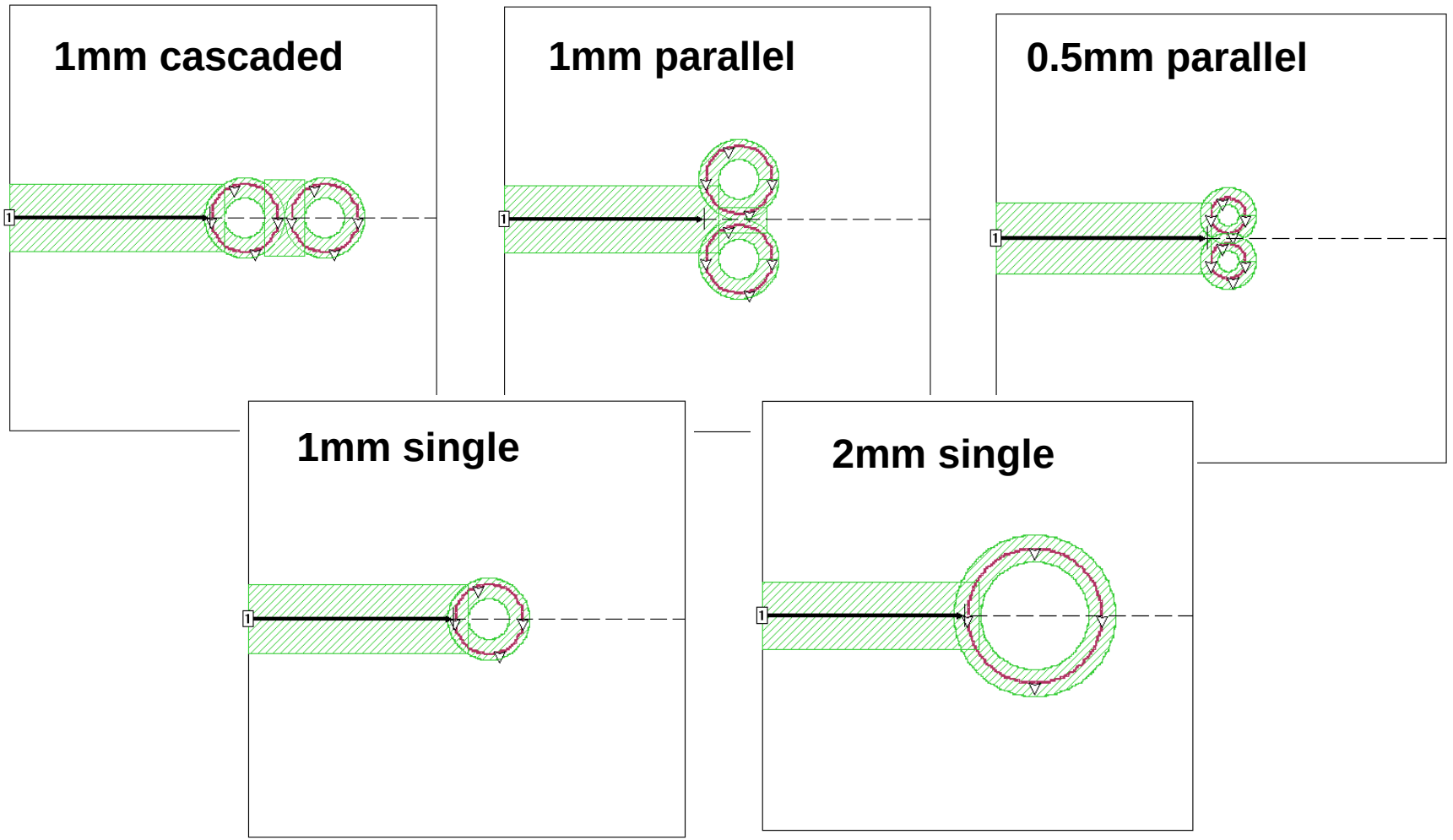
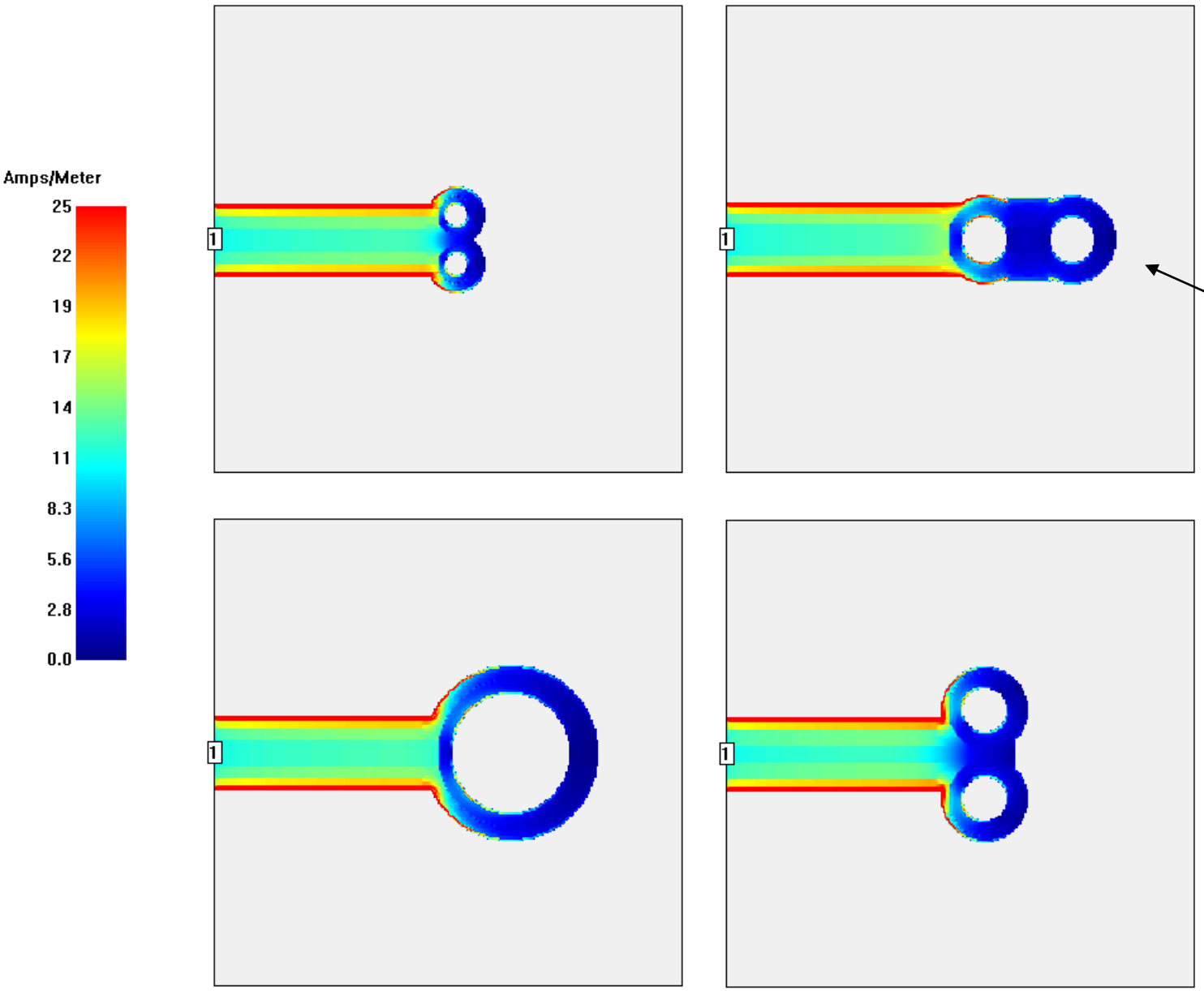
Via Inductance

Comparison of via geometries

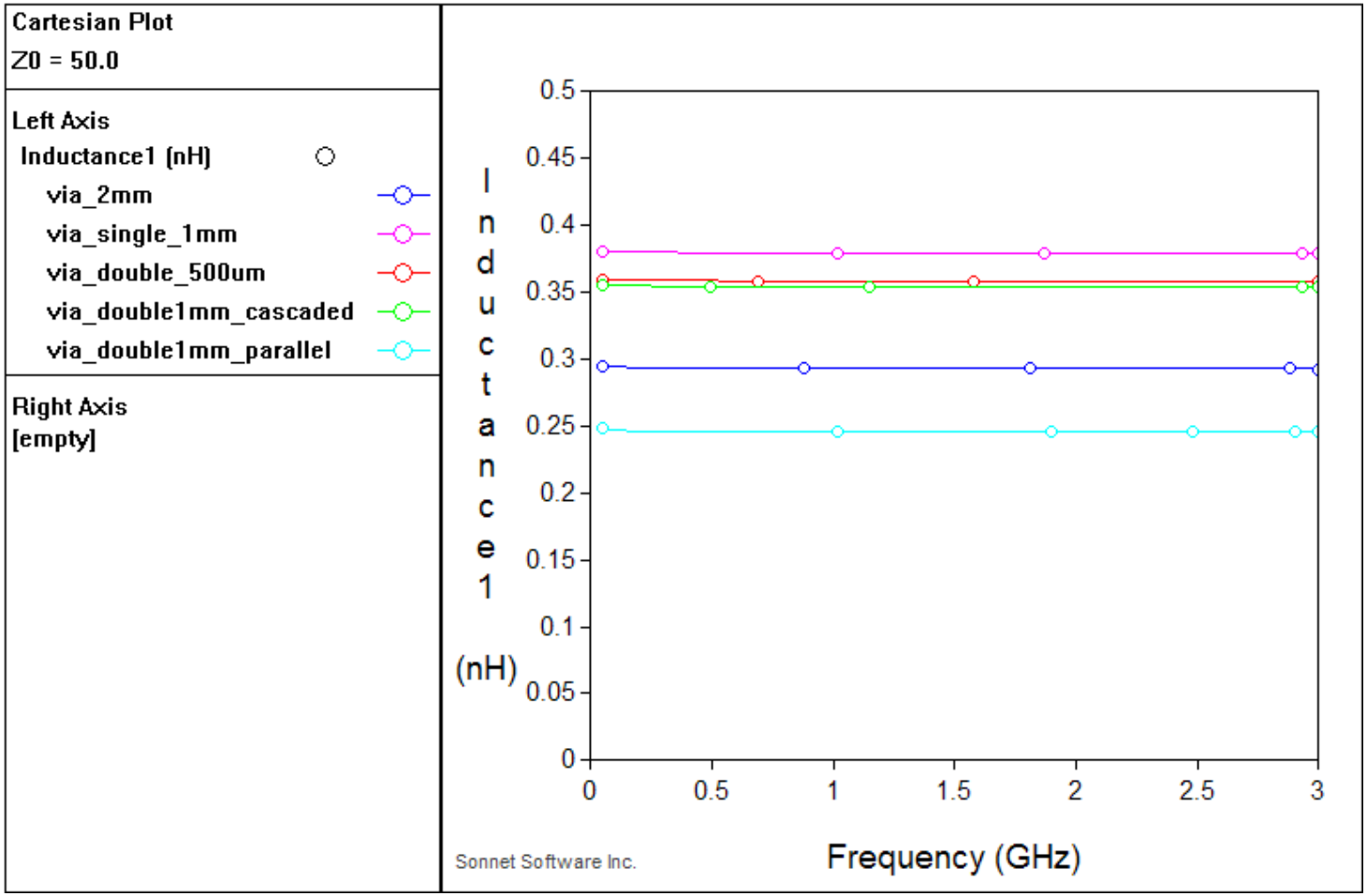
Which via geometry is best?



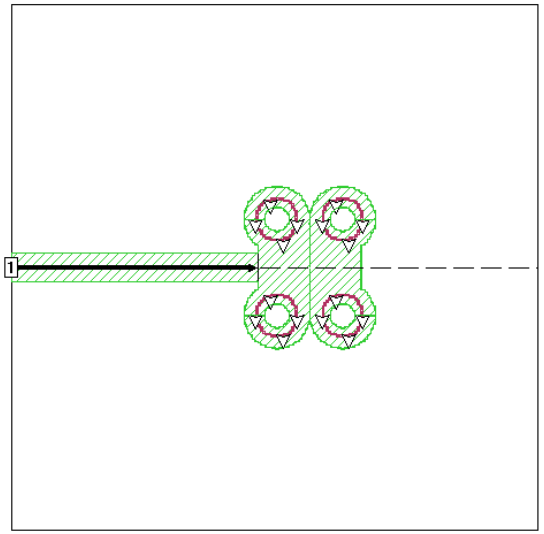


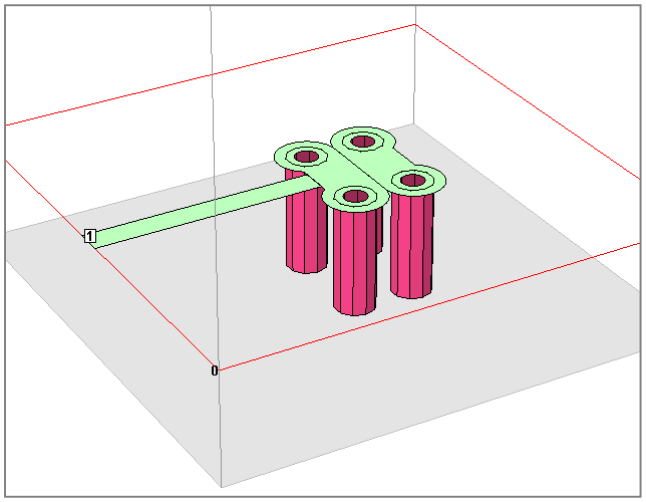
second via has almost no current, useless for RF

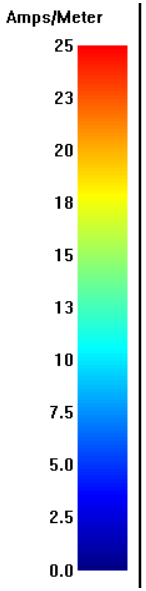
Inductance Comparison

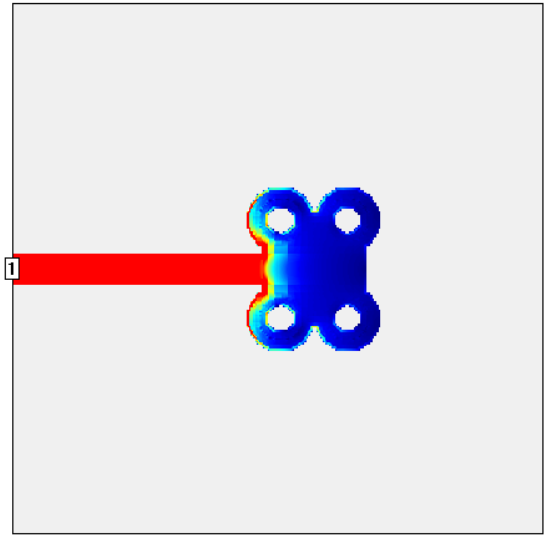


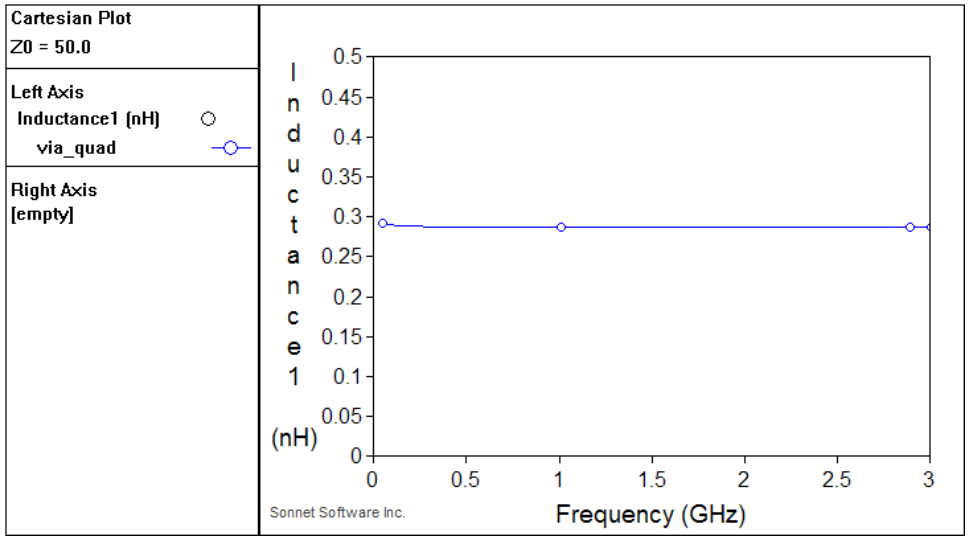
Quad Via









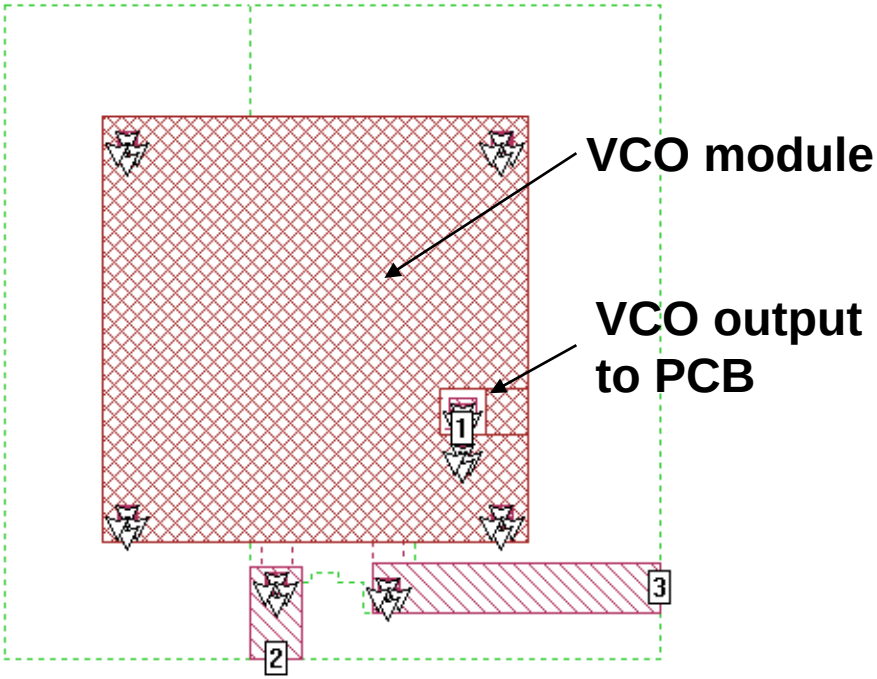


PCB Example

Finding a resonance problem

2.5GHz VCO on PCB

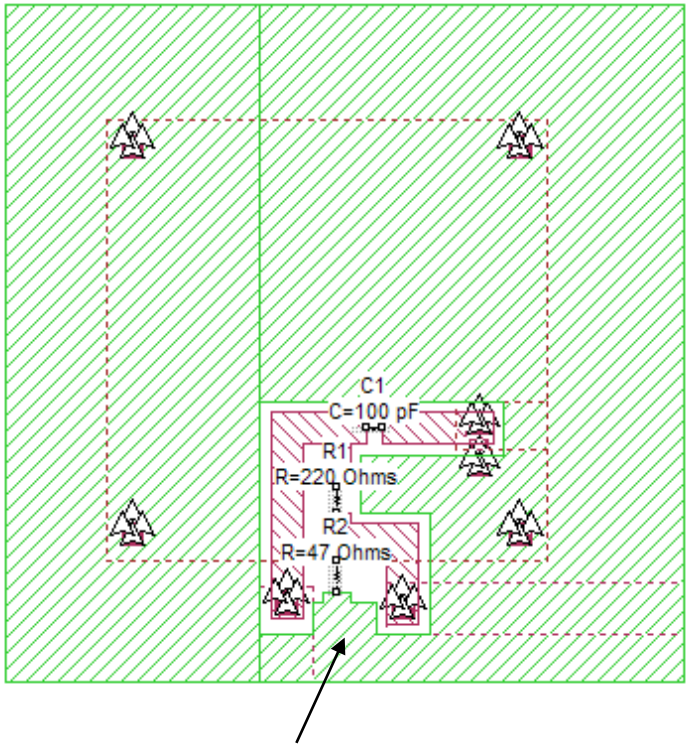
Top (Level 0)



main output
-1 dB

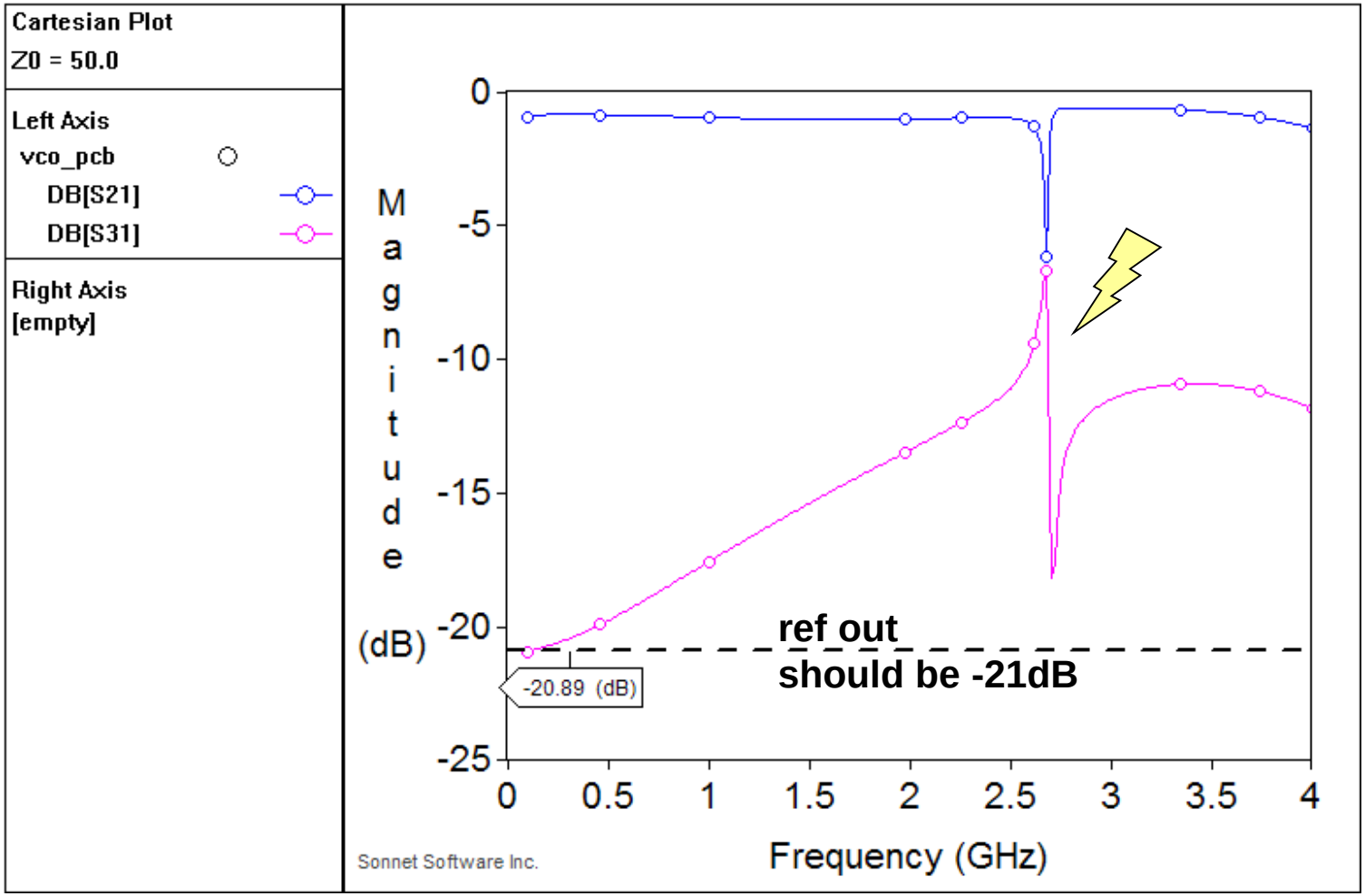
ref output
-21dB

Bottom (Level 1)

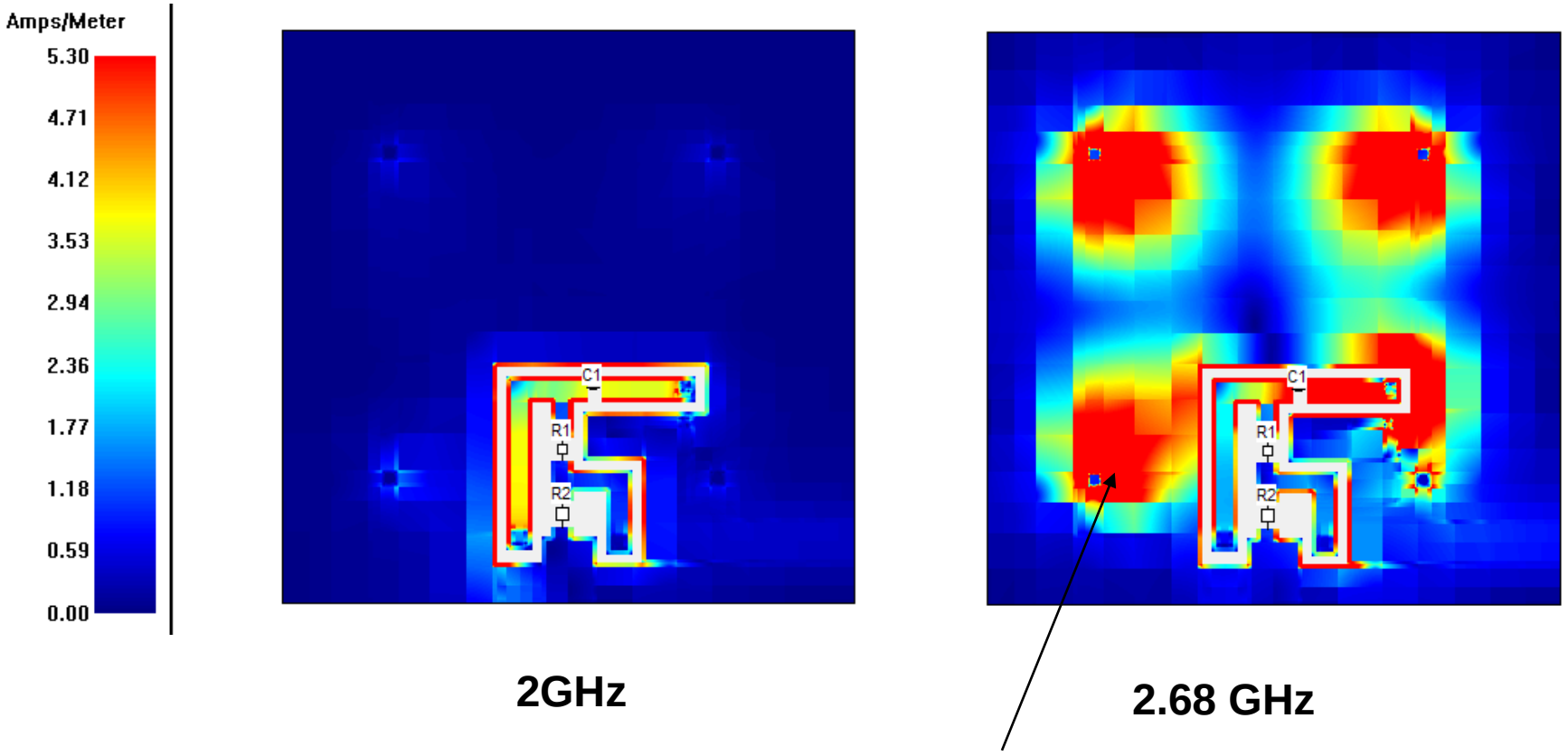


voltage divider 220 Ω / 47 Ω

Simulation Result



Current Density

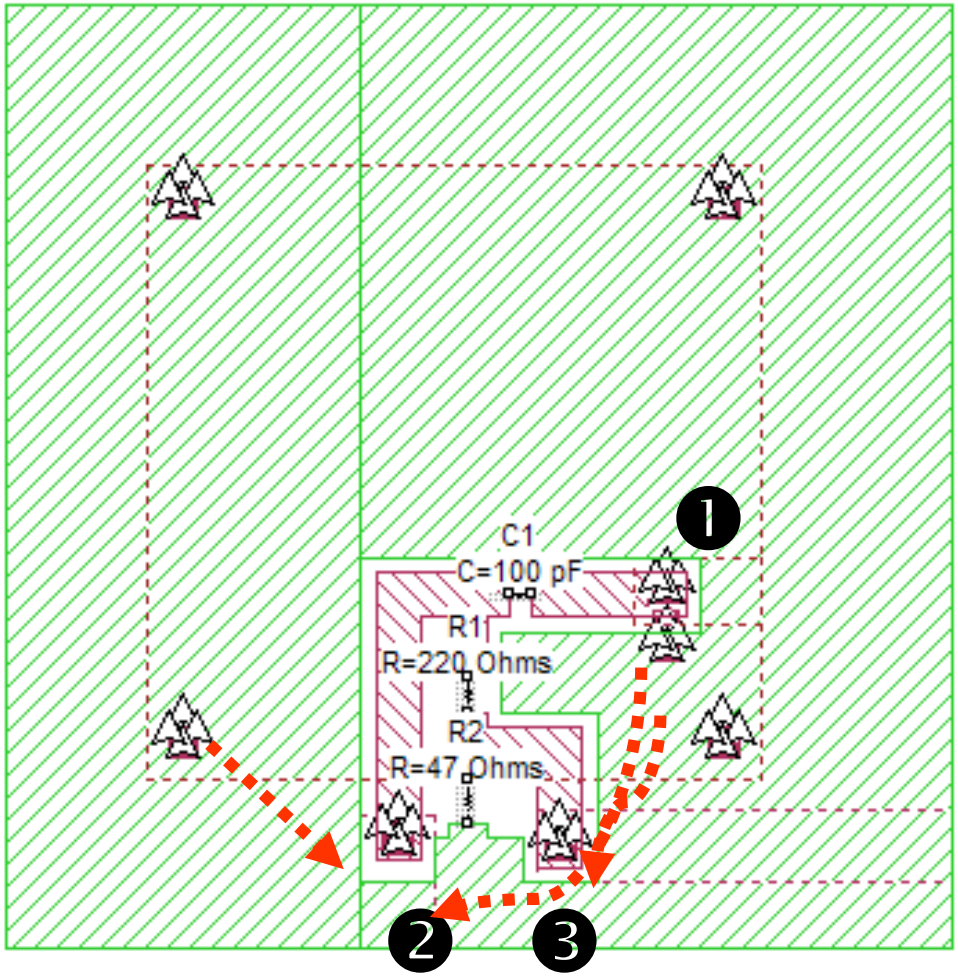


2GHz

2.68 GHz

High current on top side going down through vias !?

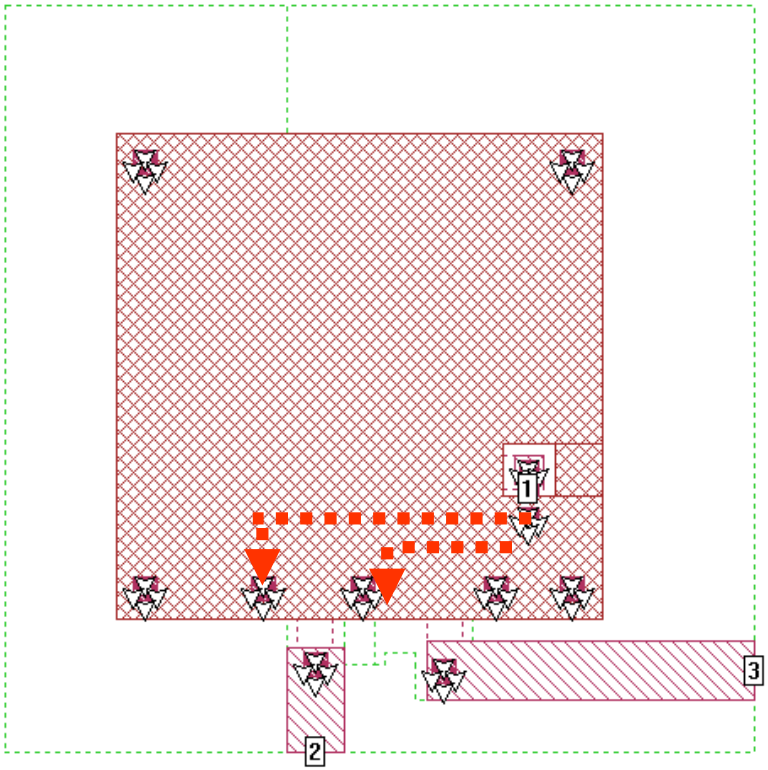
Ground Problem

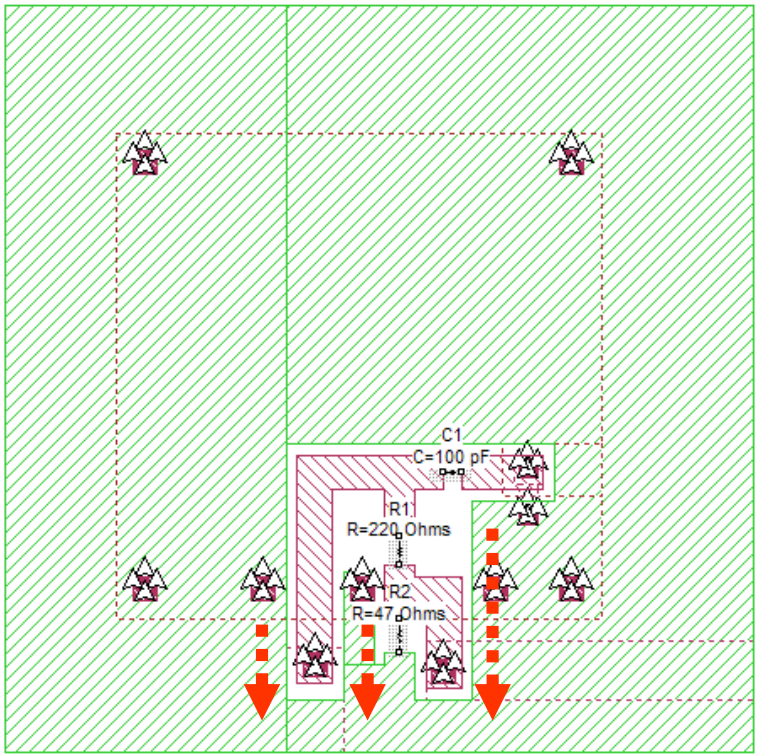


Same long ground path for both outputs causes inductive coupling between both signals

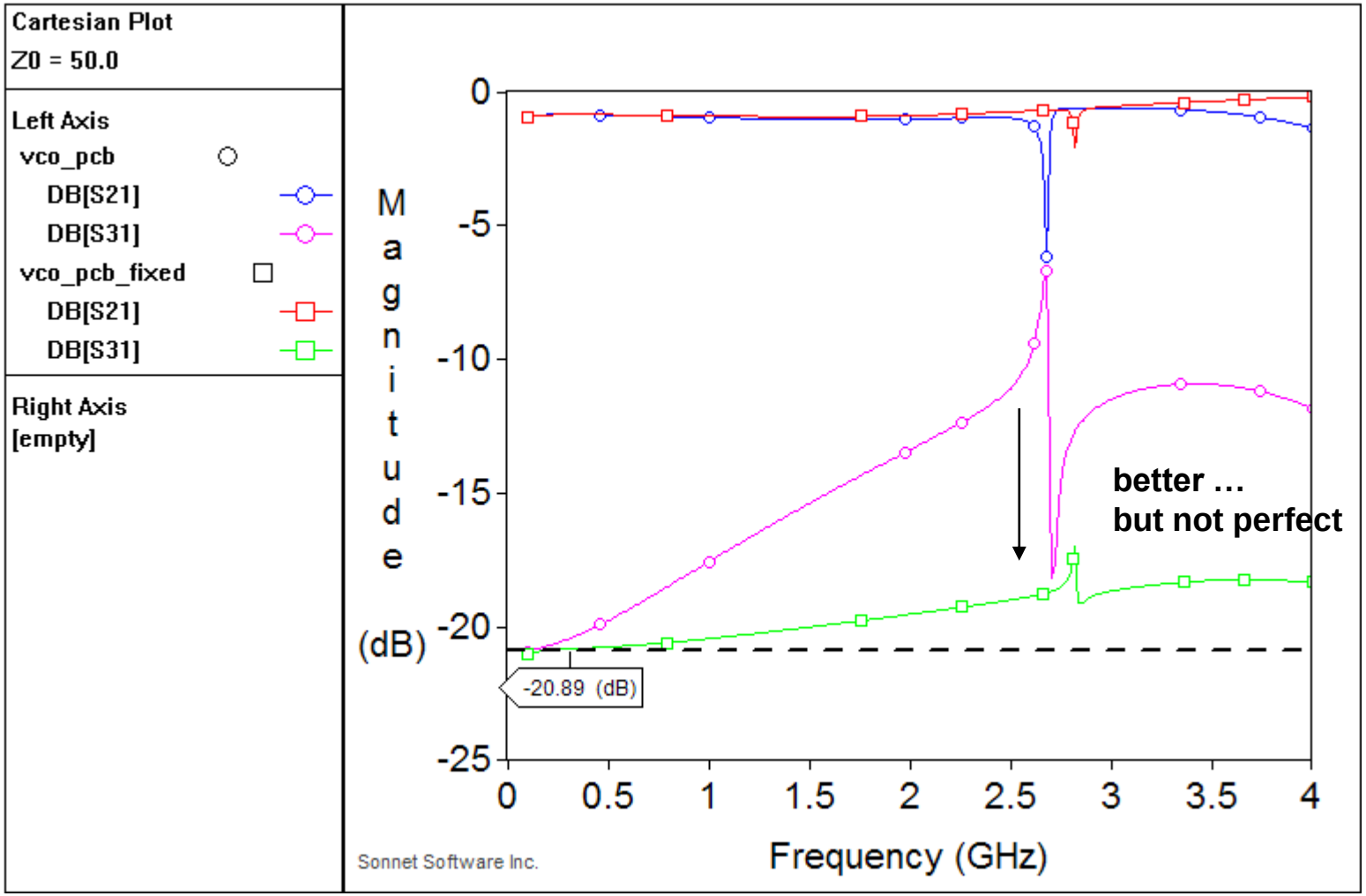
Solution:
Provide better ground, so that each signal has its own proper ground path

Better Ground

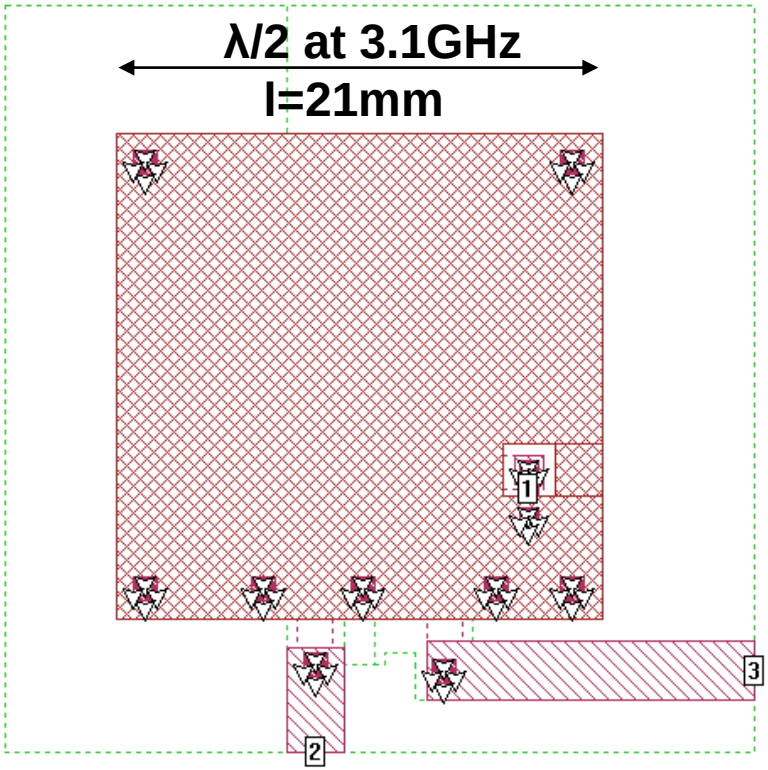




Better Ground



Resonance ?

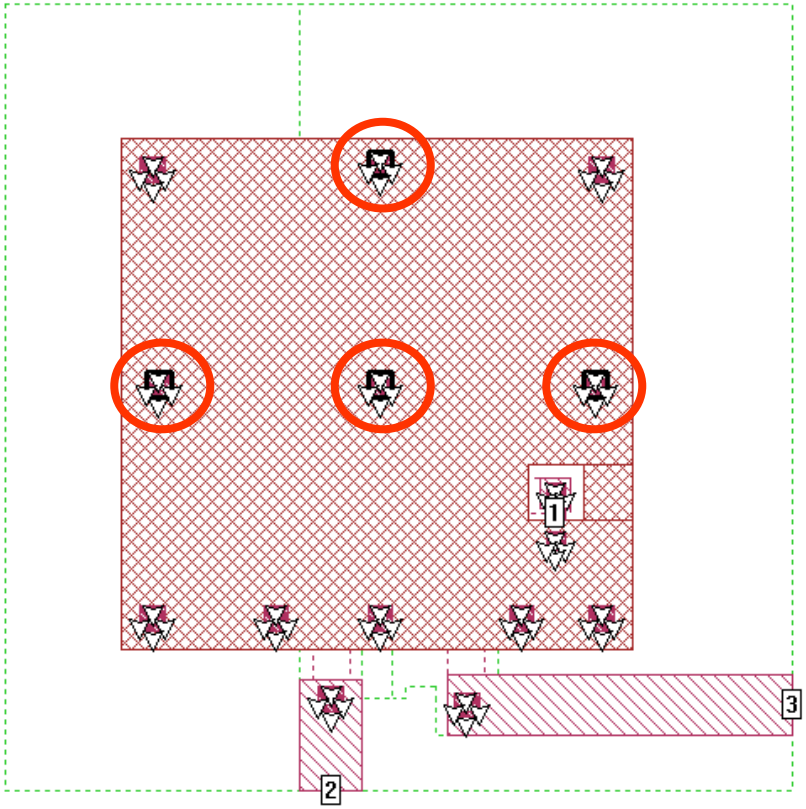


f=3.1GHz
λ=96mm in air
λ=43mm in ε_r=4.9

Not exactly our frequency, but close. The vias are part of the parasitic resonator and might shift the resonance down.

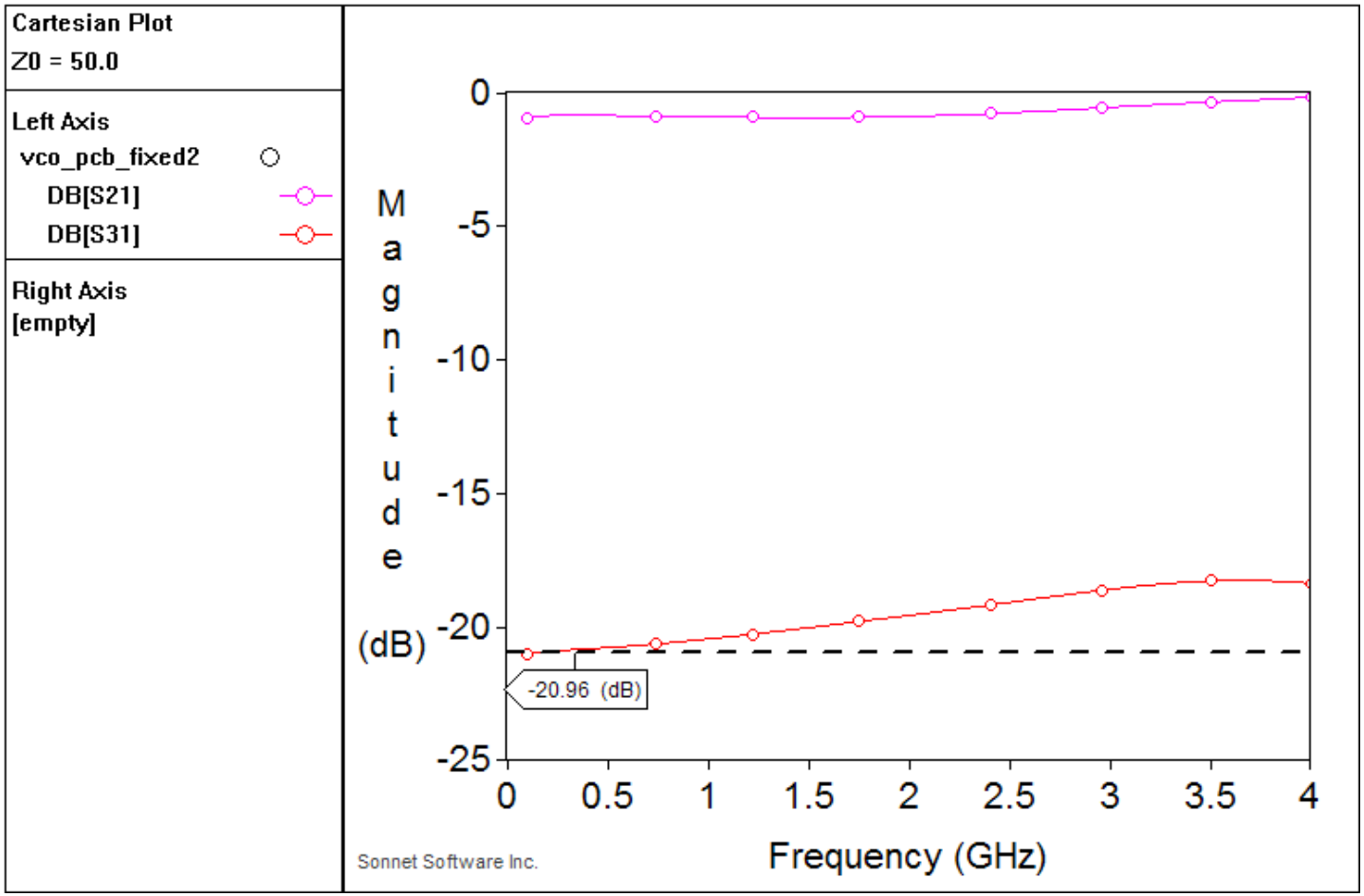
Place additional vias at maximum E field to short resonance condition

Additional Vias



Place additional vias at maximum E field to short resonance condition

Success!



Summary

- The devil is in the detail. EM can help to design the little details properly, before they cause trouble.
- Use EM to extract equivalent circuit values for parasitics and layout elements.
- EM can help to identify ground path issues, parasitic coupling, resonances and radiation
- Focus on the relevant structures. Don‘t try to put every detail into the EM model – the analysis will be too slow.
- Don‘t trust the first result. EM models are always a simplified view of reality. Try to break things, try to check consistency, find out how much you can trust results.

Thank You!

For questions:

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