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Cascaded or End-to-End Connector Models: What Do We Give Up?

Robert Branson

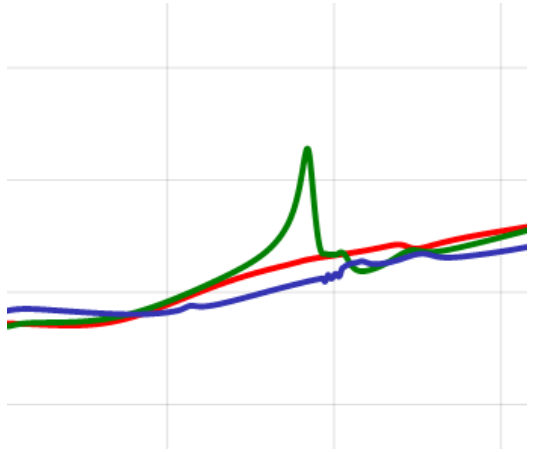
Overview

- What is a Resonance?
- Cascaded vs End-to-End Models
- Performance Impact
- Building a Simplified Model
- Isolating the Resonance
- EM Field Simulations
- Alternative Methodologies
- Additional Resonance Considerations

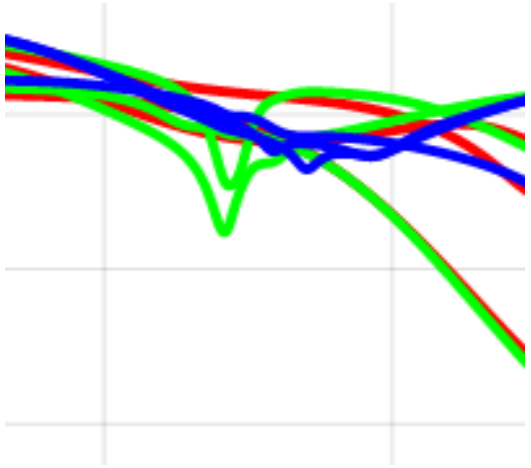
What is a Resonance?

S-Parameter Impact of Resonance

Crosstalk / RL Resonance



IL Resonance



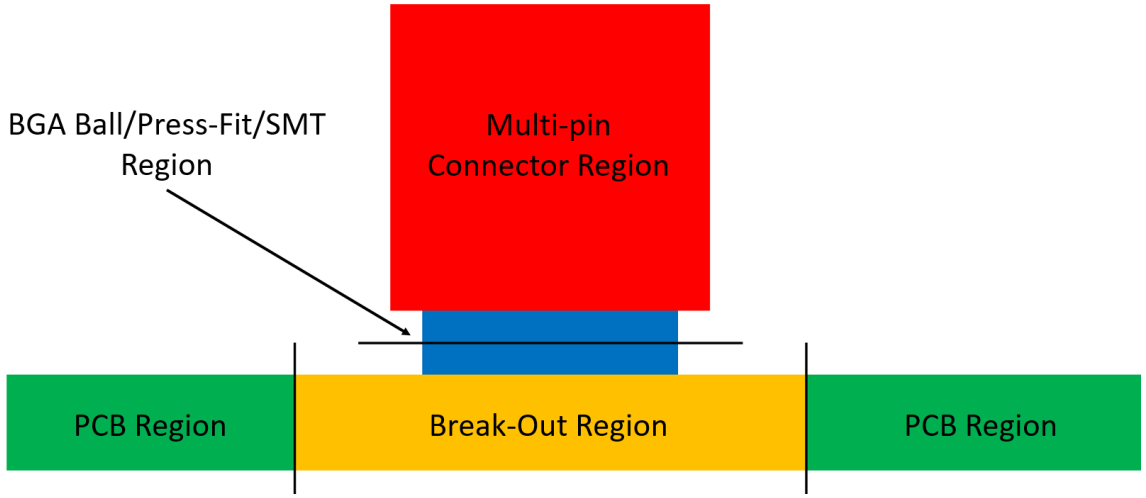
Physical Geometry Determinant of Resonance

Length-Based Resonance

Cascaded vs End-to-End Models

End-to-End Interconnect Model:

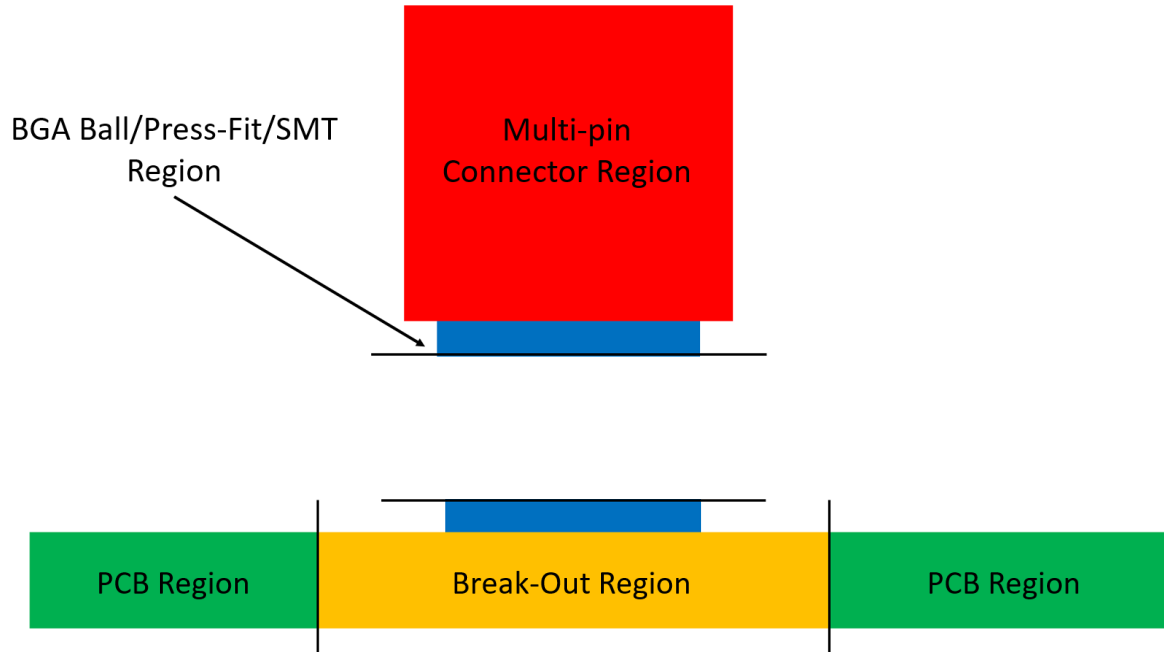
- A continuous and complete simulation of the geometry
  - There are no cuts made in the simulation
- More closely mimics actual performance in a system
- Larger simulation results in a longer run-time



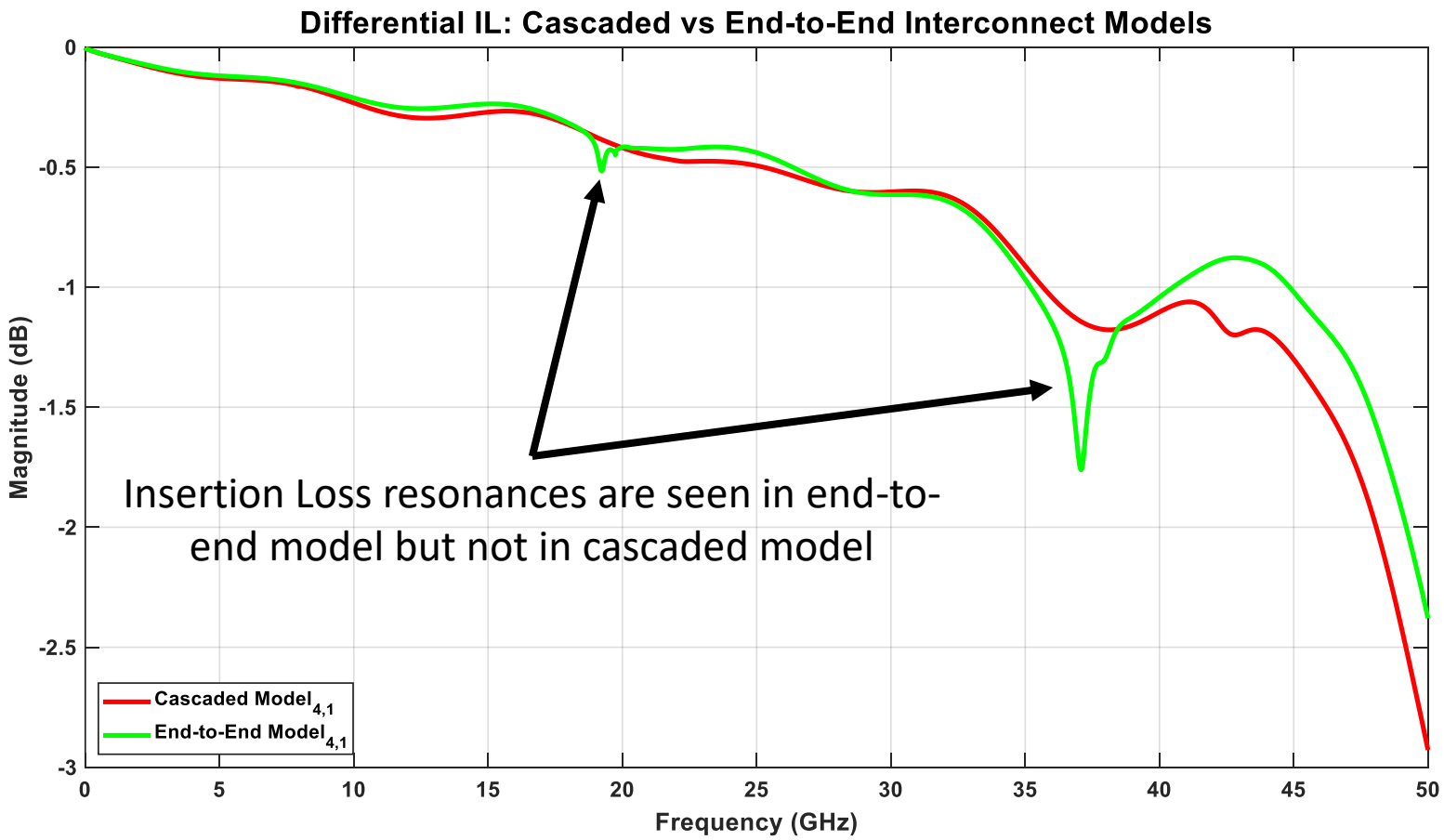
Cascaded vs End-to-End Models

Cascaded Interconnect Model:

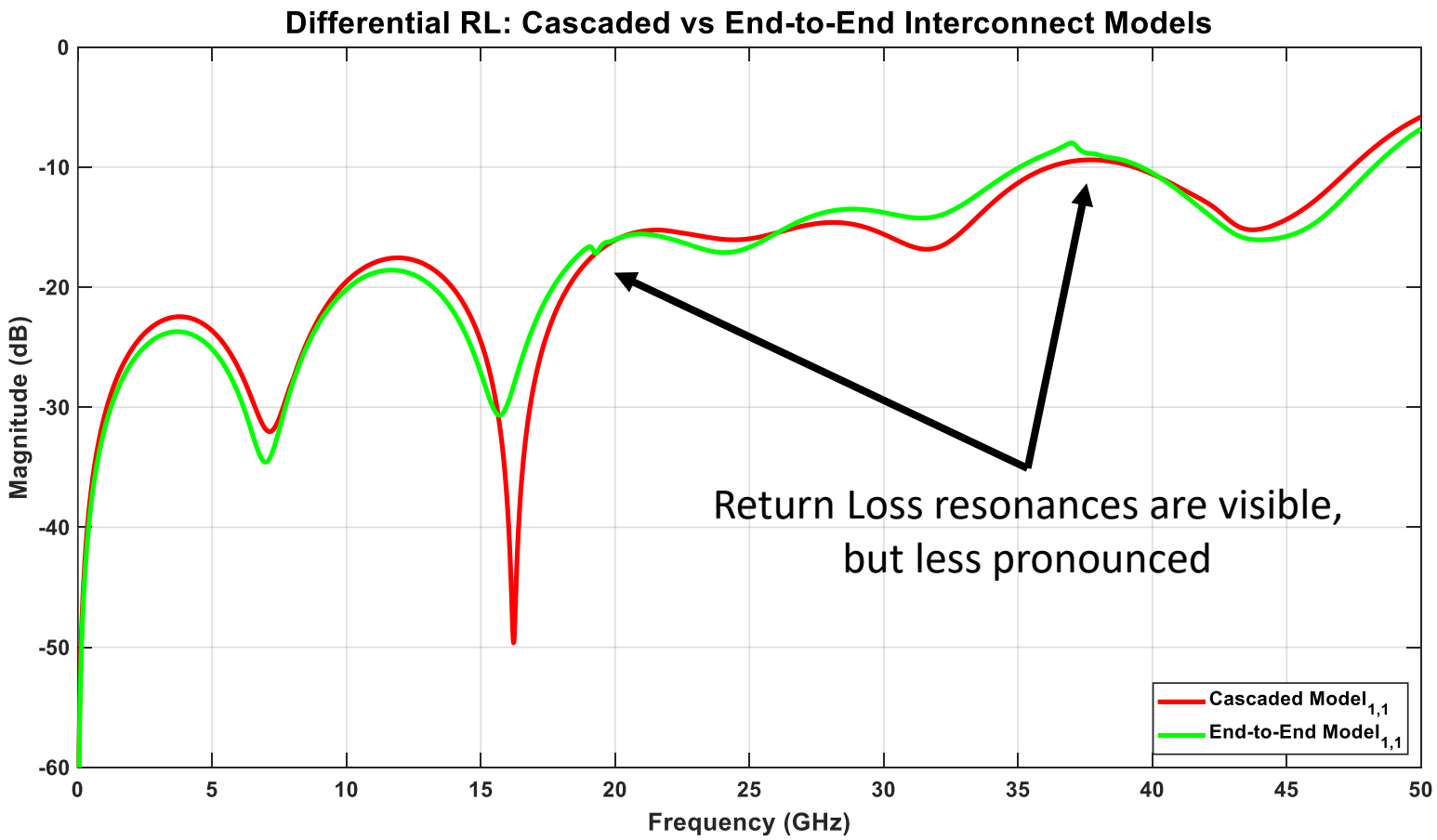
- A separate and then cascaded simulation of the geometry
  - There is a cut made in the simulation
  - Typically, this is done at the BGA region
- Allows for the mixing and matching of parts
- Smaller simulation results in a shorter run-time



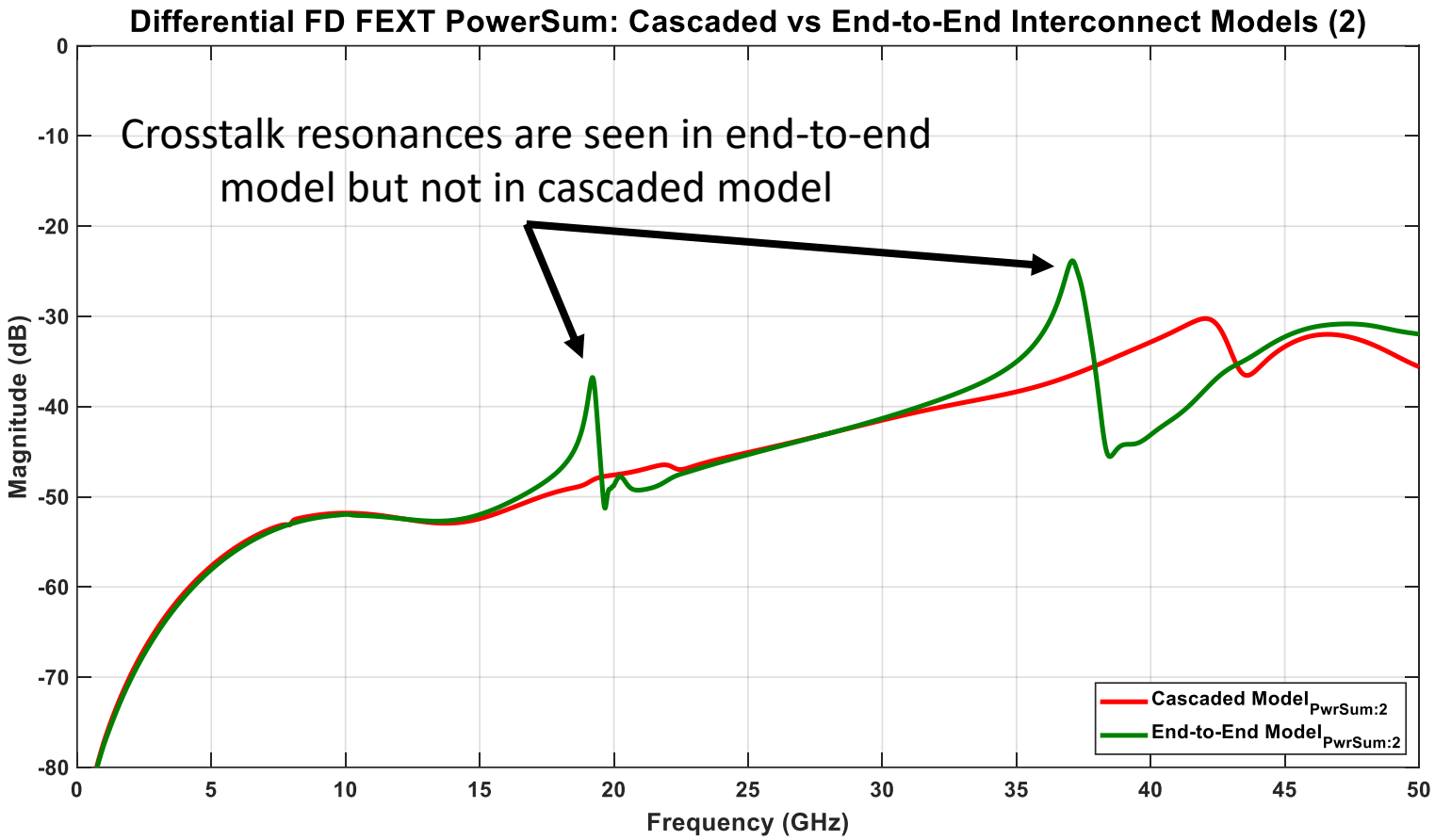
Performance Impact



Performance Impact

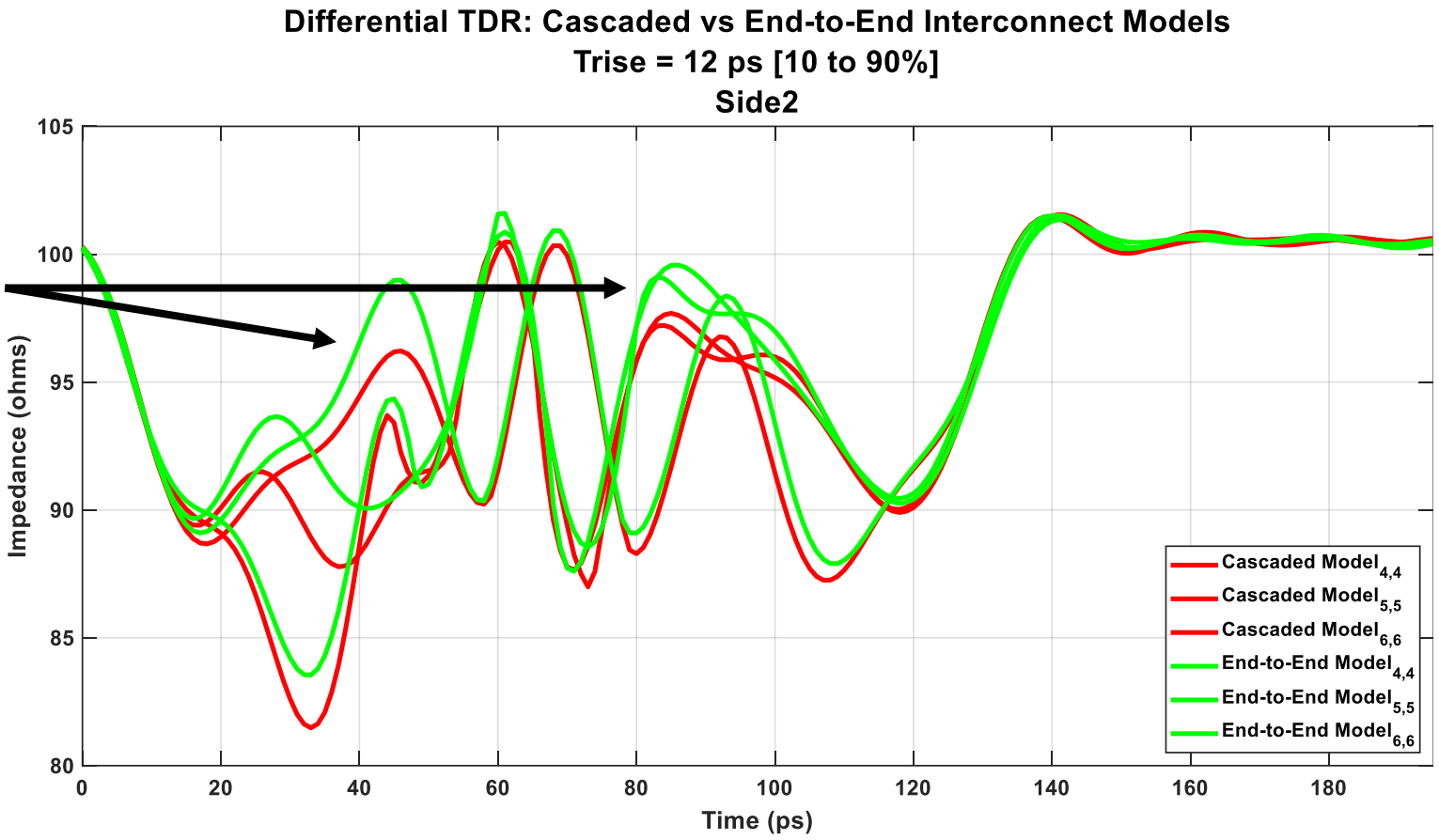


Performance Impact



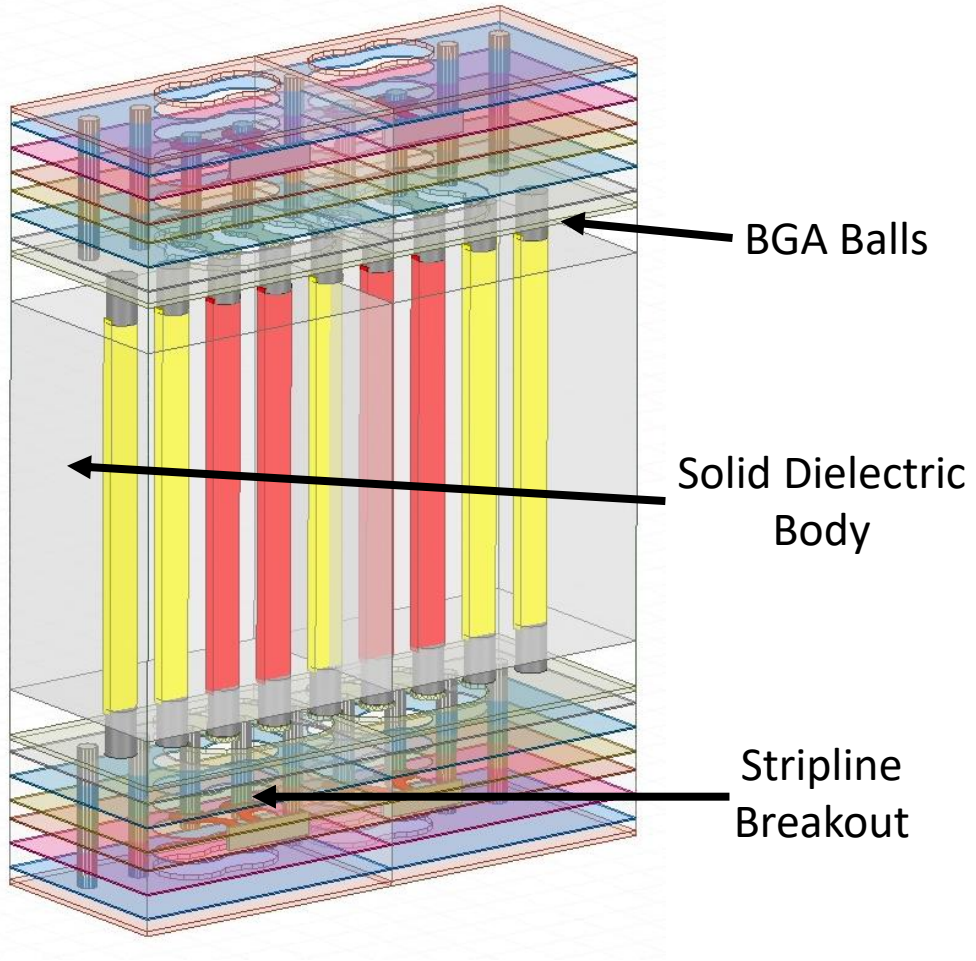
Performance Impact

There is a small impedance impact in the boundary region between the models, which is instead continuous in the end-to-end model



Building a Simplified Test Model

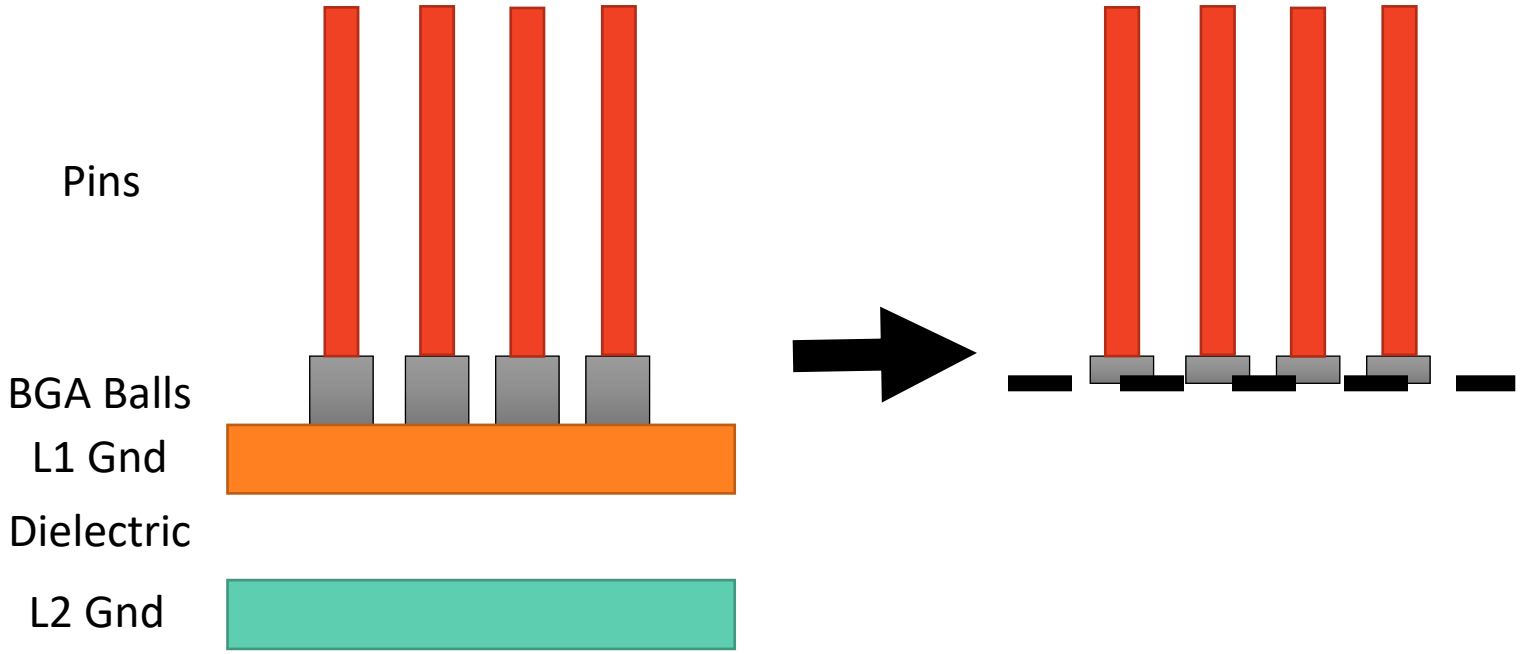
- This model was made to mimic the performance of a real connector
- Design Metrics:
  - 5mm Height
  - BGA Ball Attach
  - Short L1 Microstrip to Via
  - L8 Stripline Routing
- While simplified, this design displays similar characteristics of the real connector shown in previous slides



Isolating the Resonance

CUT AT BGA BALLS

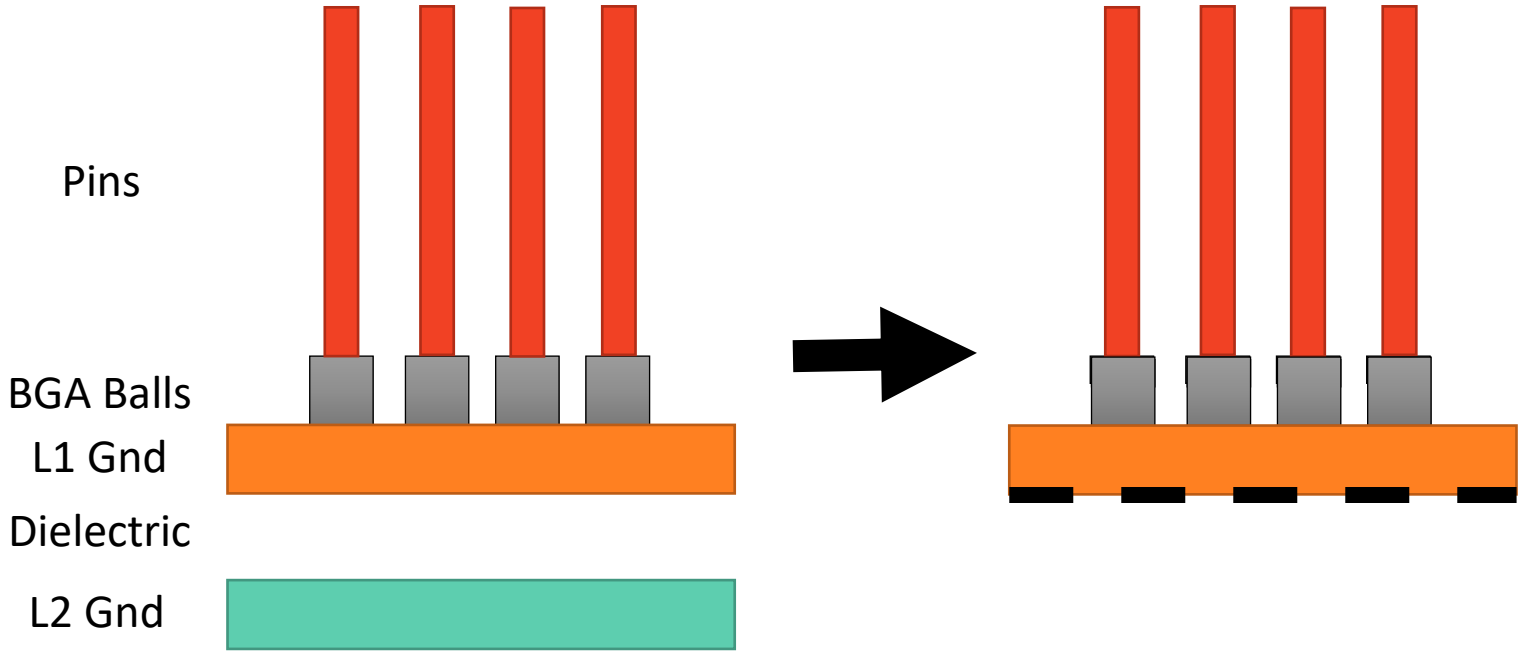
Did Not Resonate



Isolating the Resonance

CUT AT L1 GND PLANE

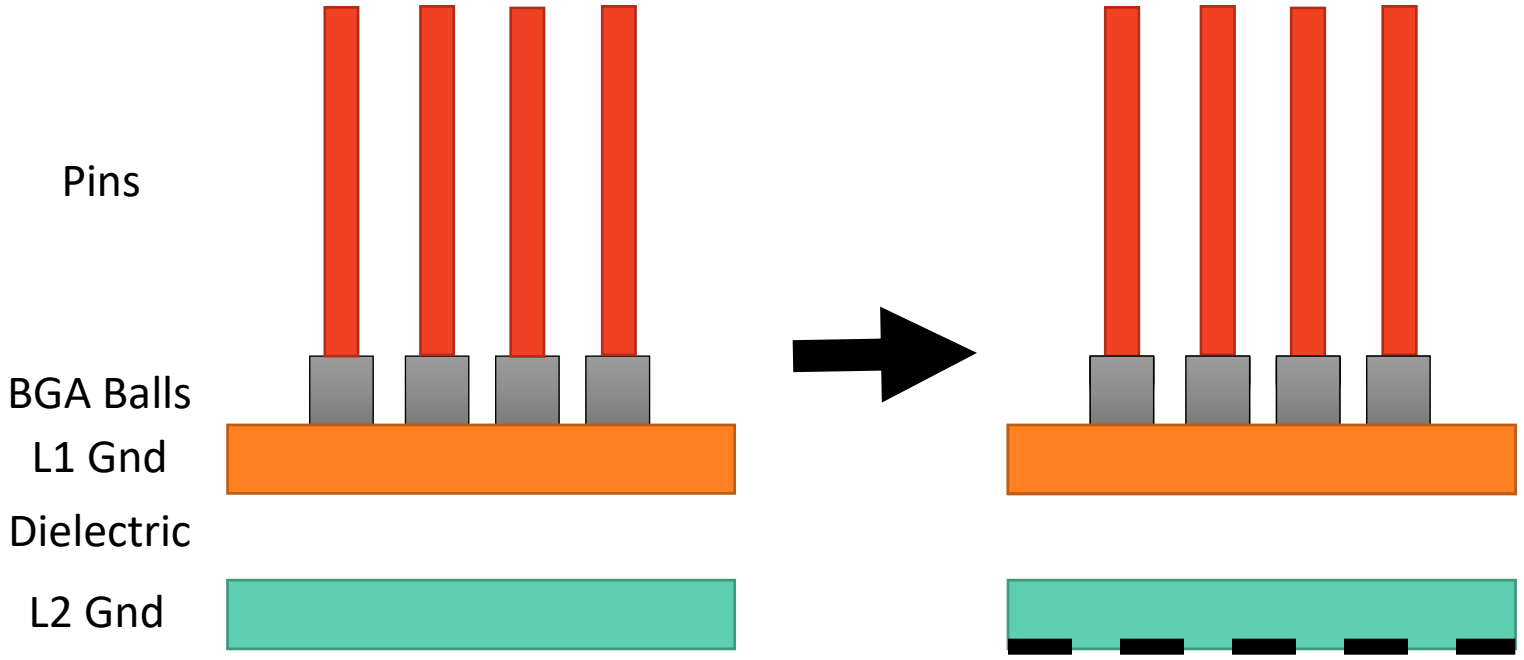
Did Not Resonate



Isolating the Resonance

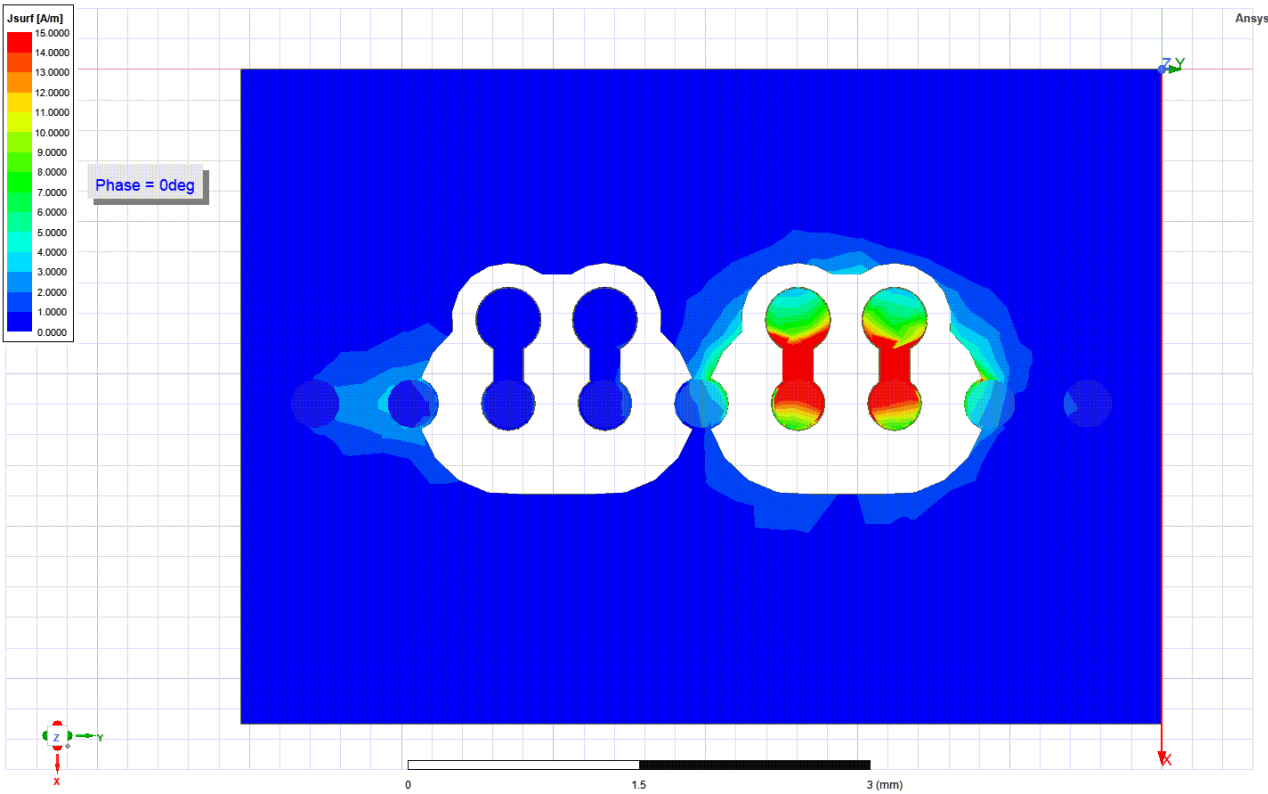
CUT AT L2 GND PLANE

Did Resonate

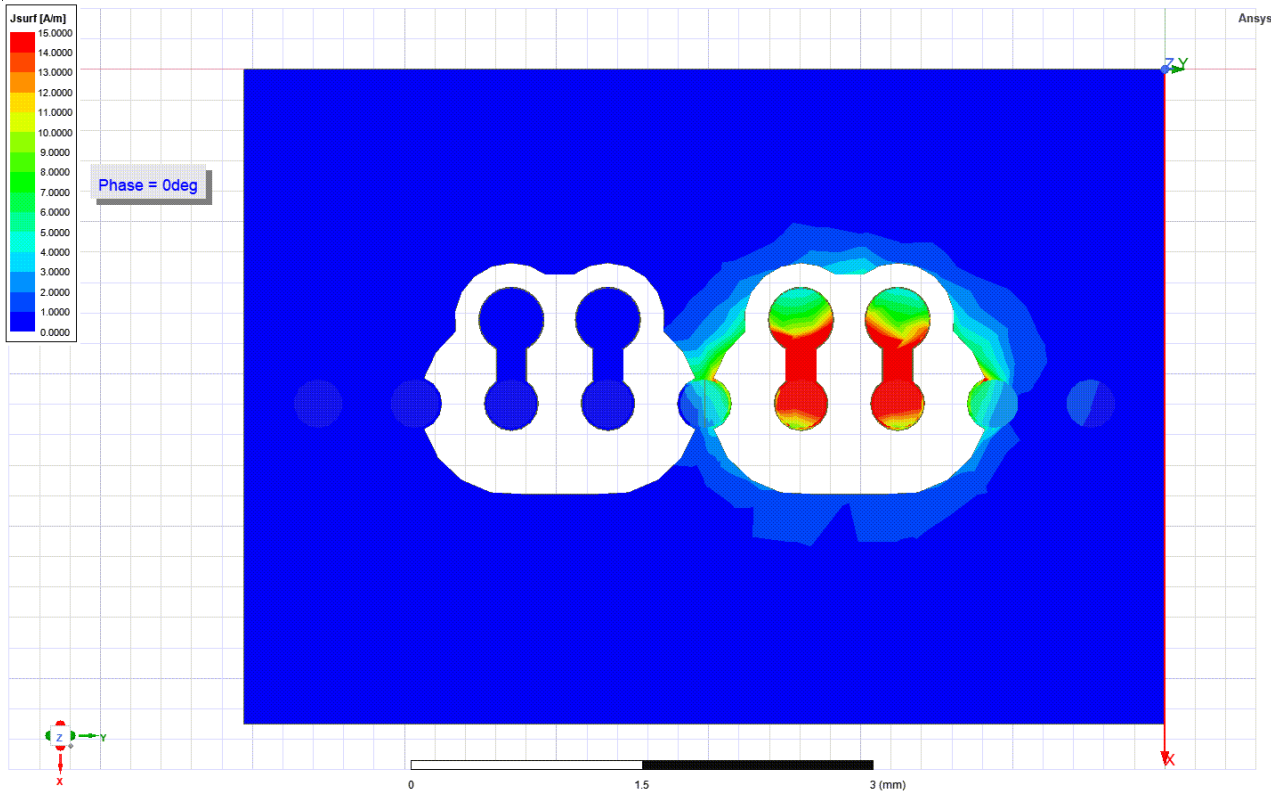


EM-Field Simulations

Simulation with Resonance

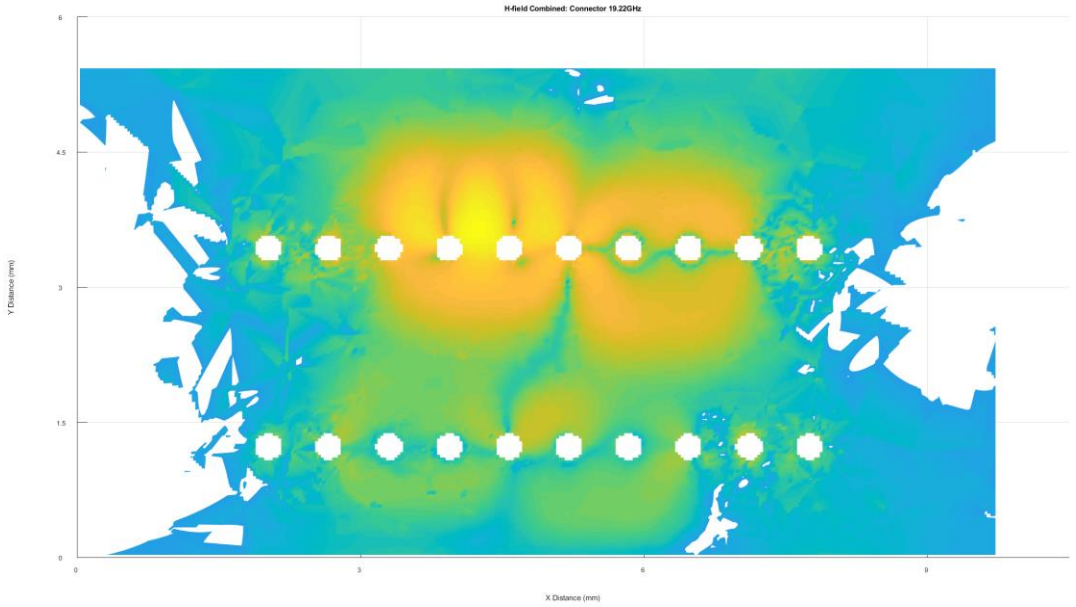


Simulation without Resonance

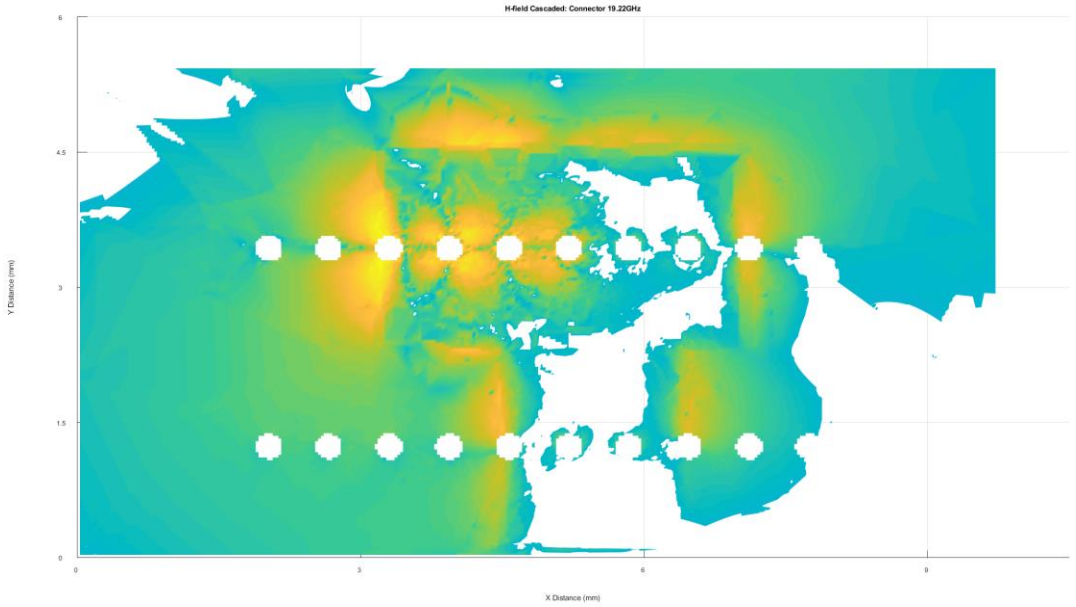


EM-Field Simulations

Simulation with Resonance



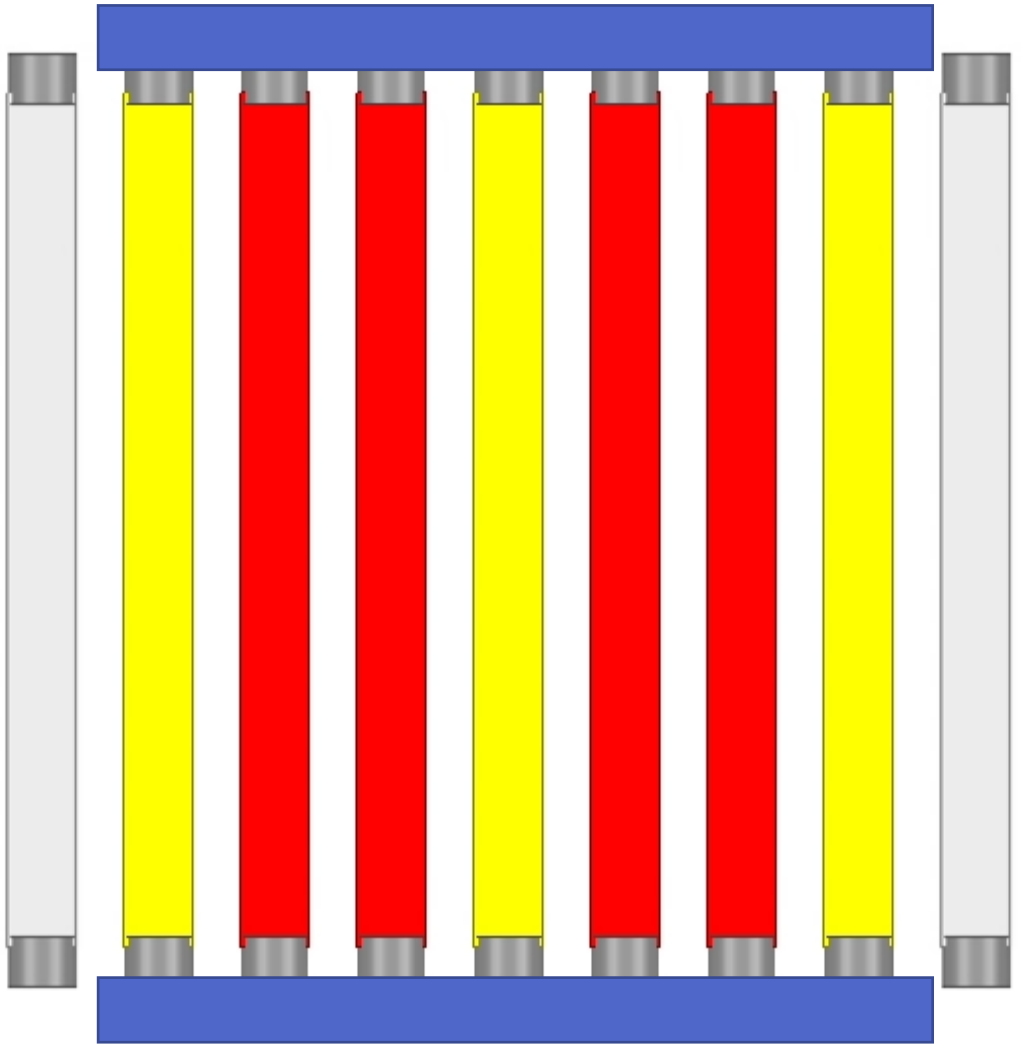
Simulation without Resonance



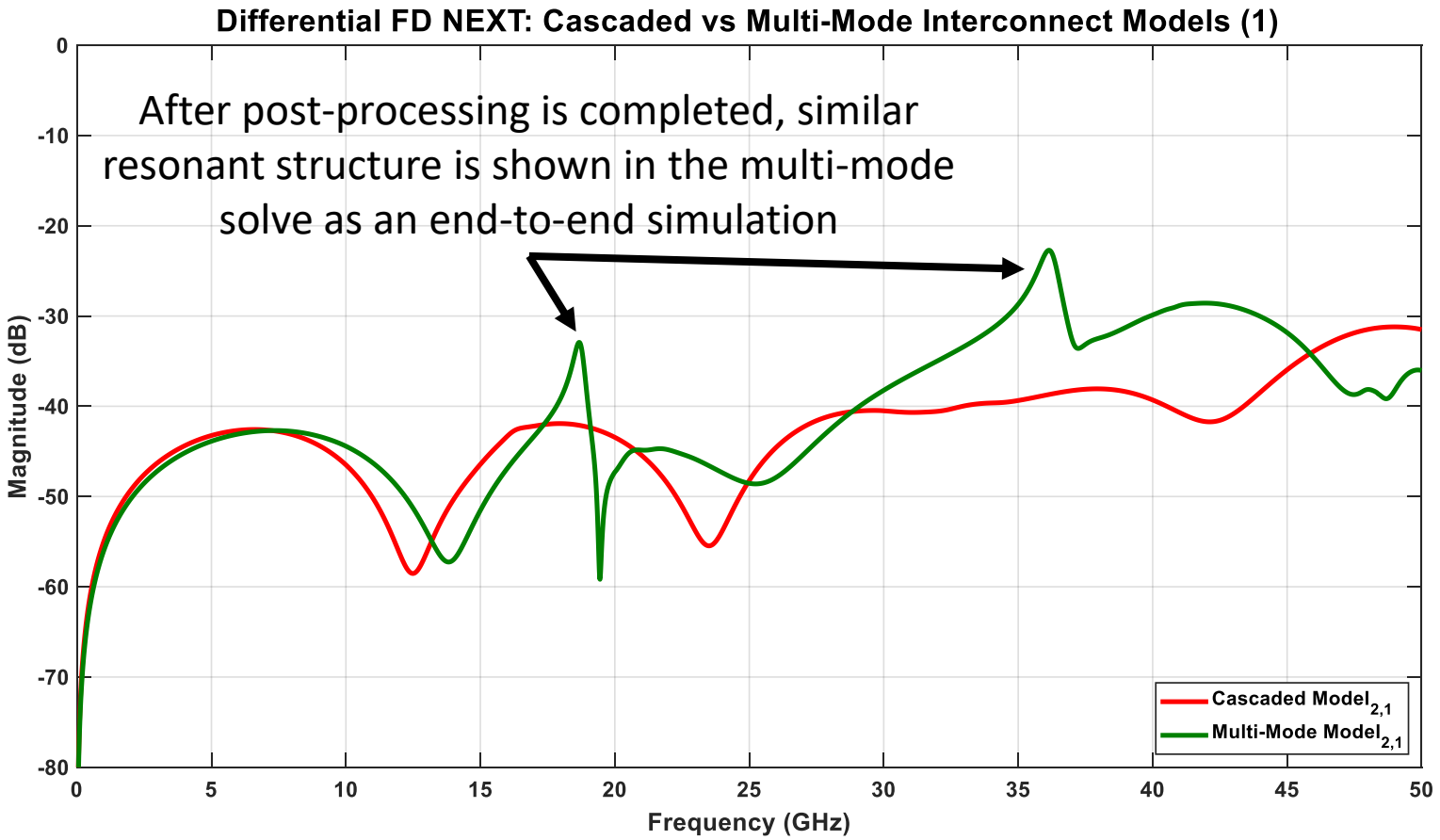
Alternative Methodologies

Multi-Mode Simulation (Single-Port)

- This involves setting all signal and ground pins as signal pins within HFSS
  - After the fact, all ground pins should be connected to each other artificially
- This generally increases simulation time and can cause bugs in simulation accuracy



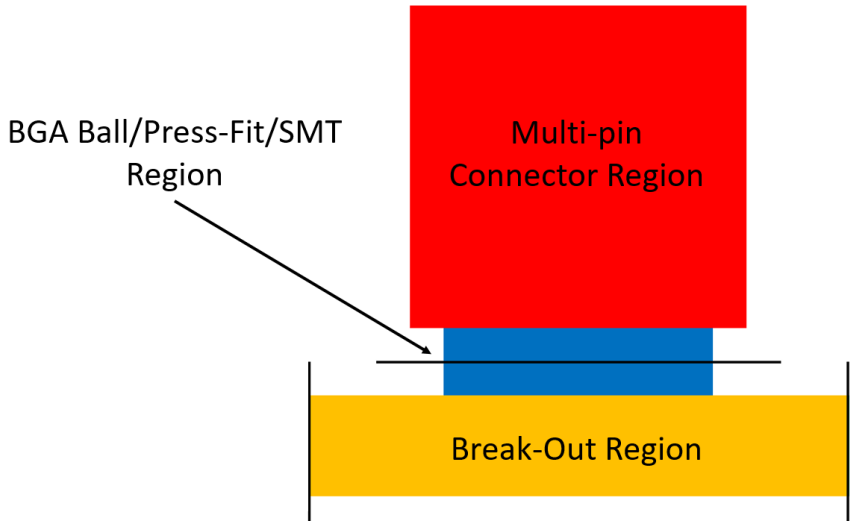
Alternative Methodologies



Alternative Methodologies

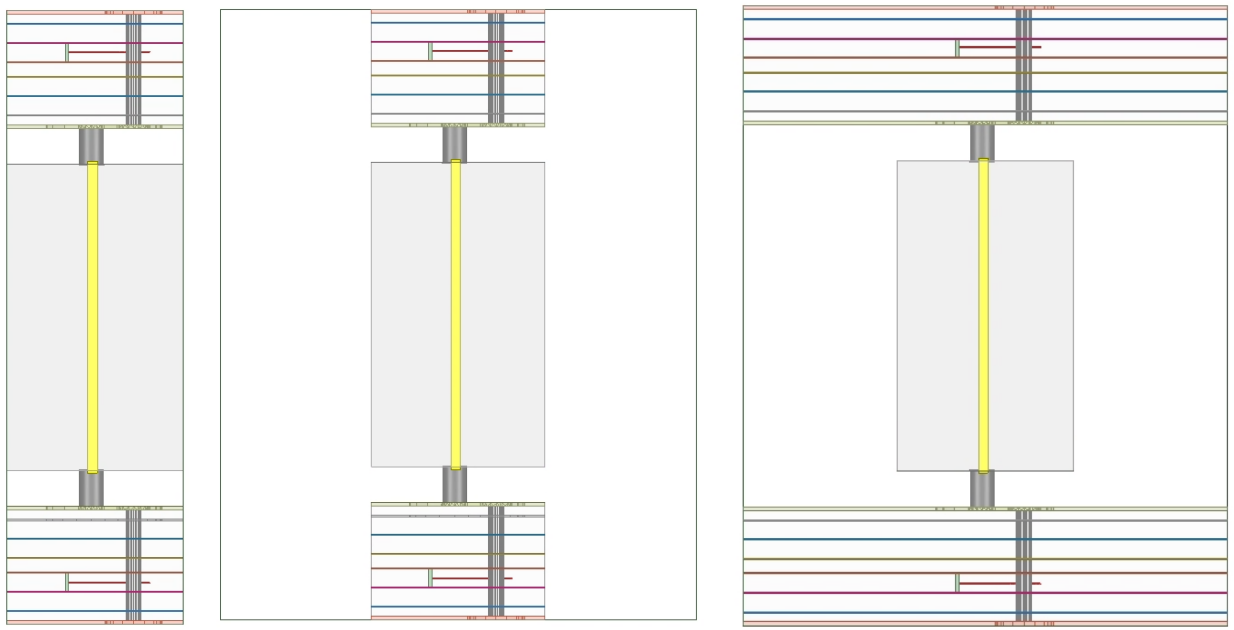
Intermittent Solving

- This is a simulation methodology where cascaded models are run with intermittent end-to-end models
- This is most useful when many simulations need to be run (often for design or optimization work)



Additional Resonance Considerations

- It is important to consider all possible factors which could impact the presence/absence of a resonance
- Some possible factors:
  - Airbox boundary type
  - Airbox location
  - Size of ground planes
  - Impedance boundaries on unused pins
  - Via location in board
  - Grounding top plane of board



Summary of Results

- For best accuracy, run an end-to-end simulation
- For fastest results, run a cascaded simulation

- Always keep in mind the potential simulation parameters that could impact the impedance and resonances of your results
- Analyzing the EM-fields can determine if the simulation design is improperly representing the simulation space

- Consider what physical geometry is causing a resonance when addressing it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