electrical performance
- PAM4 IP providers use different package ball map
- New platform design for each IP validation
- Low return on investment and slow time to market

PAM4 Interposer Usage Model



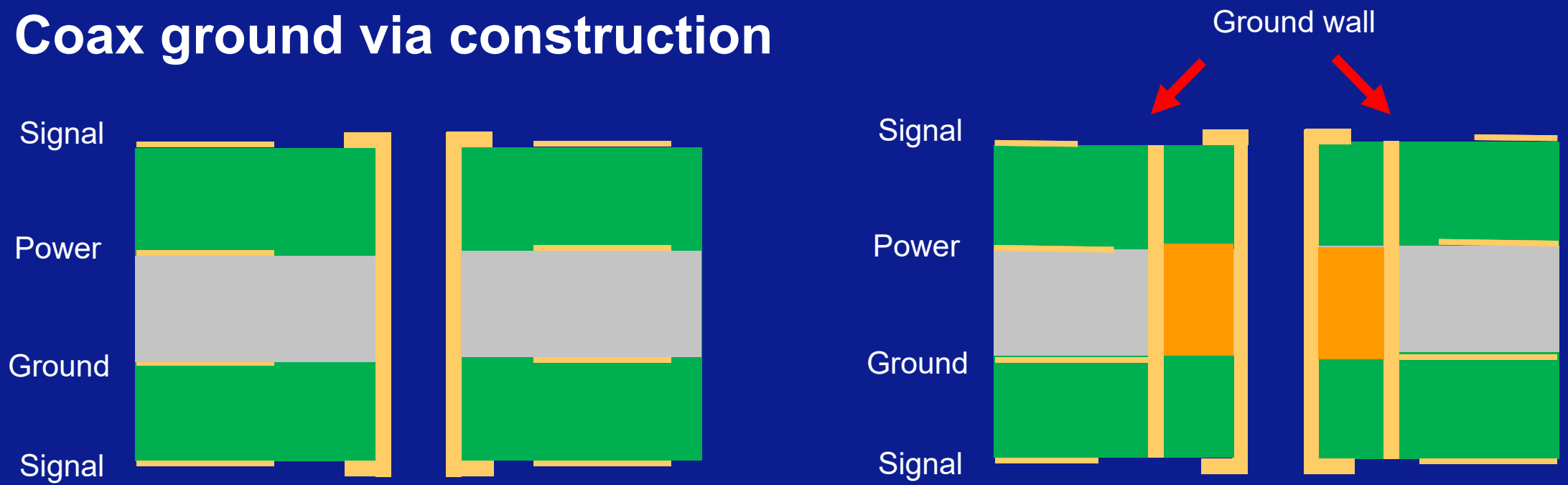


Advantages of Coax Via PAM4 Interposer

- Reuse of baseboard platform
- Reduce development cost and speed up time to market
- Excellent crosstalk isolation
- Measurements can be done on interposer
- More accurate validation of PAM4 IP electrical parameters

Design of PAM4 Interposer

Coax ground via construction



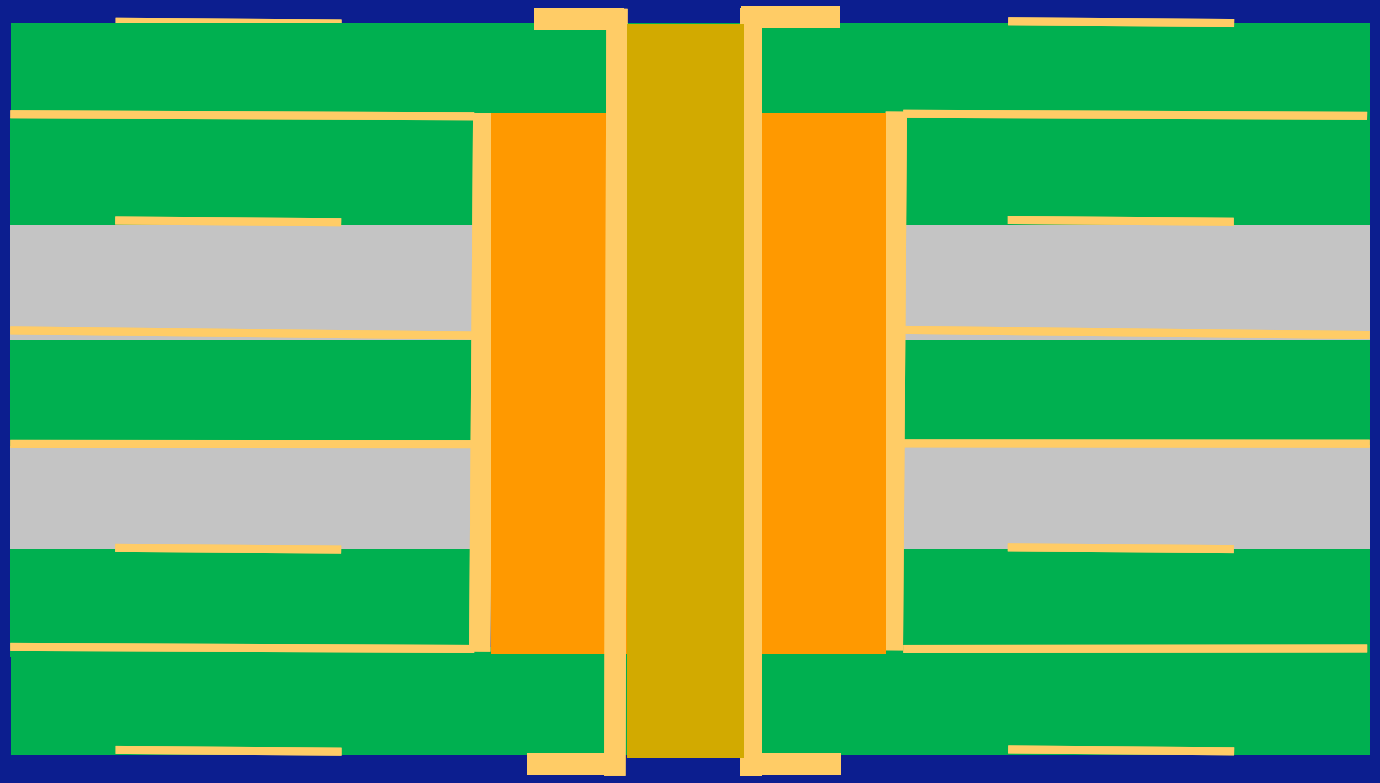
Standard via

Coax via with ground wall

Design of PAM4 Interposer

- Coax ground via internal layer construction process
  - First step is to drill the larger outer via
  - Second step is to plate this larger through hole via
  - Third step is to fill the hole with dielectric material
- Construct the top and bottom layer with traces
- Add the top and bottom layers to internal layers and press together
- Drill the inner via from top to bottom layers
- Plate inner through hole via

Manufacturing Process Demonstration

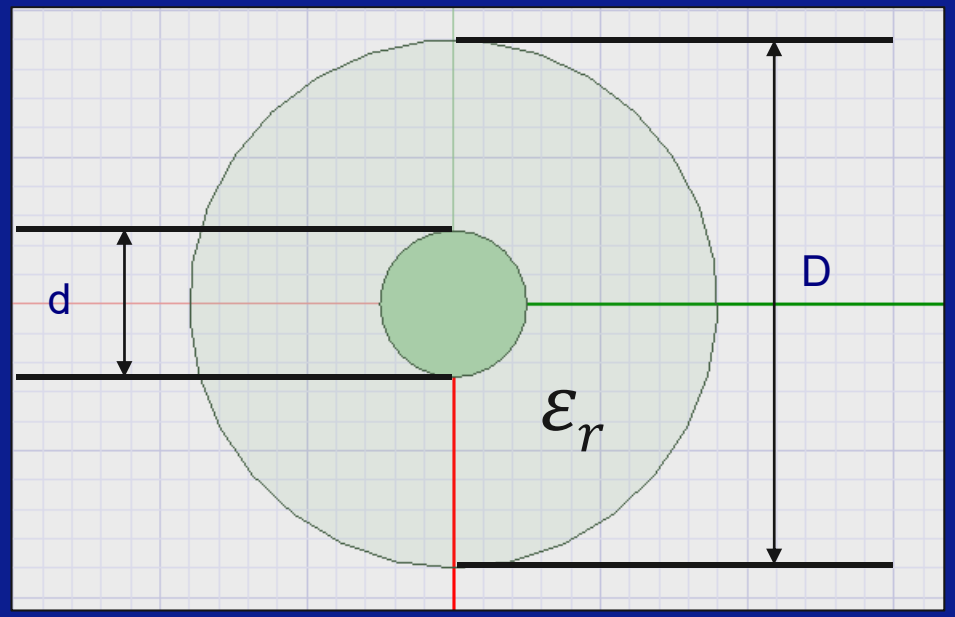


Benefits of Coax Via Ground Wall

- Minimize impedance discontinuities
- Reduce noise and crosstalk from nearby signals
- Improve EMI
- Save space compared with adding extra ground vias

Design of PAM4 Interposer

Coax via impedance estimate

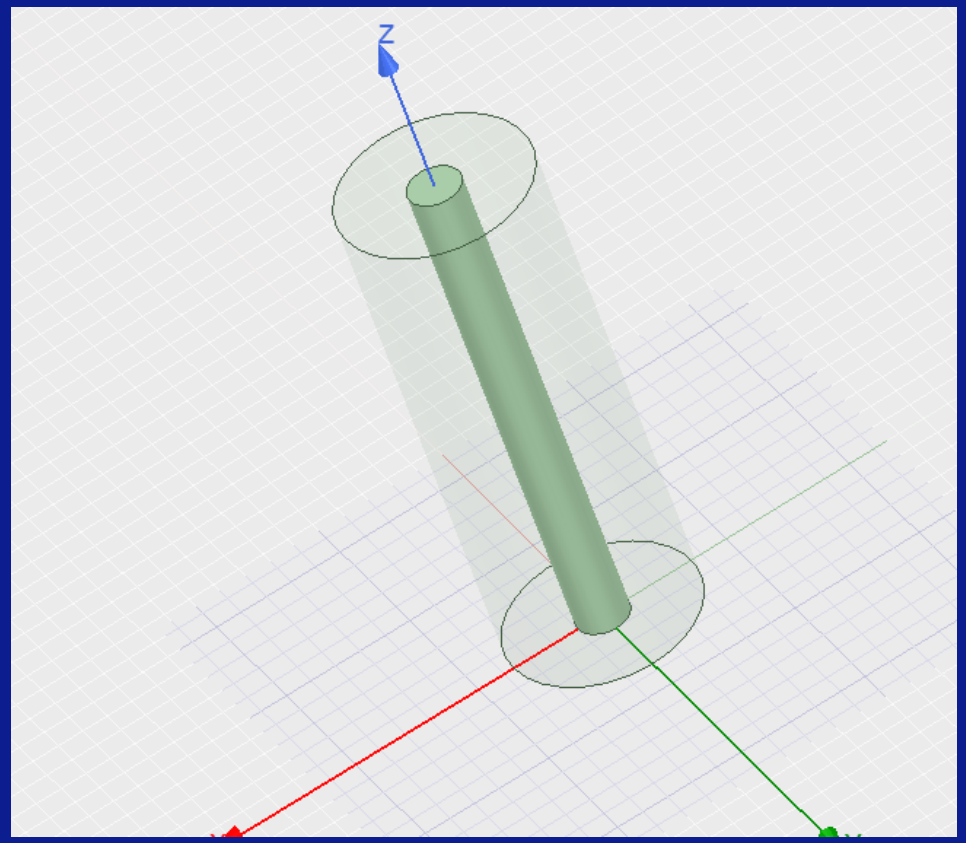


$$Z_0 = \frac{138 * log_{10}(D/d)}{\sqrt{\varepsilon_r}}$$

Z_0 : Characteristic impedance
D: Outer conductor diameter
d: Inner conductor diameter
ε_r: Relative permittivity of the dielectric

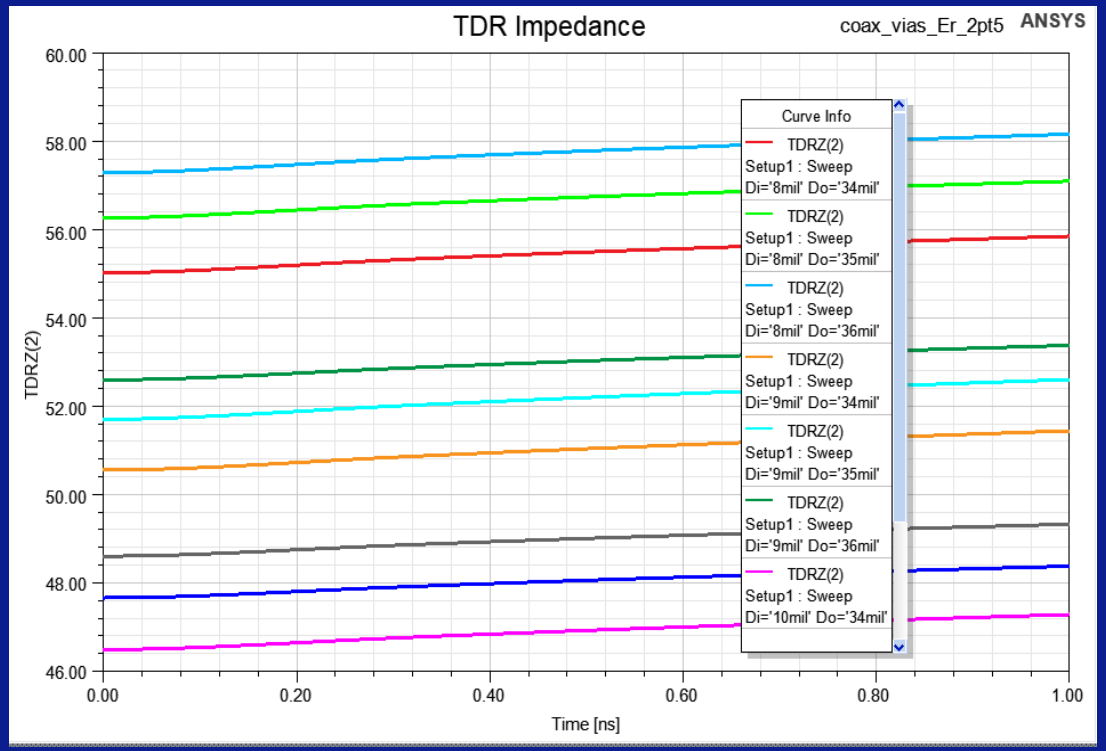
Design of PAM4 Interposer

Coax via dielectric filing material 3D EM modeling

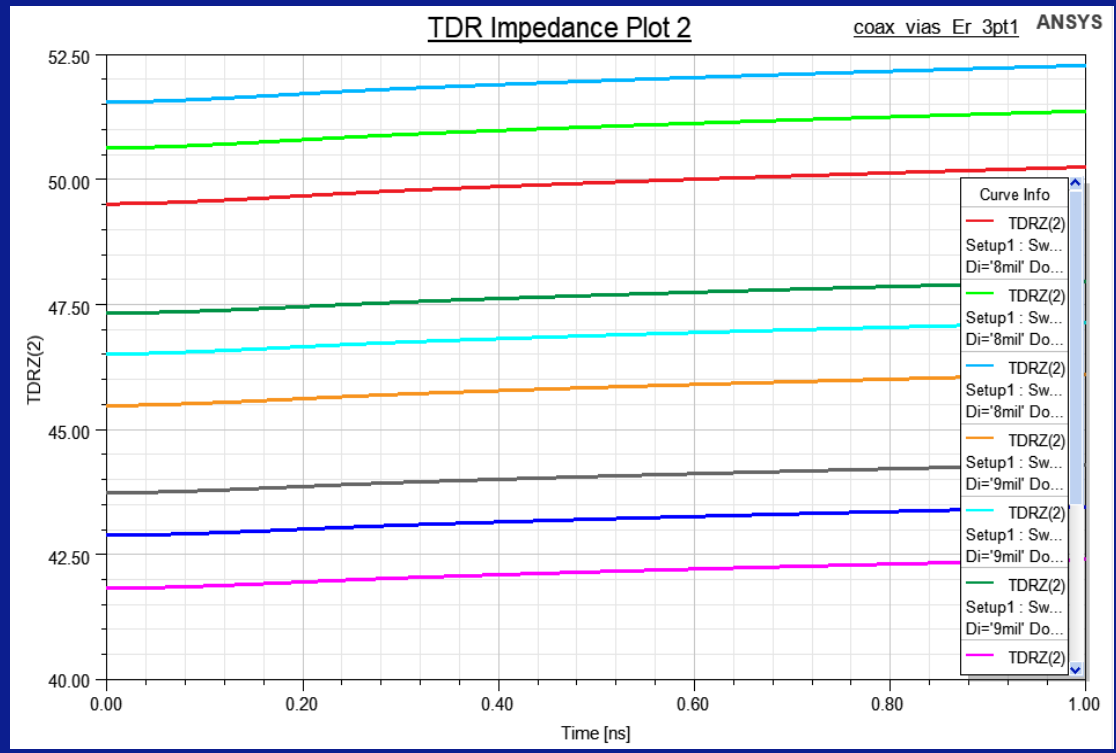


Optimize the outer conductor diameter D, inner conductor diameter d, and dielectric ε_r to meet target characteristic impedance Z_0

Design of PAM4 Interposer



ε_r=2.5

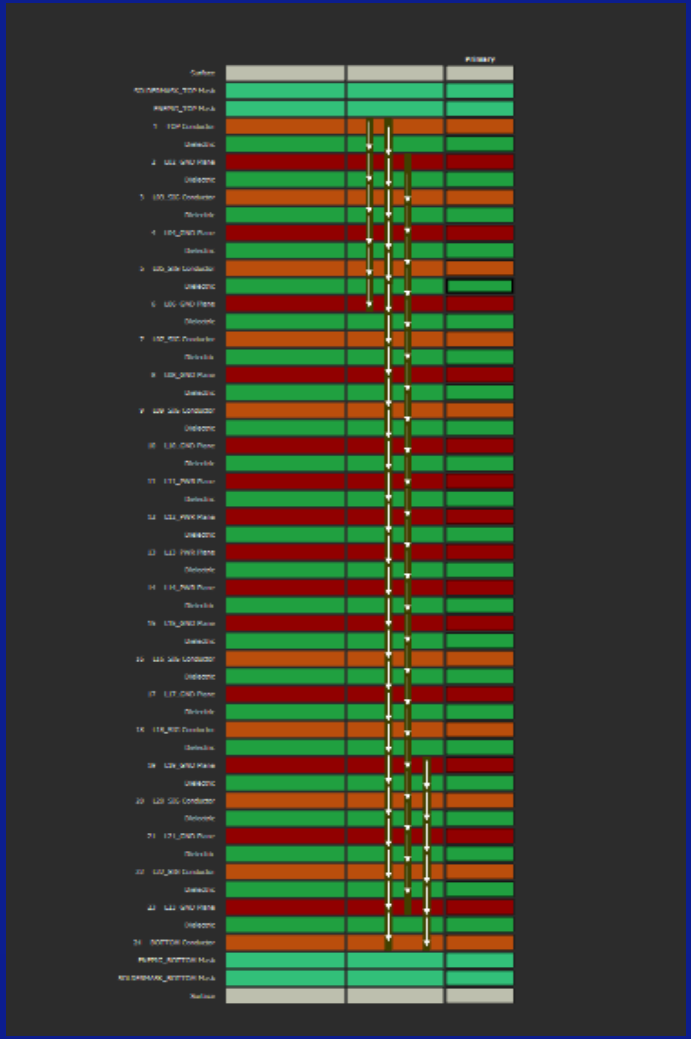


ε_r=3.1

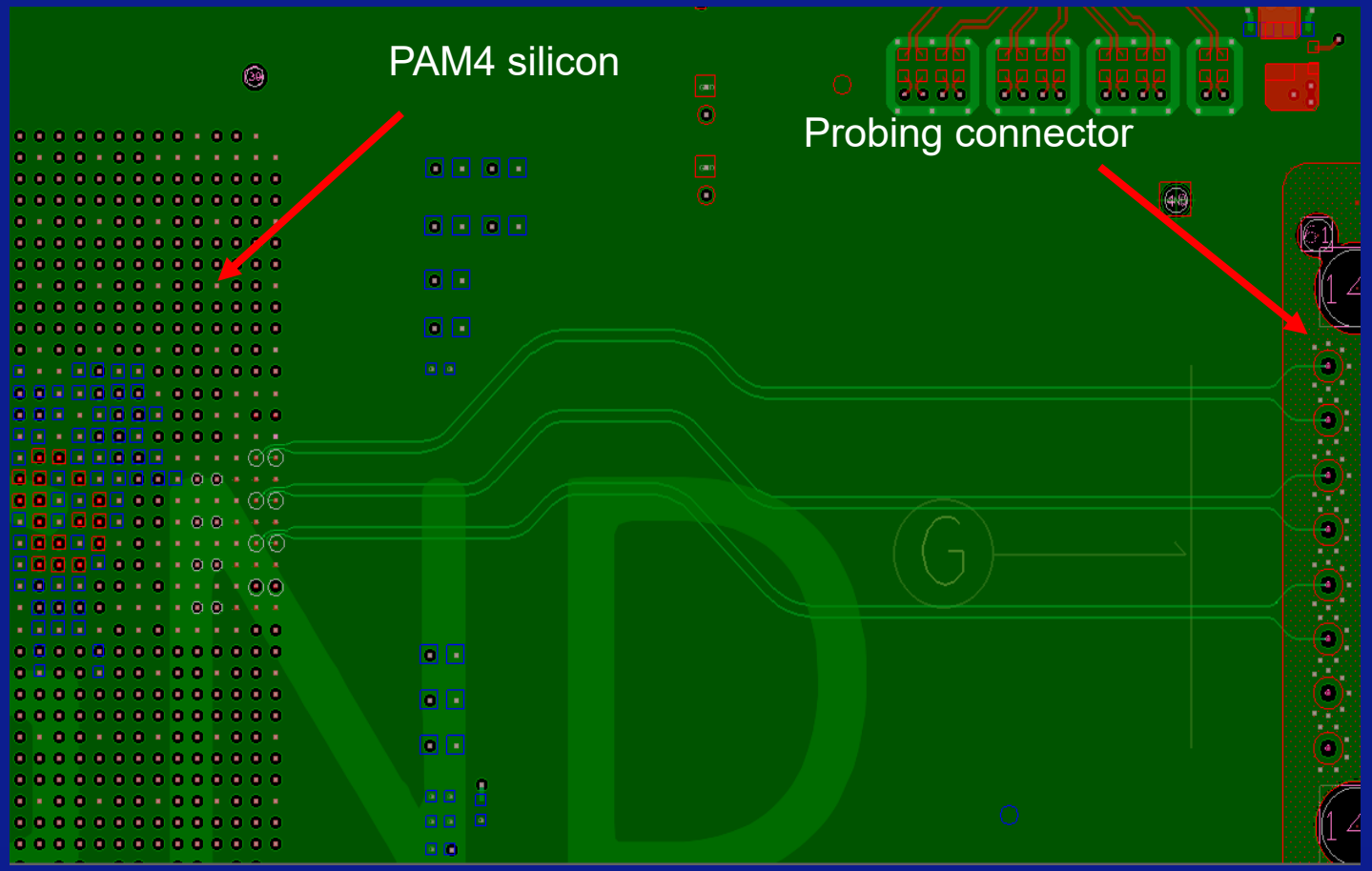
Design of PAM4 Interposer

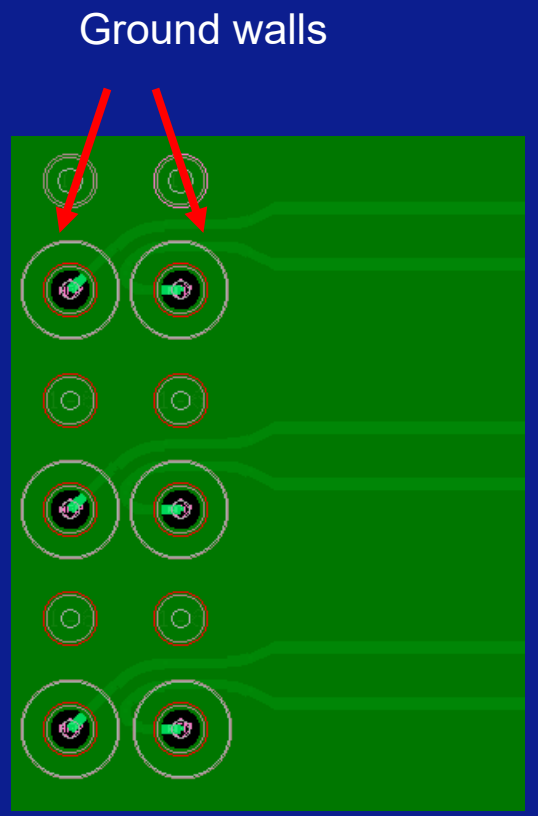
Objects		Types	
#	Name	Layer	Layer Function
		Surface	
	SOLDERMASK_TOP	Mask	Solder Mask
	ENEPIG_TOP	Mask	Coating Conductive
1	TOP	Conductor	Conductor
		Dielectric	Dielectric Prepreg
2	L02_GND	Plane	Plane
		Dielectric	Dielectric Core
3	L03_SIG	Conductor	Conductor
		Dielectric	Dielectric Prepreg
4	L04_GND	Plane	Plane
		Dielectric	Dielectric Core
5	L05_SIG	Conductor	Conductor
		Dielectric	Dielectric Prepreg
6	L06_GND	Plane	Plane
		Dielectric	Dielectric Prepreg
7	L07_SIG	Conductor	Conductor
		Dielectric	Dielectric Core
8	L08_GND	Plane	Plane
		Dielectric	Dielectric Prepreg
9	L09_SIG	Conductor	Conductor
		Dielectric	Dielectric Core
10	L10_GND	Plane	Plane
		Dielectric	Dielectric Prepreg
11	L11_PWR	Plane	Plane
		Dielectric	Dielectric Core
12	L12_PWR	Plane	Plane

Objects		Types	
#	Name	Layer	Layer Function
		Dielectric	Dielectric Prepreg
13	L13_PWR	Plane	Plane
		Dielectric	Dielectric Core
14	L14_PWR	Plane	Plane
		Dielectric	Dielectric Prepreg
15	L15_GND	Plane	Plane
		Dielectric	Dielectric Core
16	L16_SIG	Conductor	Conductor
		Dielectric	Dielectric Prepreg
17	L17_GND	Plane	Plane
		Dielectric	Dielectric Core
18	L18_SIG	Conductor	Conductor
		Dielectric	Dielectric Prepreg
19	L19_GND	Plane	Plane
		Dielectric	Dielectric Prepreg
20	L20_SIG	Conductor	Conductor
		Dielectric	Dielectric Core
21	L21_GND	Plane	Plane
		Dielectric	Dielectric Prepreg
22	L22_SIG	Conductor	Conductor
		Dielectric	Dielectric Core
23	L23_GND	Plane	Plane
		Dielectric	Dielectric Prepreg
24	BOTTOM	Conductor	Conductor
	ENEPIG_BOTTOM	Mask	Coating Conductive
	SOLDERMASK_BOTTOM	Mask	Solder Mask

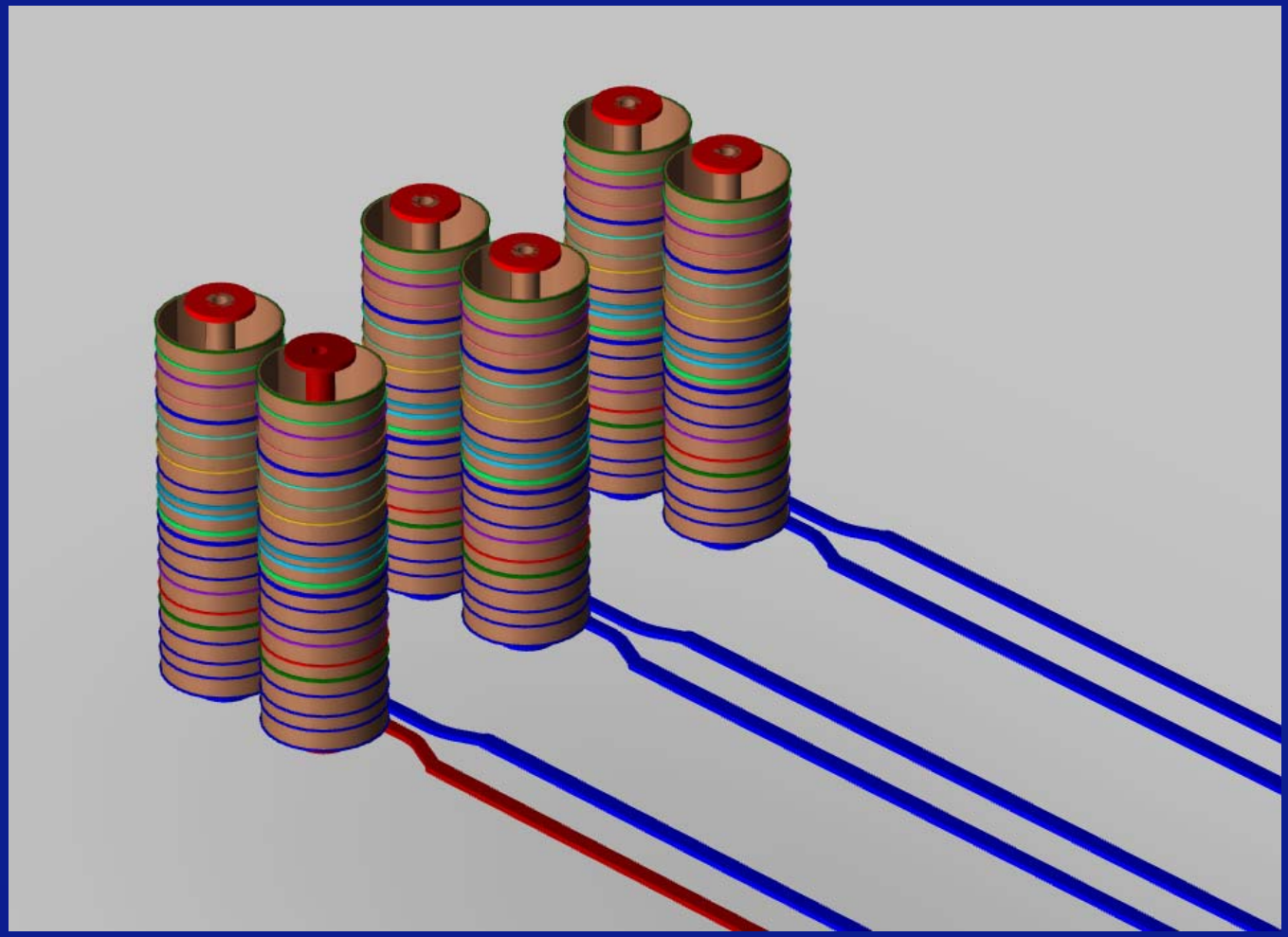


Design of PAM4 Interposer

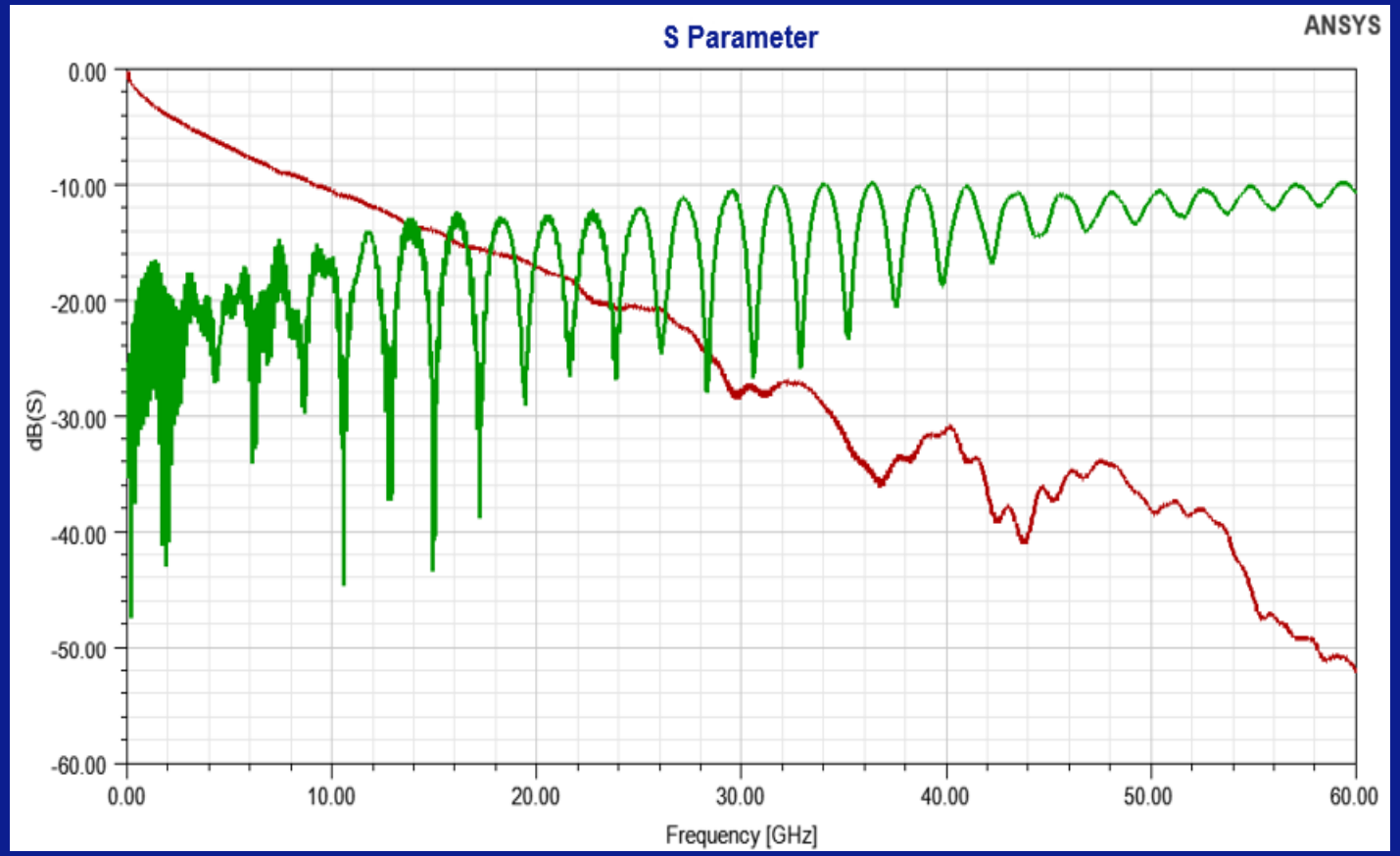




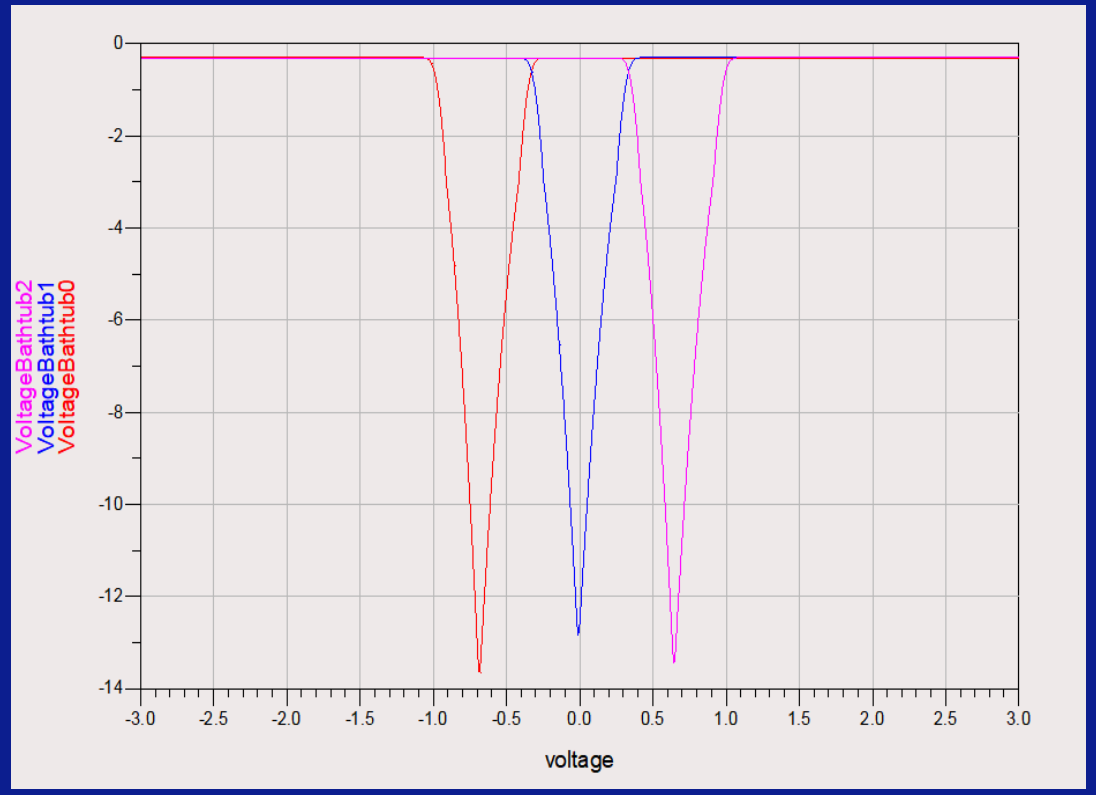
Coax Via Differential Pairs Layout



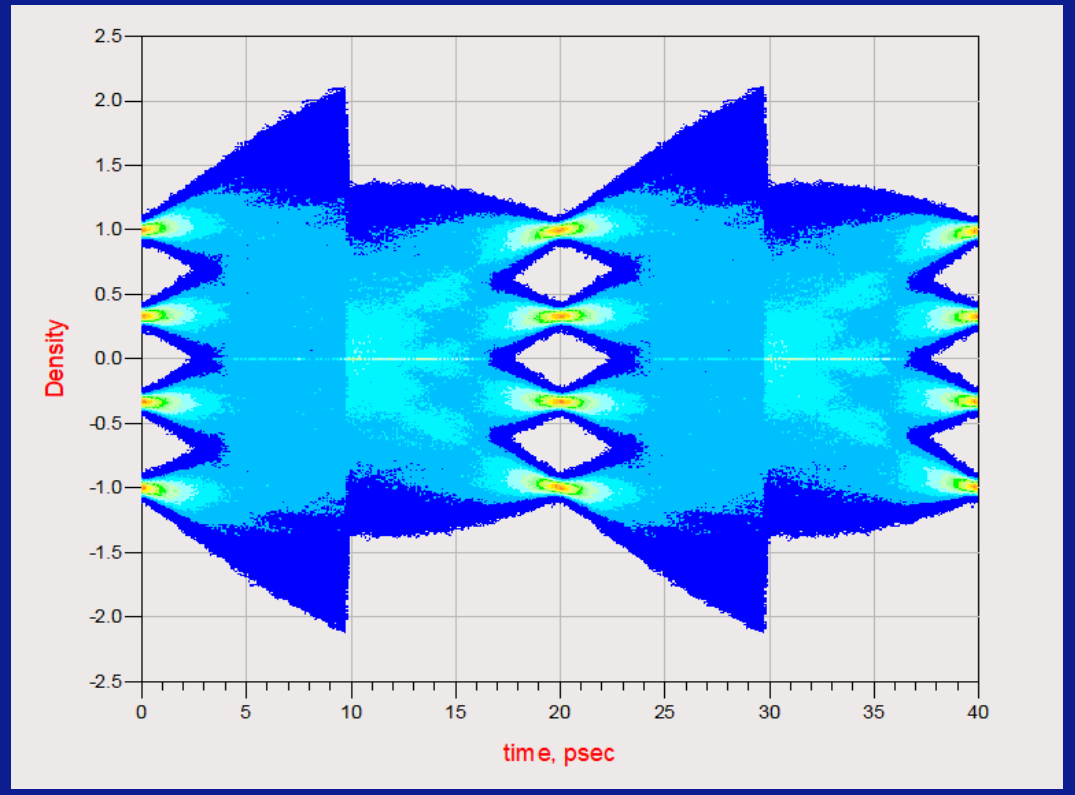
Channel Modeling



PAM4 Performance



PAM4 bit error rate



Eye diagram of 100 Gb/s PAM4

Summary

- High performance coax via PAM4 interposer
- Acceleration of PAM4 IP validation and time to market
- Good crosstalk isolation performance
- Compatible with current PCB manufacture process

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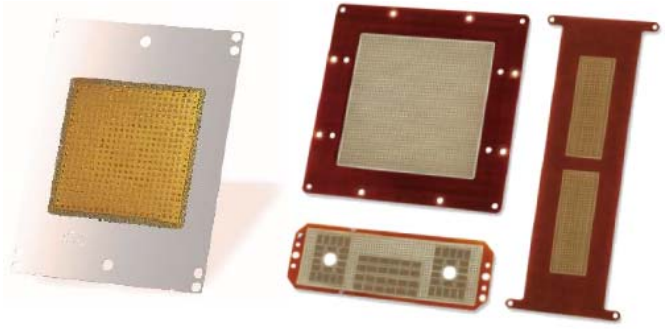
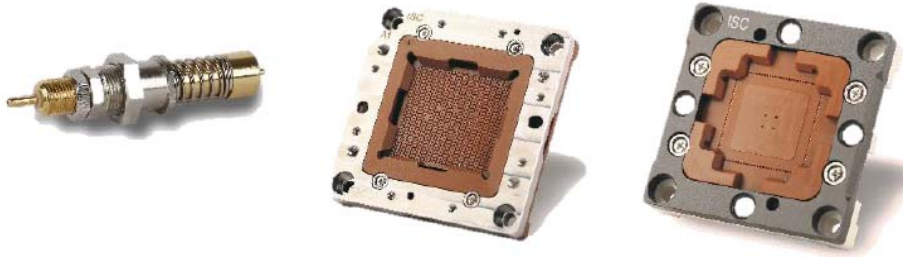


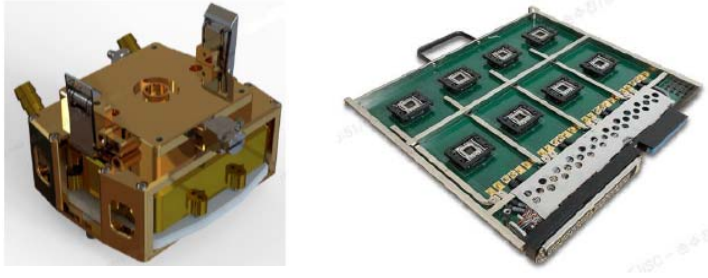
POGO SOCKET SOLUTIONS

- Excellent gap control & long lifespan
- High bandwidth & low contact resistance



THERMAL CONTROL UNIT

- Extreme active temperature control
- Safety auto shut-down temperature monitoring of the device & thermal control unit
- Full FEA analysis & Price competitiveness



BURN-IN SOLUTIONS

- Direct inserting on the board without soldering
- Higher performance BIB solution

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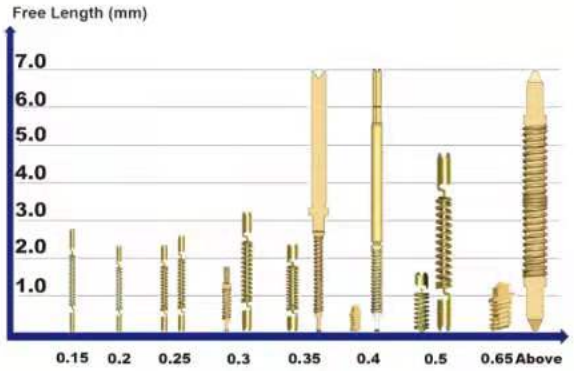
IWIN Co., Ltd. The test probe for high signal integrity at extremely high speed test

Spring probe by stamping



250 kinds of spring probe pin

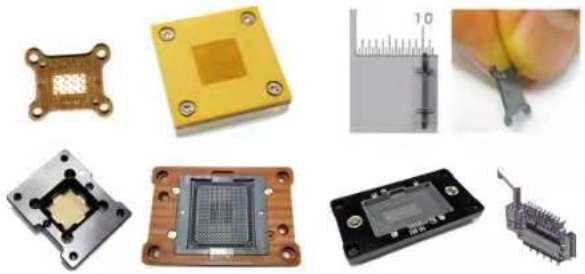
300 kinds of test socket (44,000 Pin count socket possible)

One piece spring probe

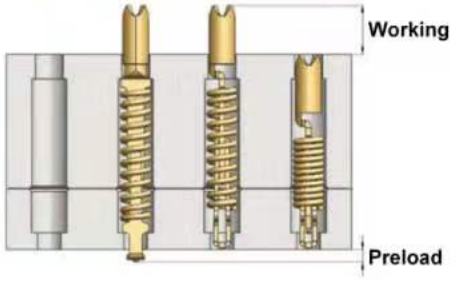
Three piece spring probe

High speed product → 0.63mm free length spring probe pin available

Finest Pitch → 0.15mm Pitch



Spring probe by stamping

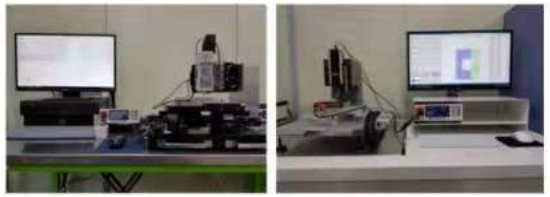


Patented

Pitch(mm)	Free Length(mm)	Current Carrying(Amps)
0.15/0.2/0.25	2.17~	0.5~
0.3	1.5~	1.5~
0.35	2.08~	1.8~
0.4	0.8~	2.5~
0.5	1.5~	3.0~
0.65	1.13~	9.0~
0.8	3.14~	3.0~

Automation

Pin assembly and Quality control



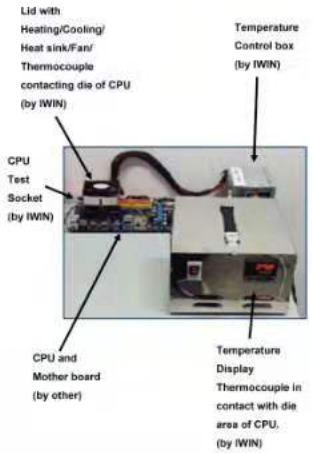
Top Figure: Socket CRES, Force, Stroke test

Bottom Figure: Data displayed

Top Figure: Socket CRES test

Bottom Figure: Data display 5,903 pins socket

Socket and Lid



Pin assembly

(Fully automated machines)

- Stamped piece parts attached to a reel fed into the assembly machine

- Assembled pins can be attached to a reel, or, supply in separate for socket assembly.

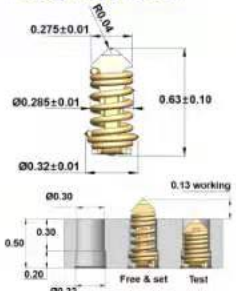
Spring probe pins for High speed

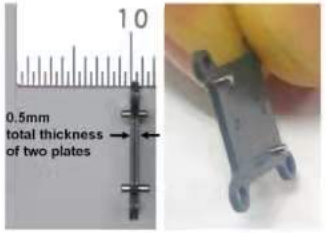
Extremely short spring probes by stamping

One piece spring probe

Three piece spring probe

Design approach





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High Performance Probe solution

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