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Powering Innovation That Drives Human Advancement

Impact of Port Type in S-Parameter Extraction of Package and PCB High-Speed Interconnects

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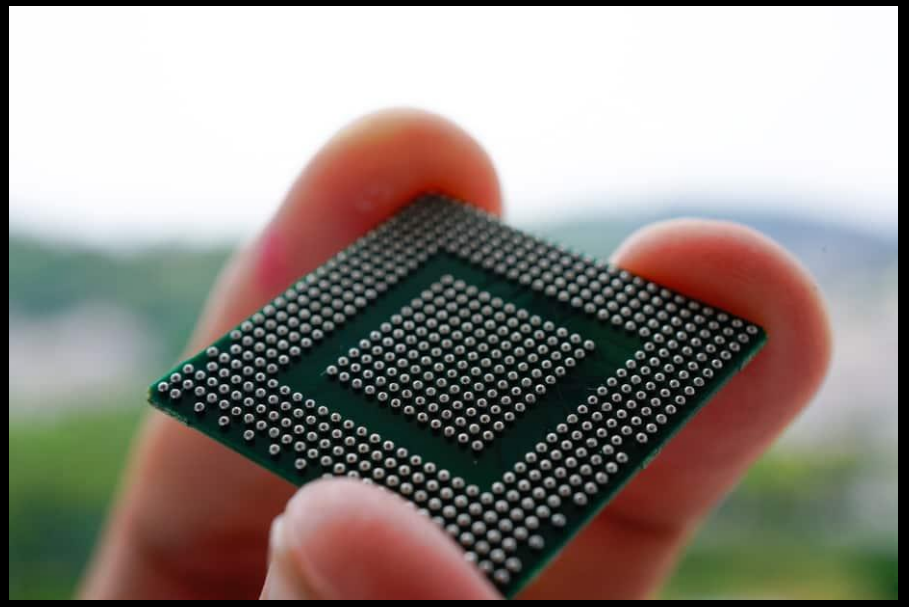
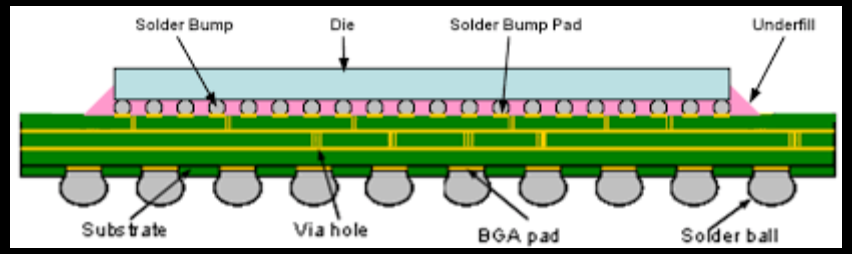
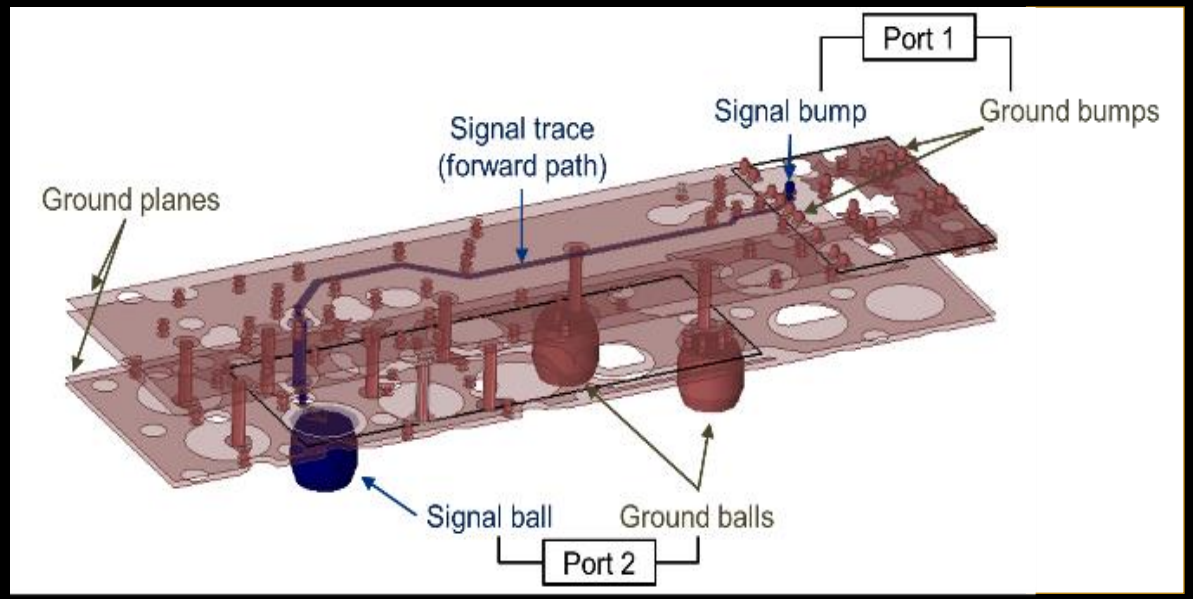
Introduction – What is a BGA (Ball Grid Array) Package?





IC-Package: structure that encapsules a semiconductor device and connects it to the application board



BGA (Ball-Grid-Array):

- Advanced IC-package technology that allows high signal density and improved electrical performance
- Suitable for high-frequency digital applications

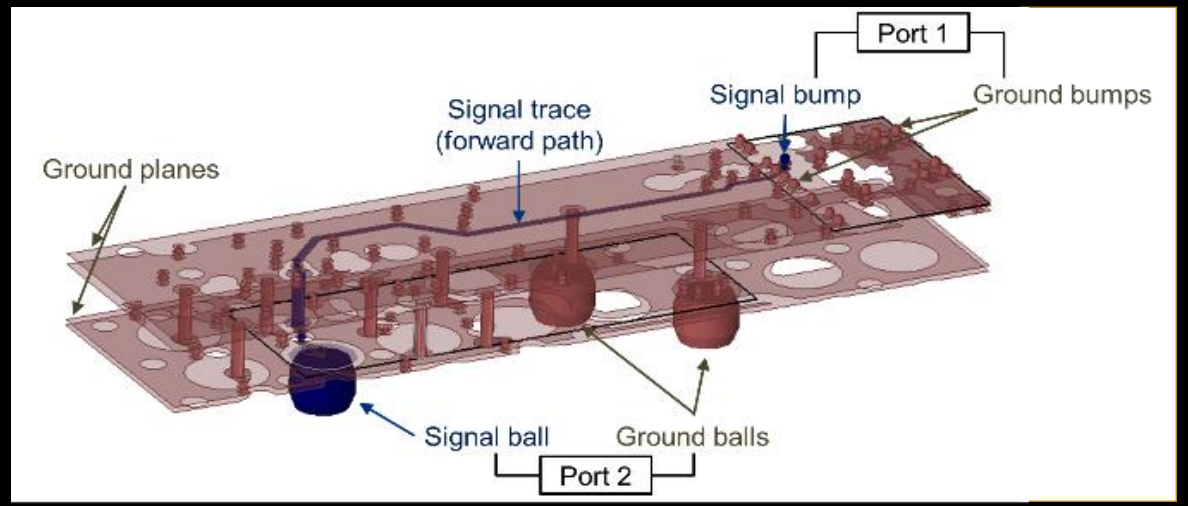
Crosstalk evaluation is crucial for modern high-speed interfaces and applications

S-parameters and Port Types

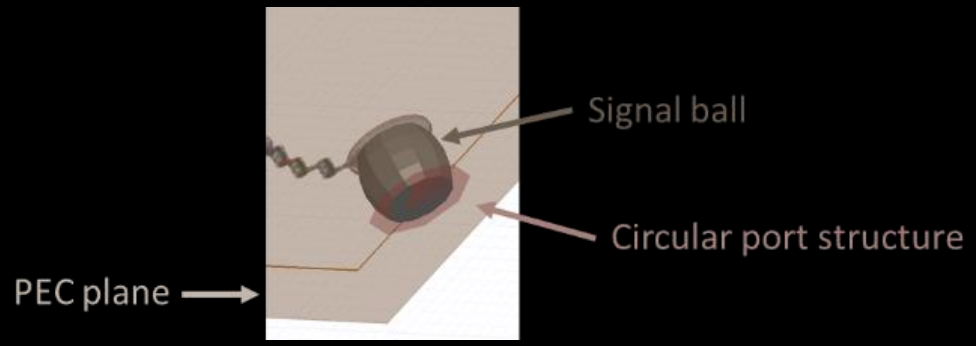
- Crosstalk can be evaluated in the frequency domain with S-parameters
  - Ratio of power transmitted from aggressor to victim
  - Sum of mutual s-parameters describes the combined contribution from multiple aggressors
- Analyzed test-case: frequency range of interest from 0 to 30 GHz

Which port type should I use?

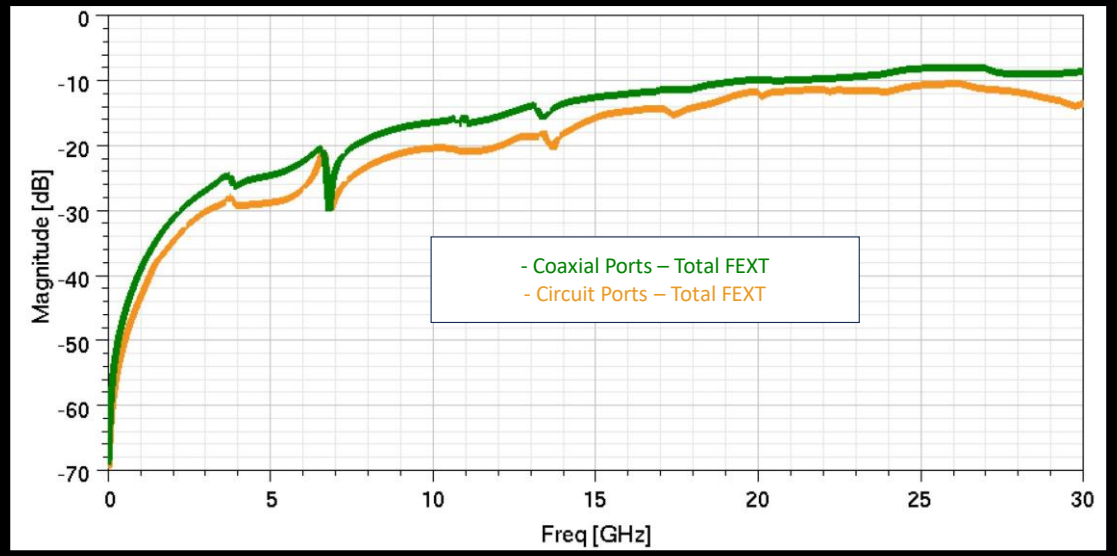
Circuit Ports



Coaxial Lumped Ports

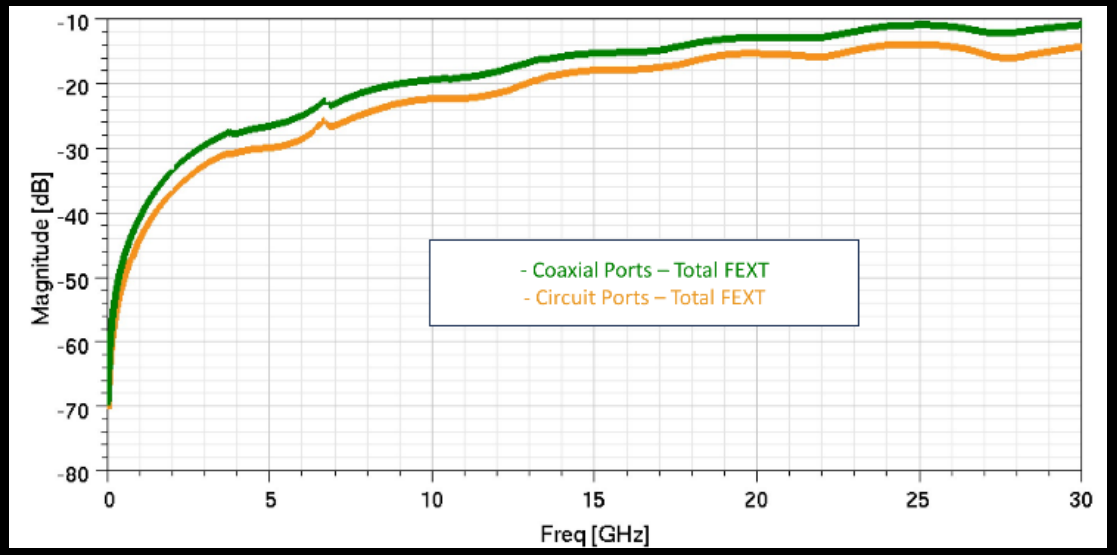


Comparison – Coaxial vs Circuit Ports – Default Setup



Victim Signal A
Total FEXT

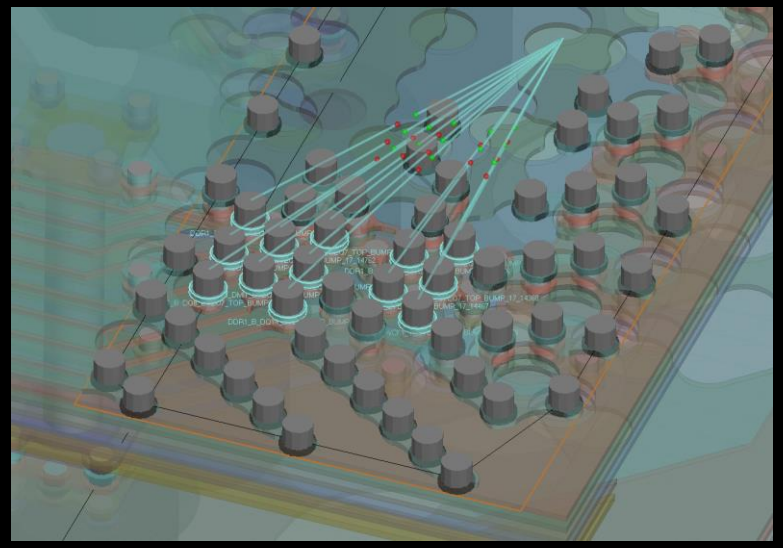
With default port setups, clear pattern is recognized:
coaxial ports give higher crosstalk.

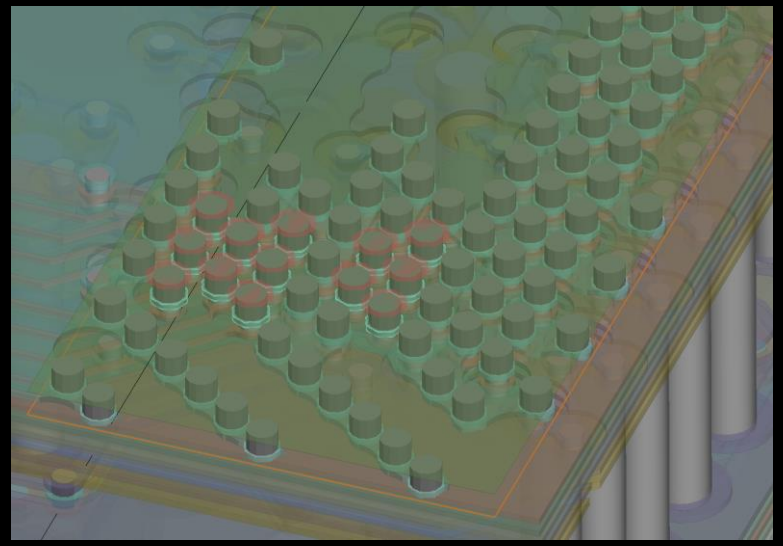


Victim Signal B
Total FEXT

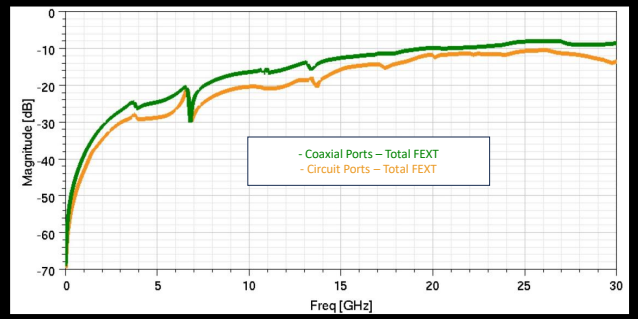
Package is the same, same nets being analyzed, no routing changes:
why are results different?

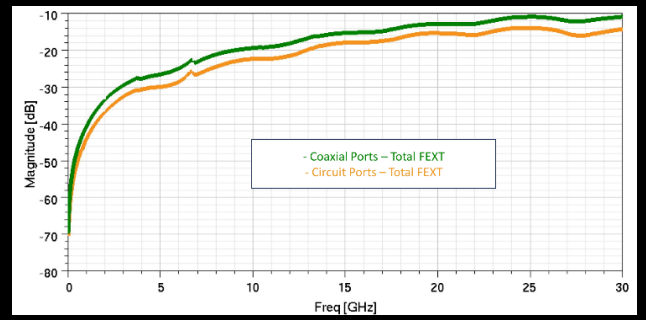
Coaxial vs Circuit Ports - Default Setup Differences





Signal A





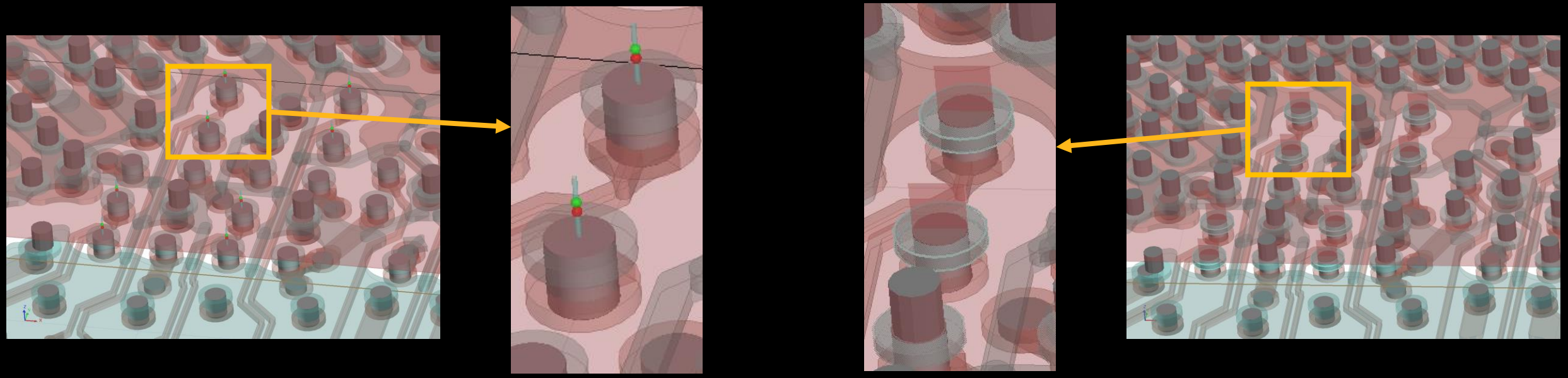
Signal B

Coaxial ports need an additional PEC plane to work properly;
Circuit ports do not require any addition or change to the geometry.

Different port types and default/classic setup
=
different physical models

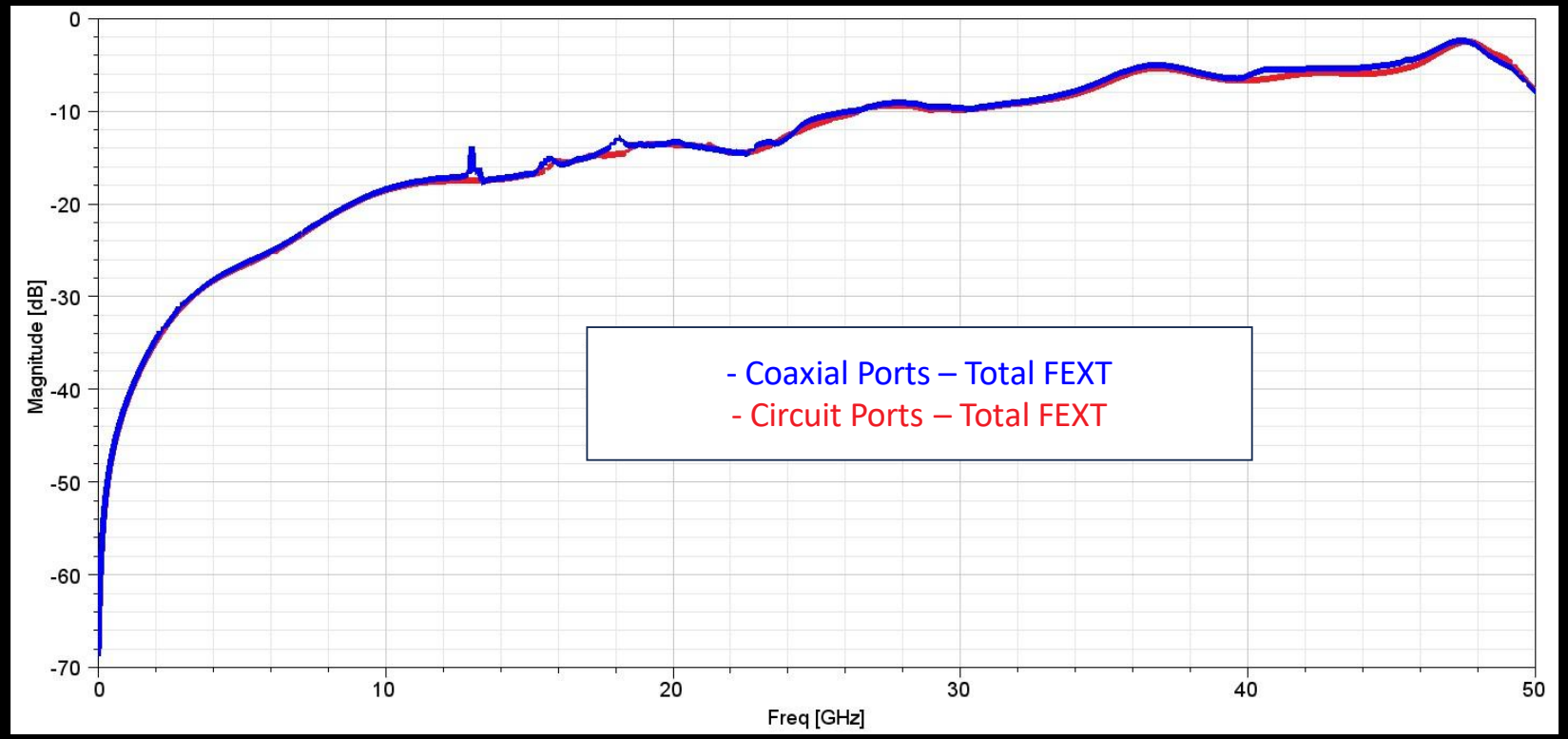
How can we simulate two identical models and only change the port type?

A Fair Fight



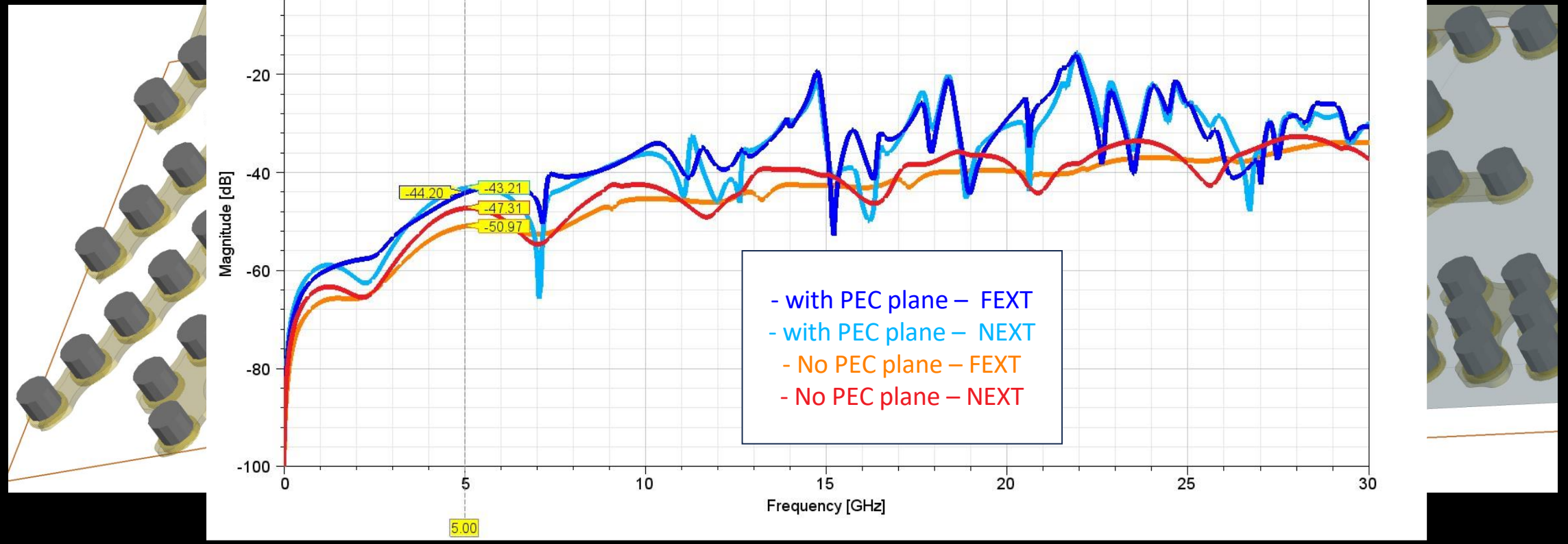
Comparison between two scenarios where the **only difference is the port type**

A Fair Fight - Results



When **only** the port type is changing, results are not changing.
Port type alone is not responsible for higher crosstalk:
lumped ports are not measuring worse crosstalk just because they are lumped.

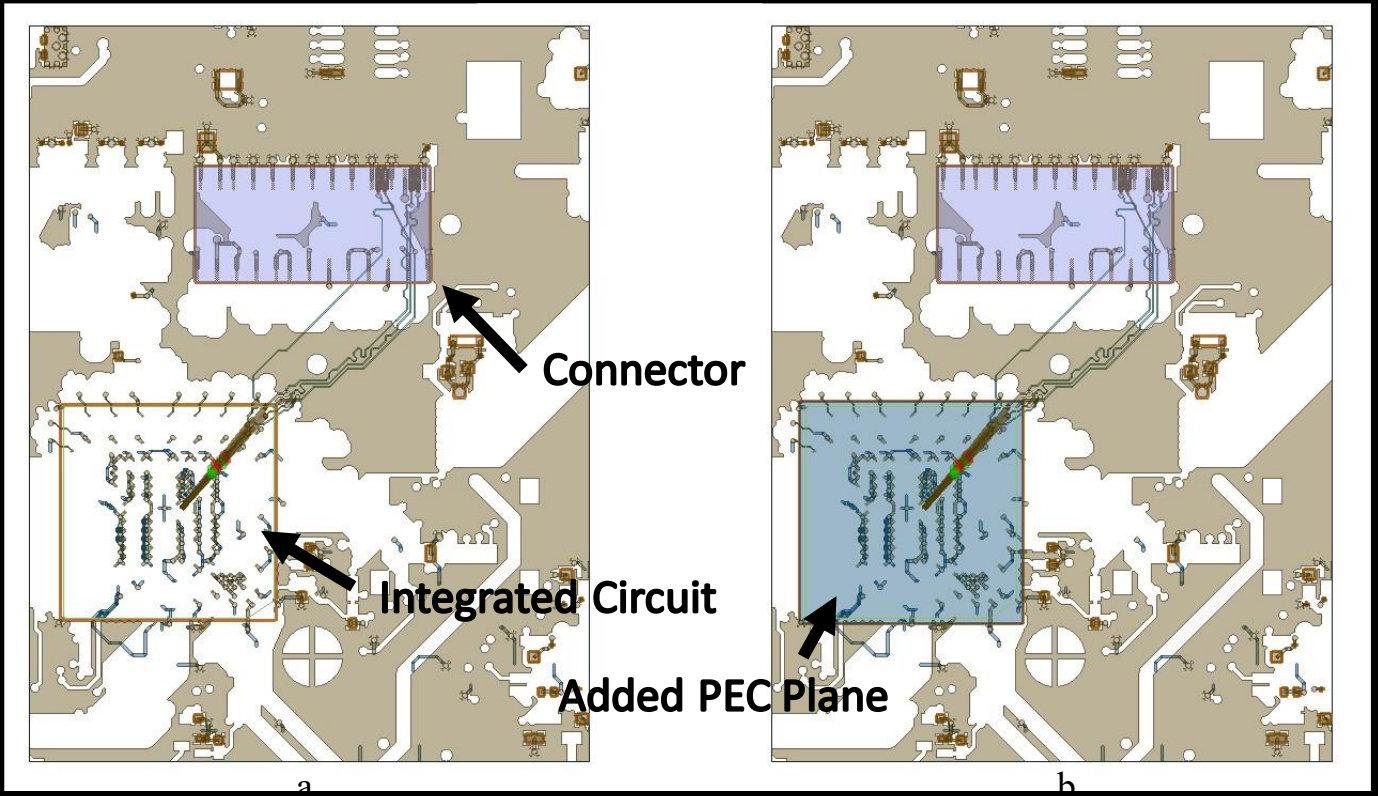
With and Without PEC Plane

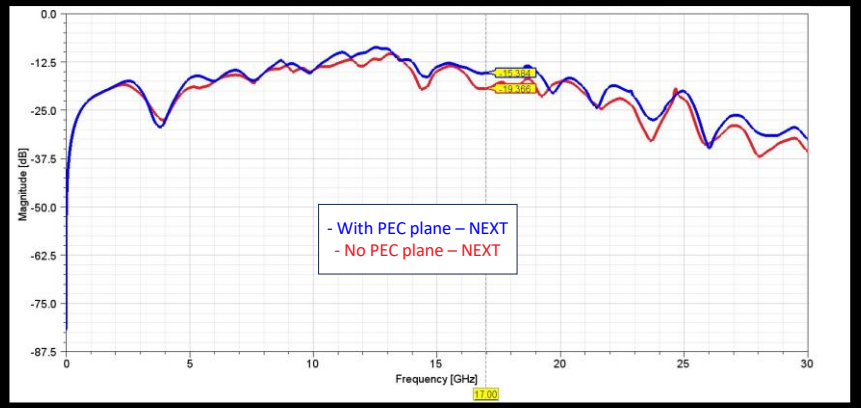


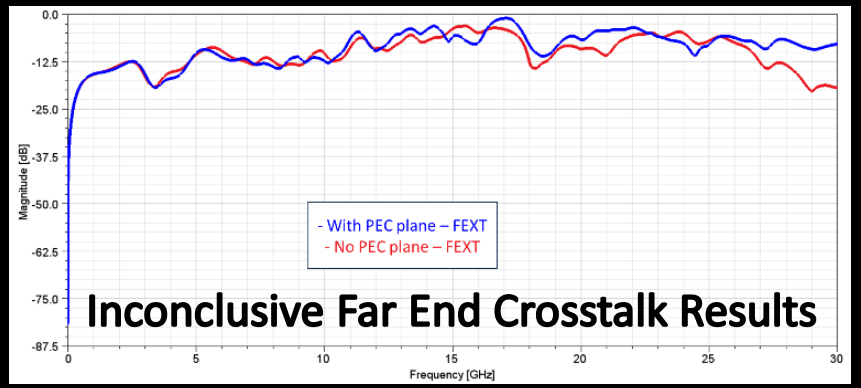
Next step: use same port type and compare results **with** and **without** PEC plane

Result: with PEC plane, crosstalk is consistently higher across entire frequency range.
Likely explanation: PEC plane acts as a shield, introducing reflections in the port area

Does This Happen on a PCB as Well?





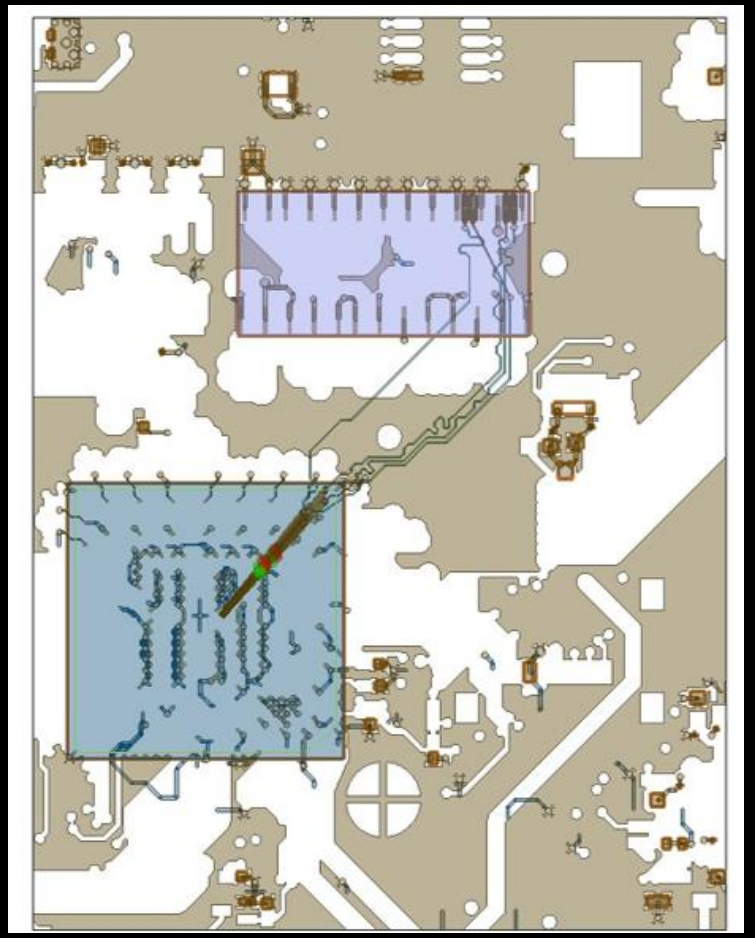


With PCB, PEC plane is applied to only a portion of signal path, different from the package test.
Near End Crosstalk is higher with PEC plane (Near End is considered the Integrated Circuit side).

Summary

- Port type does not alter Crosstalk
- Crosstalk is higher when a PEC plane is present
- A likely explanation is that the additional PEC plane acts as a sort of shield, confining the fields
- More reflected fields -> higher coupling in the device area
- We have two modeling approaches. Which is better?

PEC plane approach is preferred since it emulates the presence of a neighboring device, representing the PCB-package or package-die interaction

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