

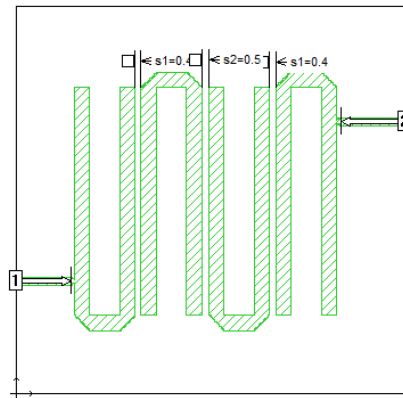


ELECTROMAGNETICS
SPECIALISTS

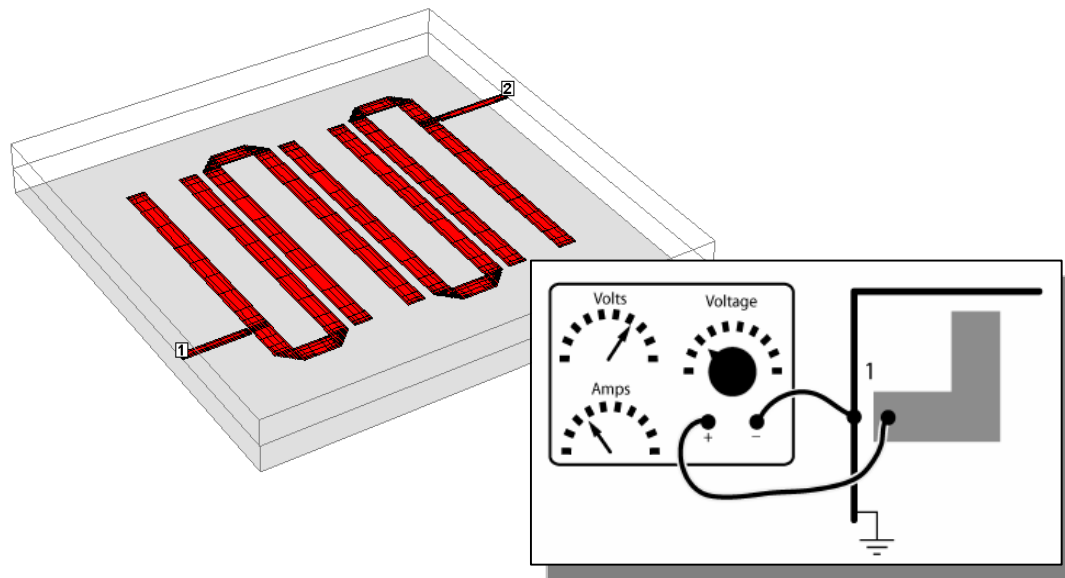
Sonnet Ports for RFIC

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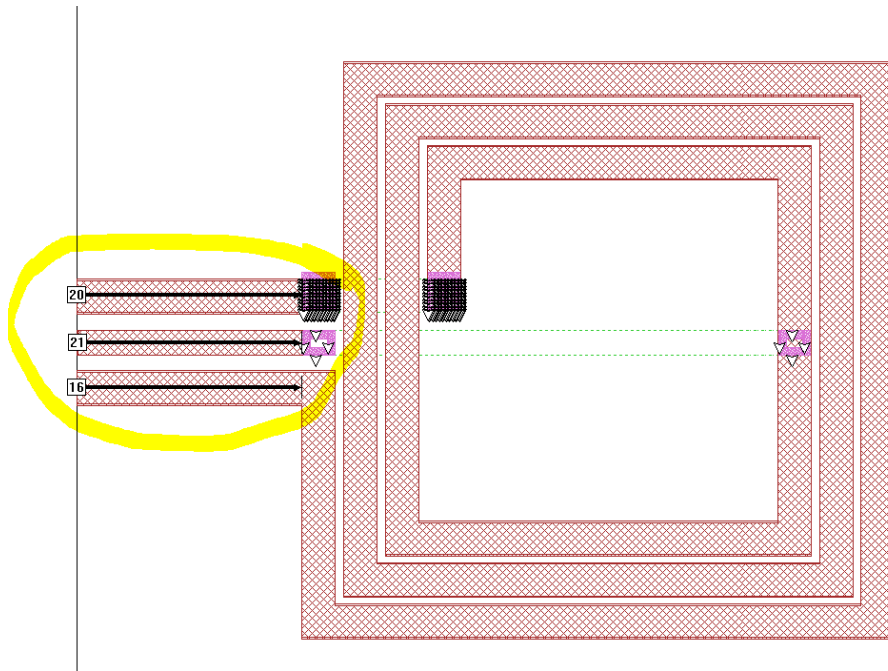
Box Wall Ports



- Used for planar feed of the circuit from the side
- Analysis box is used as port ground
- Optional reference plane shift

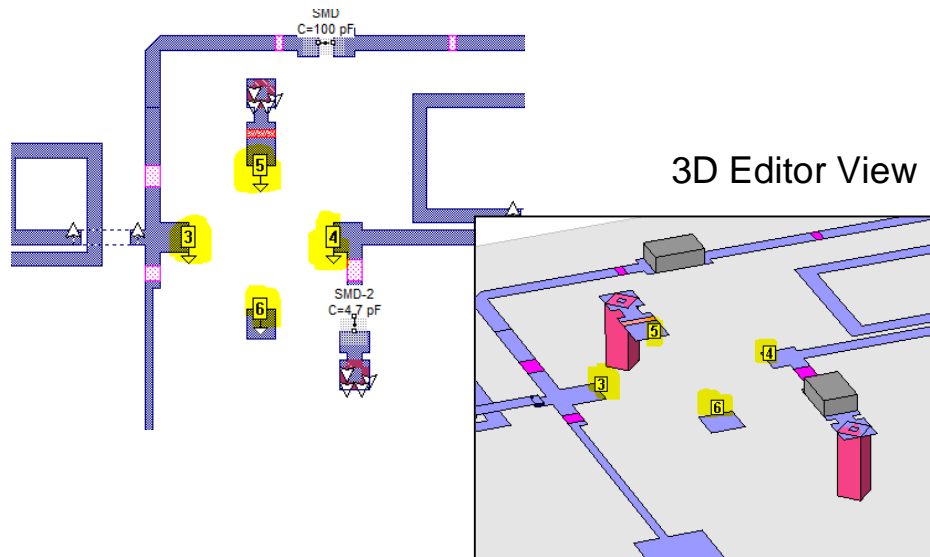


Box Wall Ports

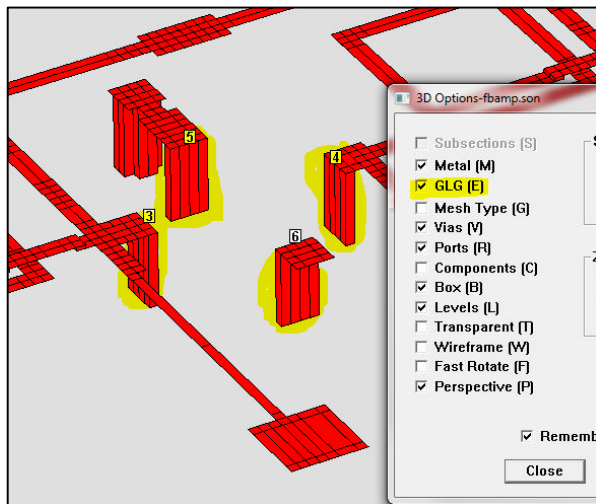


- All feed lines coming from the same box wall are calibrated together in the same calibration group
- This means we have 4 calibration groups for box wall ports, one for each box wall
- When used with reference plane shift, coupling between feed lines in the same calibration group (= coming from the same box wall) is removed

Auto Grounded Ports

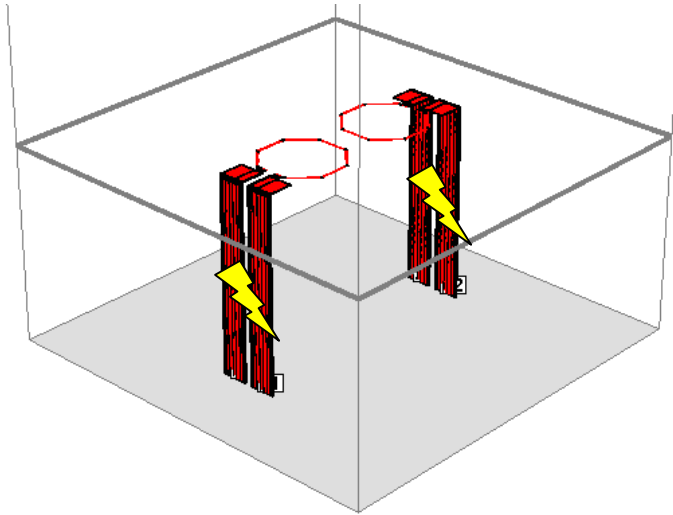


3D Subsection View with „GLG“ enabled



- Used for ports inside where we have no access to the box side wall
- A via to the bottom of the analysis box is created internally by the solver during analysis, so that current can flow through the port.
- This ground via is not shown in the xgeom model editor
- The ground via can be seen in the 3D subsection view with “GLG” enabled in the 3D view options
- Each auto grounded port is calibrated individually, independent of the rest of the model
- Parasitic coupling to other ports or to the circuit is not removed

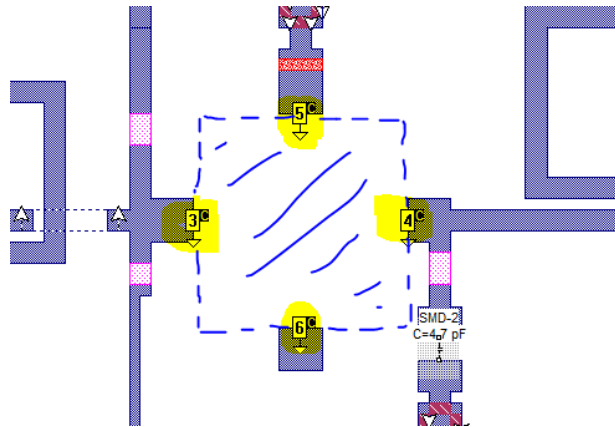
Auto Grounded Ports



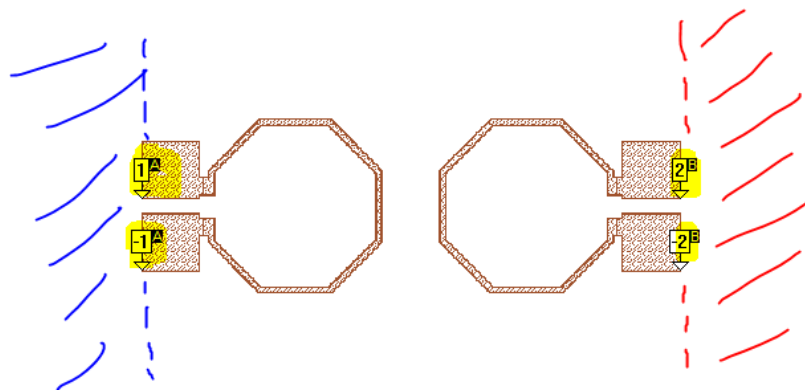
Problem with auto grounded ports
with thick substrates

- Each auto grounded port is calibrated individually. Parasitic coupling to other ports or to the circuit is not removed. The **longer** the ground vias are, and the **closer** they are together, the more this parasitic coupling will show in results.
- Some circuits are sensitive to this ground via coupling, if ports should have high isolation in certain frequency range.
- Calibration of individual vias instead of coupled vias might remove the wrong amount of ground via inductance for closely coupled vias, see example
- The amount of error can be easily tested with a simplified simulation model that has ports only.

Co-calibrated Ports



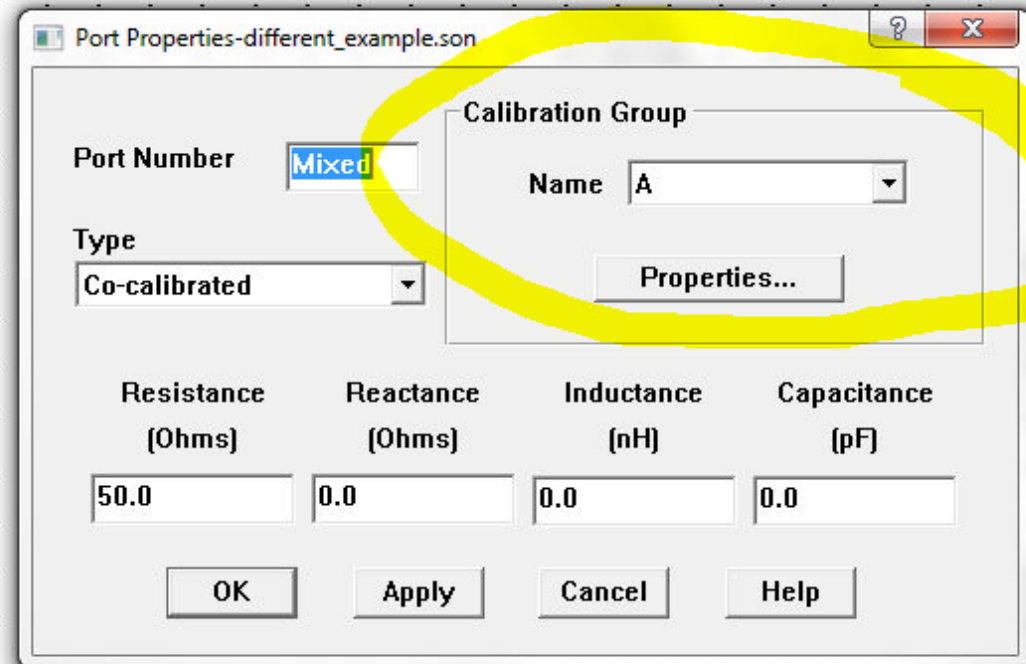
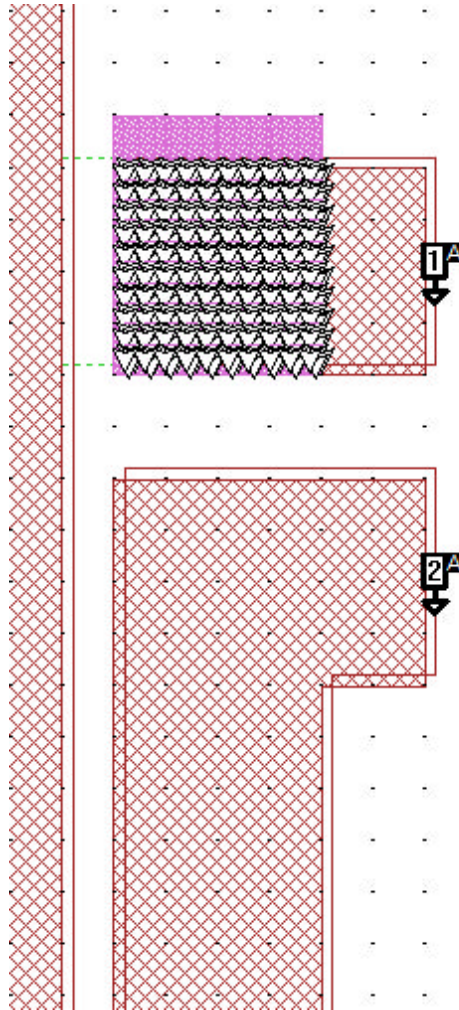
One calibration group



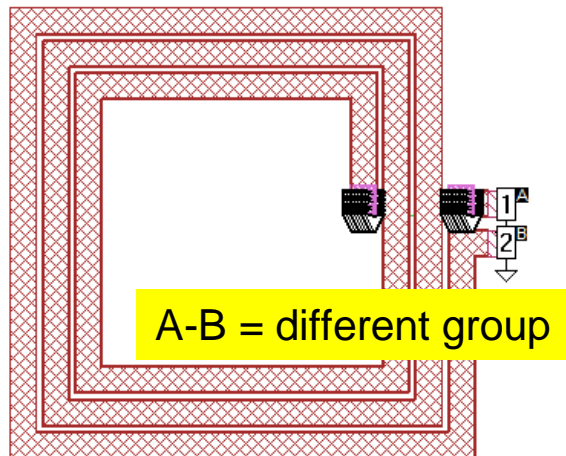
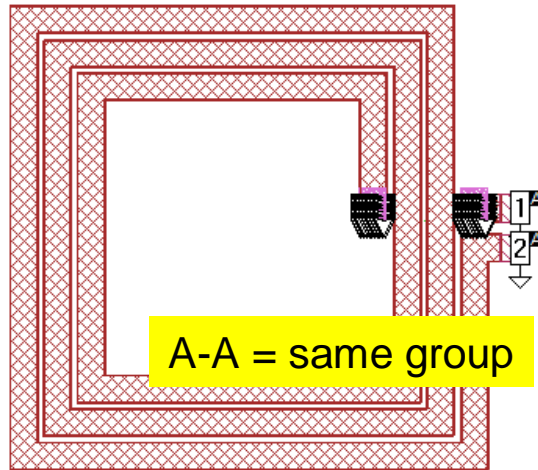
Two calibration groups A and B
Each group contains two ports.

- Co-calibrated ports are calibrated with multiple vias in the same calibration group, so that parasitic coupling inside this group is removed from results.
- Group is manually assigned by the user!
- The parasitic coupling between different groups can not be removed, only within the same calibration group.
- The default ground reference is the Sonnet analysis box. Ground vias go down to the bottom of the analysis box, or up to the top of the box.
- The technical requirement is that ports in the same group must be located “on the boundary of an empty rectangle“. This condition is fulfilled for the ports in the upper left example, and also for the co-linear ports in the lower left example. 6

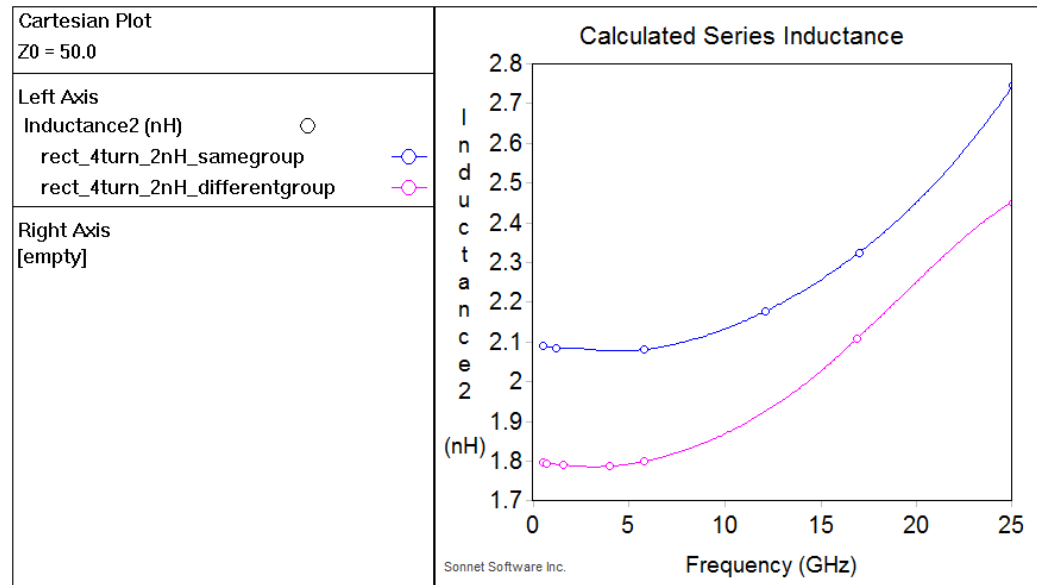
Assigning the Port Group



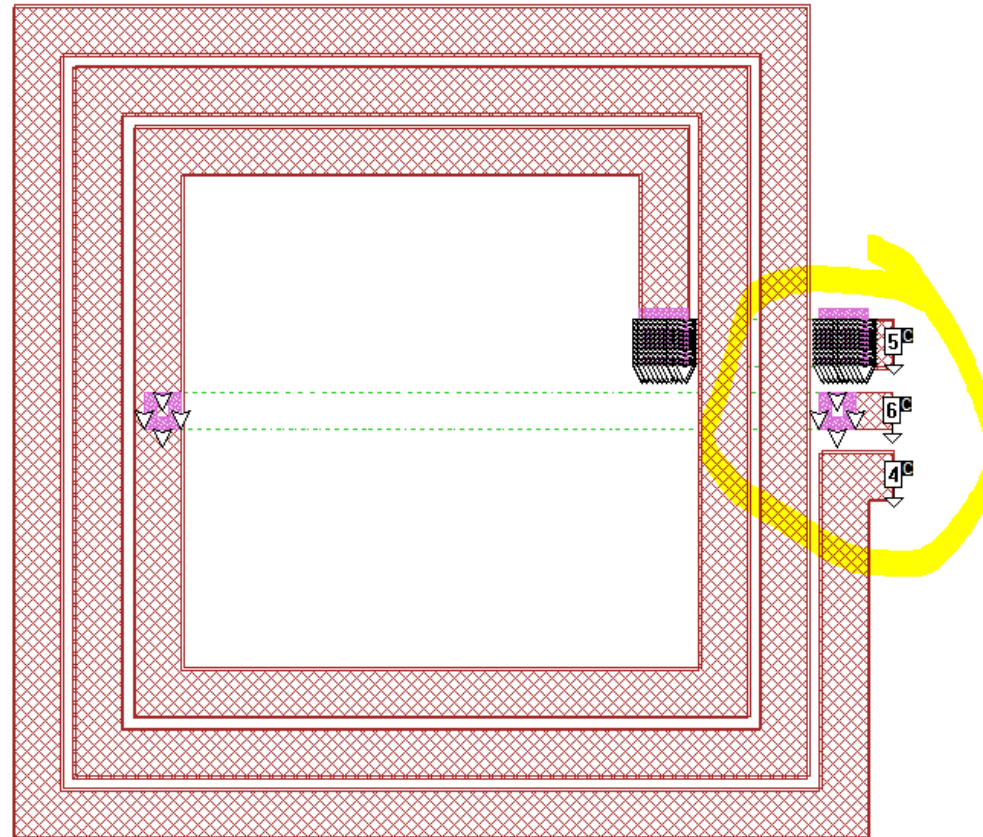
Co-calibrated Port Groups



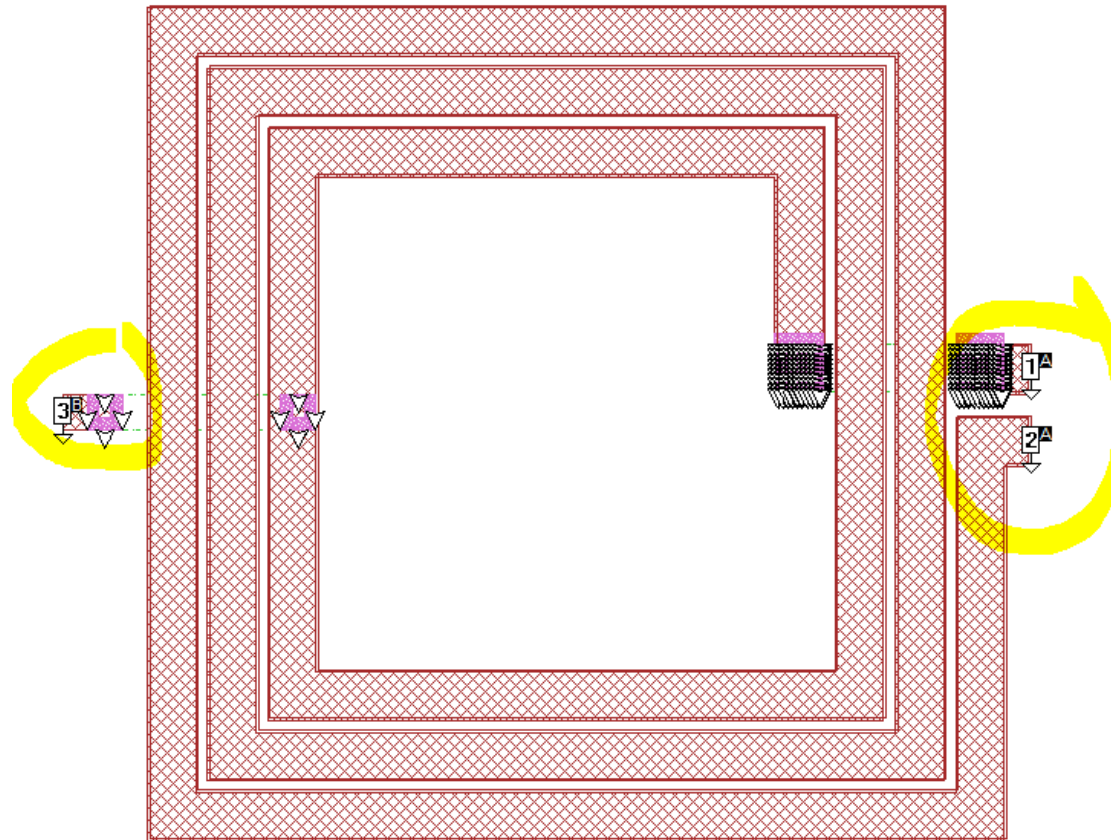
- Co-calibrated ports are only co-calibrated (in the original sense of the word) when they are in the same calibration group!
- The parasitic coupling between different groups can not be removed, only within the same calibration group.



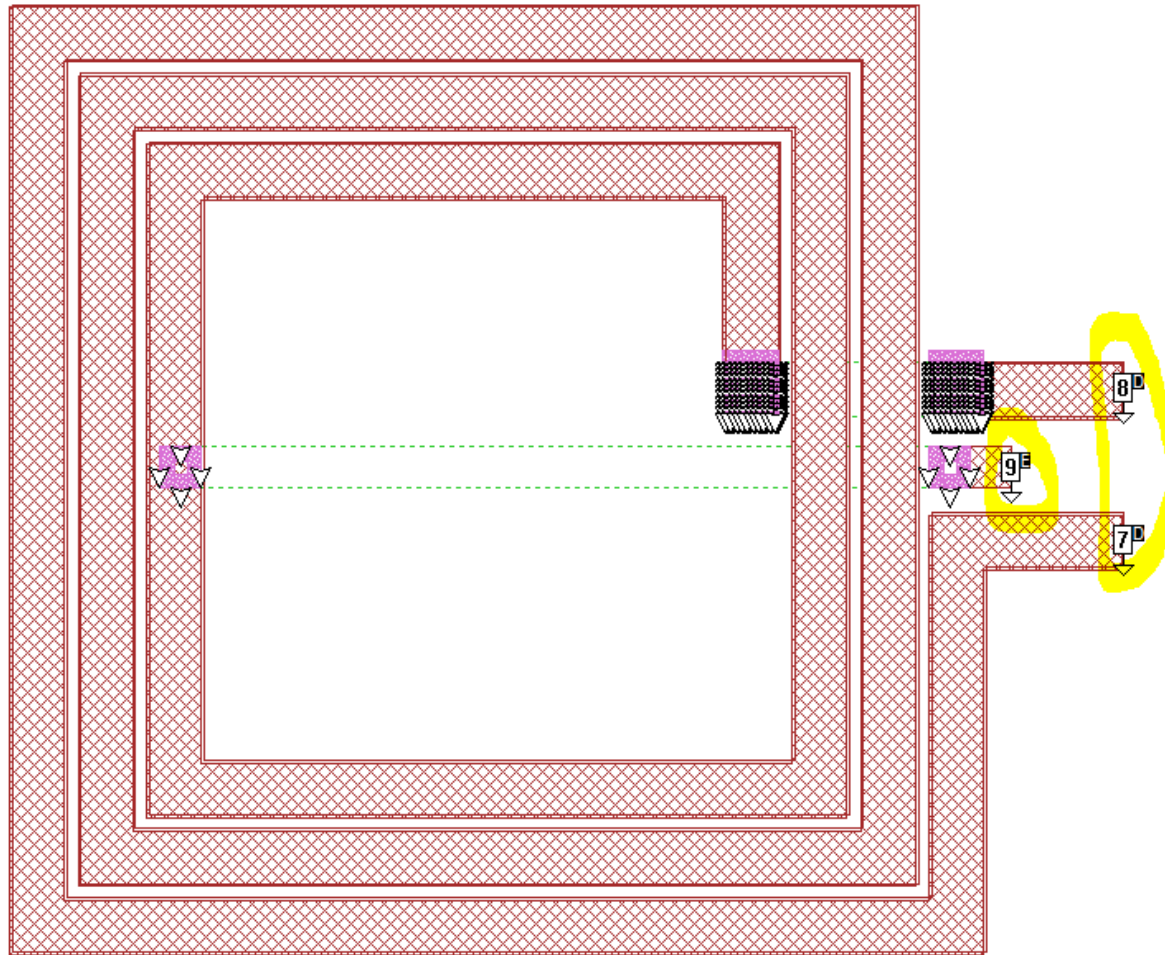
Same Group



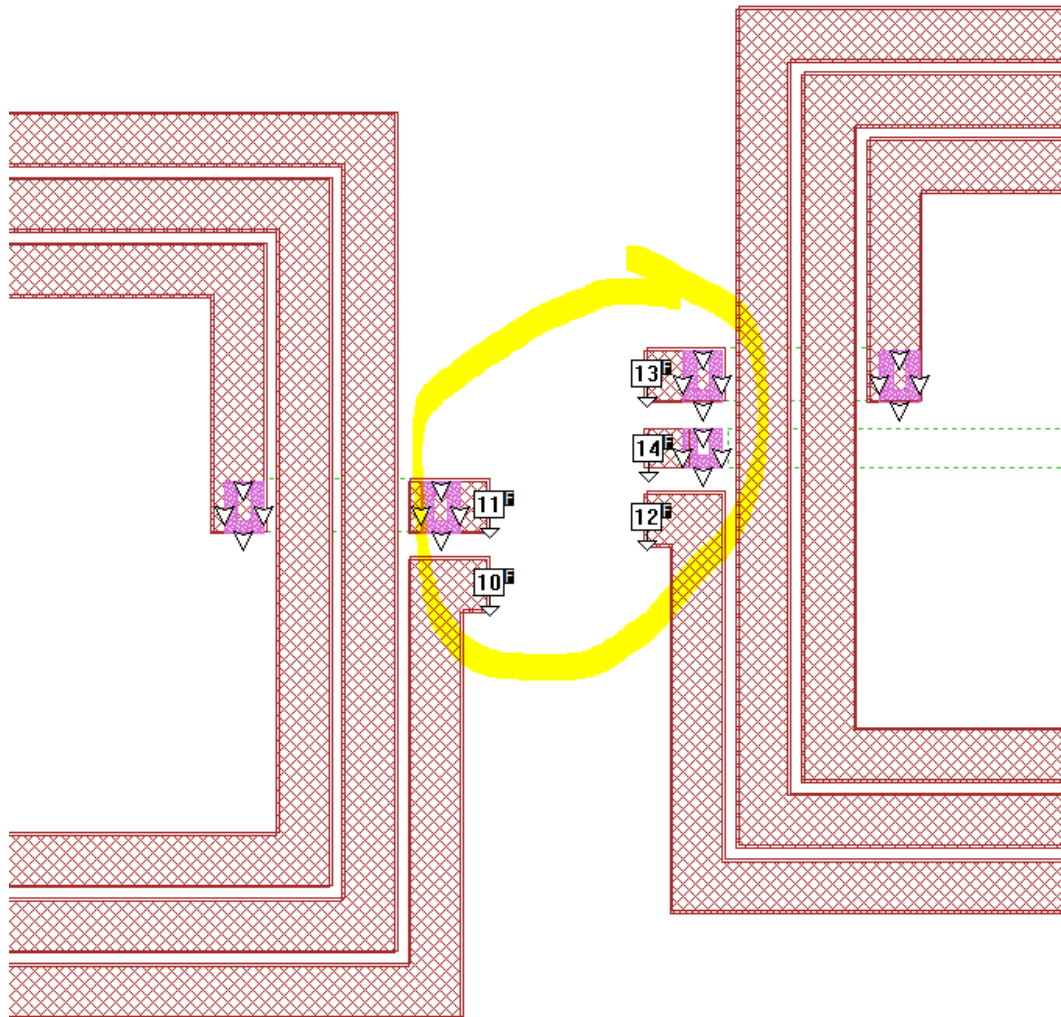
Different Group



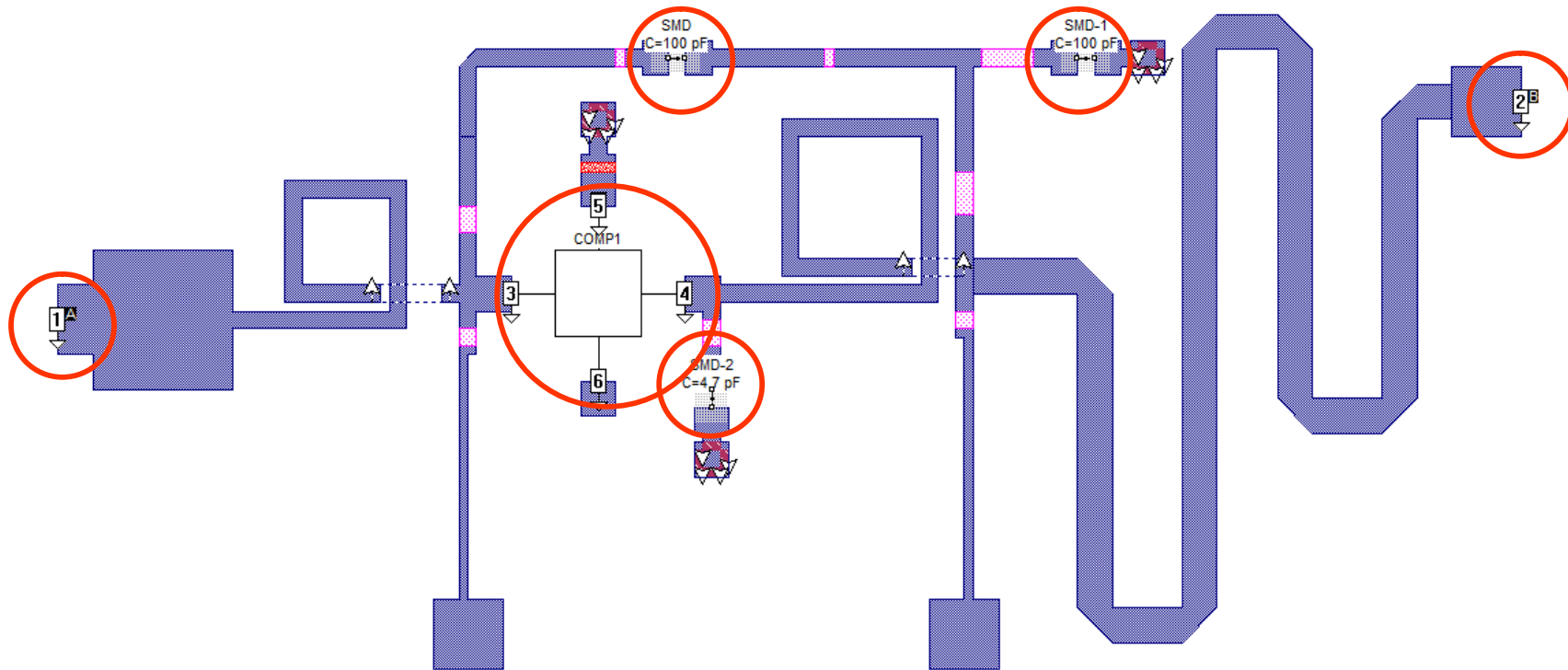
Different Group



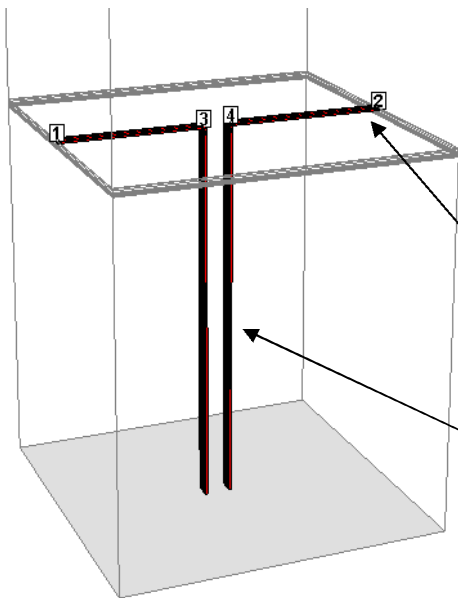
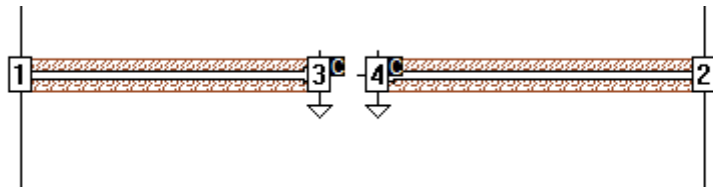
Same Group



Multiple Calibration Groups



Global (Box) Ground



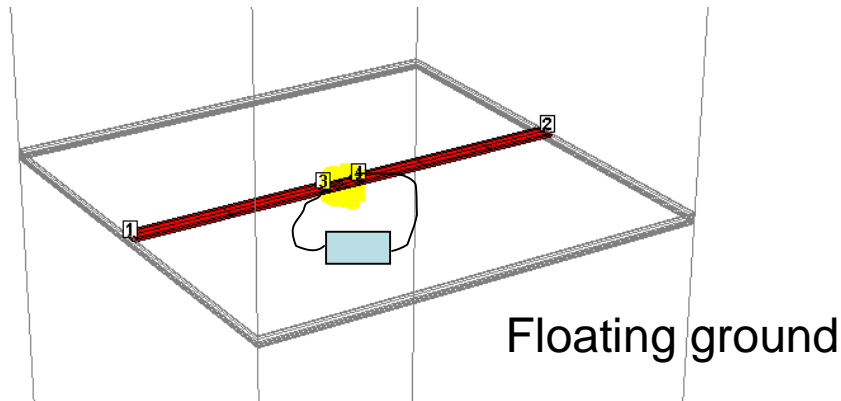
- In most cases, the Sonnet box is used as the common port reference (global ground).
- This means that ports have to connect to the box, so that current can flow.
- The results are easy to use and easy to interpret.

Box wall port ground reference = analysis box

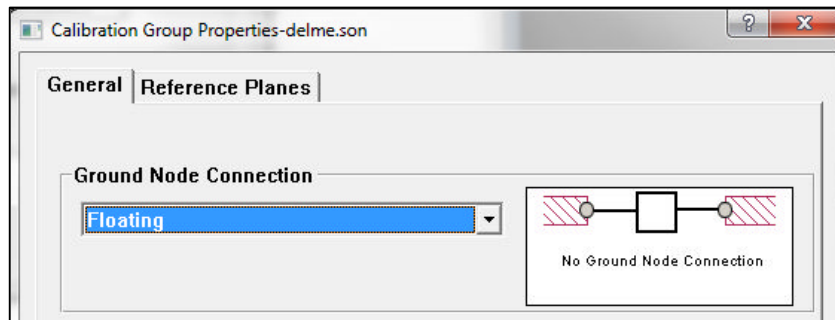
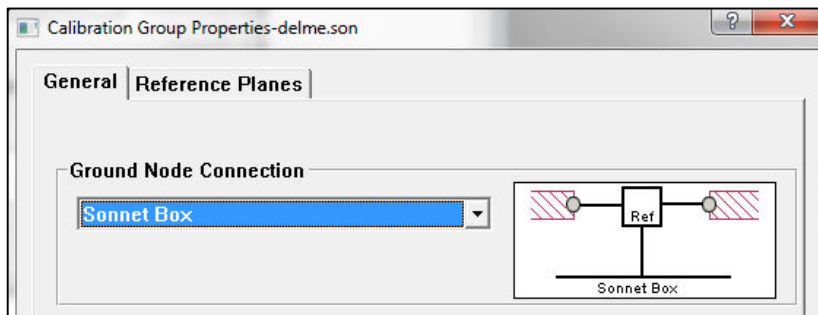
Cocal ports with global ground.

Vias are created by the solver to get box ground access

Floating Ground



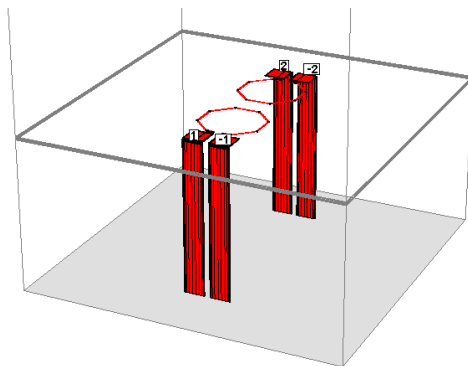
- If we connect a pure series element, with no shunt path, we can also use a local ground instead of vias to the analysis box.
- Be careful with mixing local & global ground: Current can NOT flow from local ground ports directly to the global (box) ground.
- Another way to see it: Currents in ports 3 & 4 and not independent!
- We can not interpret the S31 path in this example because they have different grounds.
Complete path through the series element at ports 3+4 is required.



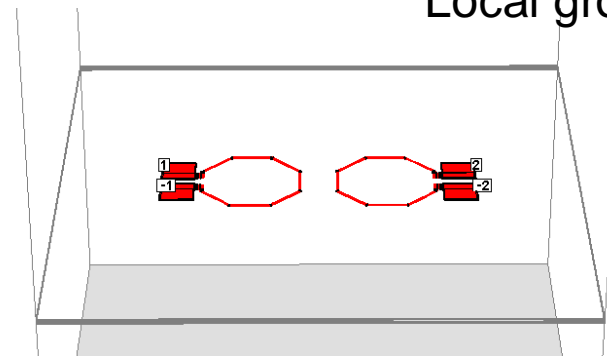
Global vs. Floating Ground

- Global ground is the default choice
- Results are easy to understand and use
- For series elements like the ideal RLC components, a floating ground will give the same results as global ground.
- For RFIC with large distance to box ground, local ground might be useful to avoid very long vias that might create parasitic coupling.
- Ports with local ground have no connection to the Sonnet box, so there is no shunt path to the global (box) ground.

Global ground

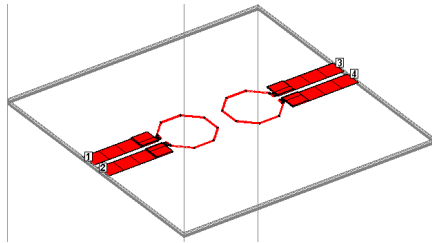


Local ground

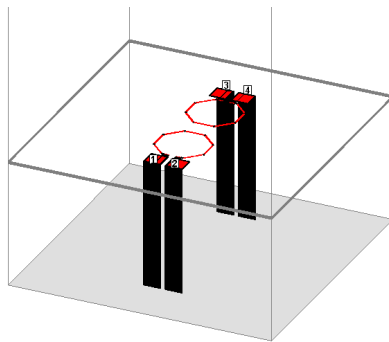


RFIC Inductor Coupling

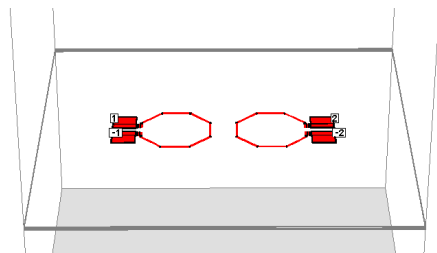
Box wall



CoCal Global ground



CoCal Local ground



- RFIC analysis means thick substrate = long ground vias, so that we better use box wall ports, for planar feed from the side.
- If box wall ports are not possible, then co-calibrated ports are an option. Depending on the requirements, these are used with global or local ground:
 - Global ground with long vias will give the proper shunt effects to the substrate, but might suffer from parasitic coupling of the vias in the port feed structure. Ports within the same calibration group are properly co-calibrated, but there might be coupling between different calibration groups.
 - Local ground is useful to avoid the long ground vias. However, this will remove the shunt path to the substrate.
- Example on the left side:
 - Box wall ports will provide good inductor models and accurate coupling results
 - Co-cal ports with global ground reference will provide good inductors model, but might suffer from parasitic coupling
 - Co-cal ports with local ground reference will provide accurate coupling results, but the individual inductor models will miss the shunt path to the substrate

Application Notes

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