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Single Ended Analysis in a Differential World

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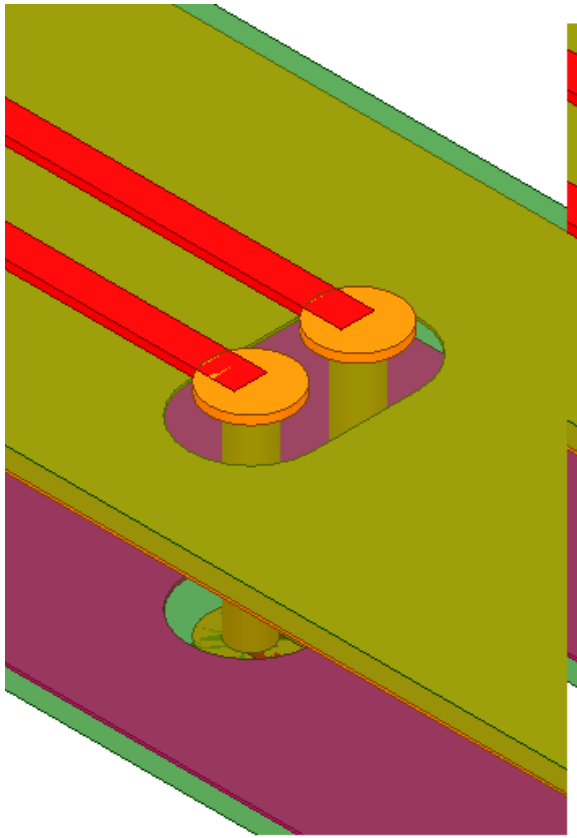
Overview

- Objective: Highlight cases where single ended analysis can help in a differential environment

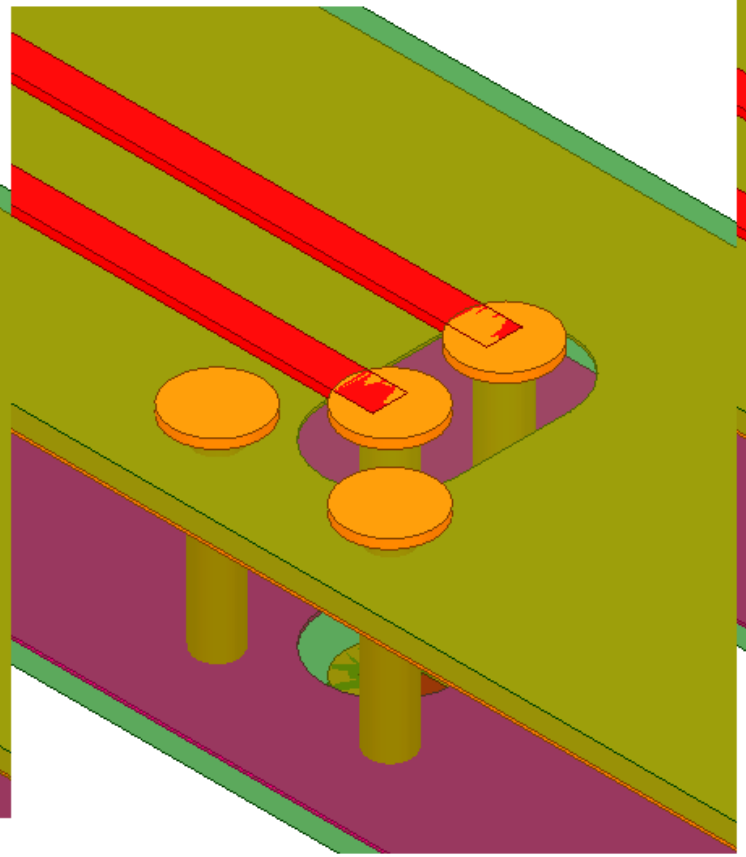
- 3 use cases to illustrate singe ended benefits
  - Differential Via transitions through a PCB
    - Differing quantities of reference vias
  - Differential trace with a power plane
    - Adding a power plane to a differential via transition
    - Changing the quantity of neighboring vias between power/gnd
  - Length matching methods
    - Trace humps of differing quantity and a serpentine
    - When does length match skew impact results?

Differential Via Balance

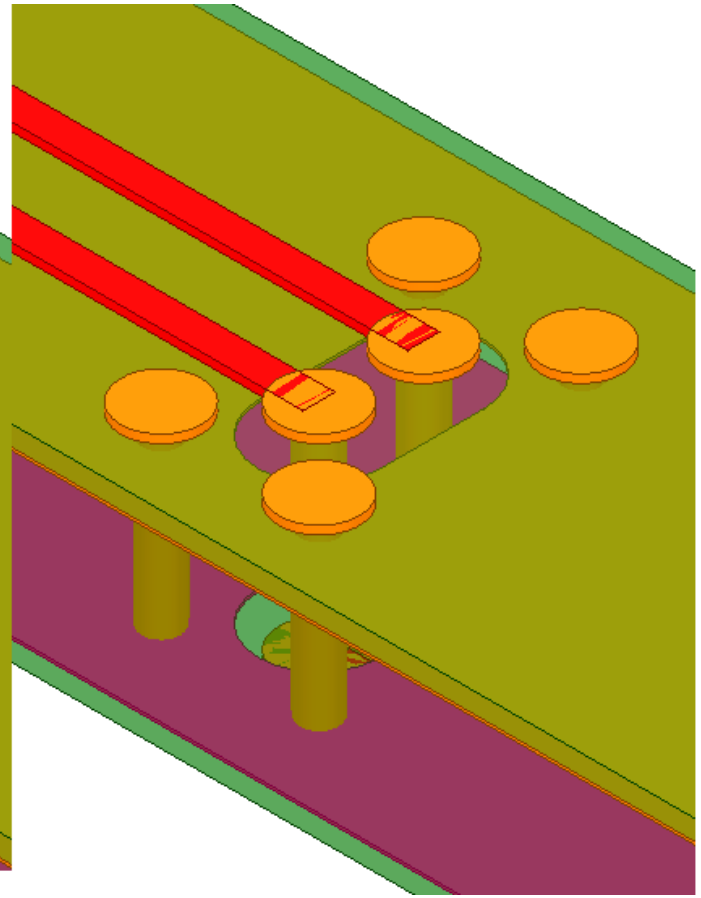
No Reference Vias



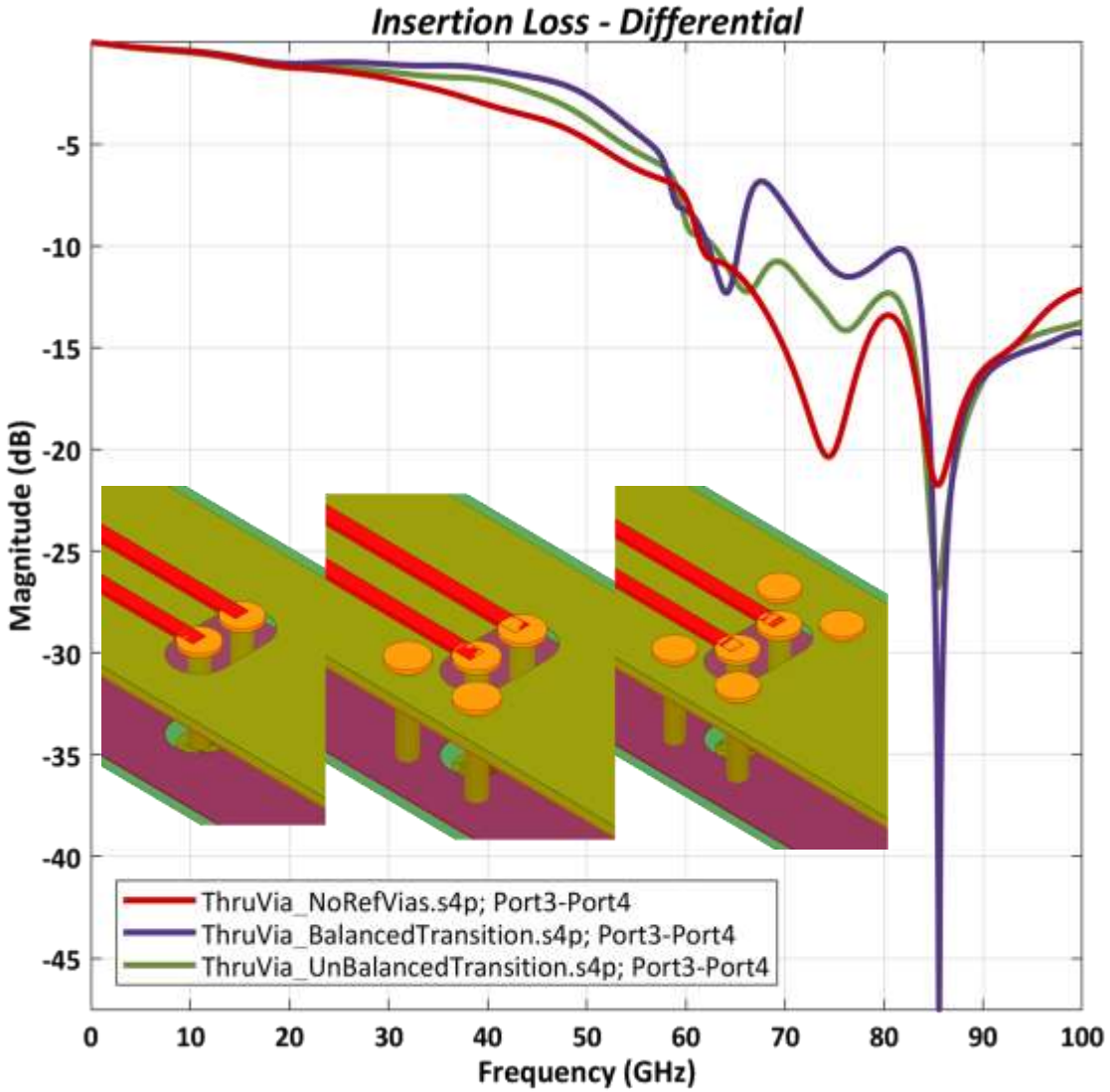
Unbalanced Reference Vias



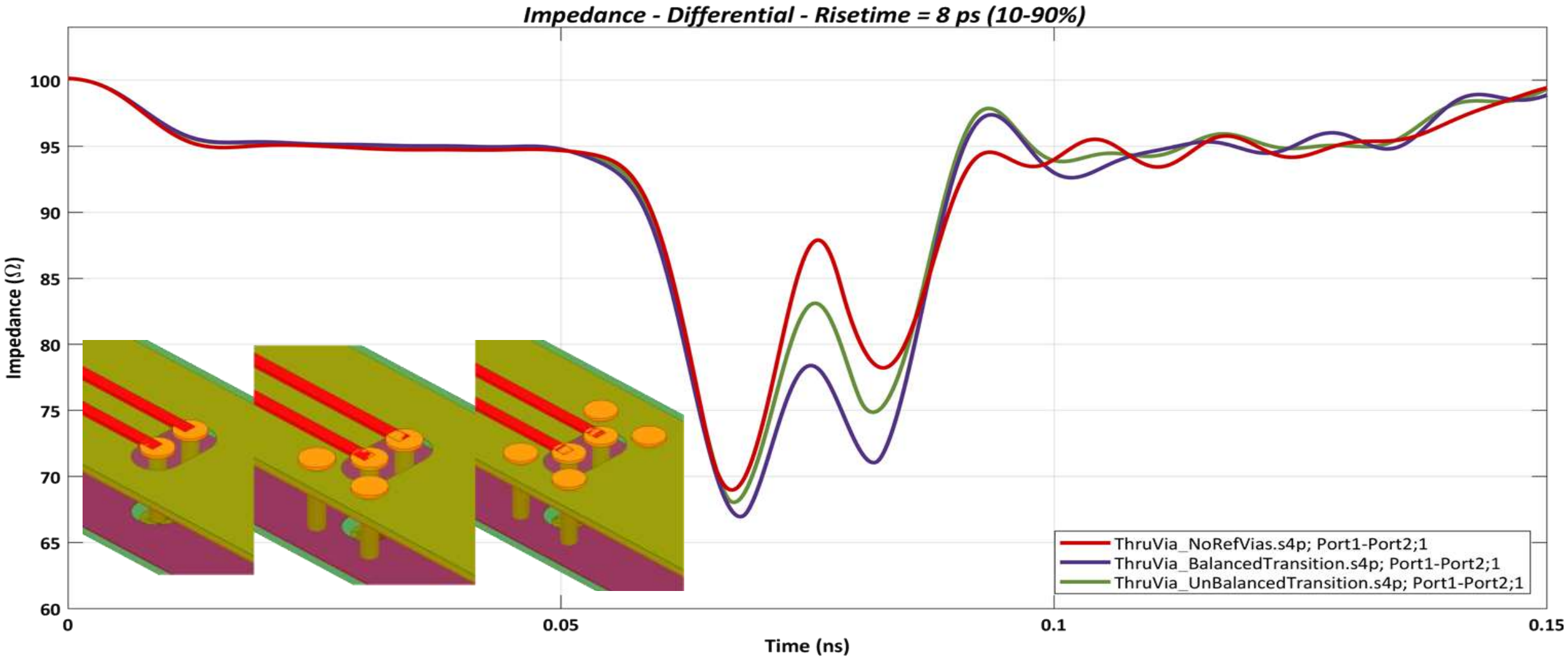
Balanced Reference Vias



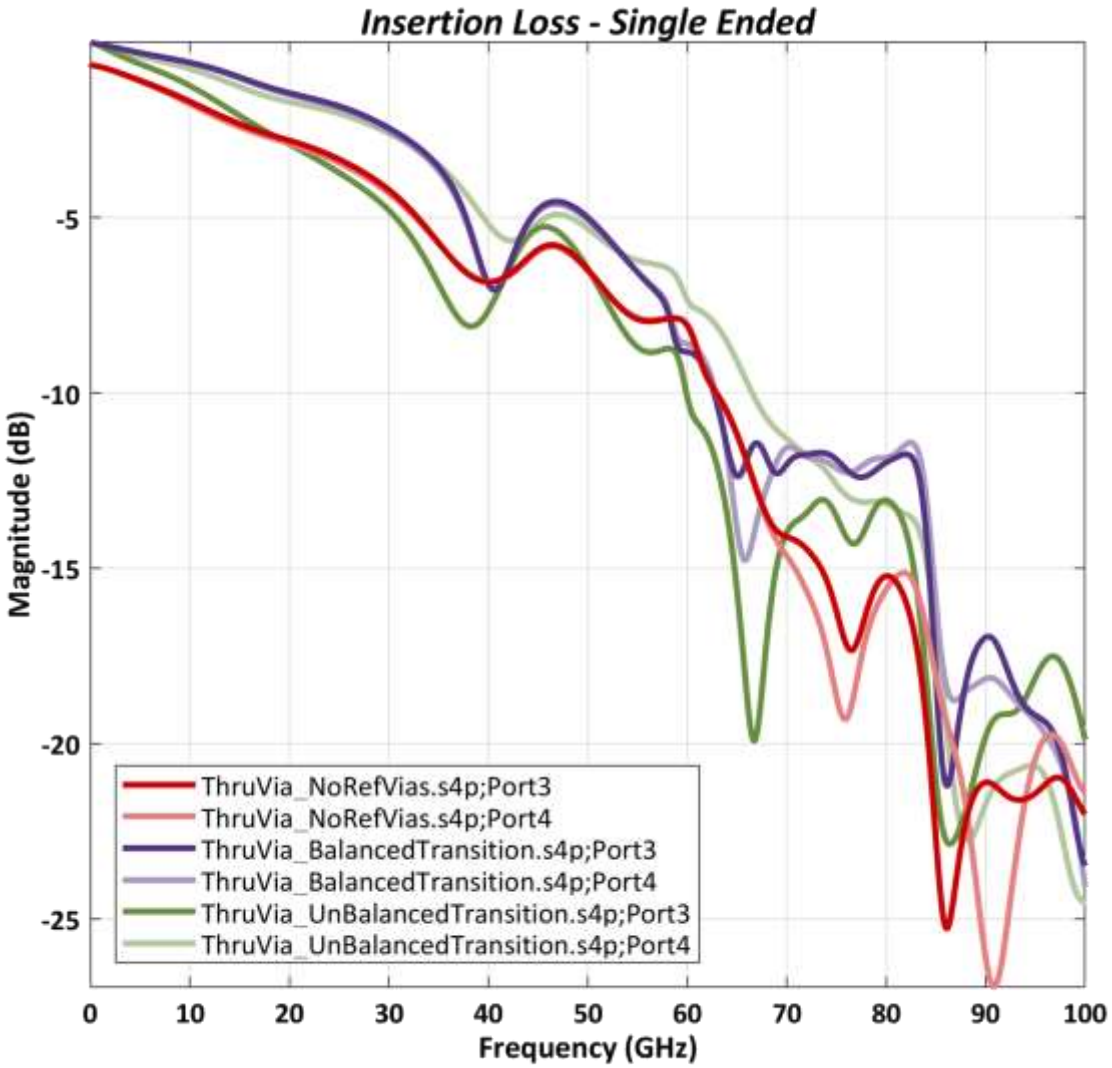
Differential Via Balance

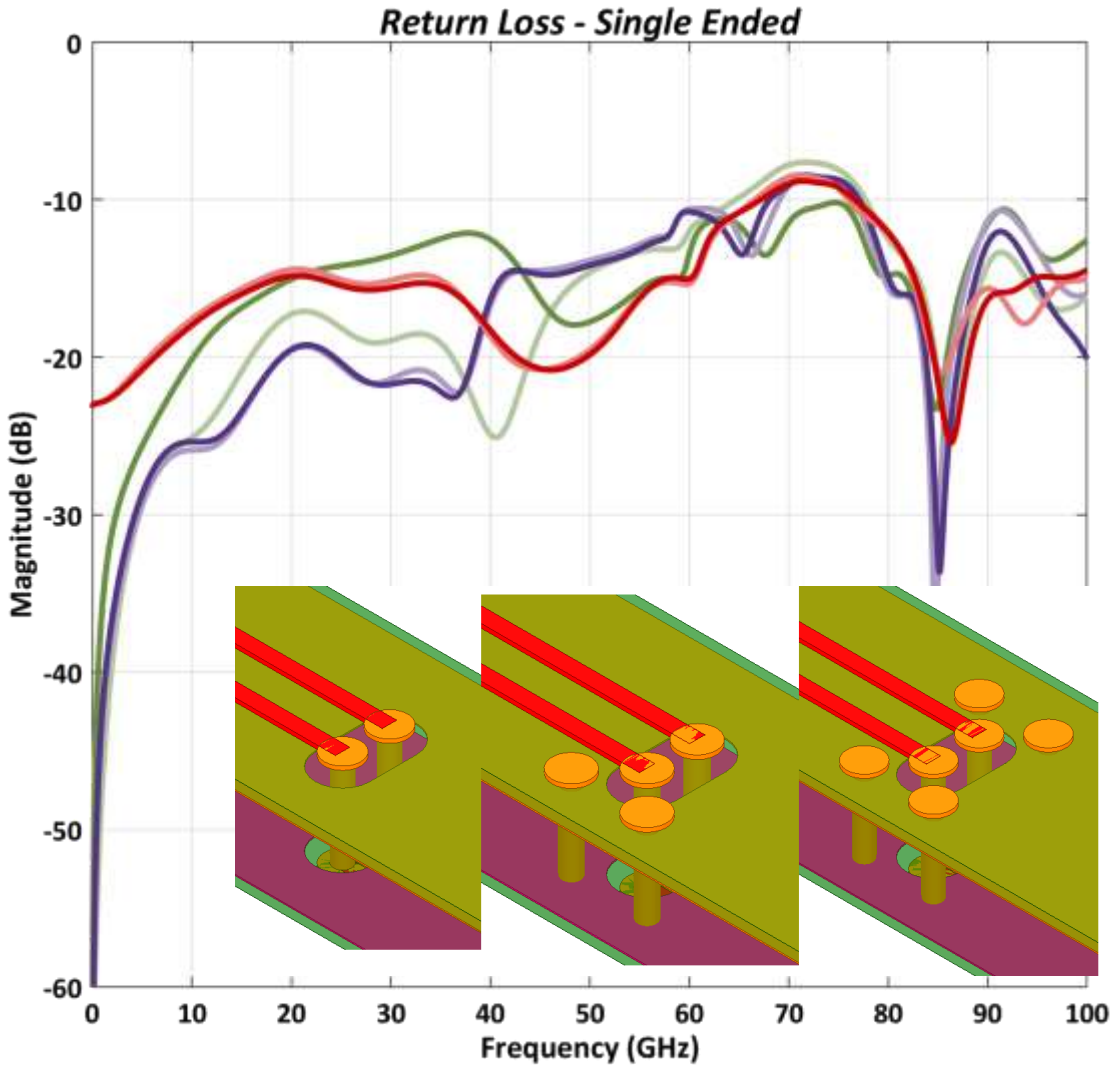


Differential Via Balance

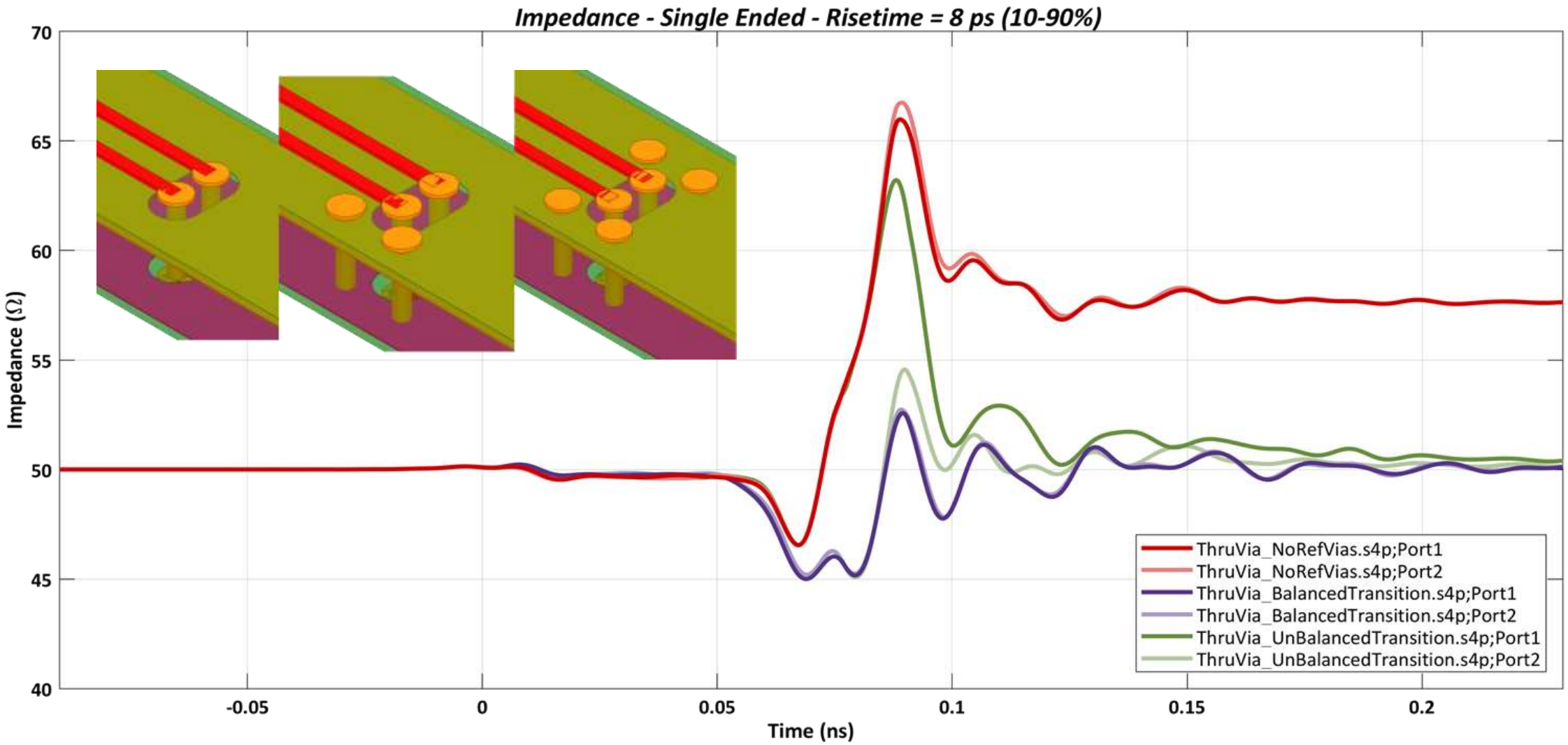


Differential Via Balance

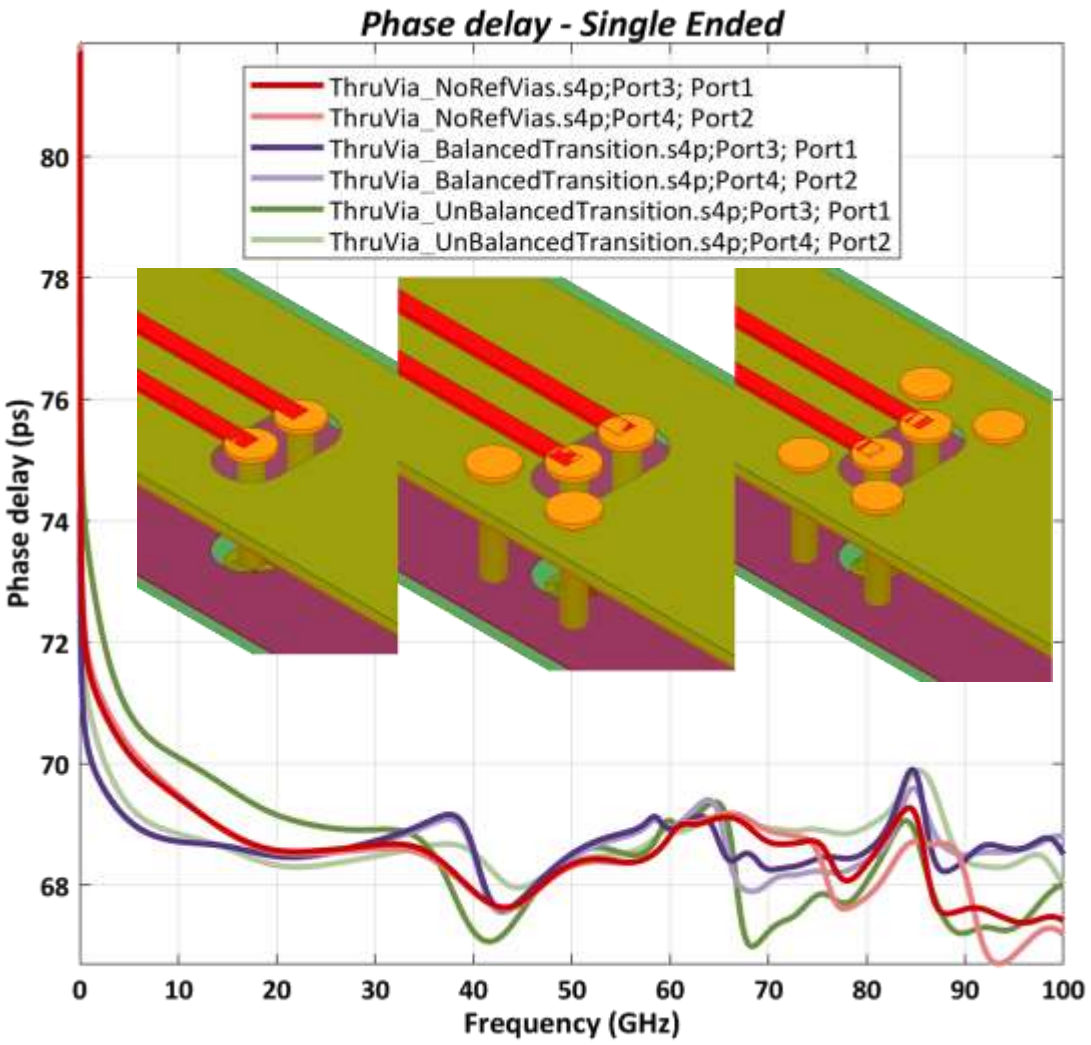


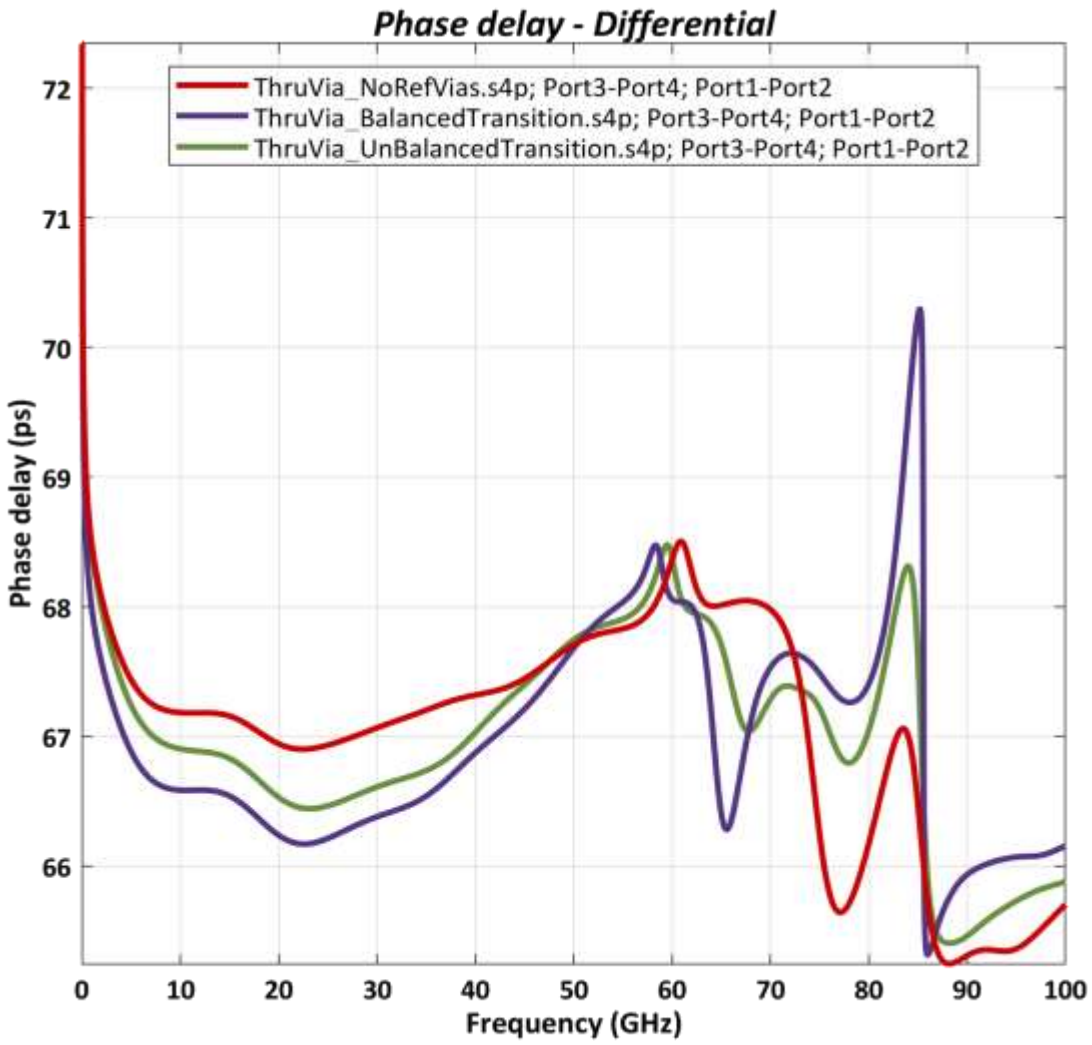


Differential Via Balance



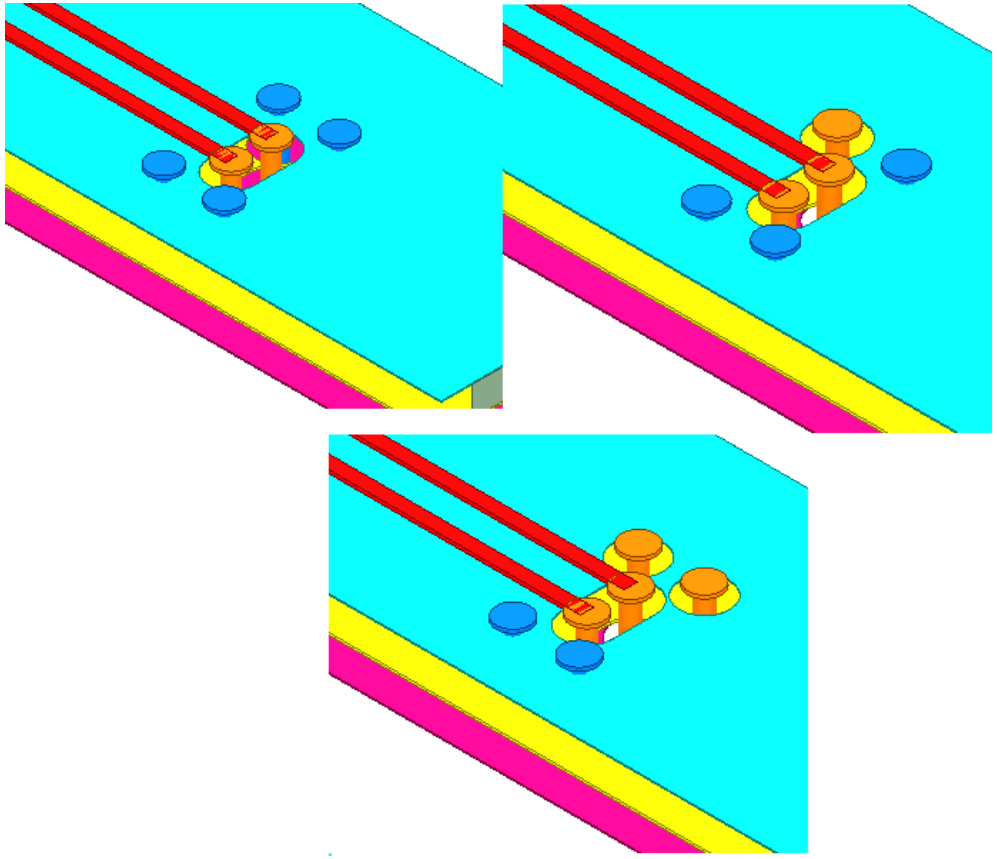
Differential Via Balance



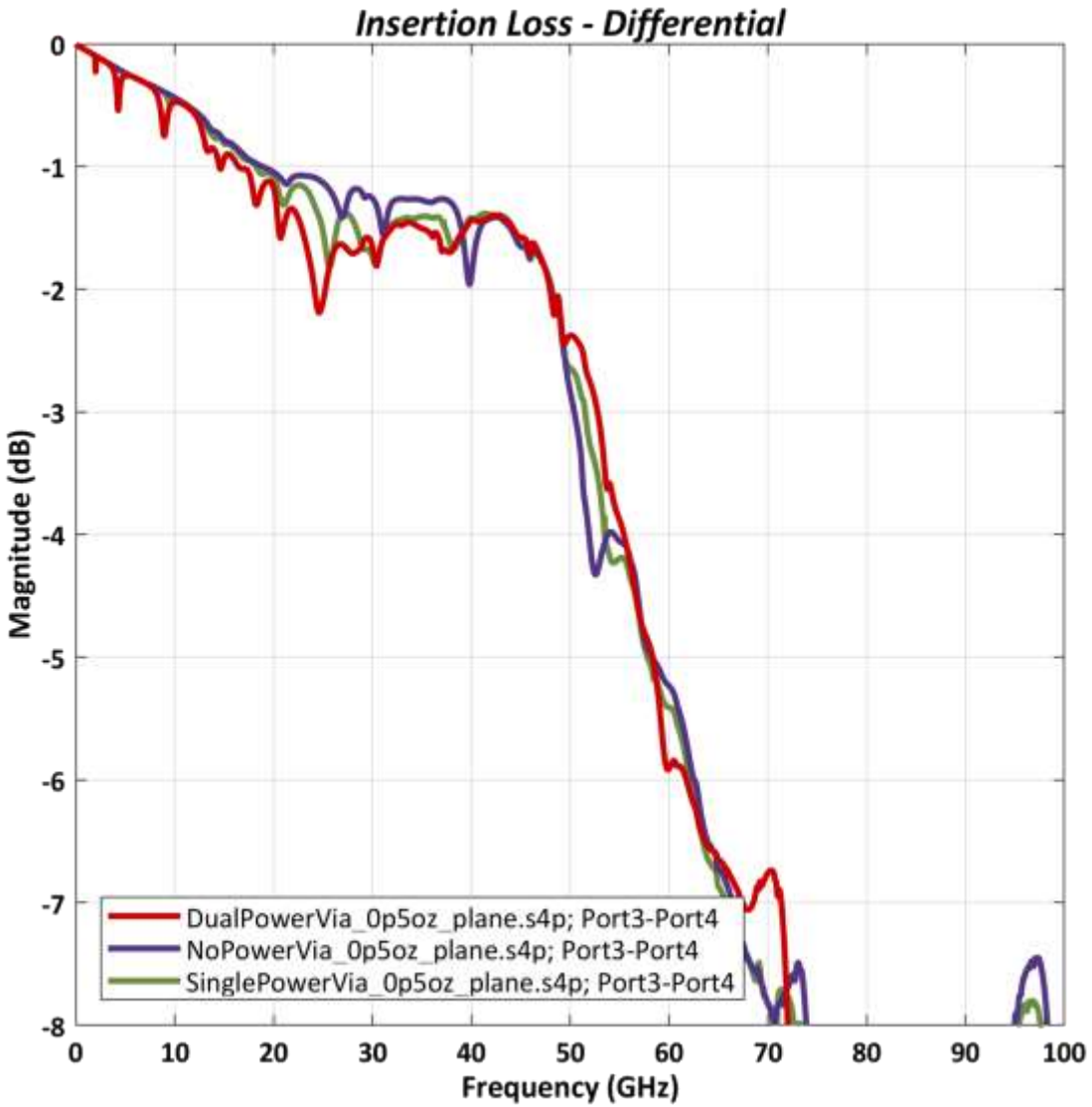


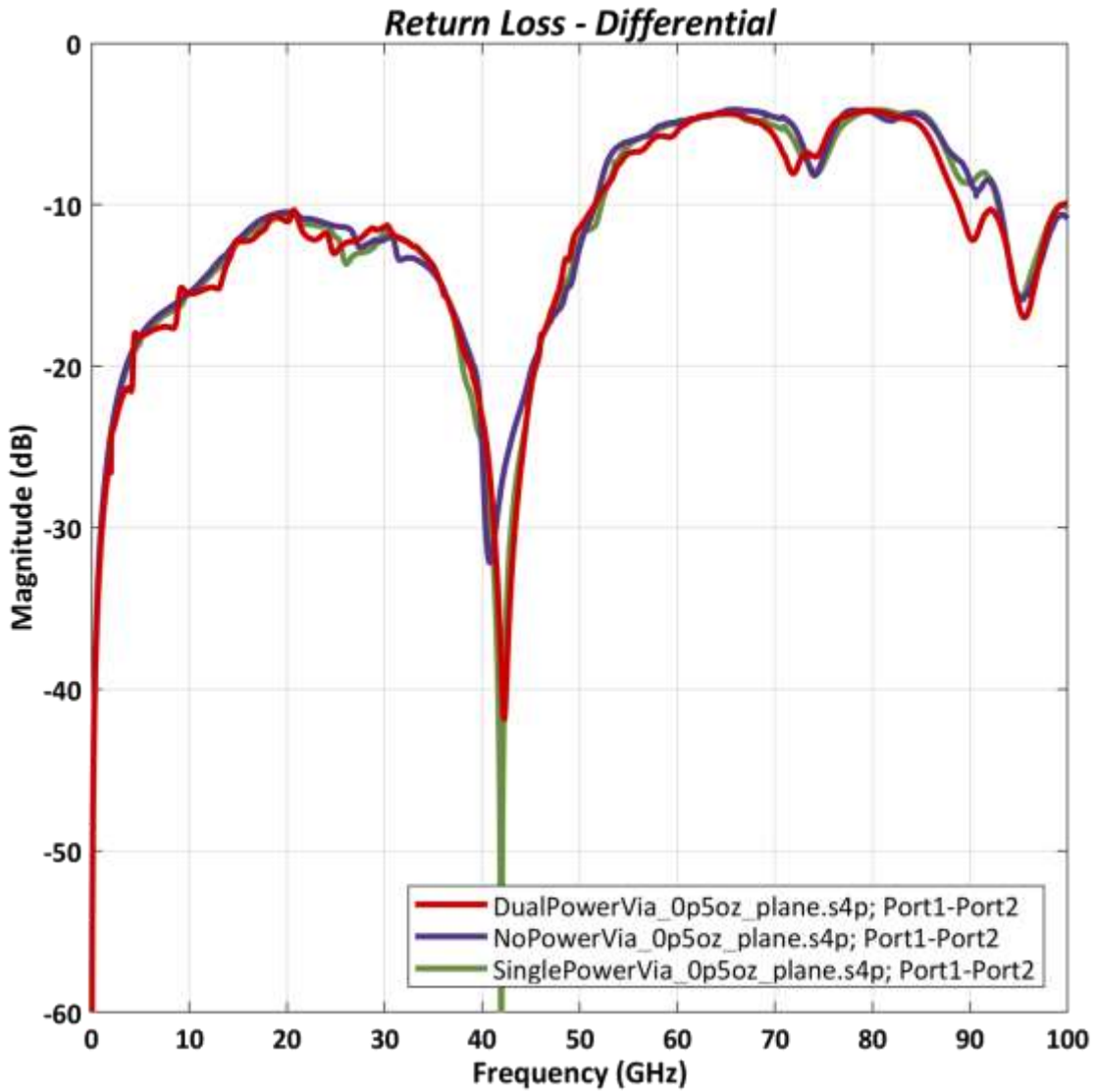
Differential Transition With Power Plane

- Using the previous example let's add in a power plane
  - Plane sits at the midpoint between the two ground planes
  - Void in the power plane for thru vias same dimensions as the ground plane void
  - DC voltage applied to one side of the plane, decoupling cap applied on the other side
    - Cap value = 1.0 pF
  - 3 cases simulated including the power plane
    - All surrounding vias attached to ground
    - 3 vias tied to ground, 1 via tied to power
    - 2 vias tied to ground, 2 vias tied to power



Transition with Power Plane





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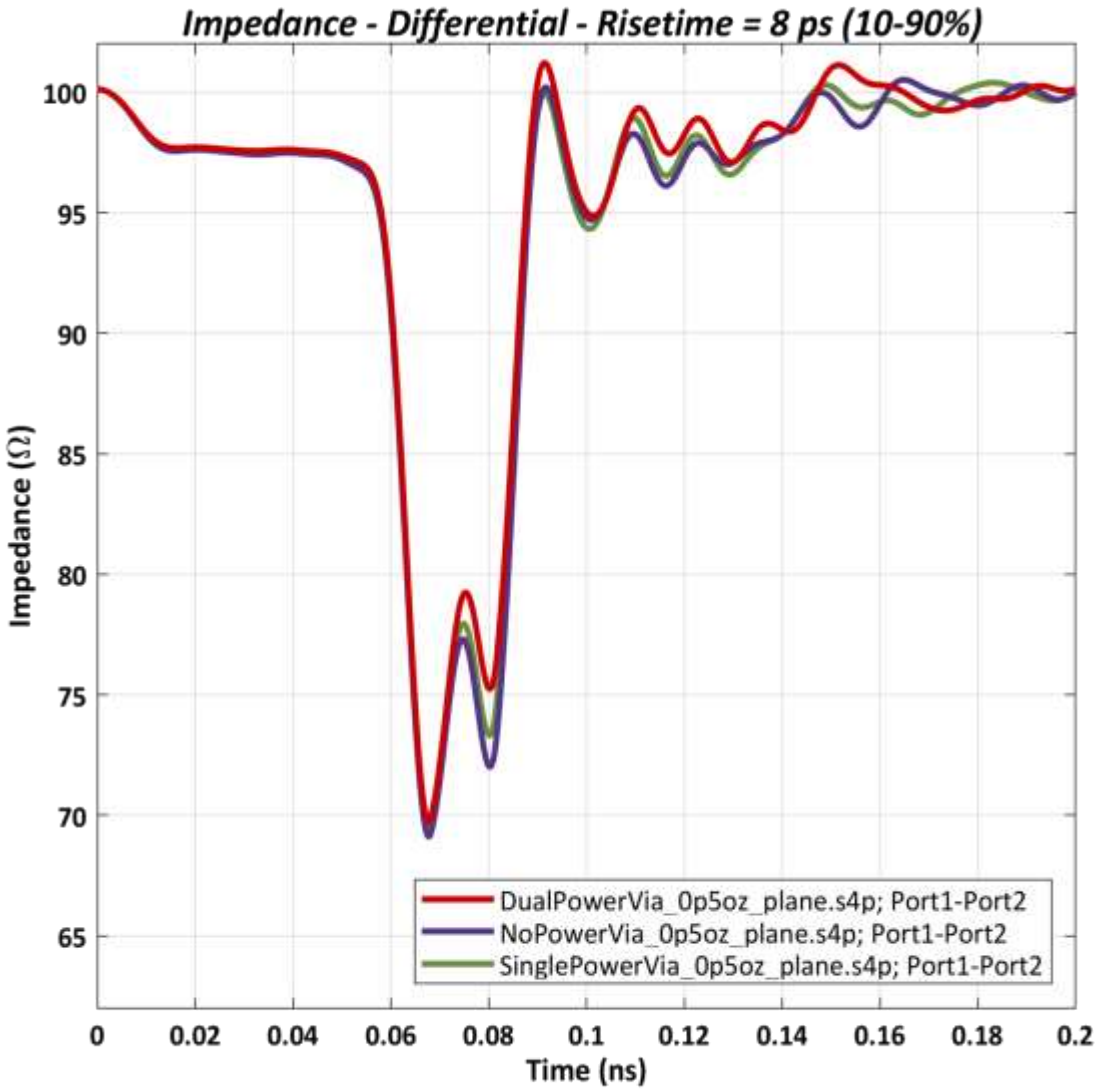
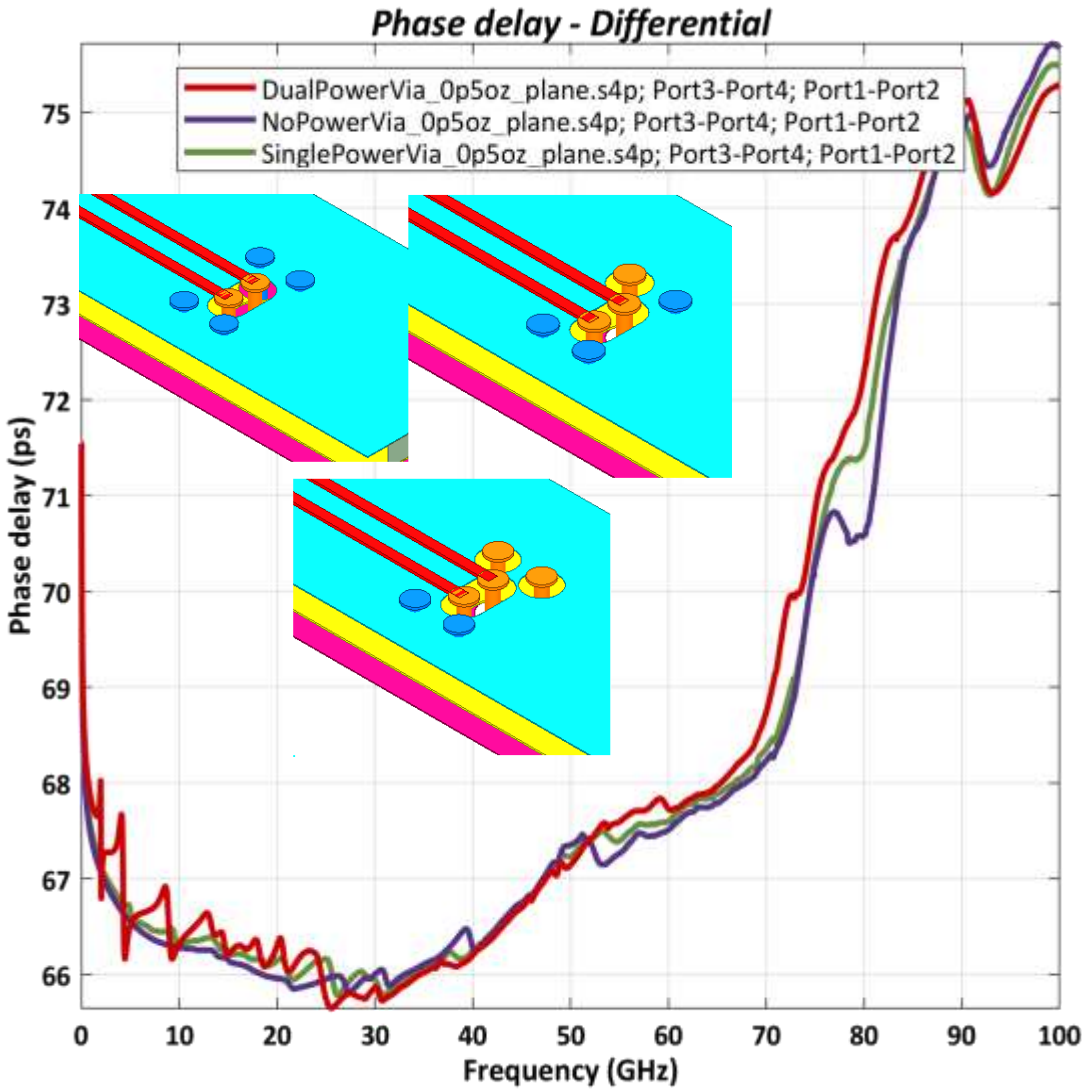
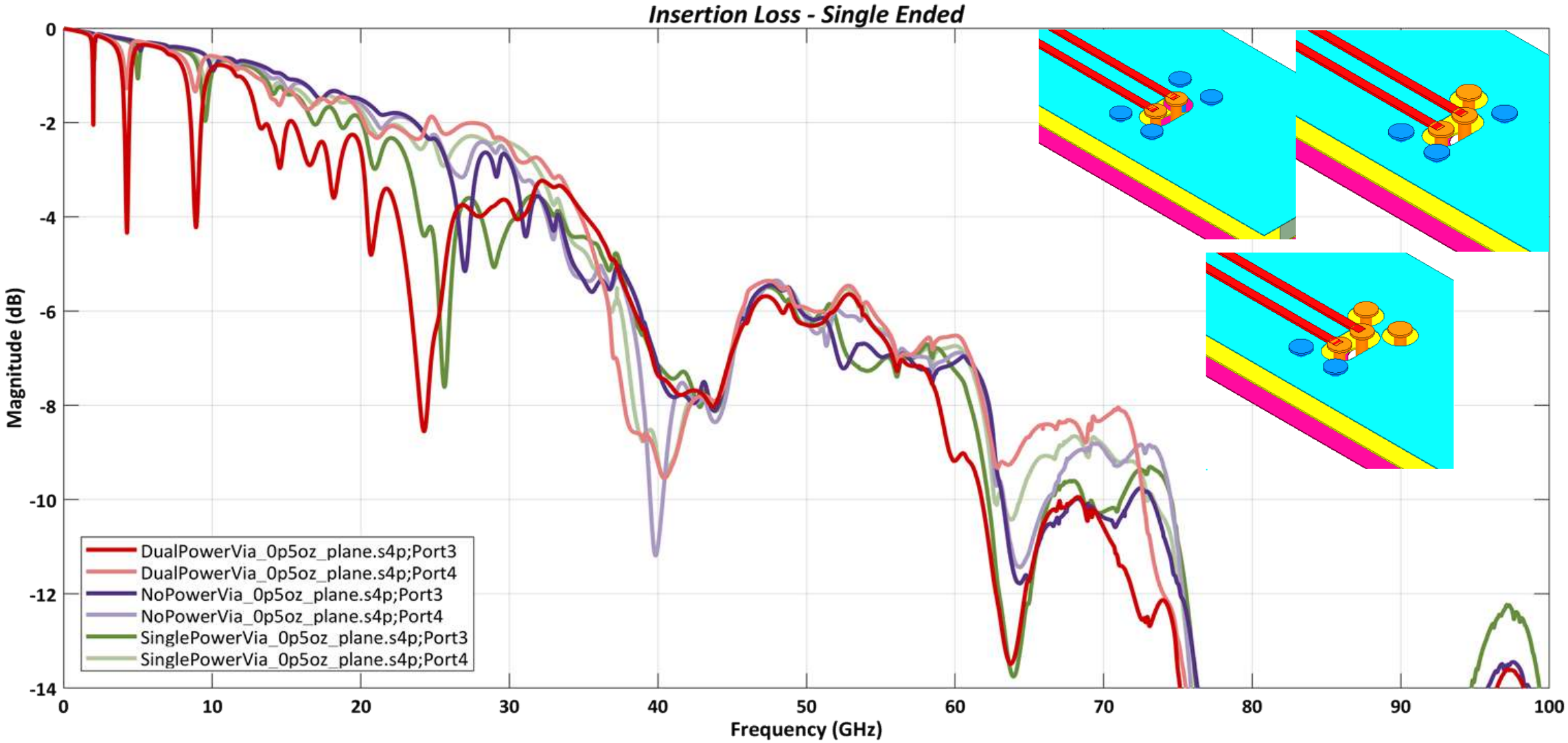




Transition with Power Plane



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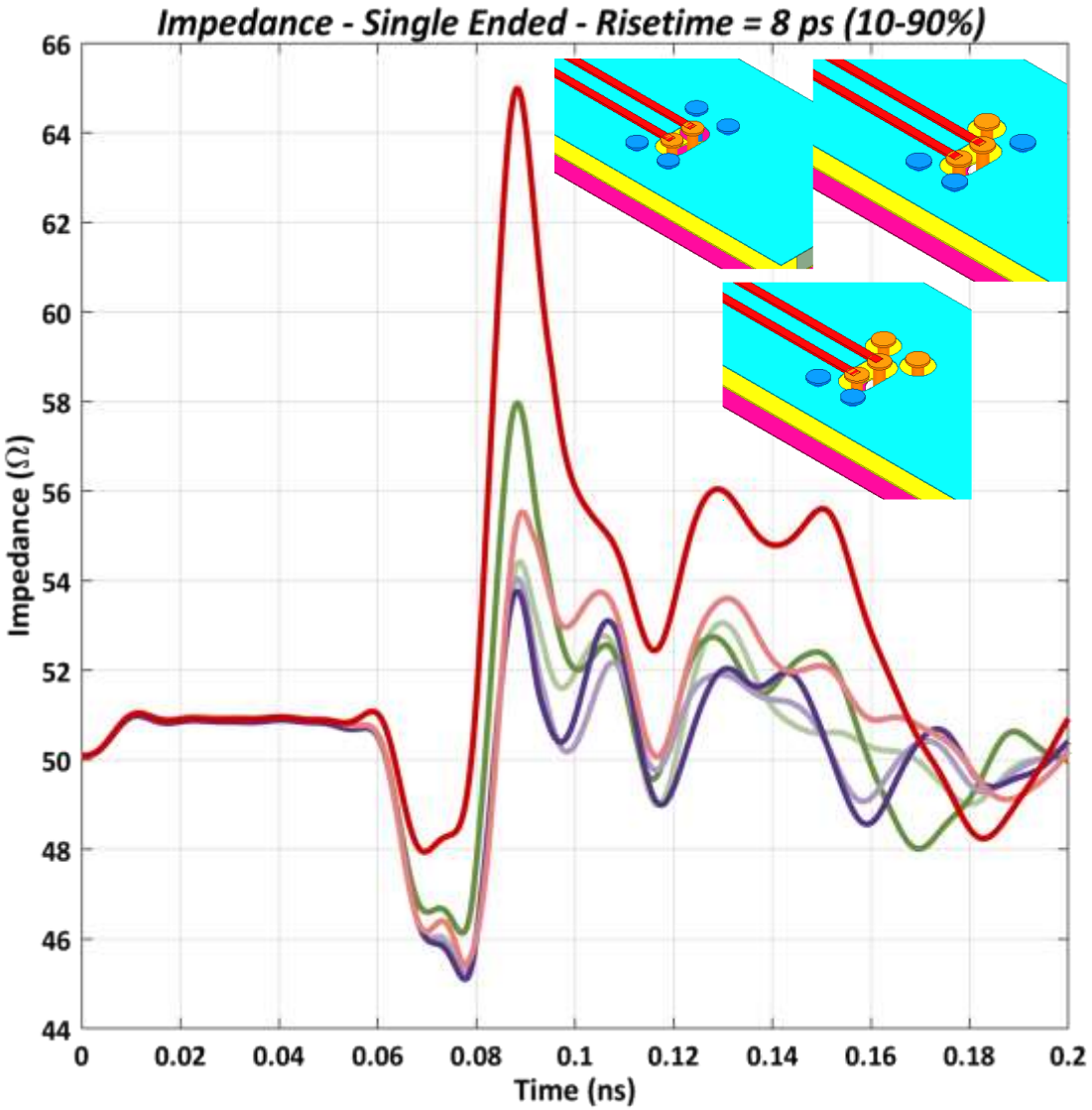

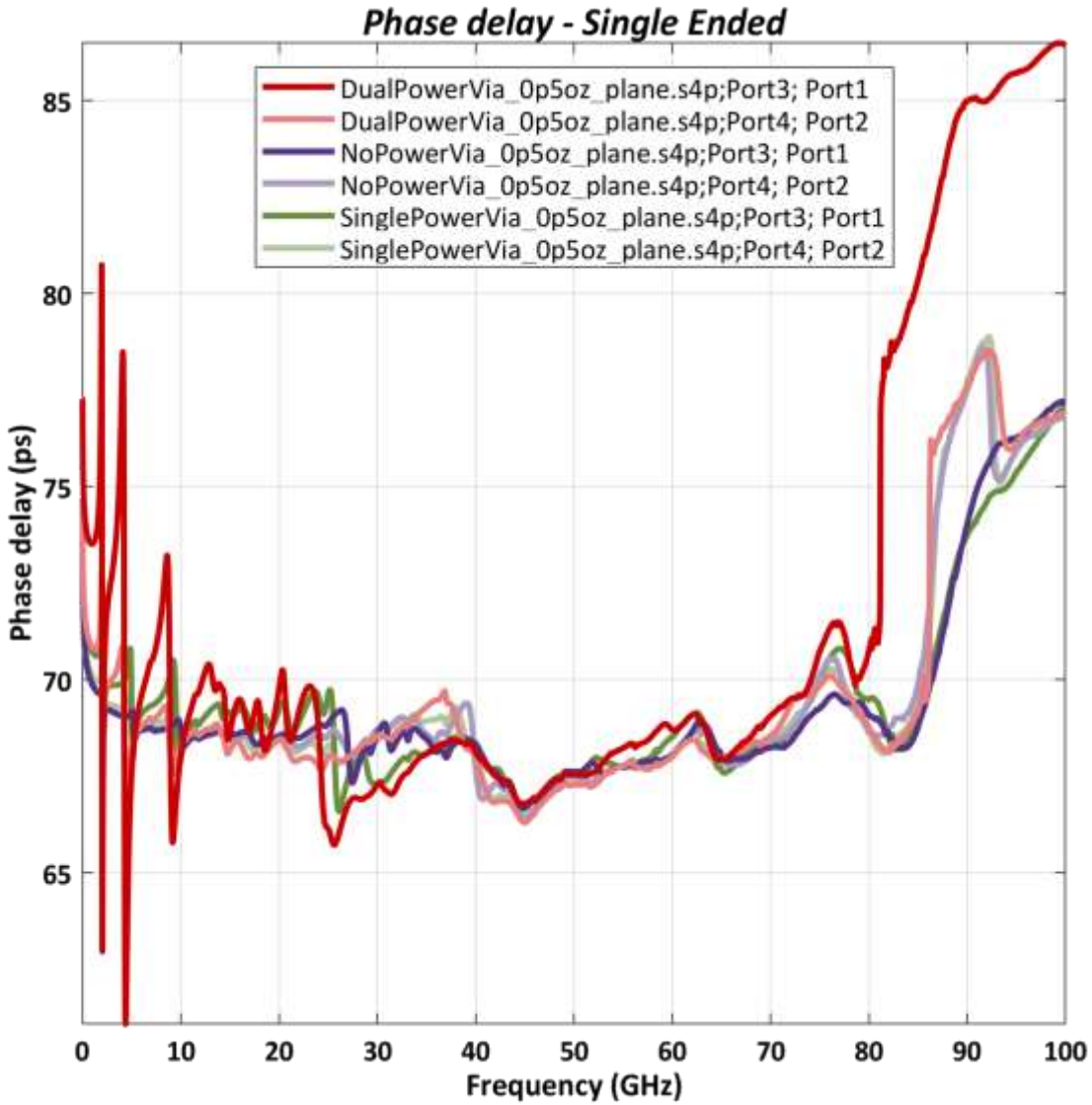

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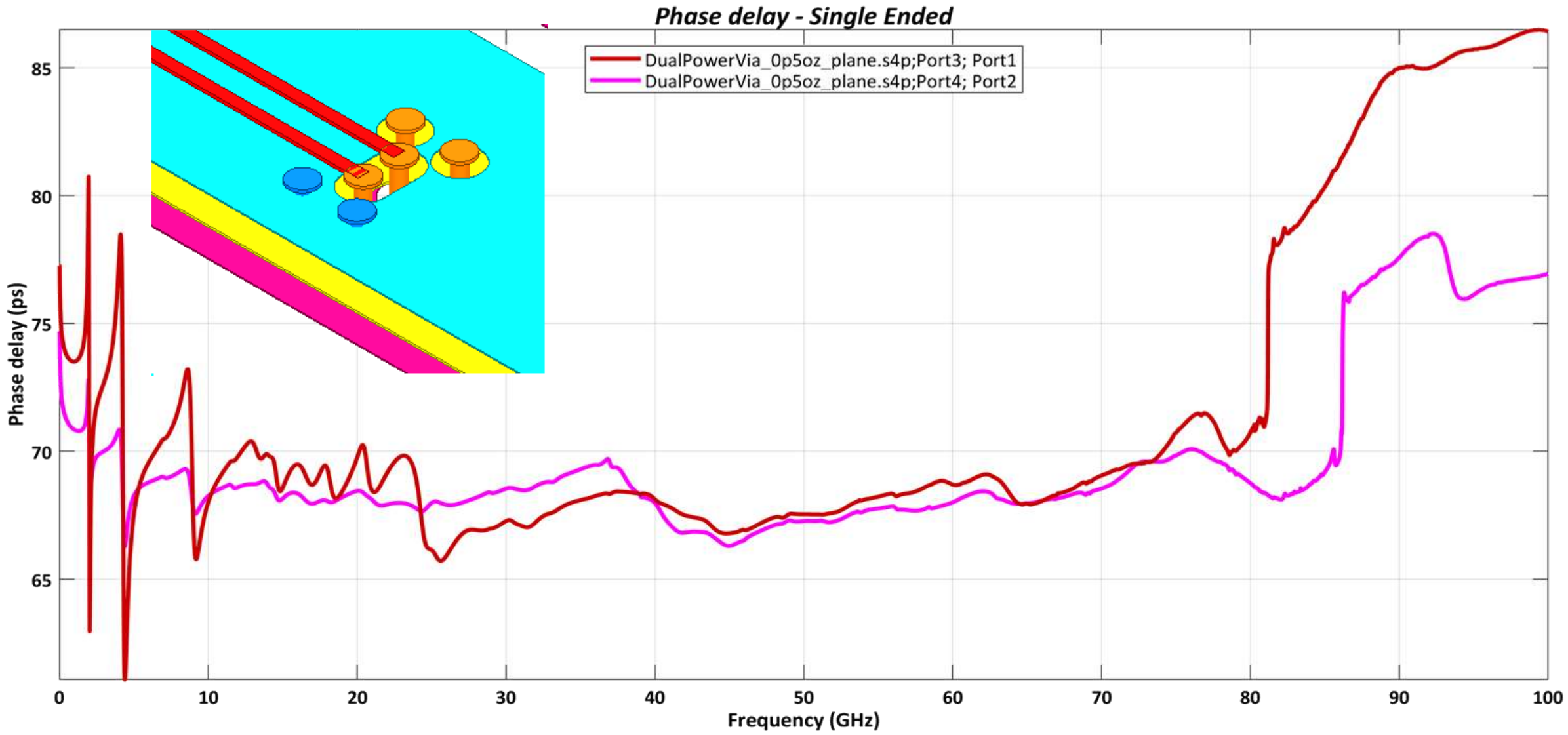

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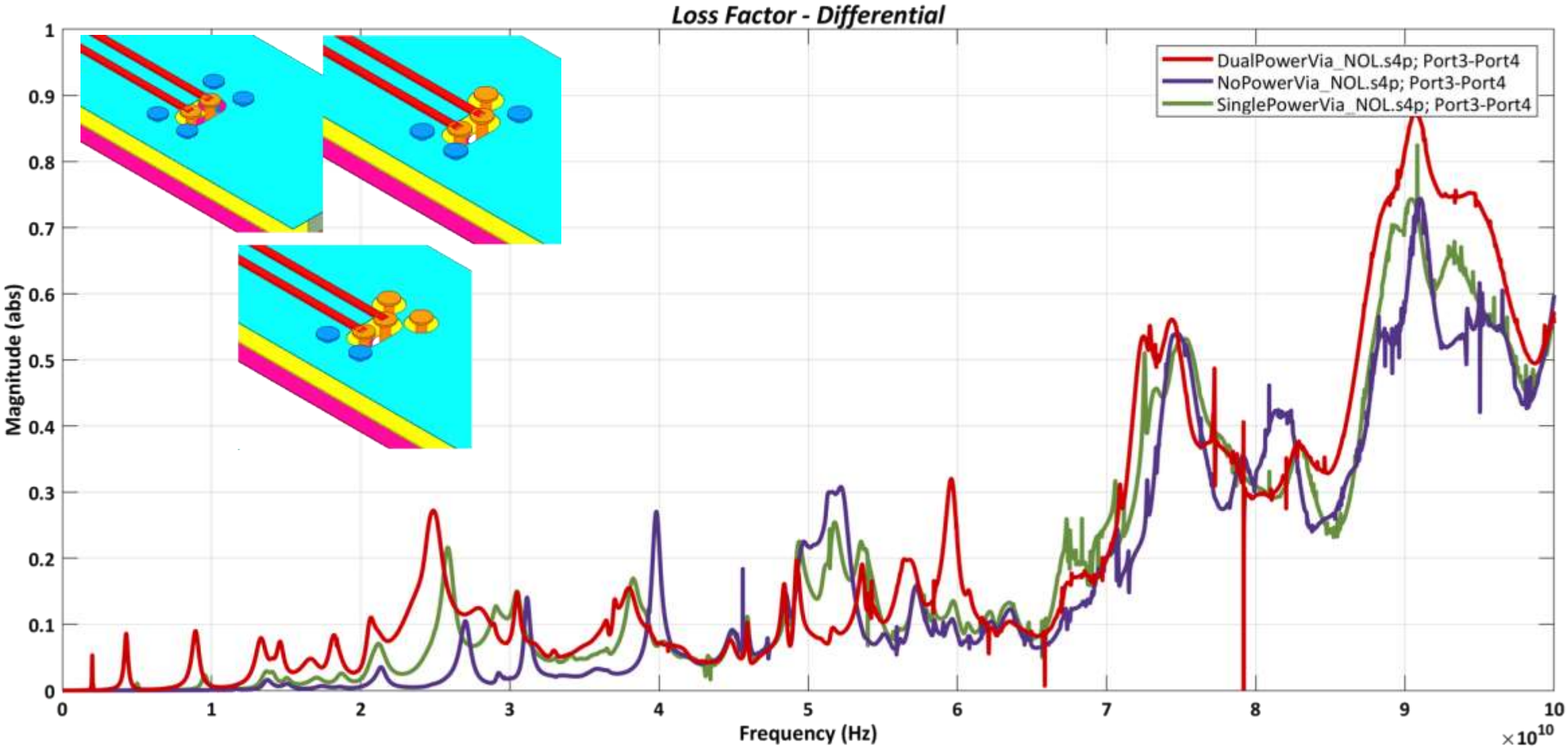
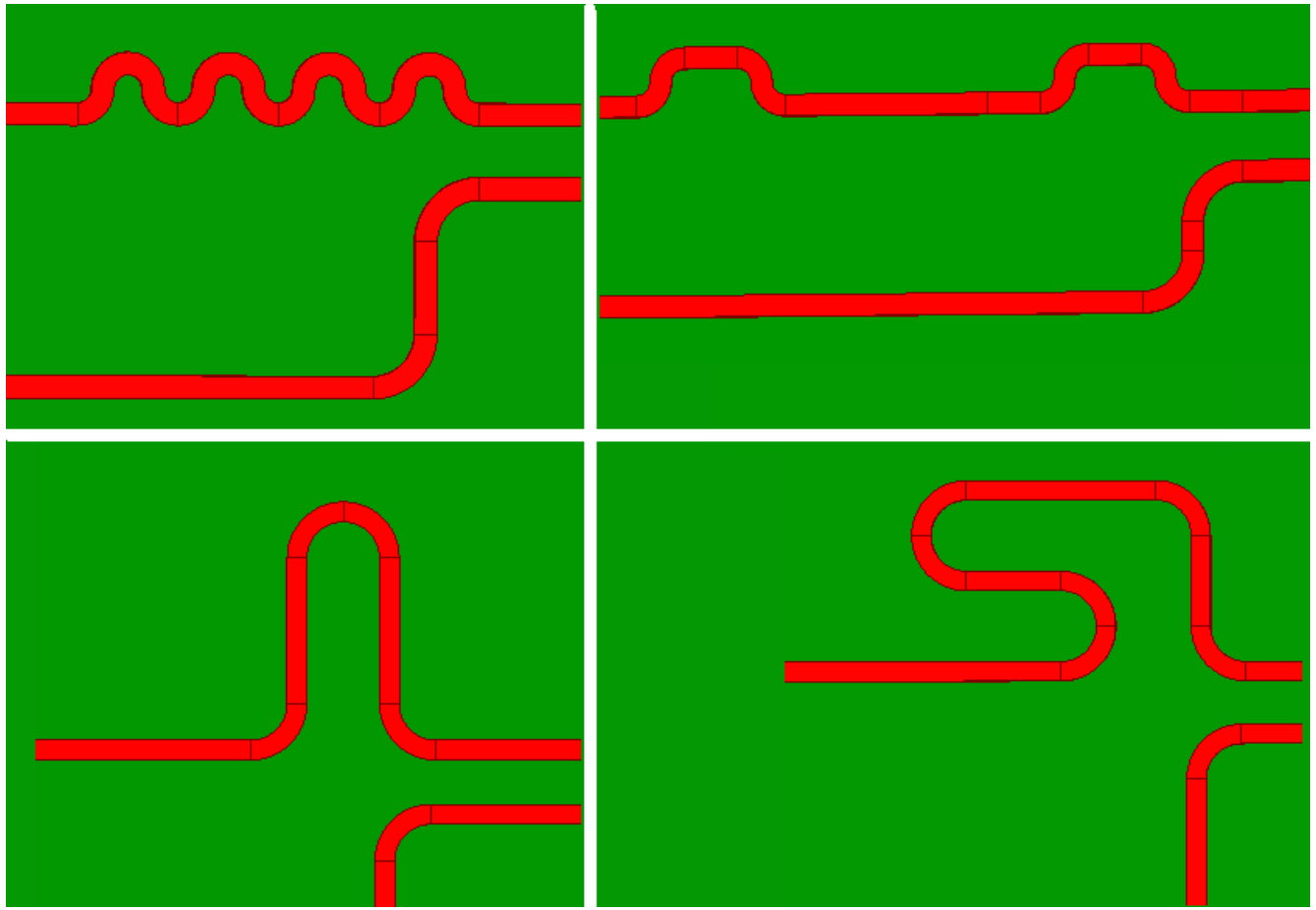
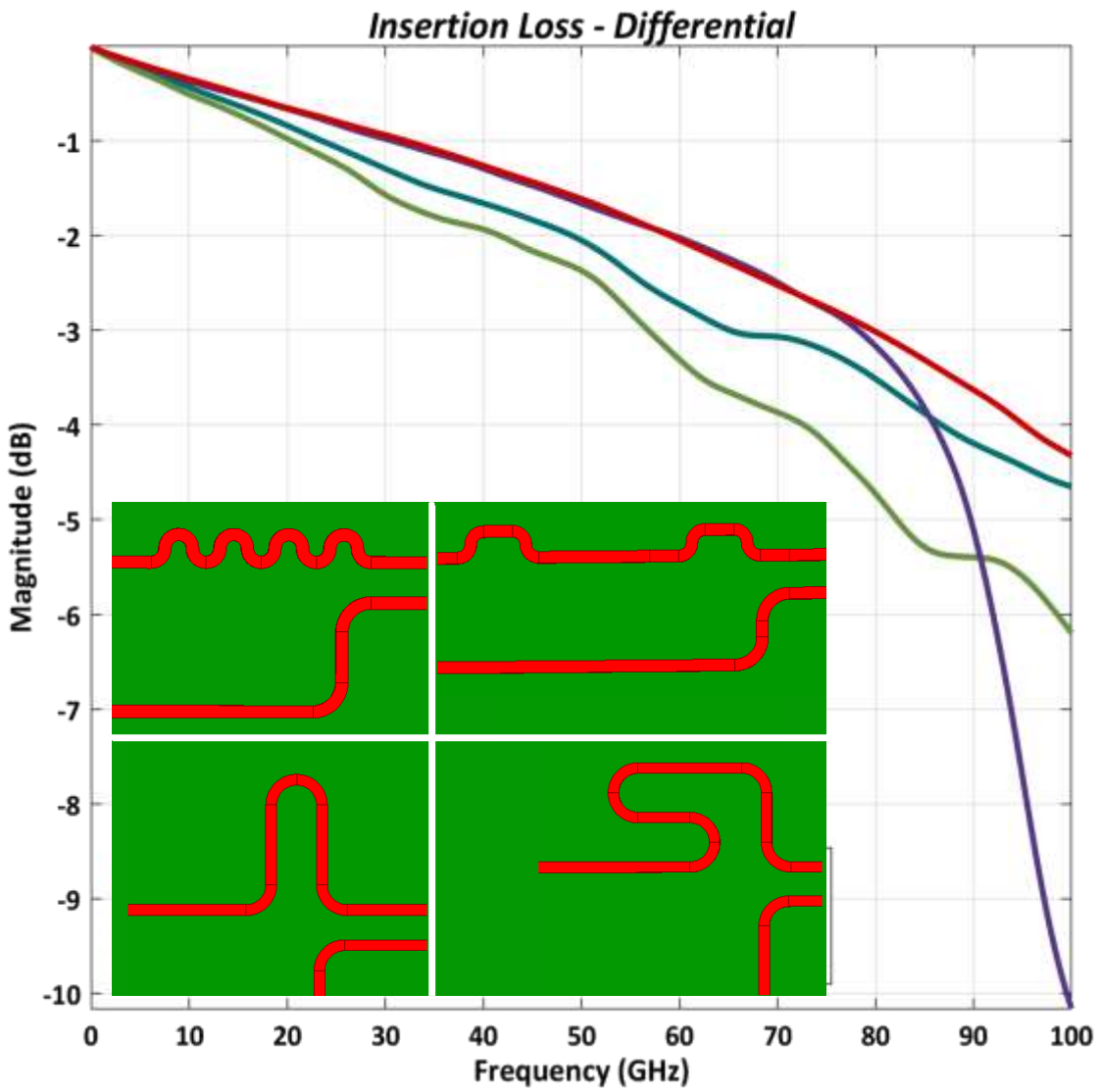


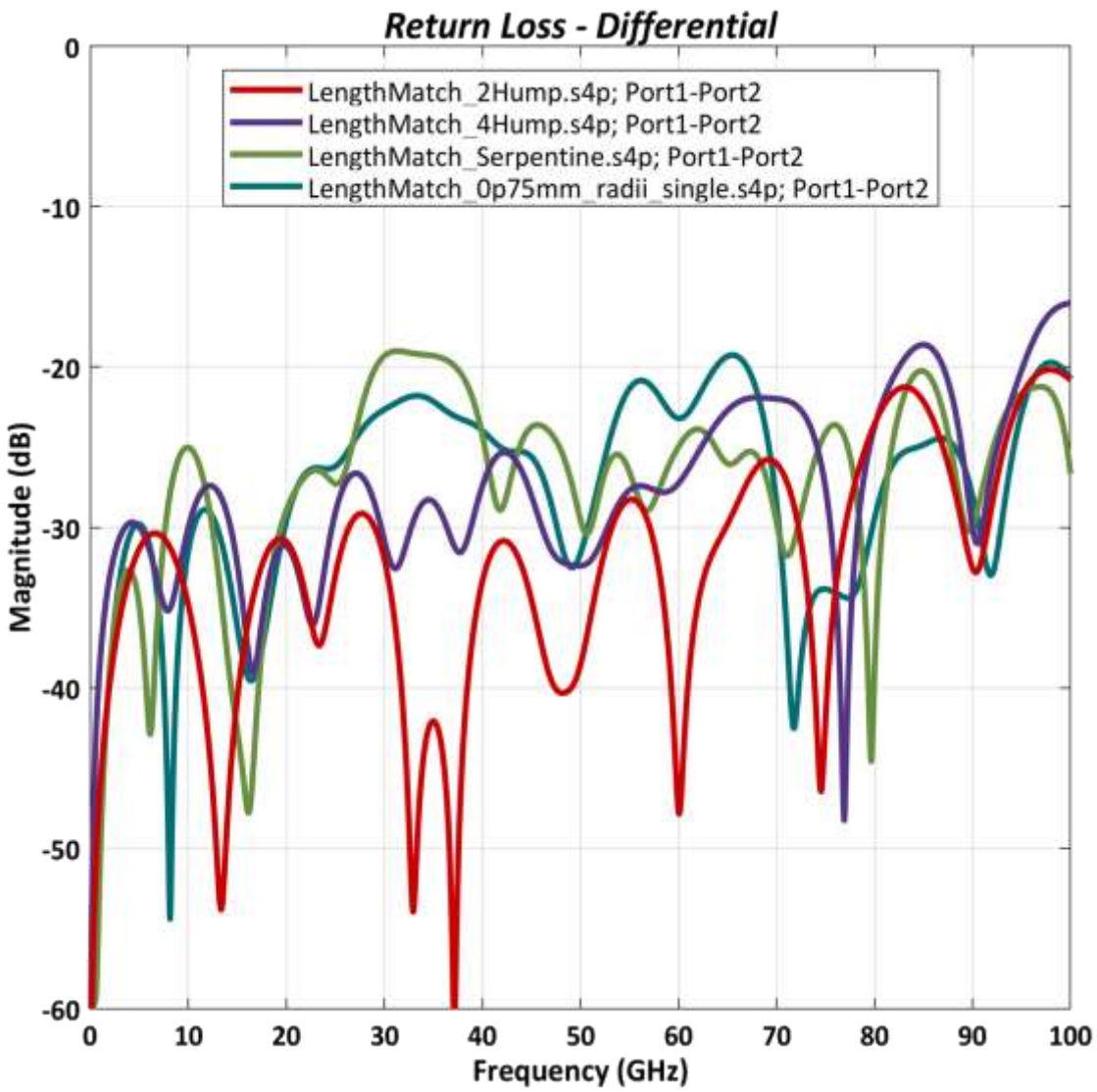
Length Matching Cases

- Different types of length matching
  - 4 hump w/ 0.25 mm radii
  - 2 hump w/ 0.25 mm radii
  - Single Loop w/ 0.75 mm radii
  - Serpentine with 0.75 mm radii
    - Radii in reference to inside corner
- Are the individual cases length matched?
- Are there other details we can discern from looking at the SE data vs DP?



Length Matching





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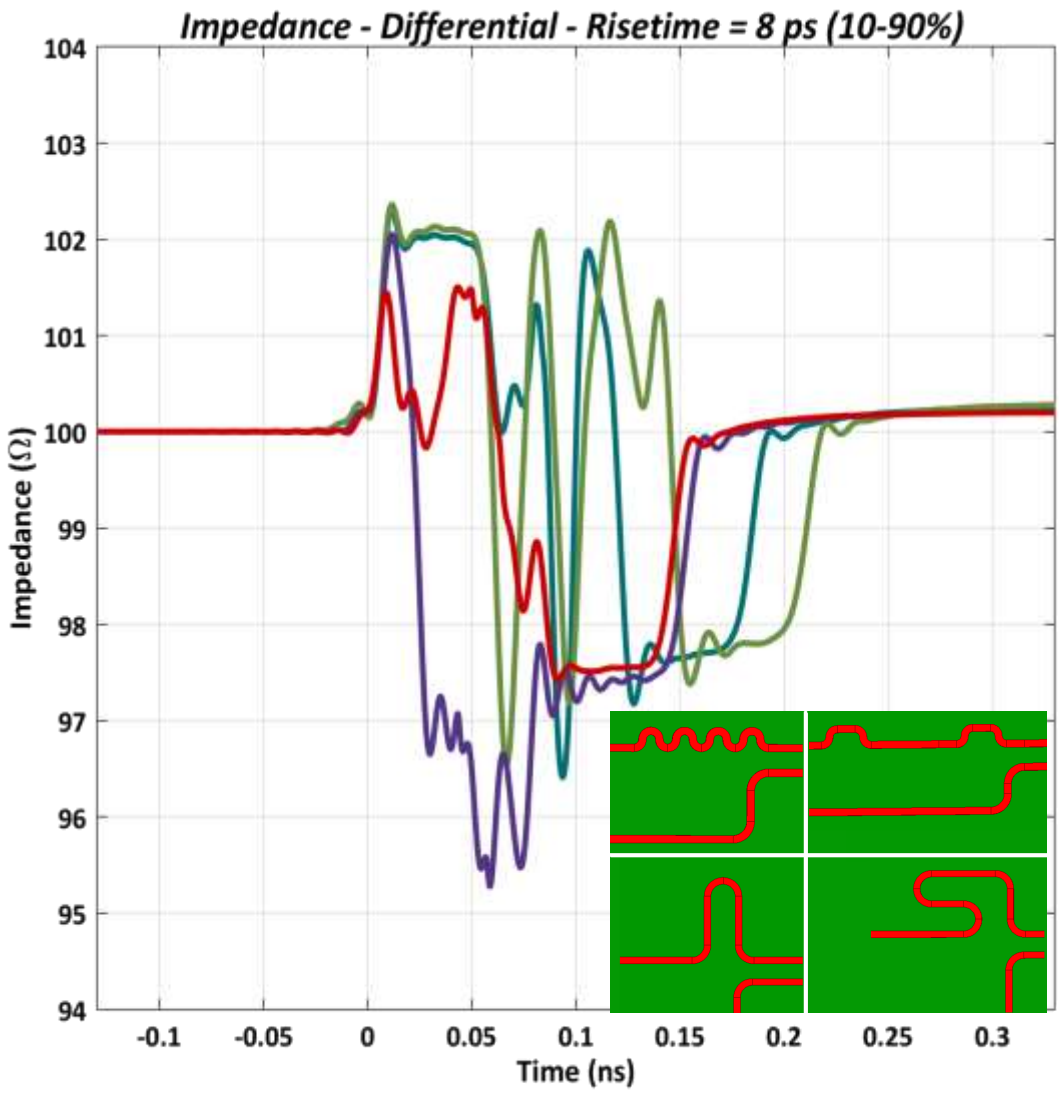

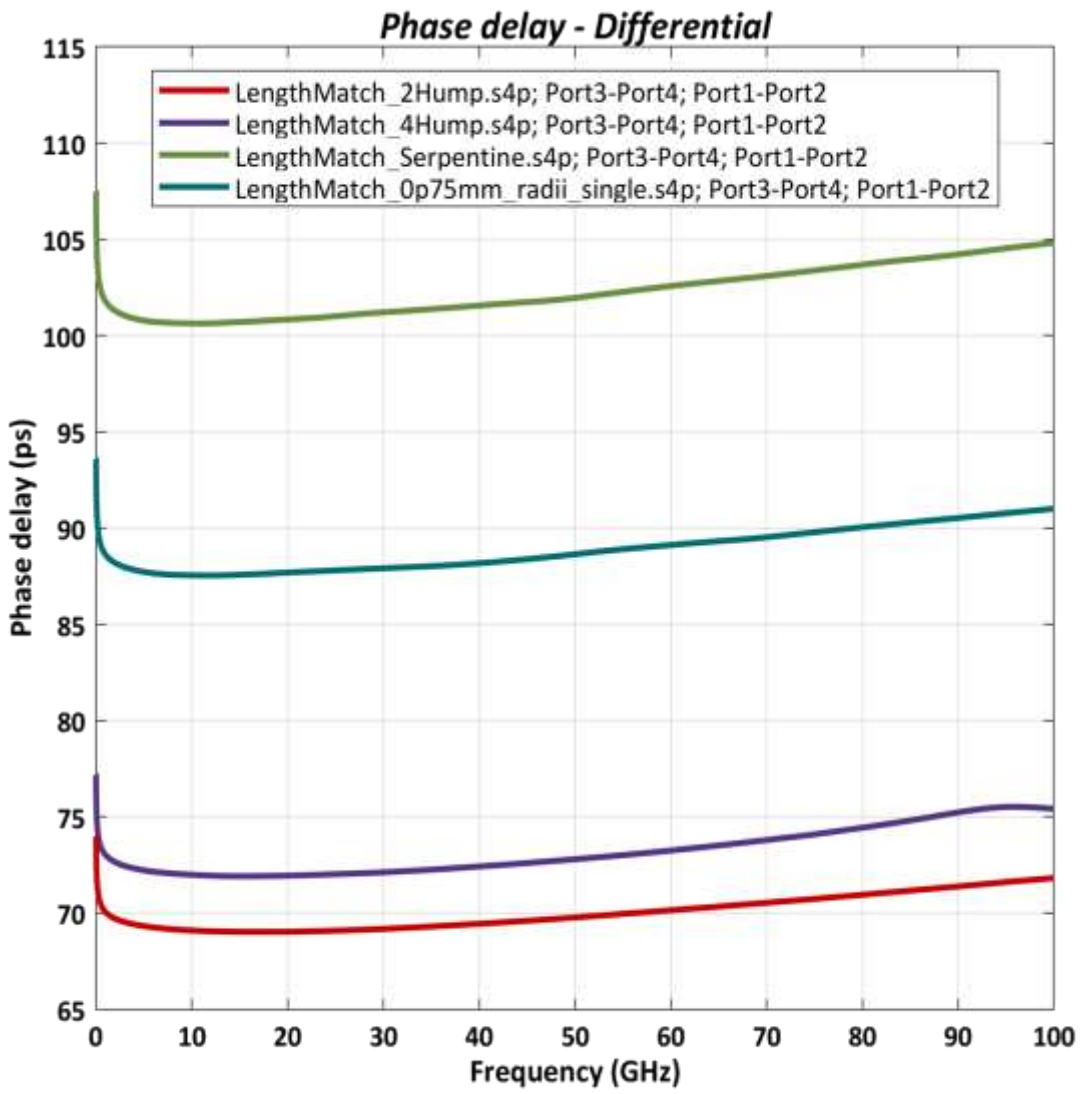

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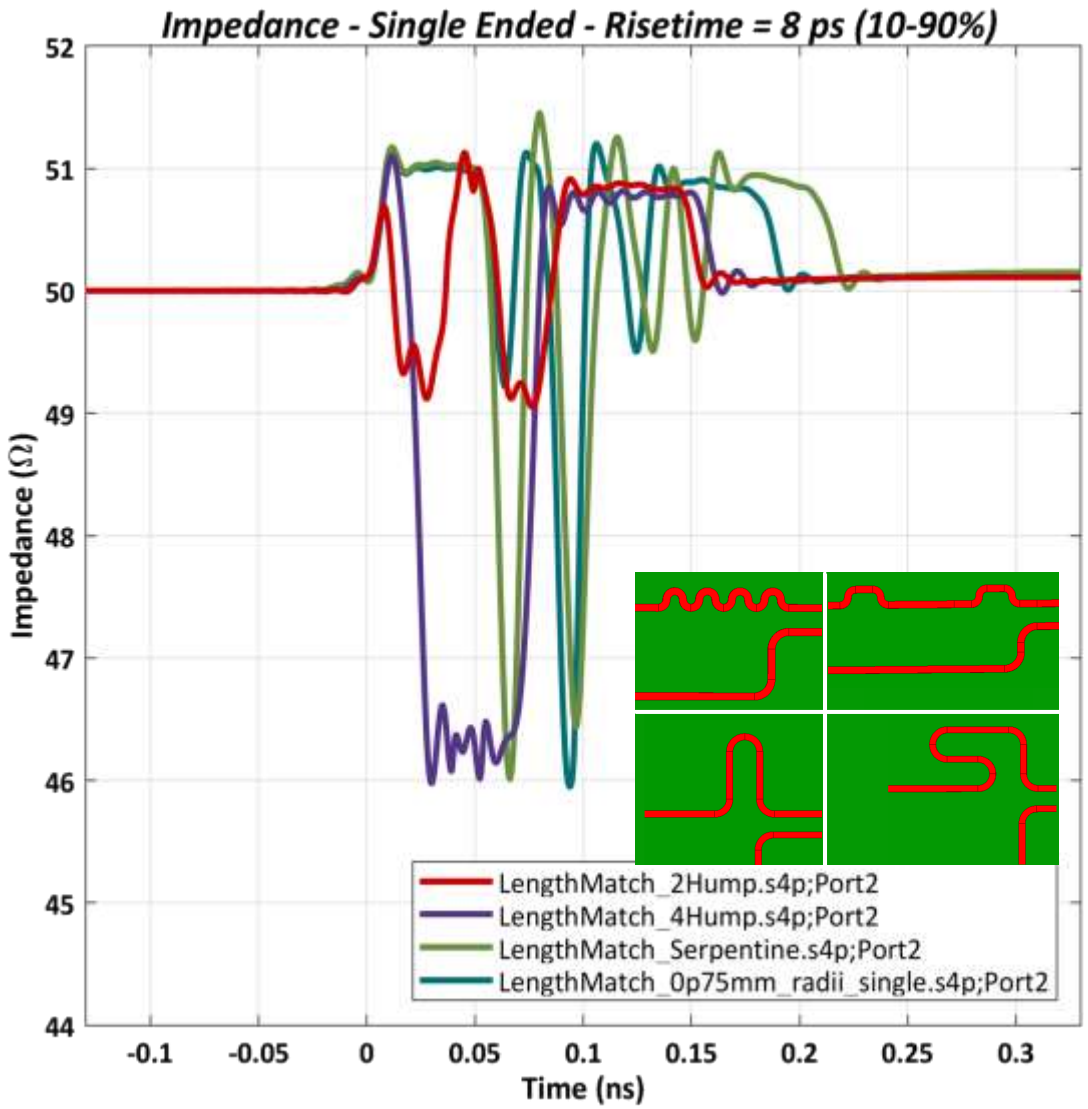
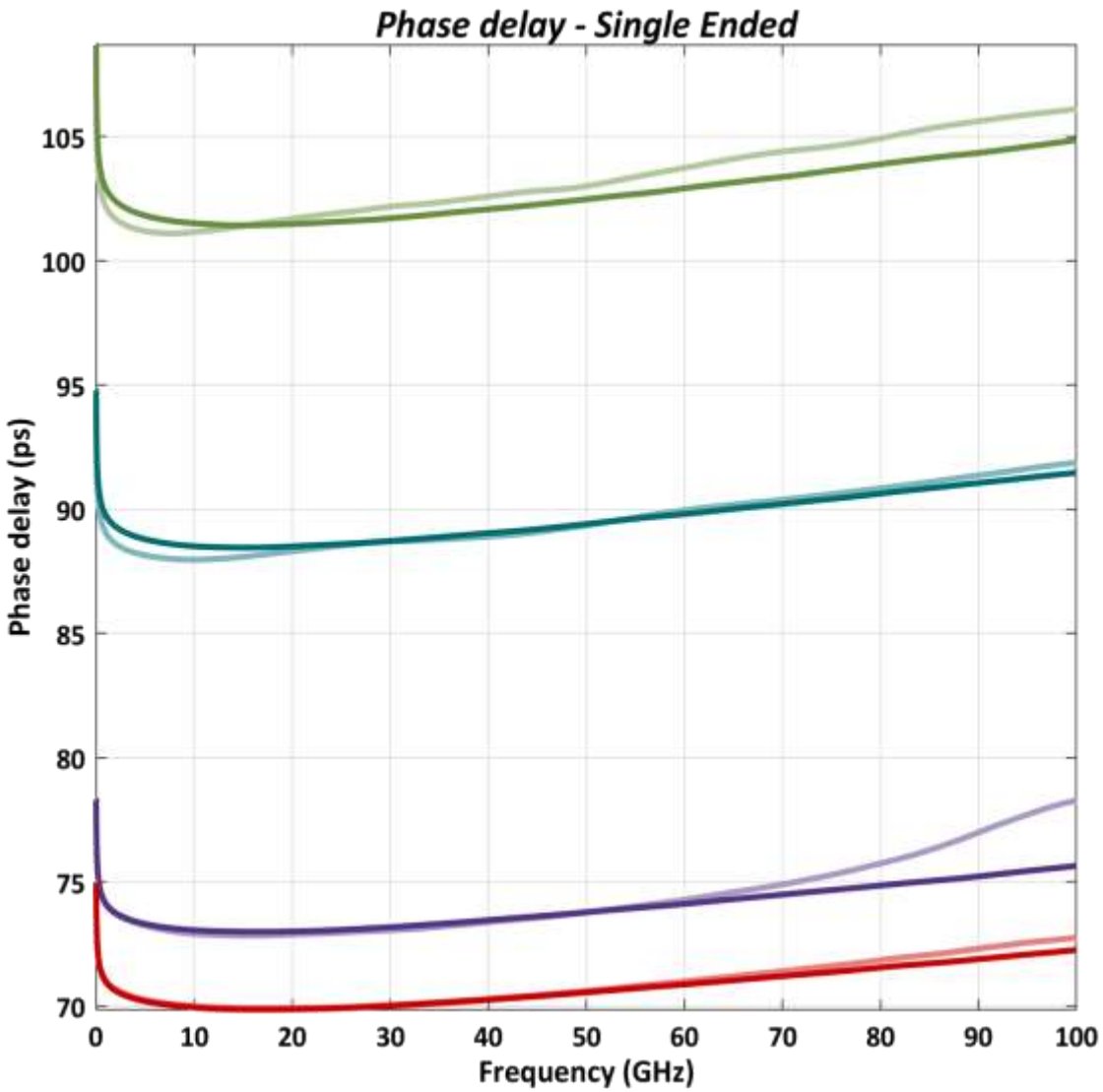


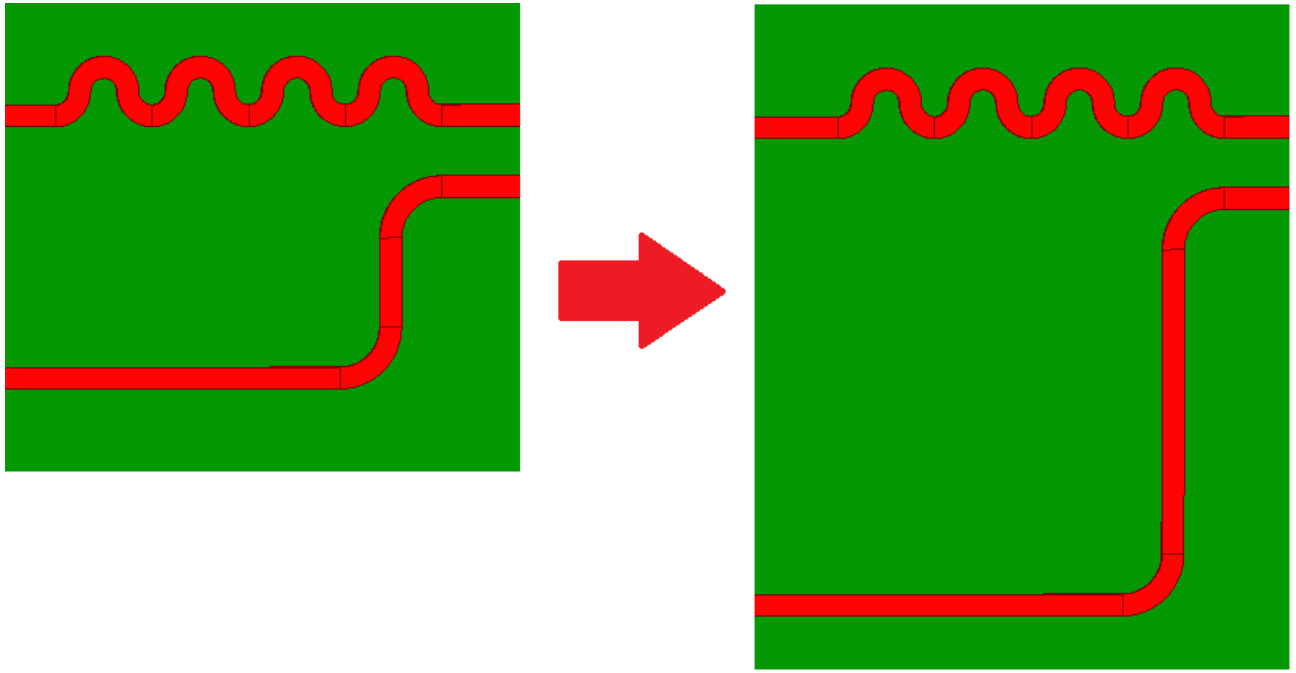


Liar, Liar, Pants on Fire!

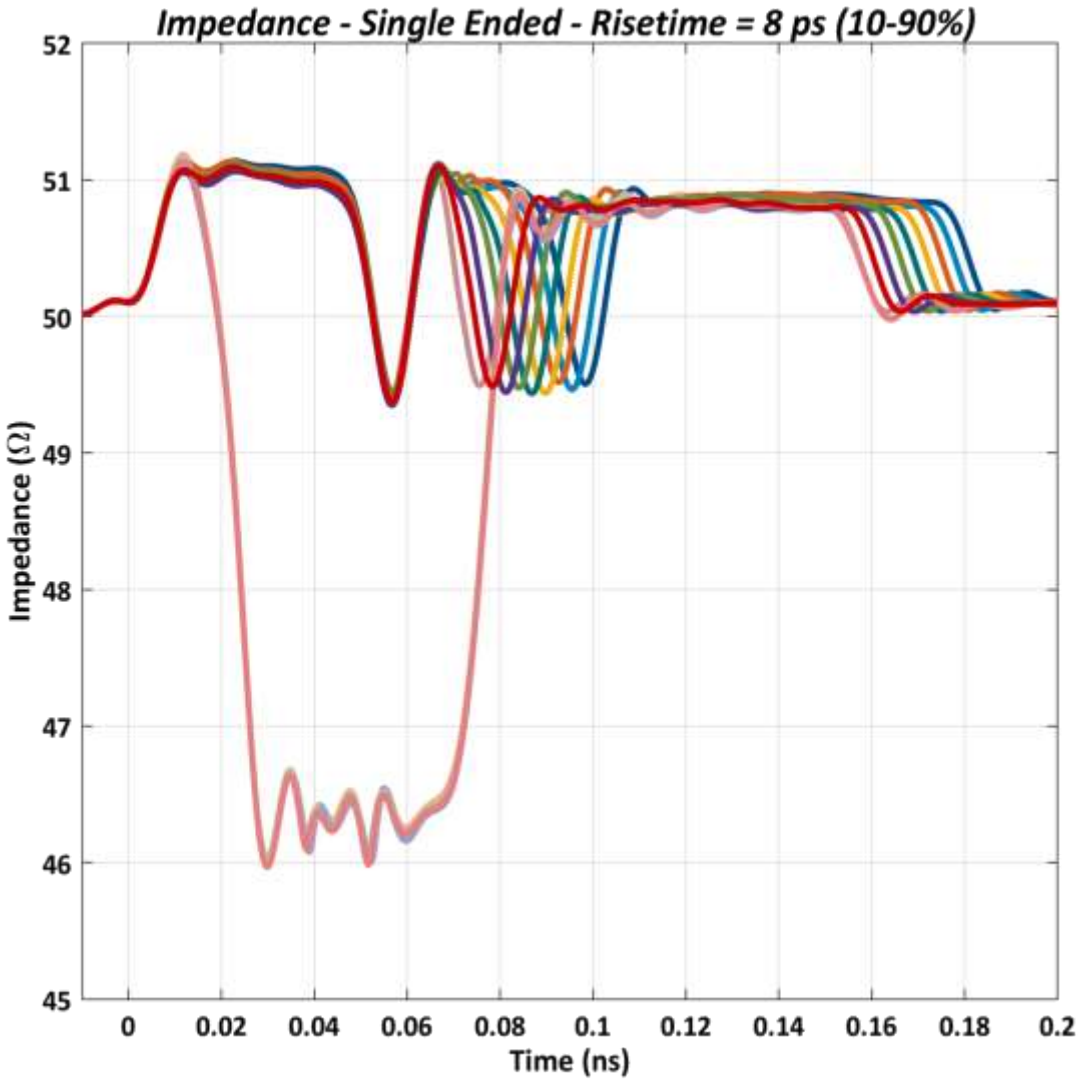
- Does Differential Mode sit on a throne of lies?
- Baby, bathwater. You know the adage
- Let's throw differential mode a bone…
  - Regarding length matching, DP IL can point to a design issue
  - How does skew affect differential results?

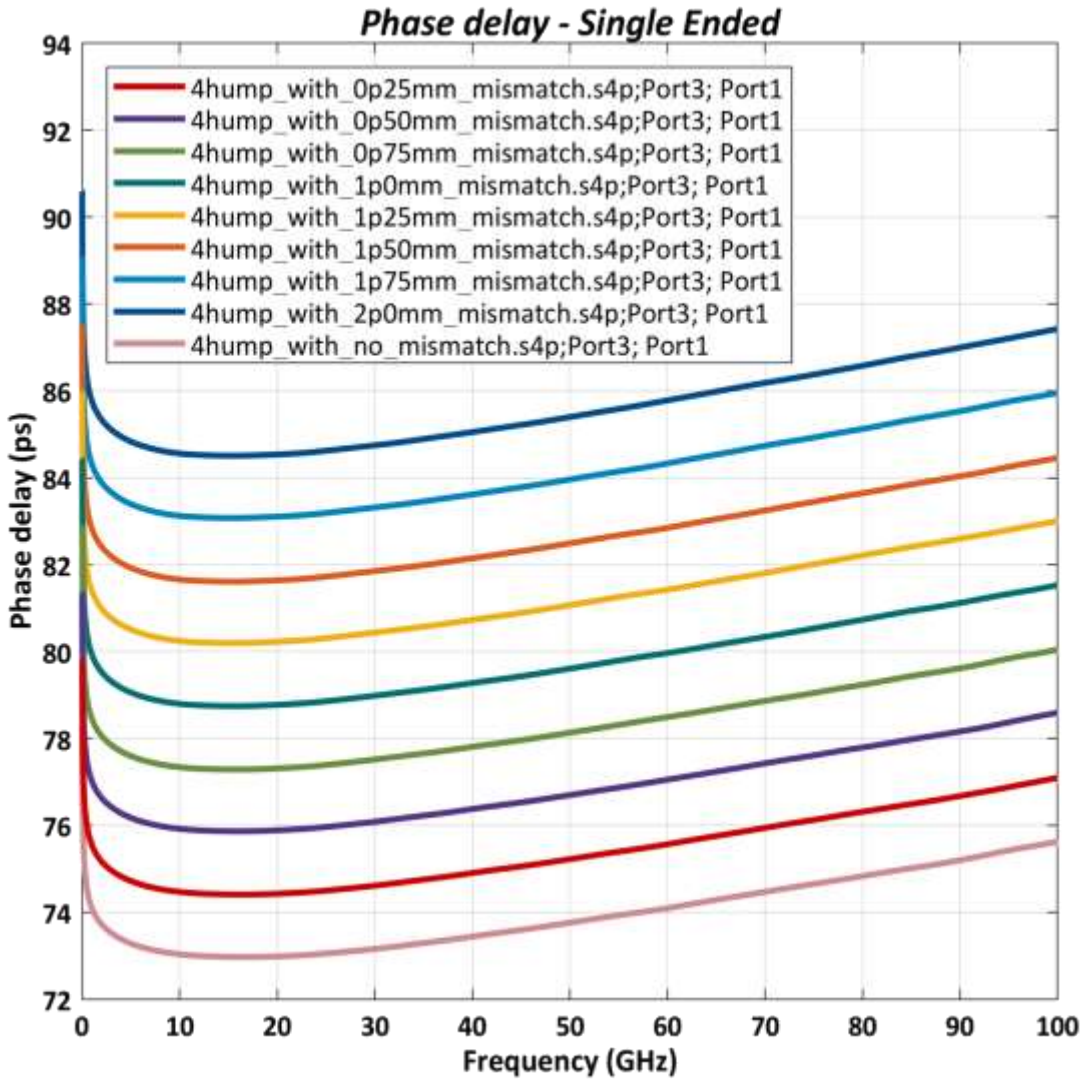
When Does Skew Become an Issue?

- Length matching is important in application
- What delta of length does it take to skew sim results?
- Experiment
  - Using the 4 hump length match feature, incrementally add skew
    - 0.25 mm of mismatch per step
    - 2 mm of mismatch total



Effects of Added Skew





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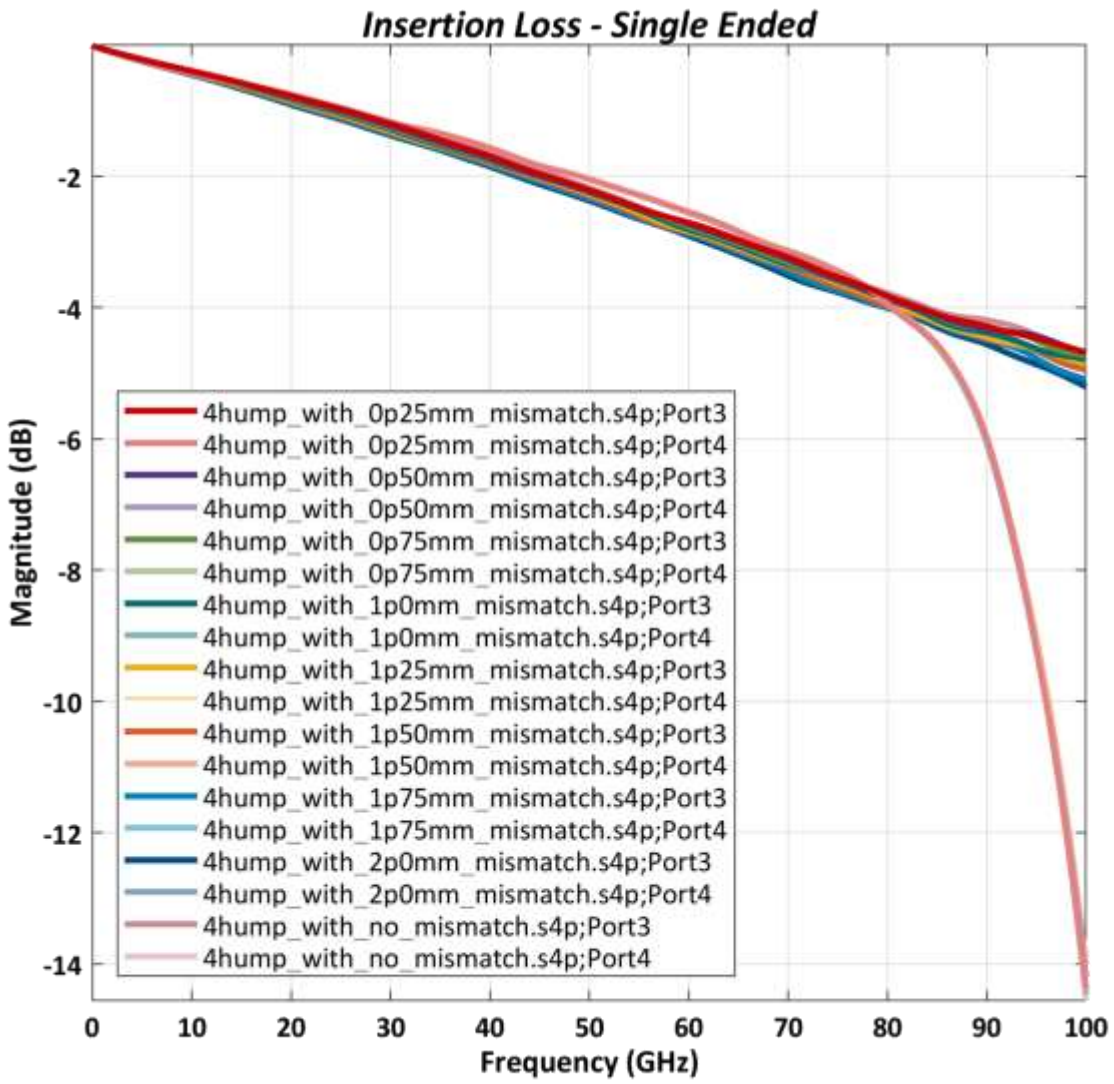

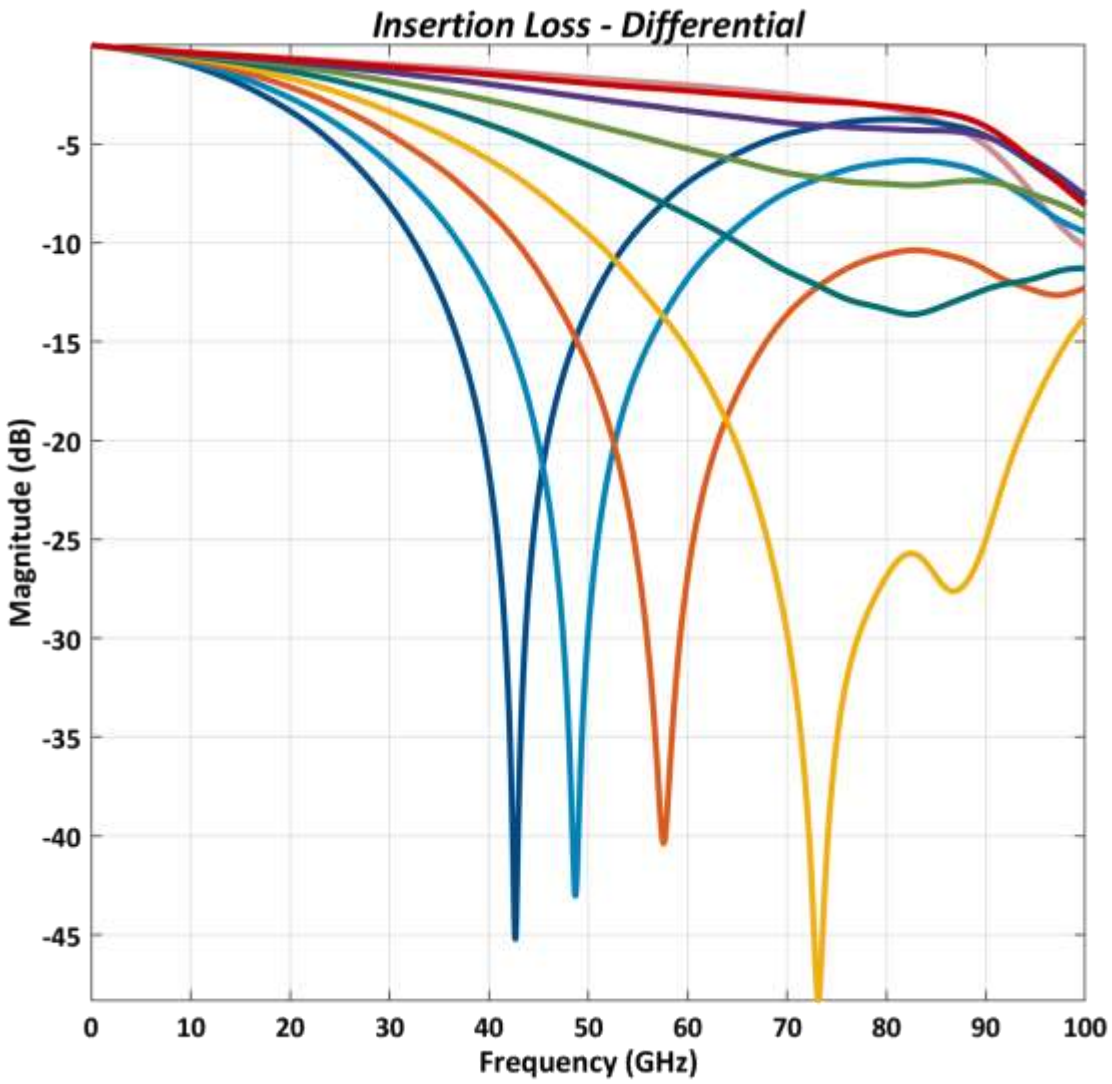

Summary

- Differential results don't tell the whole story
  - May hide modeling errors
    - Ex: no vias in model to tie ground planes together
  - Can hide potential performance improvement opportunities
    - Ex: Length matching, not all methods are equal
  - Could mask the severity of an issue
    - Ex: Power plane case, phase delay with 2 powered vias
  - Surprise! Differential results can HIGHLIGHT a single ended issue
    - Ex: lack of phase matching influencing results
- Link to Scott McMorrow's corner bend radii study
  - https://blog.samtec.com/wp-content/uploads/2020/08/08_13_2020_geek_speek_corner_bends.pdf

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