Array Connectors for Multi-Channel Antennas-to-Bits System Architectures

Kiana Montes | Samtec
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Multi-Channel Antennas-to-Bits Applications

5G/LTE

PHYs/MSOs

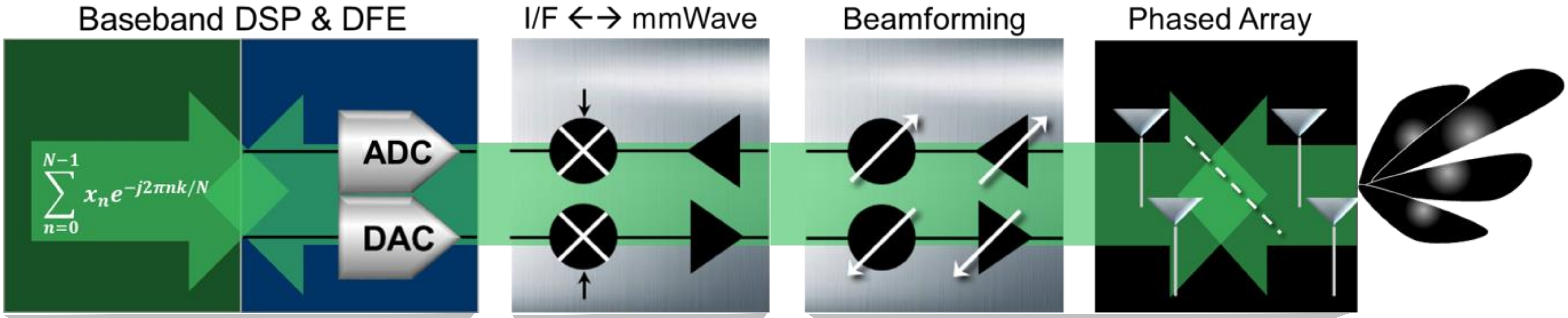
Radar Arrays

T&M

LEO/MEO

RFSoC

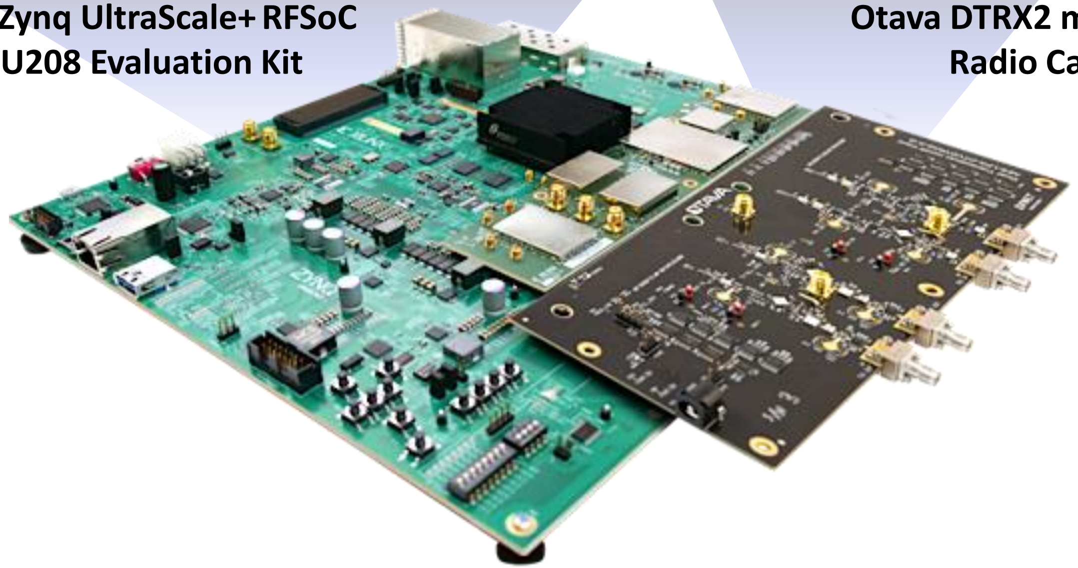
Multi-Channel Antennas-to-Bits Systems Architectures

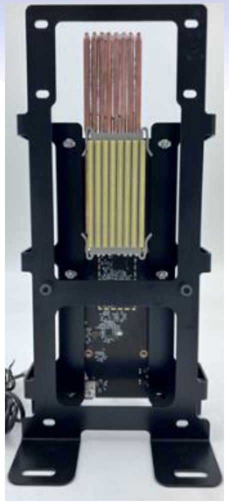


AMD Zynq UltraScale+ RFSoC ZCU208 Evaluation Kit

Otava DTRX2 mmWave Radio Card

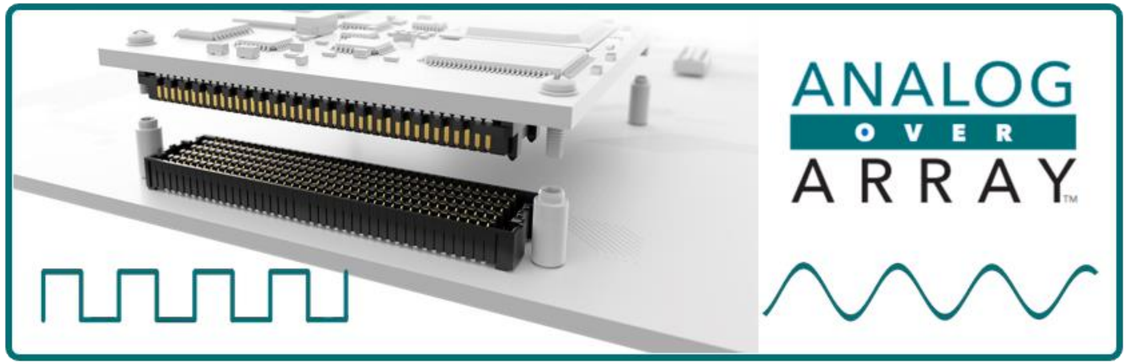
Otava PAAM





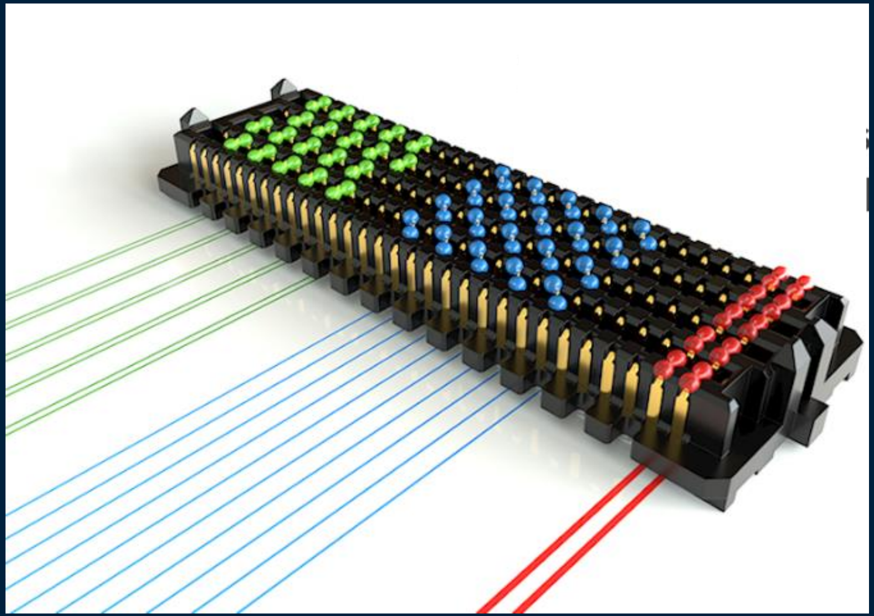
New Design Challenges

- Density and Diversity of signals
  - ADCs
  - DACs
  - Clocking
  - Data
  - Power
- Traditional RF connector challenges:
  - Connector misalignment
  - Board real estate
  - Cost
- Design Solution: Samtec Analog Over Array™ technology
- RFMC 2.0 interface provide access to the ADC/DAC, clocking and data path signals



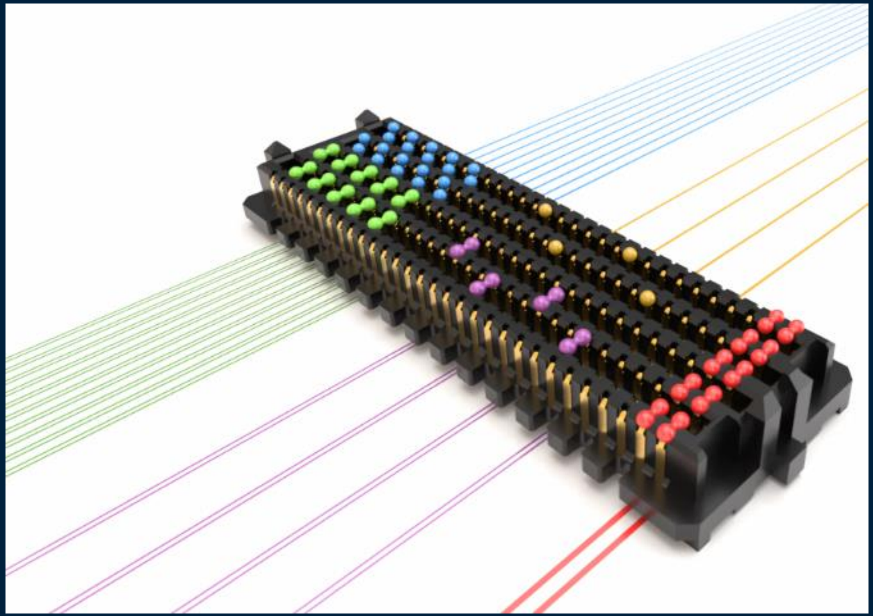
Samtec Analog Over Array™ Technology

Current Open-Pin-Field Arrays



Digital DP
Digital SE
Power
Analog DP
Analog SE

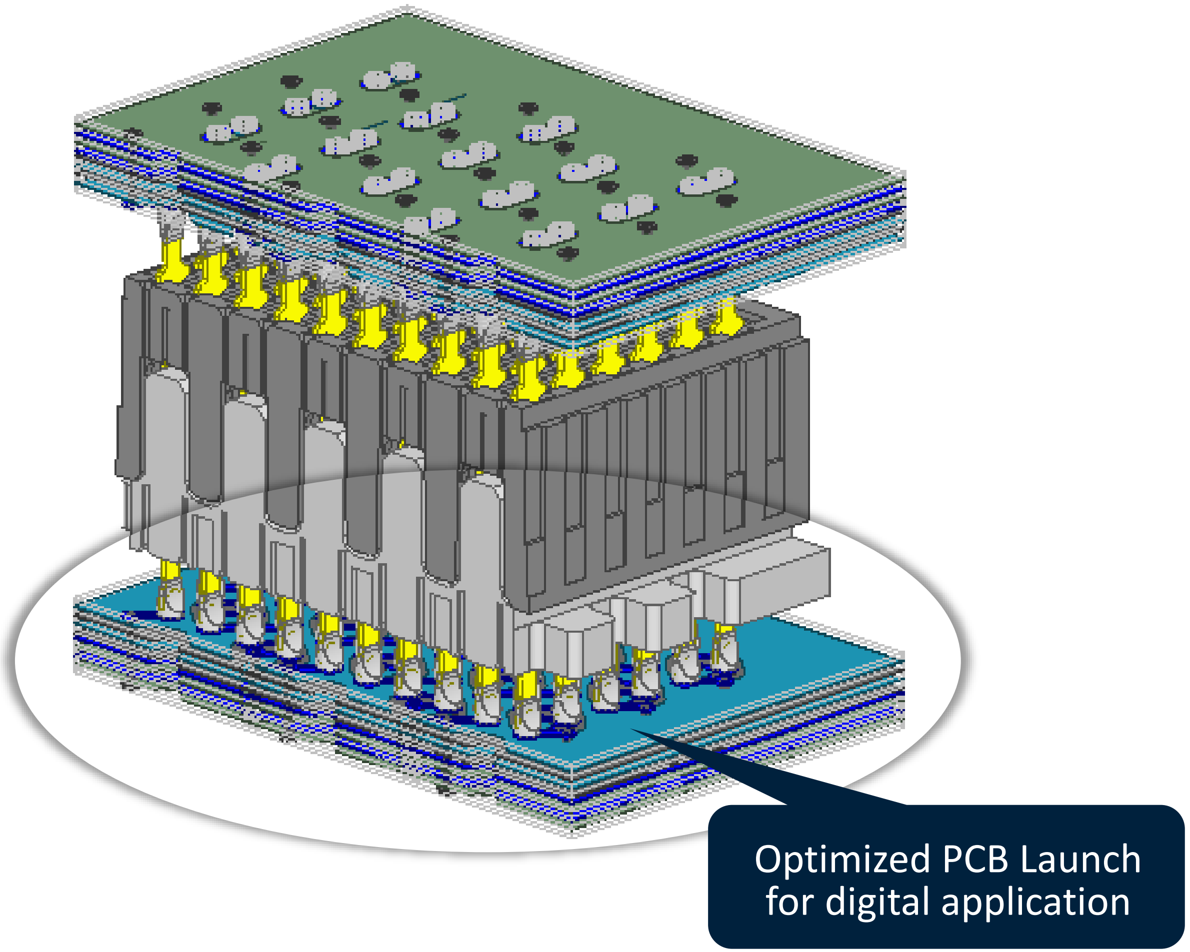
Enhanced Analog Over Array™ Technology



But . . . How can an engineer implement Analog Over Array™ technology?

Leveraging Existing Interconnect for Analog/RF

SEARAY™ 1.27 mm – 10 mm stack height



Reference Target Performance

Design Choices

1. Dog bone to non-dog bone launch approach
2. 115 Ω to 100 Ω trace transition
3. Optimal pin orientation for differential launch
4. Pin configuration selection
5. GND fencing placement

Reference Target Design Requirements

samtec

- Maximizing Connector Performance

- Key Design Specifications:
  - Analog Bandwidth: 8.00 GHz
  - Crosstalk: -63 dBc (FIN <= 8.00 GHz)
  - Return Loss: -10 dB (FIN <= 8.00 GHz)

AMD Zynq Ultra Scale+ RFSoC

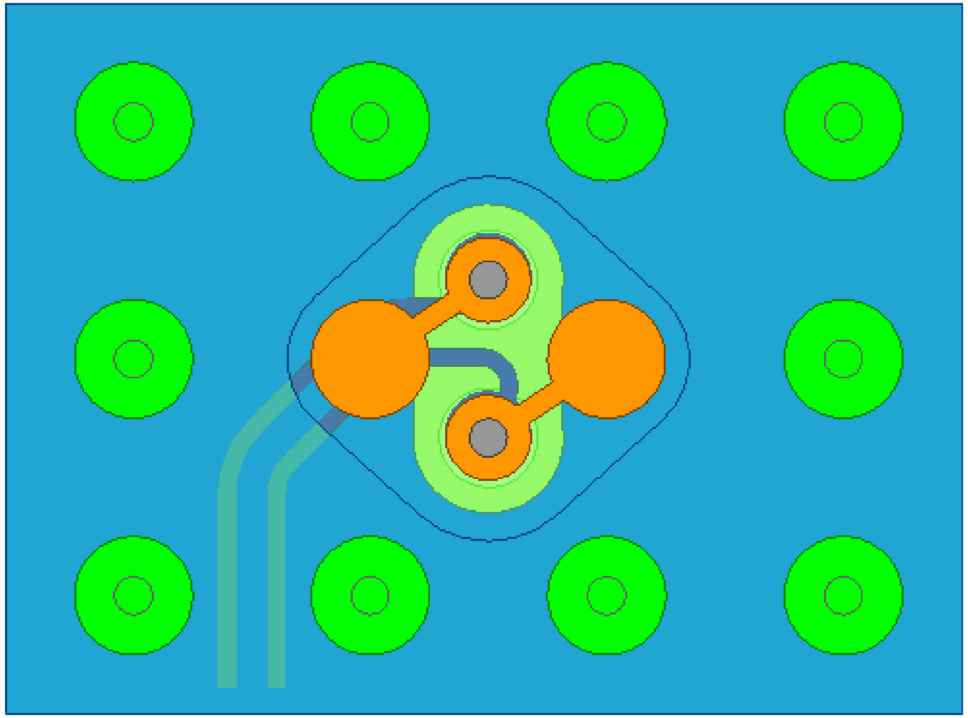
Analog input bandwidth[4]	Full-power bandwidth (–3 dB)	–	7.125	–	GHz
Return loss (R_L)[5]	Up to 4 GHz	–	–12	–	dB
	Up to 7.125 GHz	–	–10	–	dB
Optimized common mode voltage range	Performance optimized range. AC and DC coupling modes[6]	0.68	0.7	0.72	V
Maximum common mode voltage range	Available range before triggering over-voltage protection. AC and DC coupling modes[6]	0.4	0.7	1	V
Crosstalk isolation between channels[7]	F_{IN} = 0–4 GHz	–	–69	–	dBc
	F_{IN} = 0–7.125 GHz	–	–63	–	dBc

RF-ADC Electrical Characteristics for ZU6xDR Devices*

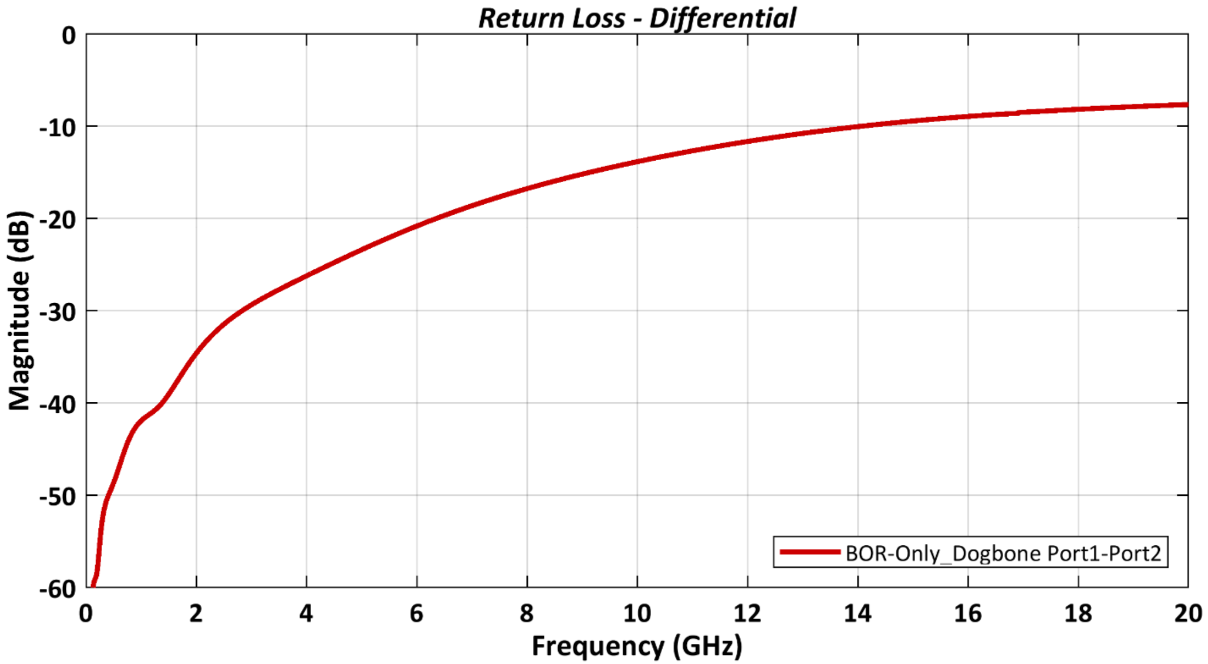
Analog bandwidth	Full power bandwidth (–3 dB)	–	7.125	–	GHz
Return loss (R_L)[5]	Up to 4 GHz	–	–12	–	dB
	Up to 7.125 GHz	–	–10	–	dB
On-die Termination	Single-ended on-die termination to external 3V V_{DAC_AVTT}		50		Ω
Crosstalk isolation between channels[6]	F_{OUT} = 0–4 GHz	–	–69	–	dBc
	F_{OUT} = 0–7.125 GHz	–	–63	–	dBc

RF-DAC Electrical Characteristics for ZU6xDR Devices*

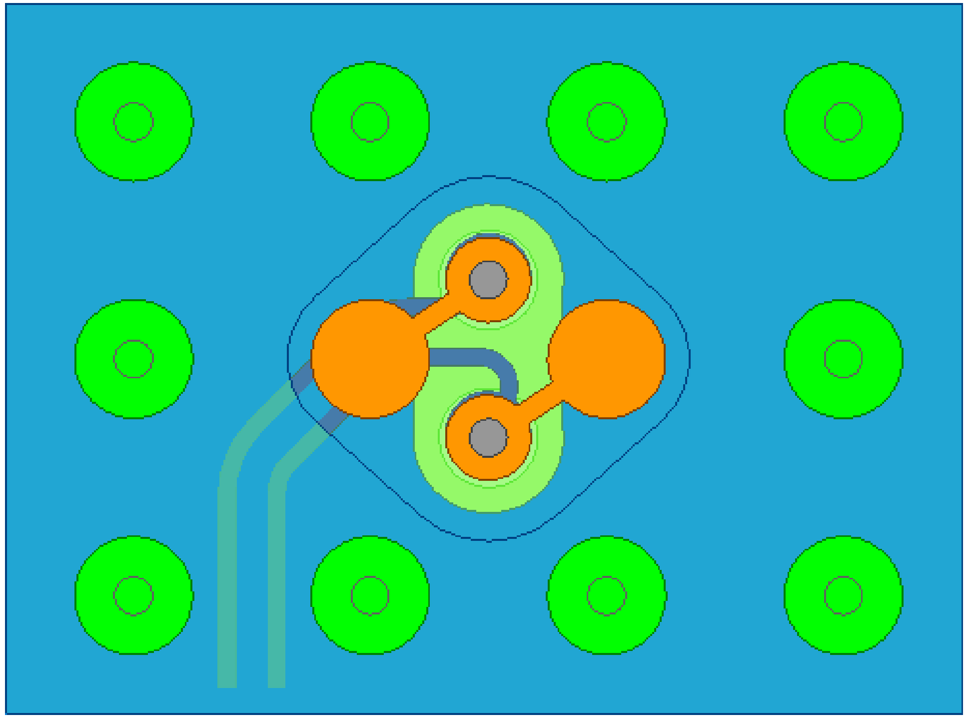
Current Launch Design is Benchmark



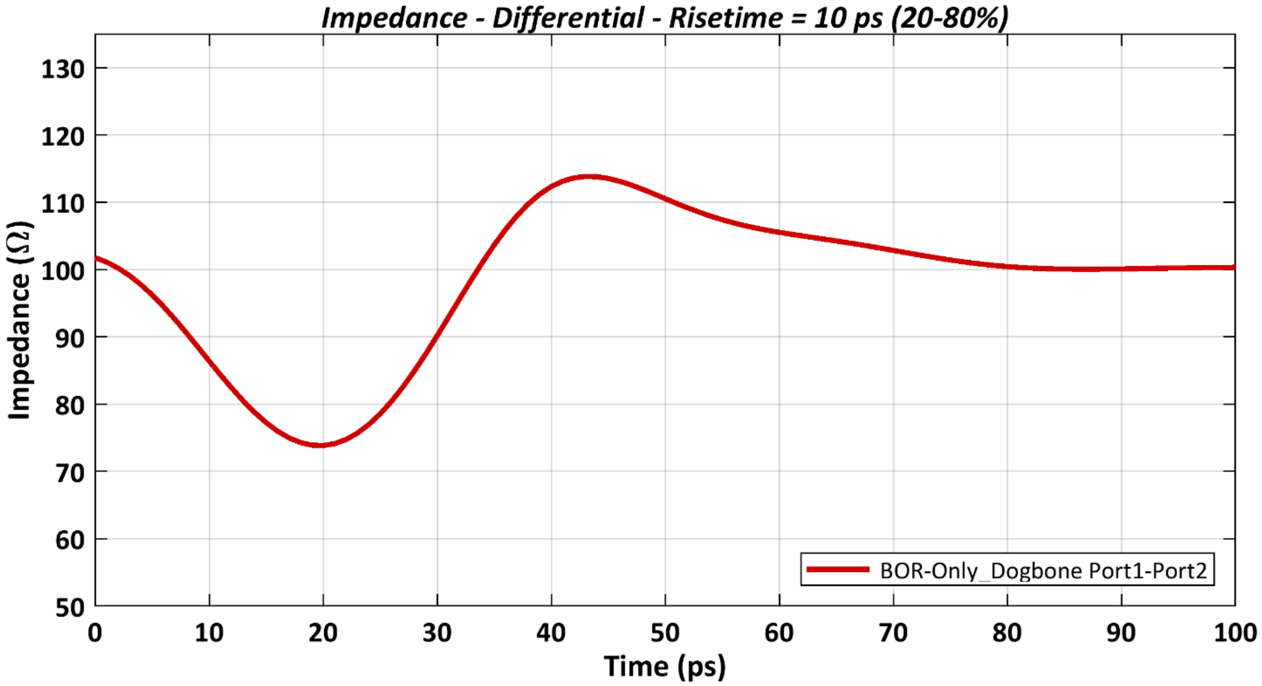
Optimized Digital Launch Design



Current Launch Design is Benchmark



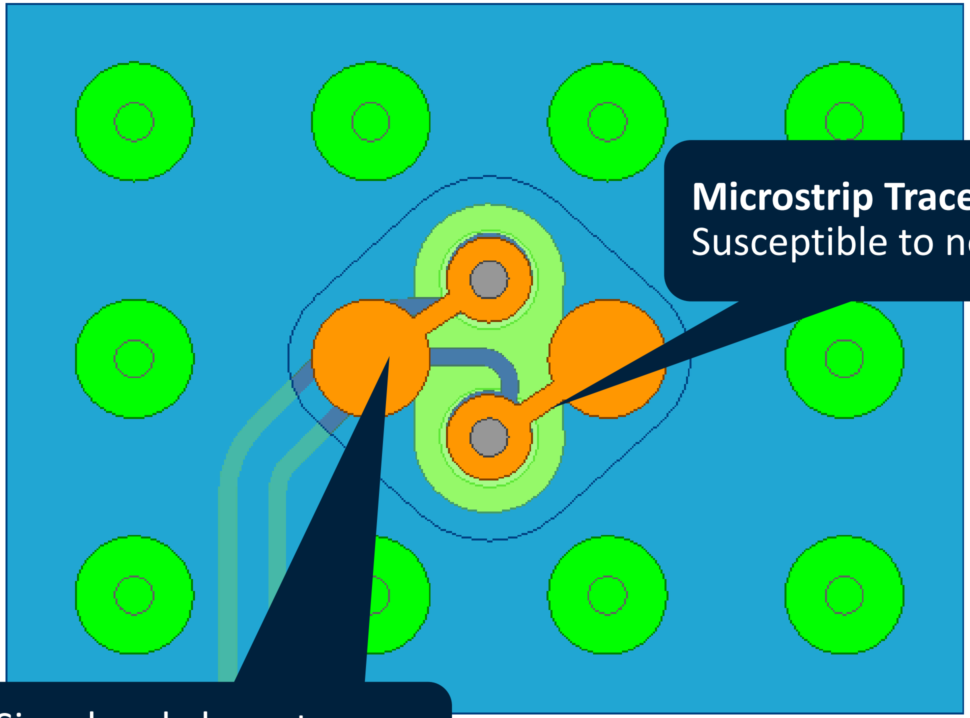
Optimized Digital Launch Design



Large Capacitive Dip at the PCB Transition

Current Launch Design is Benchmark

Why dog bone structure might not be the best approach for analog application

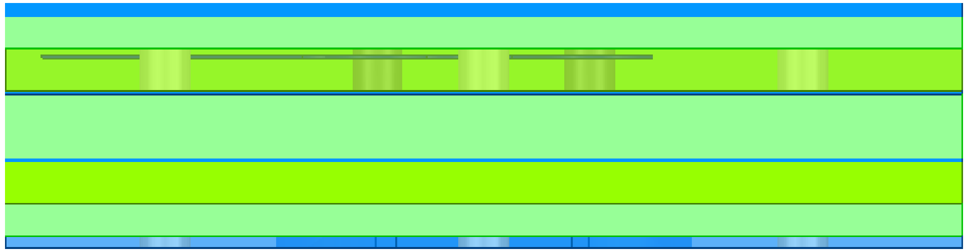


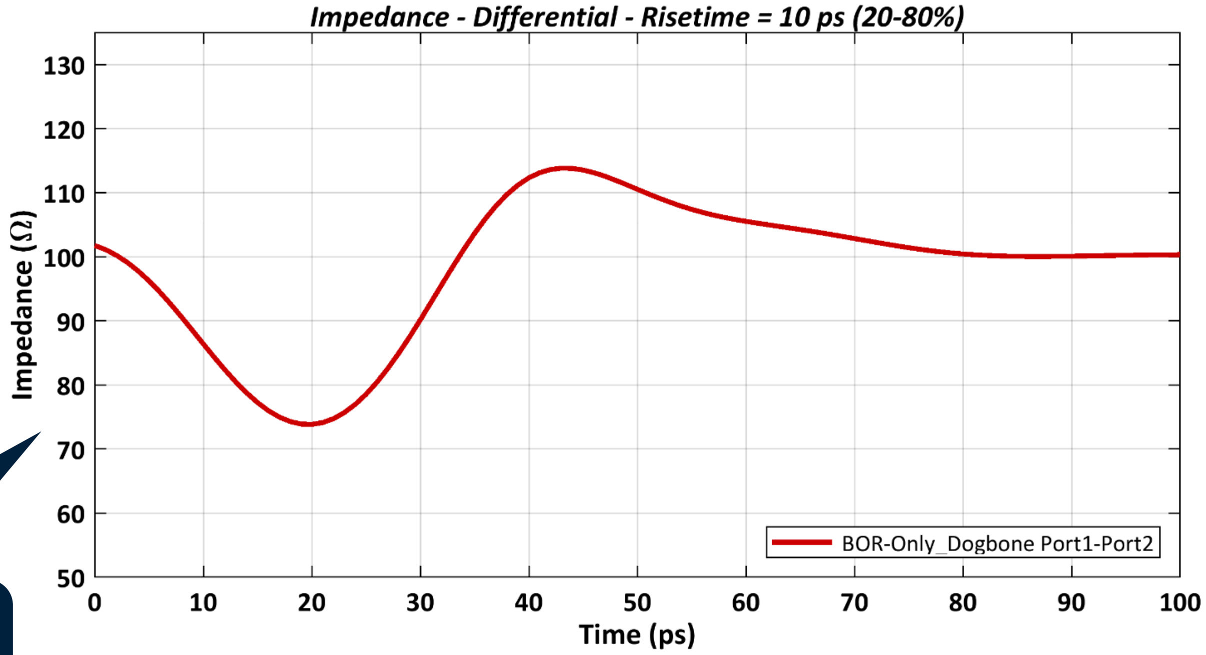
Microstrip Trace:
Susceptible to noise

Signal pad above trace introduces additional noise

Can we further improve the performance of the BOR?

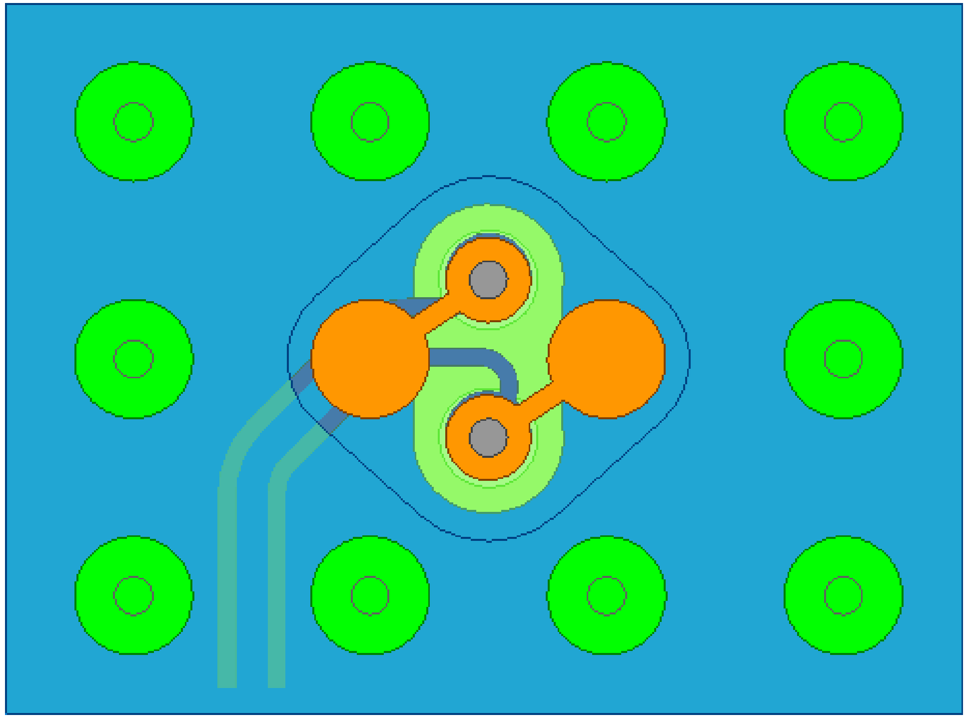
Routing Layer: L2





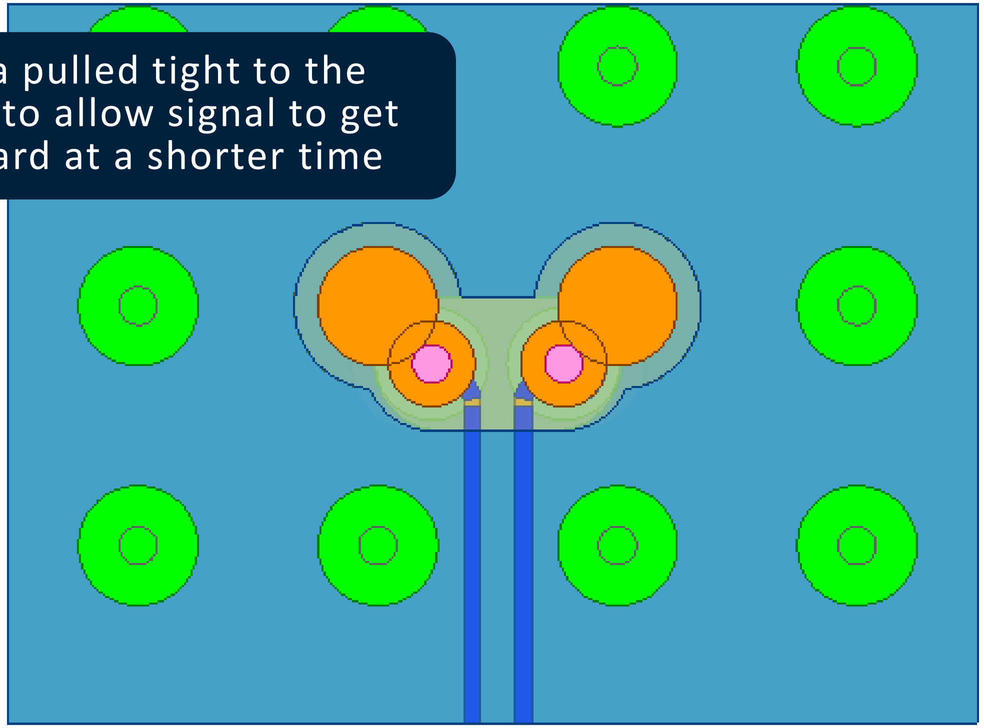
Design Choice #1: Dog Bone to Non-Dog Bone

Digital Differential Topology



RF/Analog Differential Topology

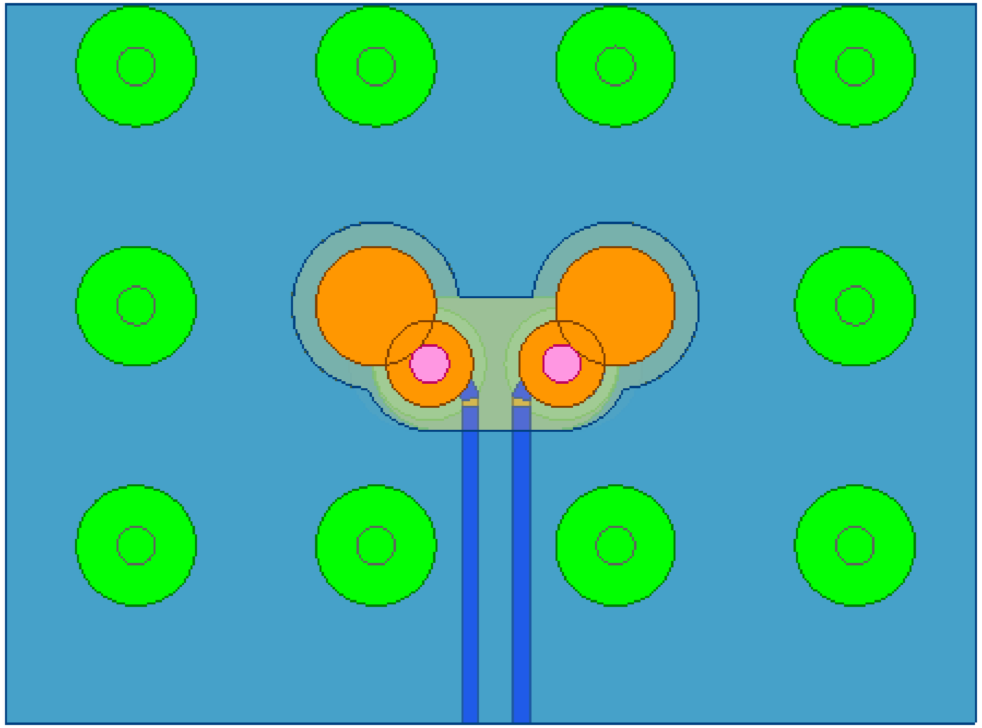
Signal via pulled tight to the signal pad to allow signal to get to the board at a shorter time



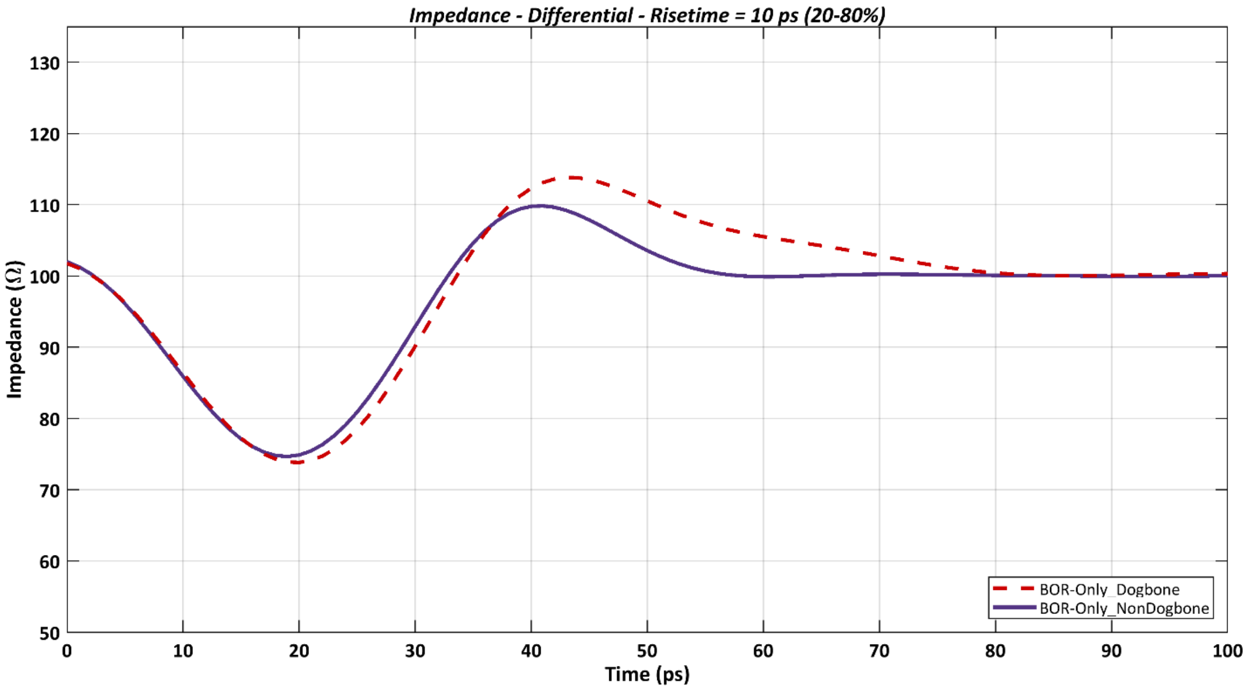
Trace are routed away from signal pads

Dog Bone to “Snowman” Approach

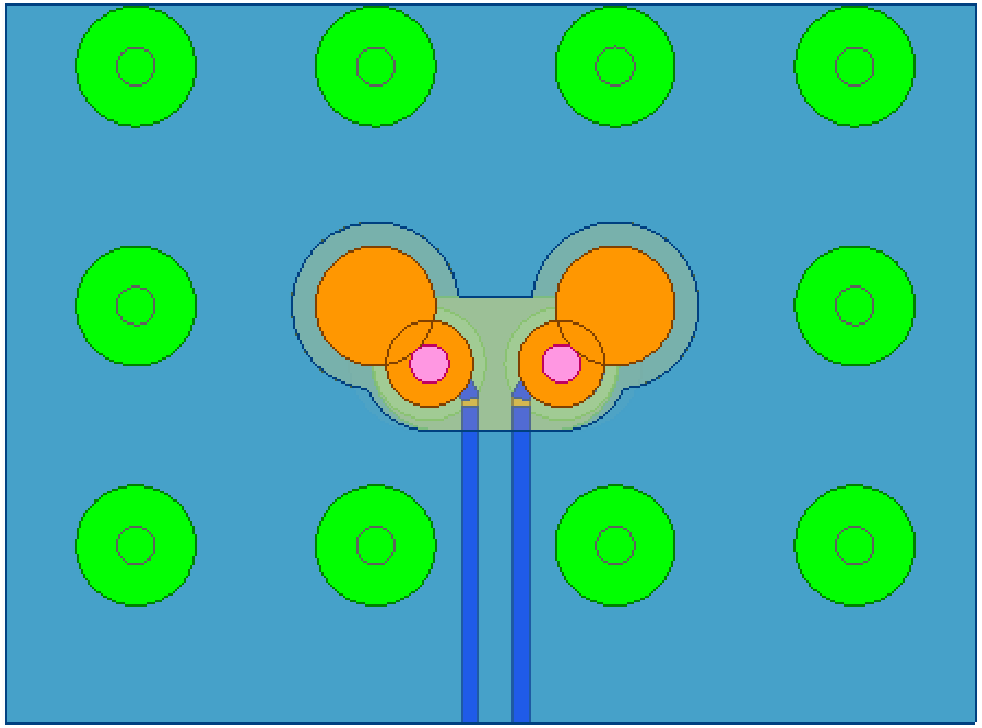
Design Choice #1: Dog Bone to Non-Dog Bone



Dog Bone to "Snowman" Approach



Design Choice #1: Dog Bone to Non-Dog Bone



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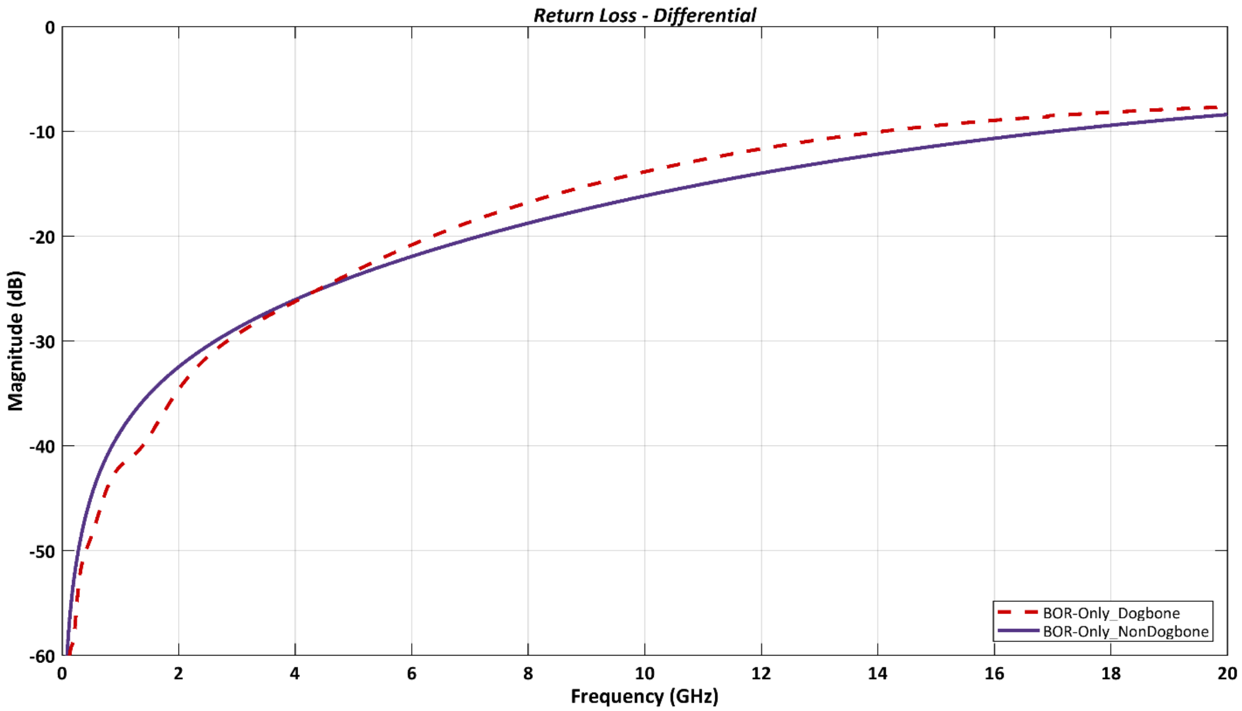
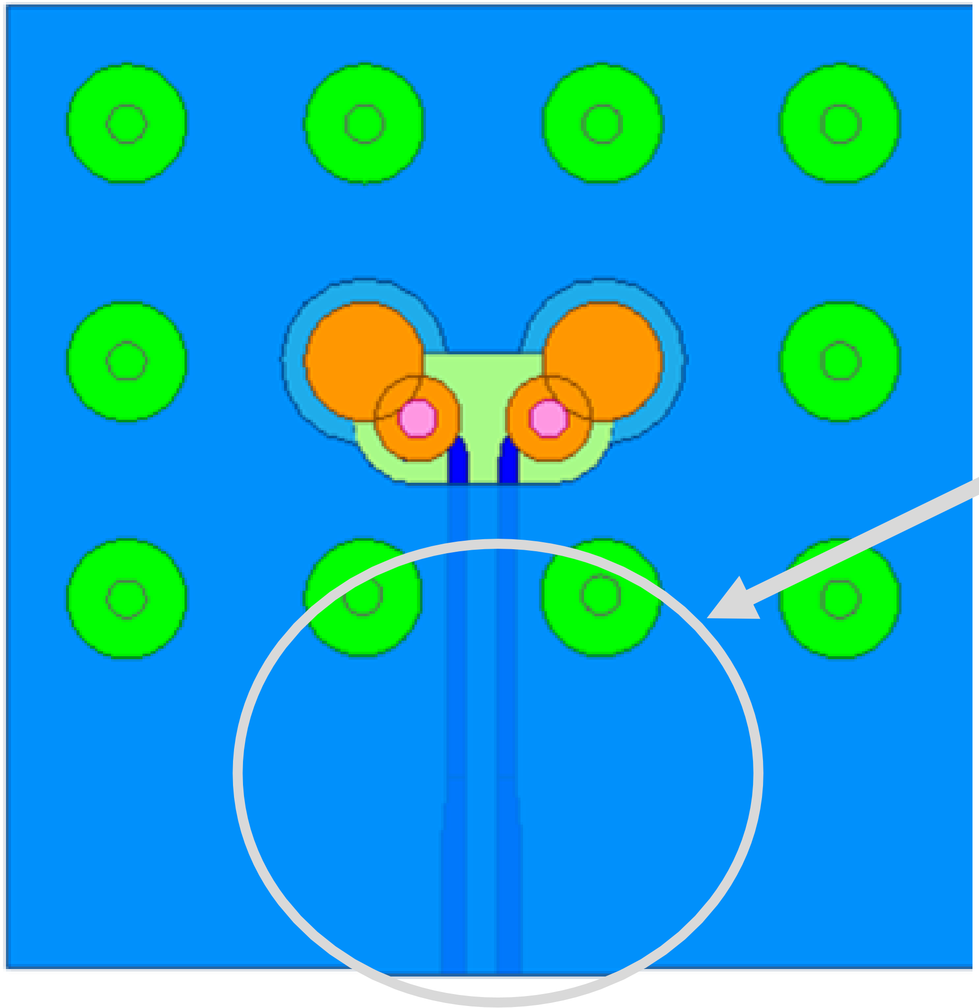
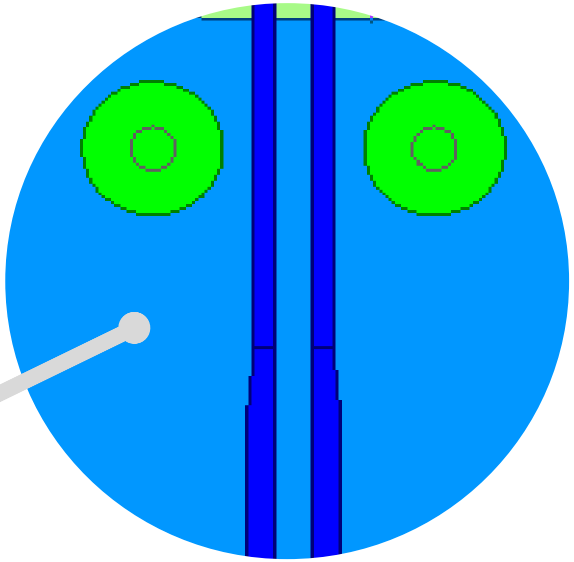


Design Choice #2: 115 Ω to 100 Ω Trace Transition



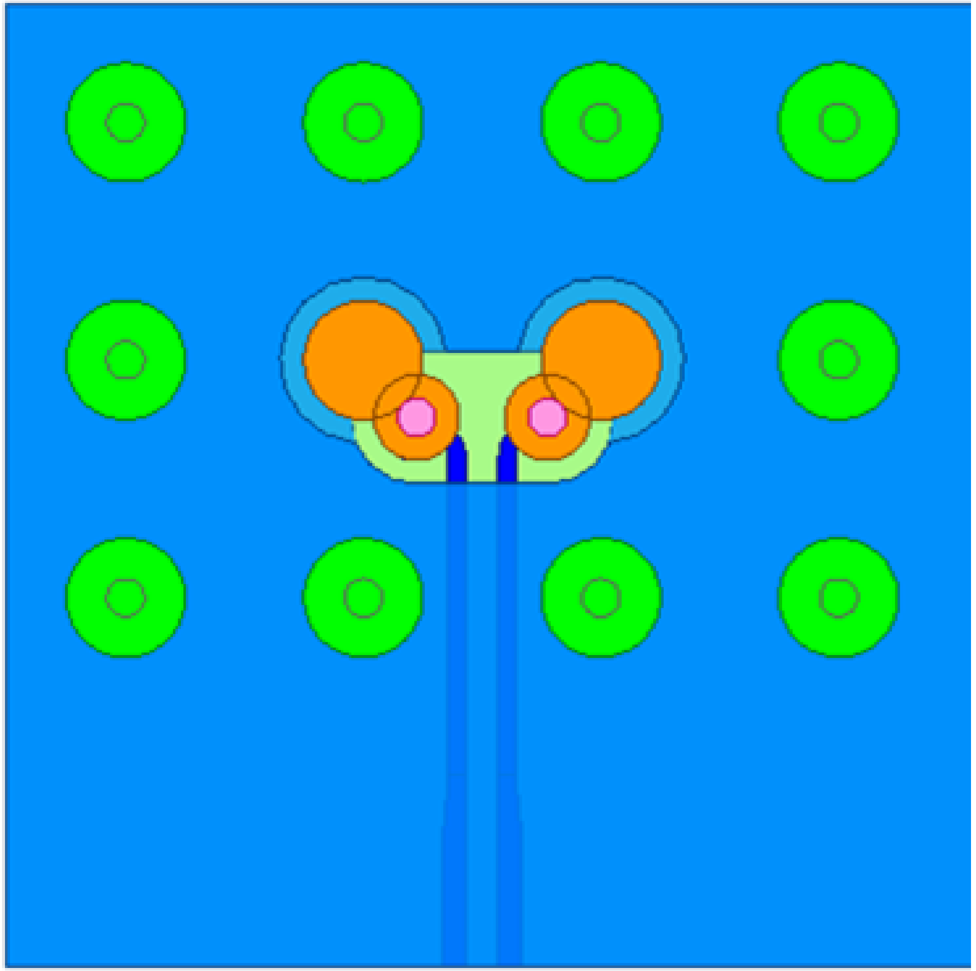


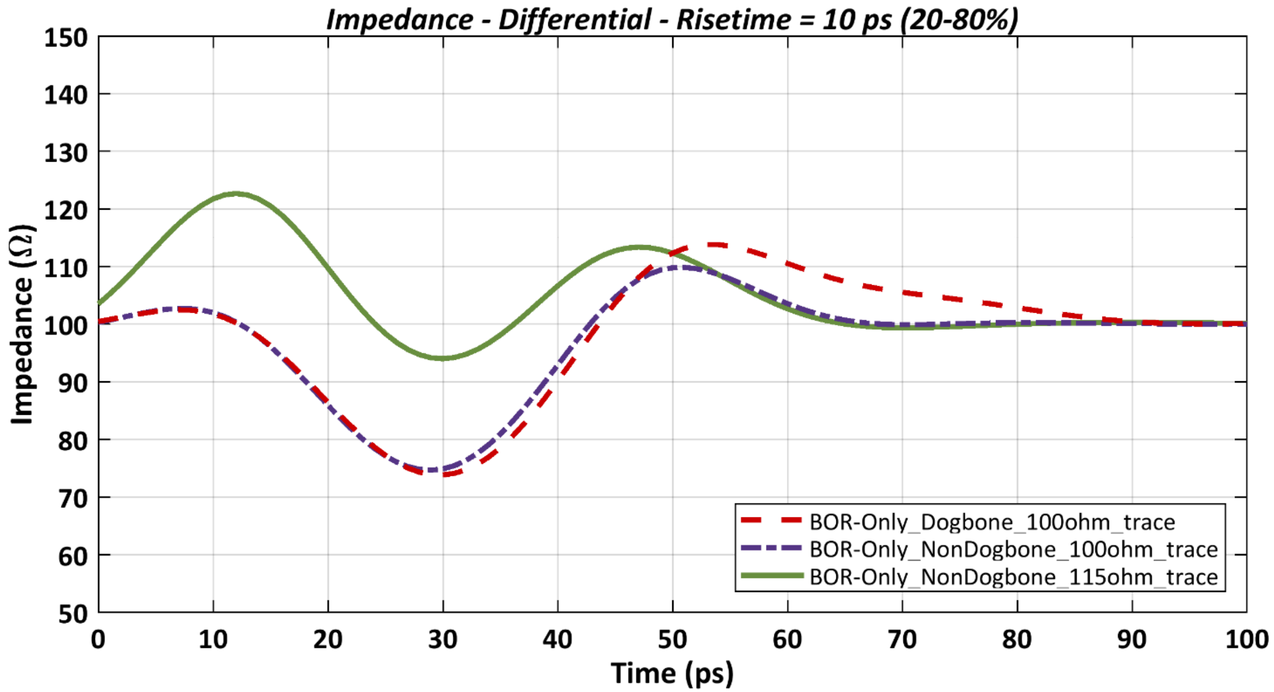
System impedance is 100 Ω

Prior to transition Z rises to 115 Ω

Trace tapers from 4.5 mil to 3.5 mil

Design Choice #2: 115 Ω to 100 Ω Trace Transition





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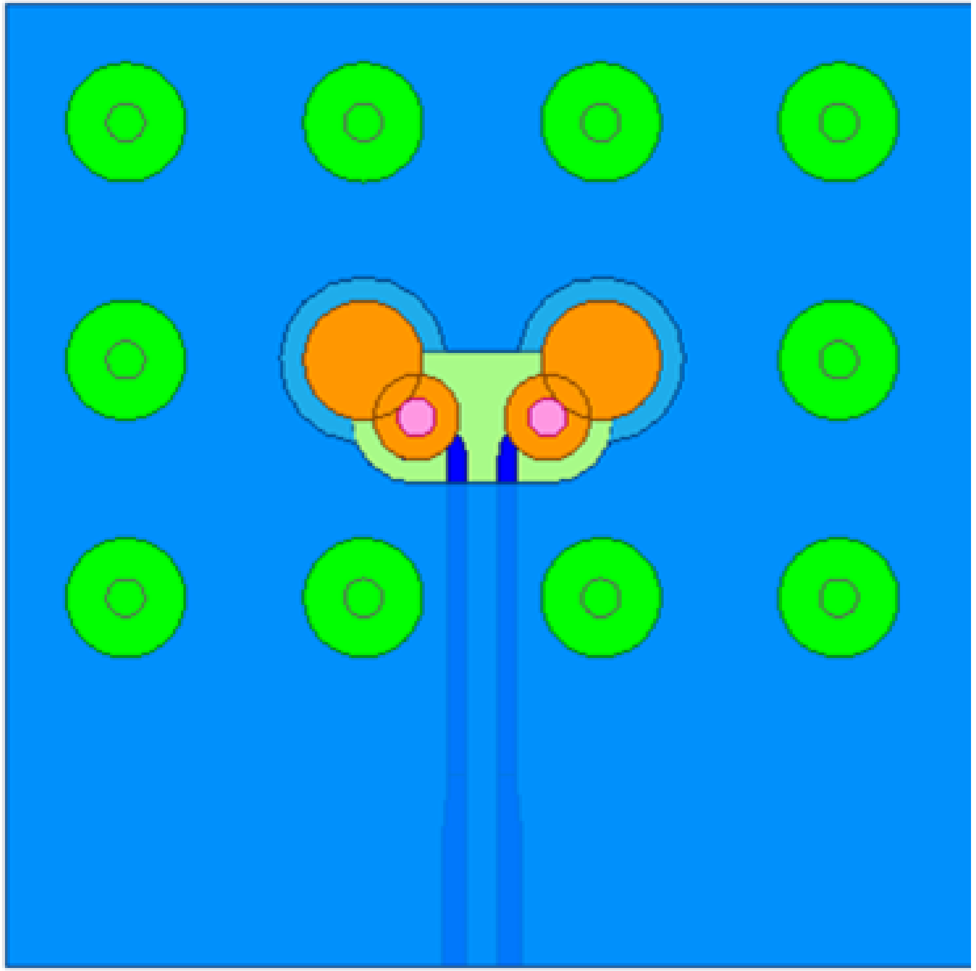
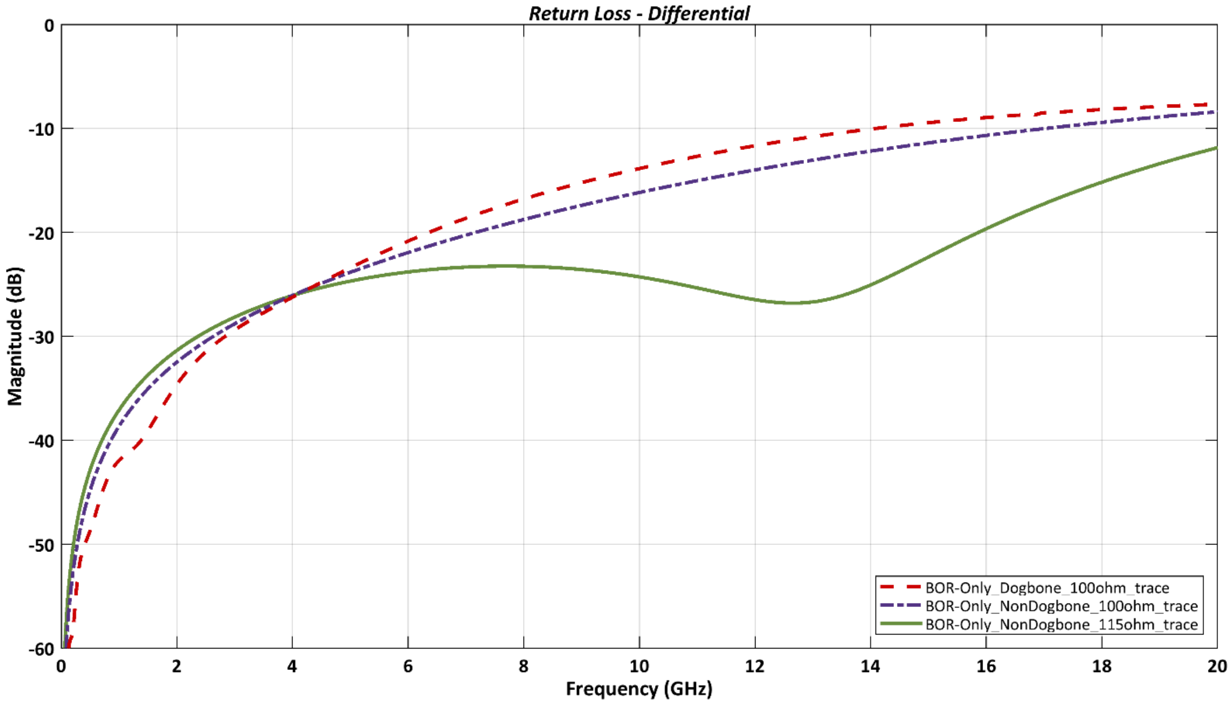
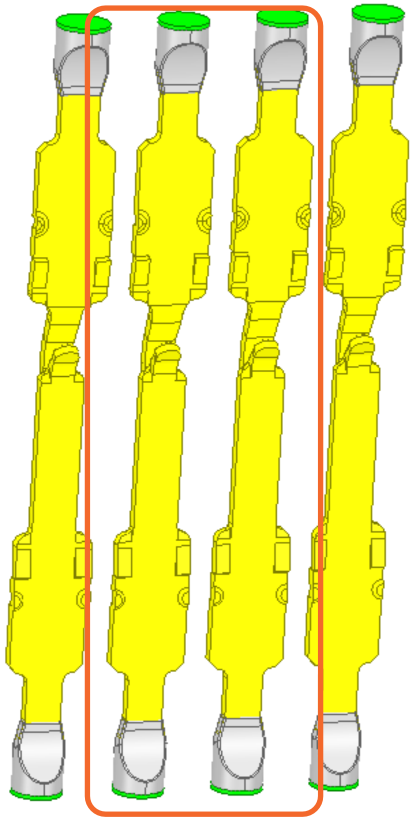
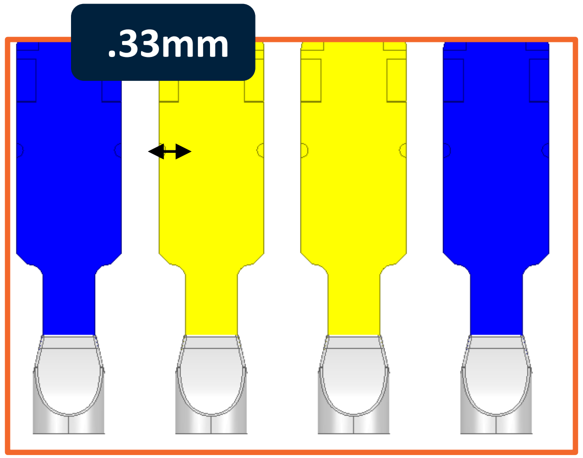




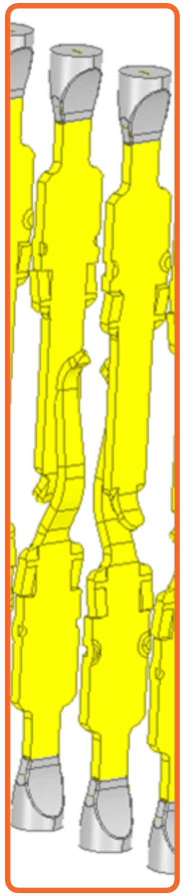
Helps return loss in desired frequency range

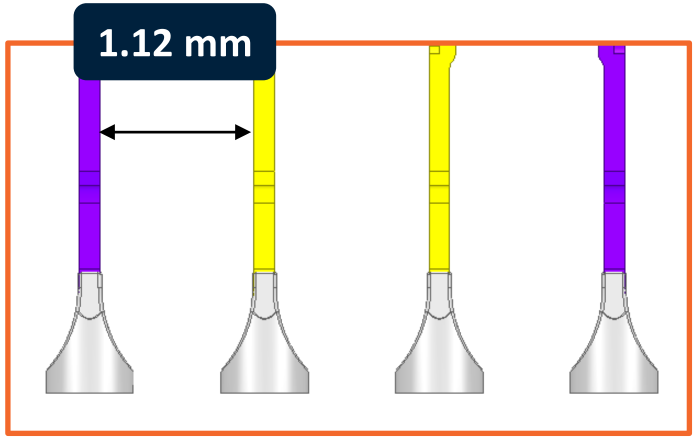
Design Choice #3: Optimal Orientation





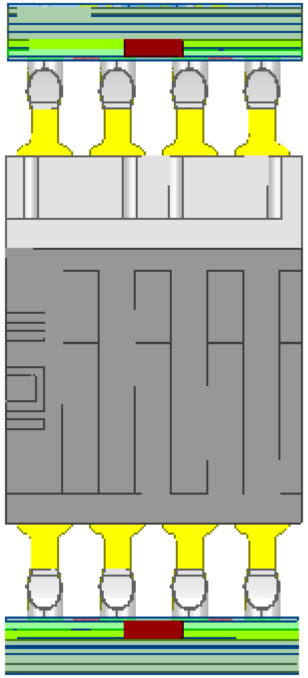
In-Row Pair:
Edge coupling between signal pair



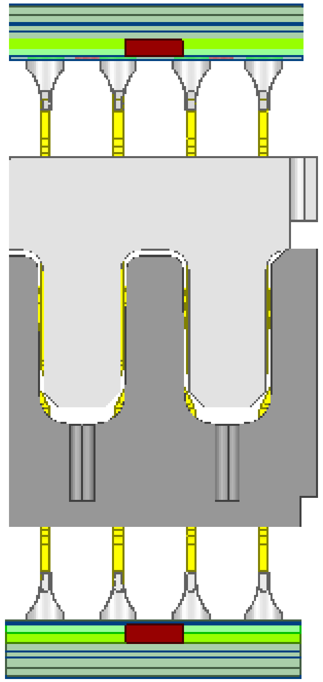


In-Column Pair:
Broad side coupling between signal pair

Design Choice #3: Optimal Orientation



In-Row Pair



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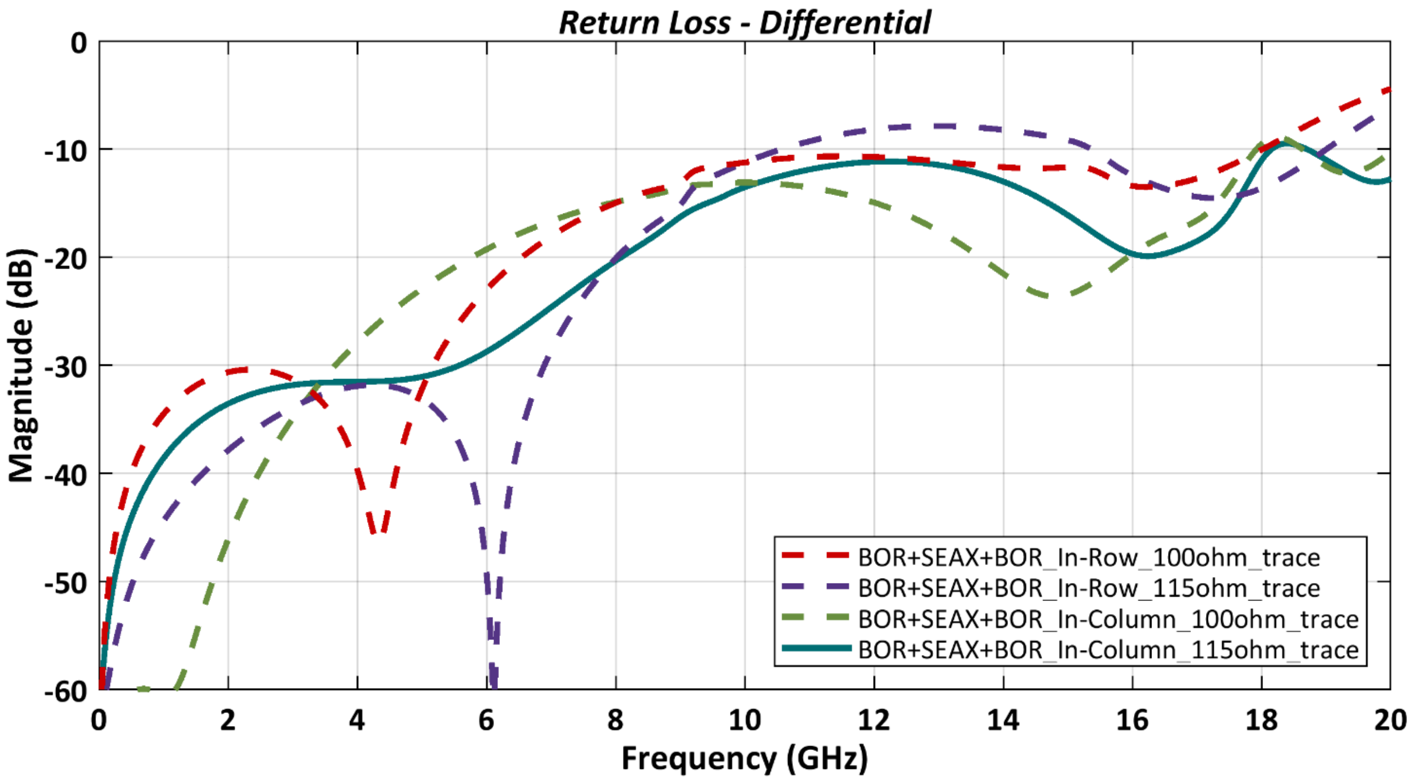

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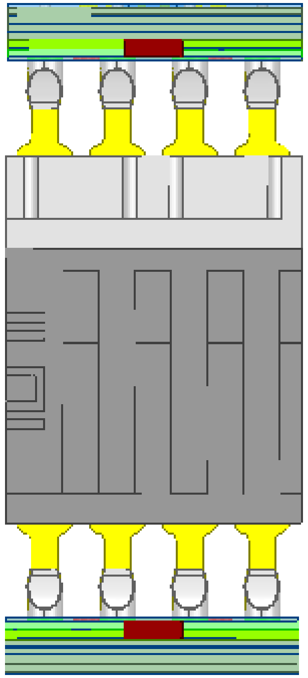
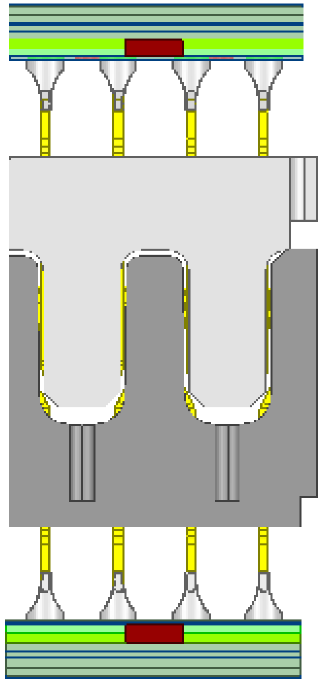
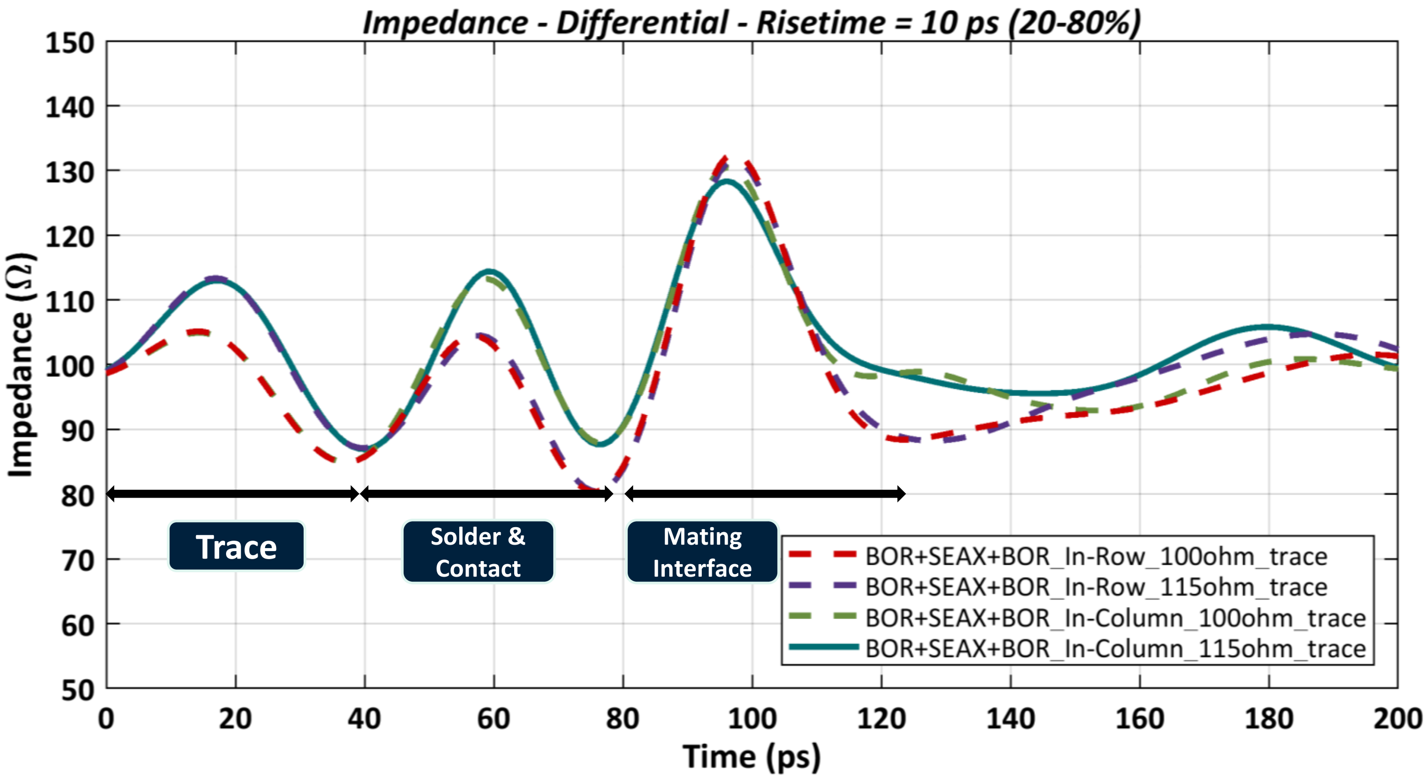


In-Row Pair

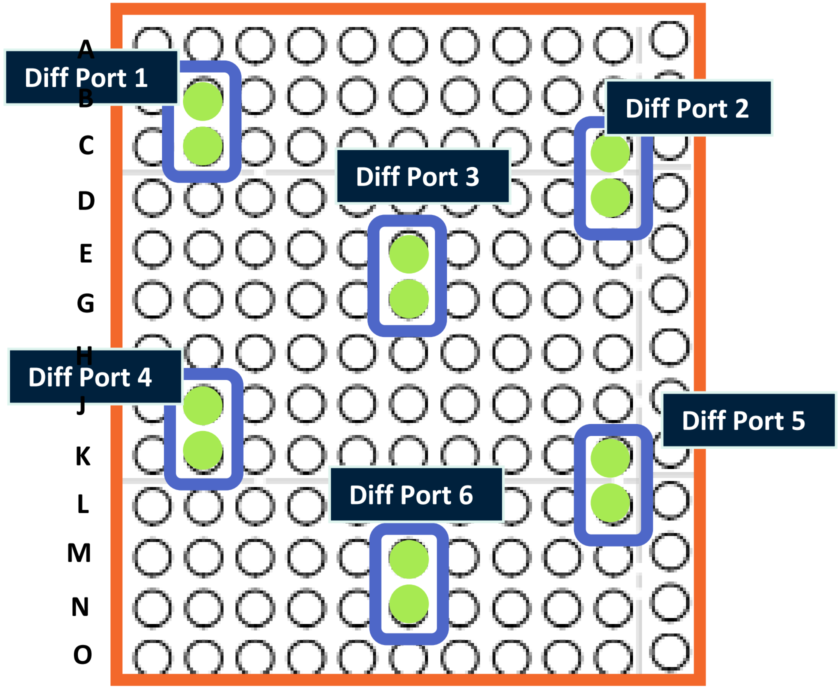


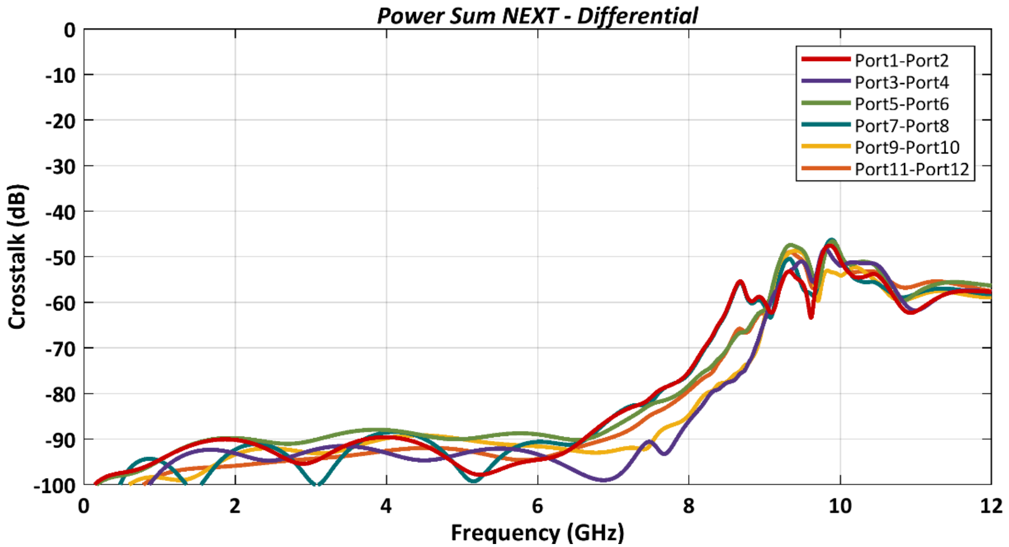
In-Column Pair

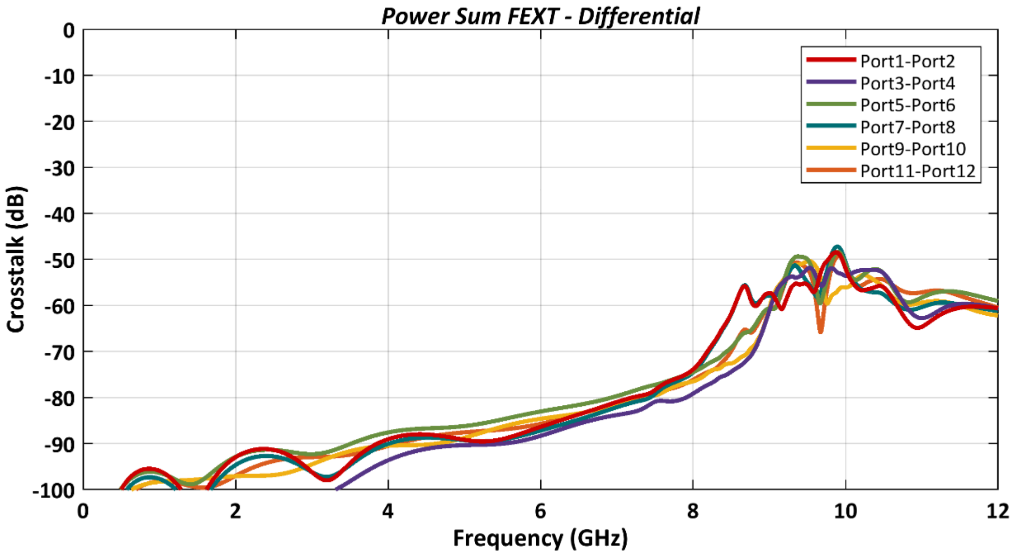


Design Choice #4: Pin Configuration Selection

How dense can we get?

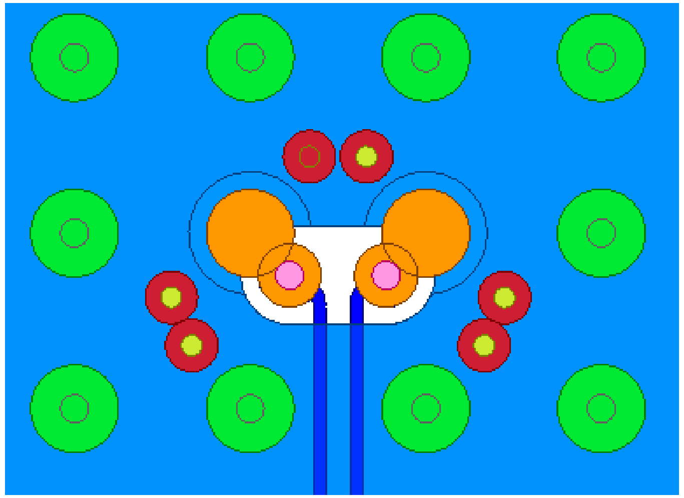




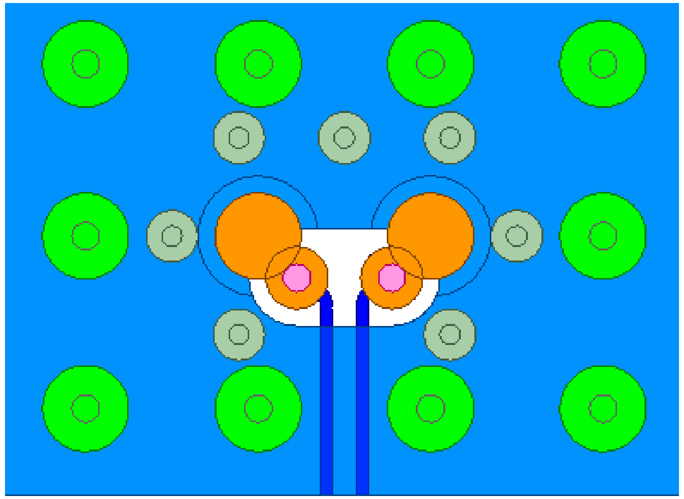


Design Choice #5: Ground Fencing Placement

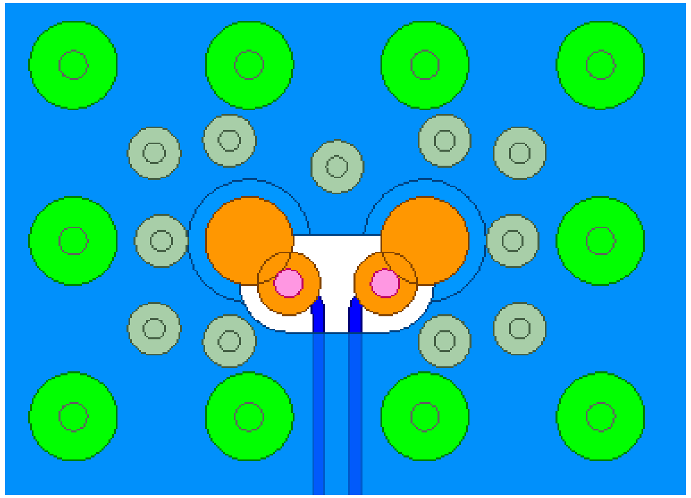
Ground fencing helps increase isolation between pairs



GND Fencing #1

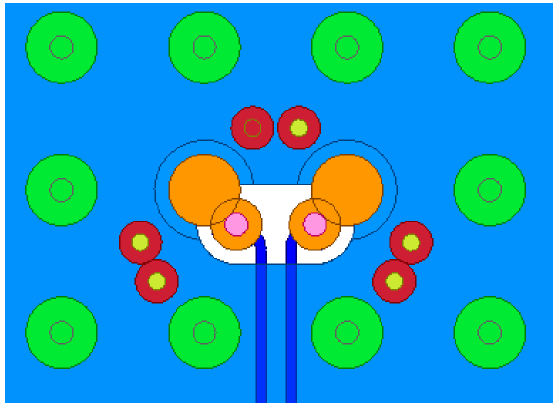


GND Fencing #2



GND Fencing #3

Design Choice #5: Ground Fencing Placement



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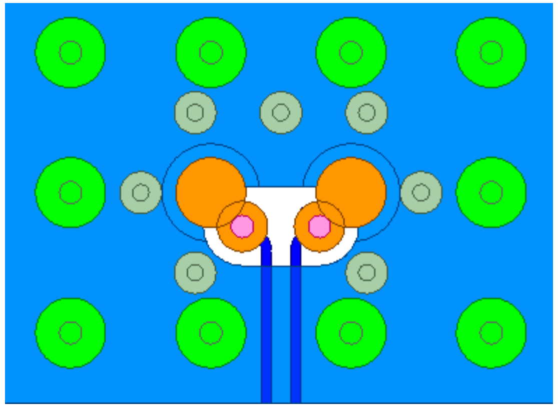
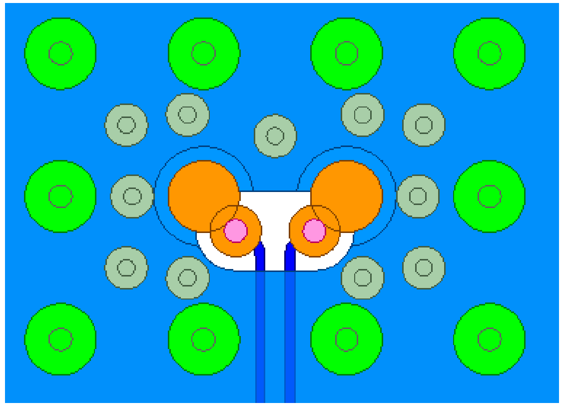
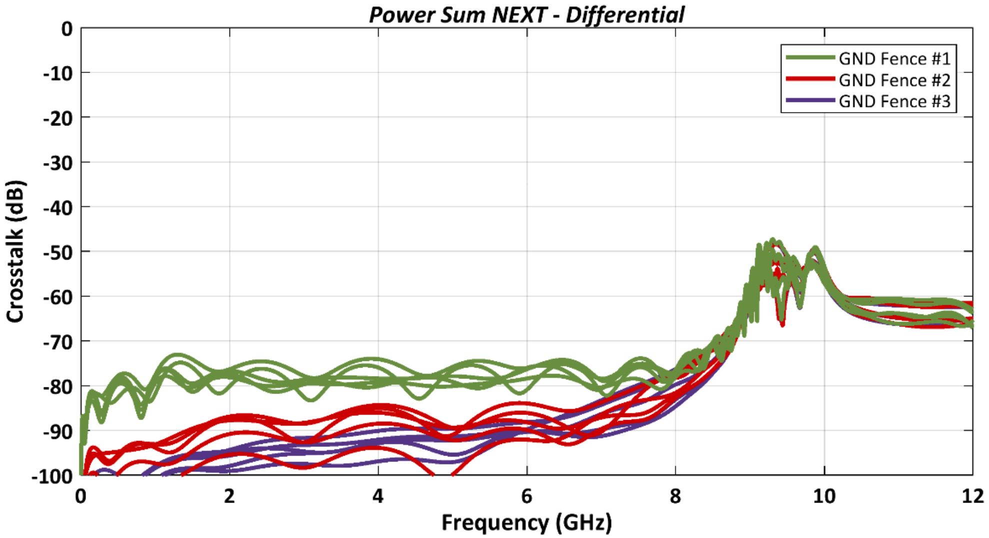
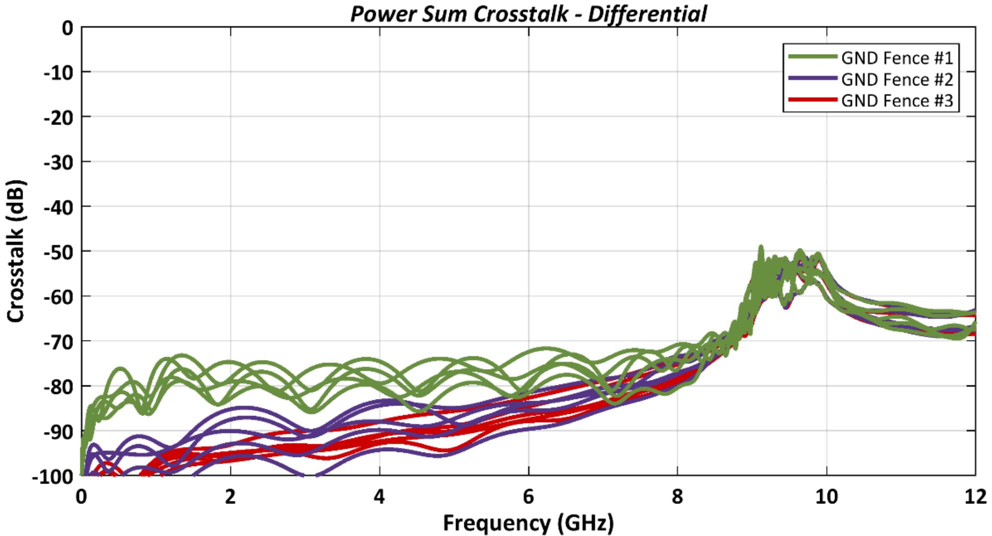


GND Fencing #2

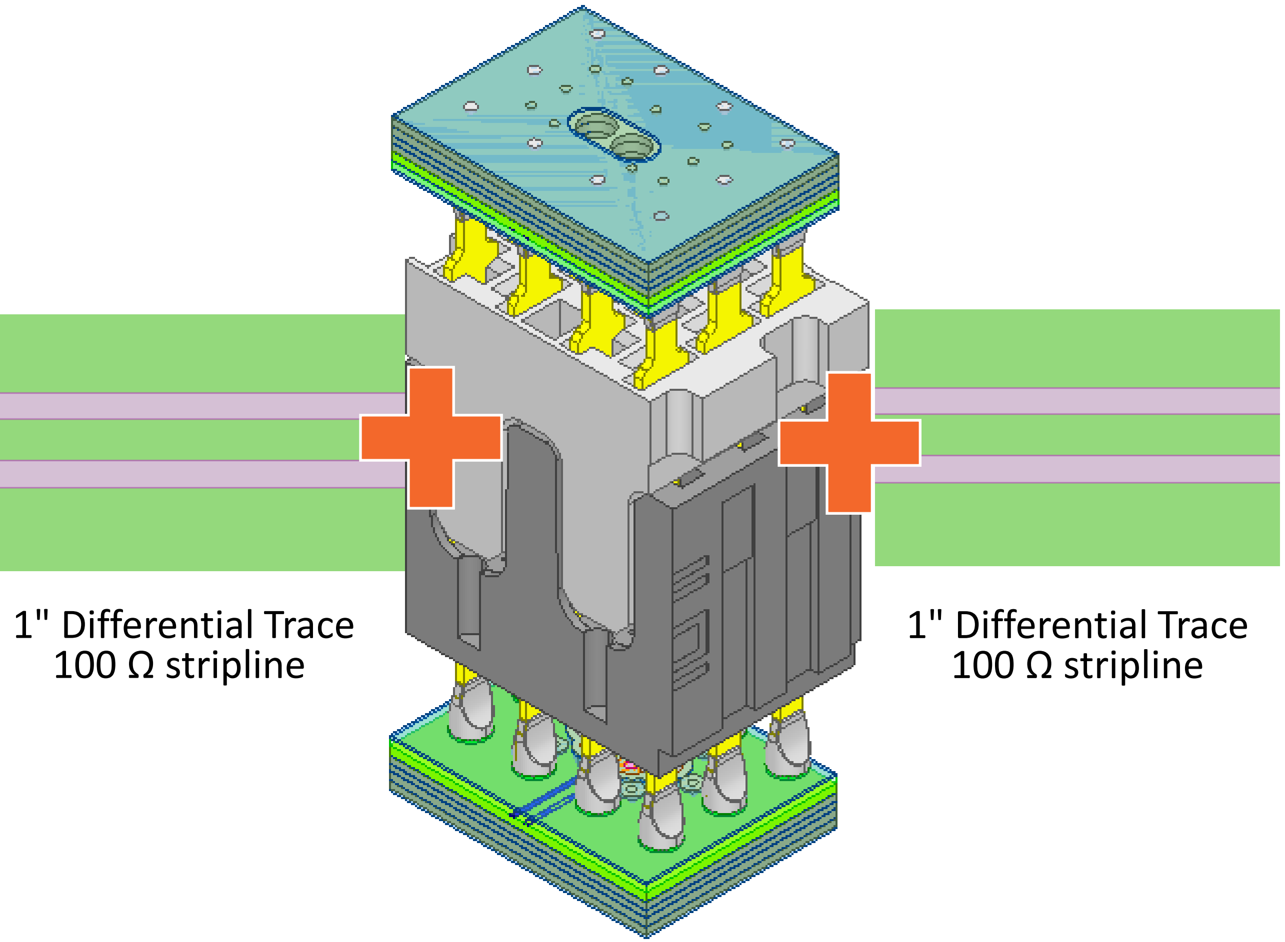


GND Fencing #3



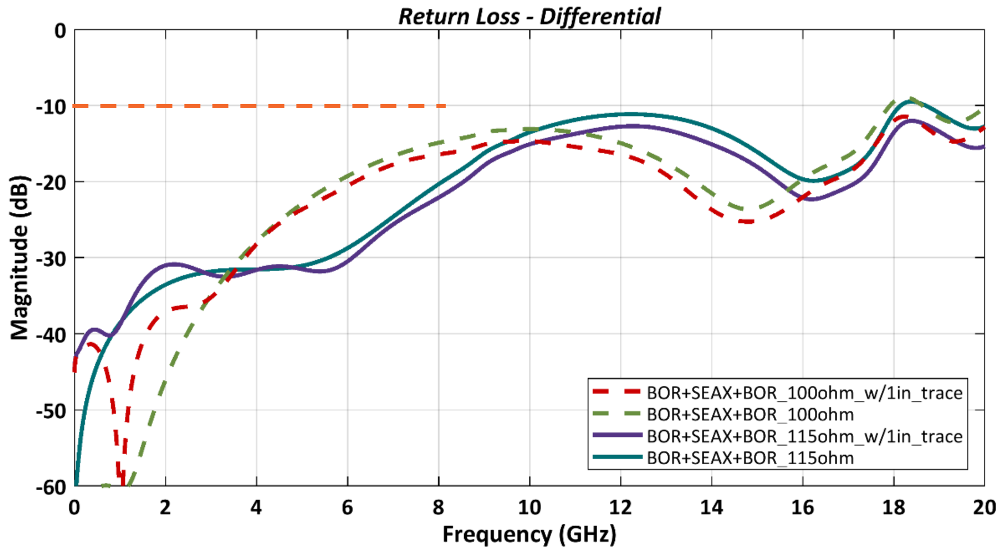


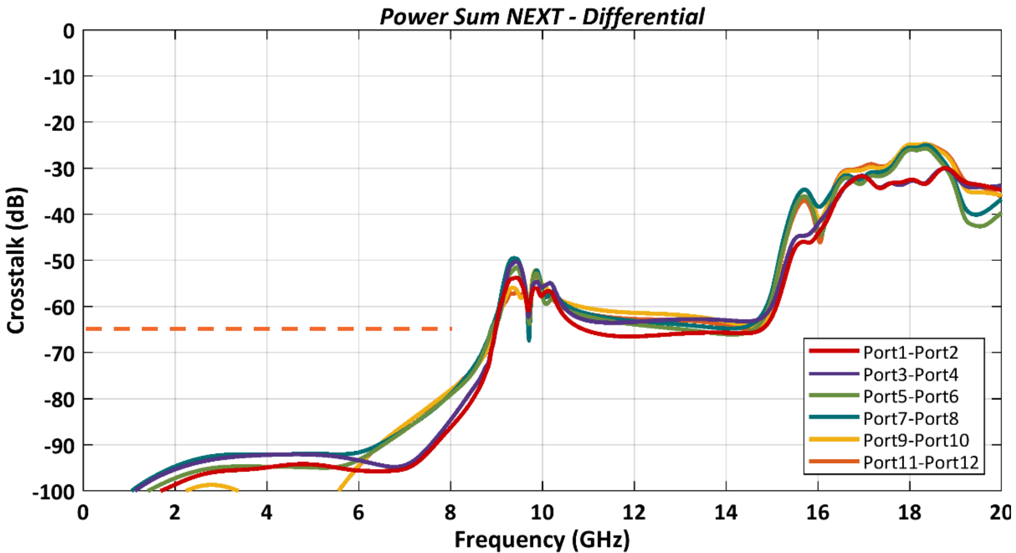
Channel Performance



1" Differential Trace
100 Ω stripline

1" Differential Trace
100 Ω stripline

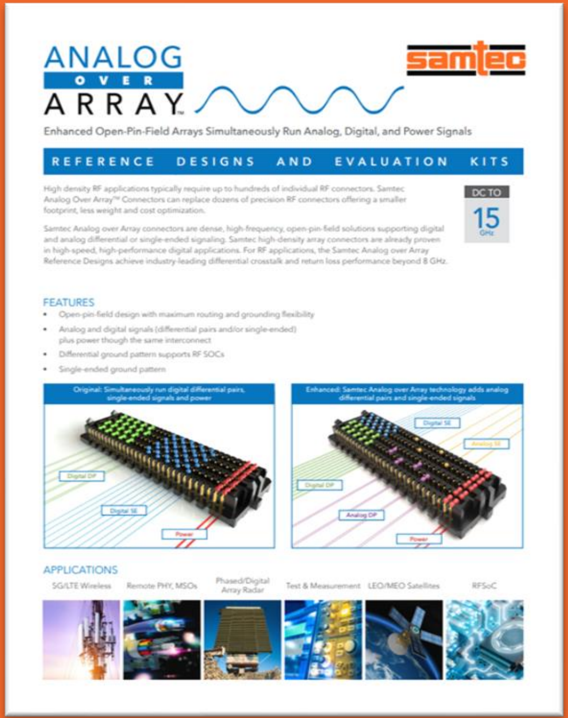




Key Takeaways

- Tapering trace prior transition helps return loss in desired frequency range
- Selecting in-column terminal pins for the differential pair provides minimum coupling
- Analog over Array™ technology optimizes the routing of analog/RF signals
- Samtec's holistic design of RF signal channels optimizes performance in complex Antenna-to-Bits applications

Available Technical Support


ANALOG OVER ARRAY

Enhanced Open-Pin-Field Arrays Simultaneously Run Analog, Digital, and Power Signals

REFERENCE DESIGNS AND EVALUATION KITS

DC TO 15 GHz

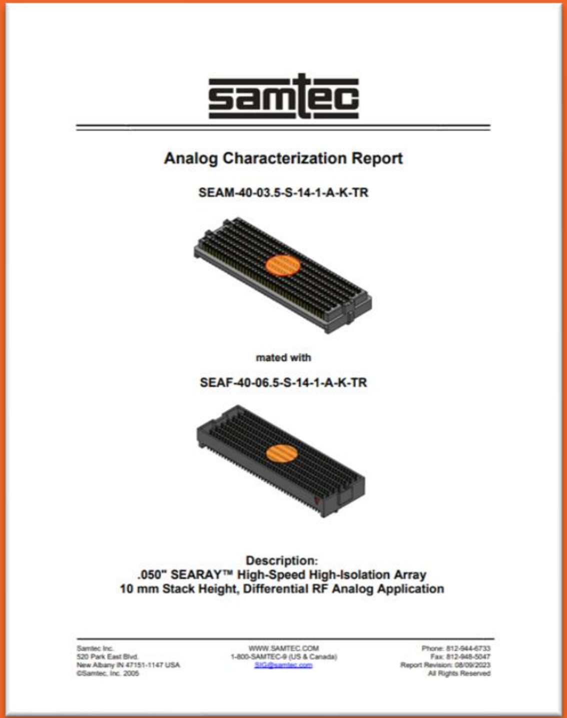
FEATURES

APPLICATIONS


Array Connectors for Mixed-Signal Multi-Channel RFSOCs up to 8 GHz

White Paper

June 2023


Analog Characterization Report

SEAM-40-03.5-S-14-1-A-K-TR

mated with

SEAF-40-06.5-S-14-1-A-K-TR

Description:
.050" SEARAY™ High-Speed High-Isolation Array
10 mm Stack Height, Differential RF Analog Application

eBrochure	White Papers	Characterization Reports	Evaluation Kits

Analog Over Array™ Roadmap

samtec

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