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Simberian Electromagnetic Solutions

De-compositional analysis of a connector breakout with Simbeor and HyperLynx

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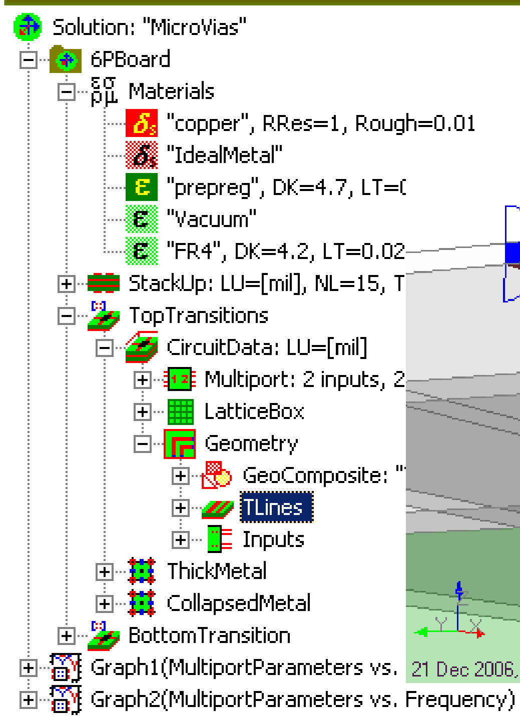

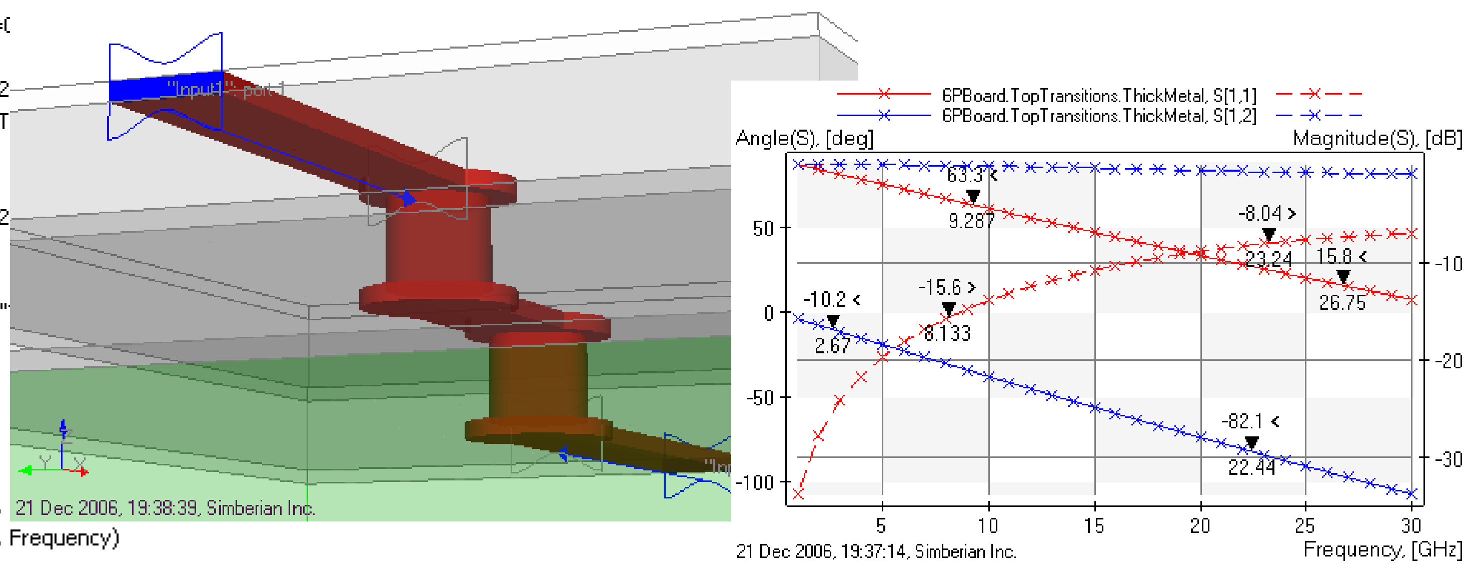

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Introduction

- Show step-by-step how to use S-parameters models of discontinuities generated with Simbeor in a system-level analysis
- Use HyperLynx 7.7 with Eldo from Mentor Graphics corporation for the system-level analysis

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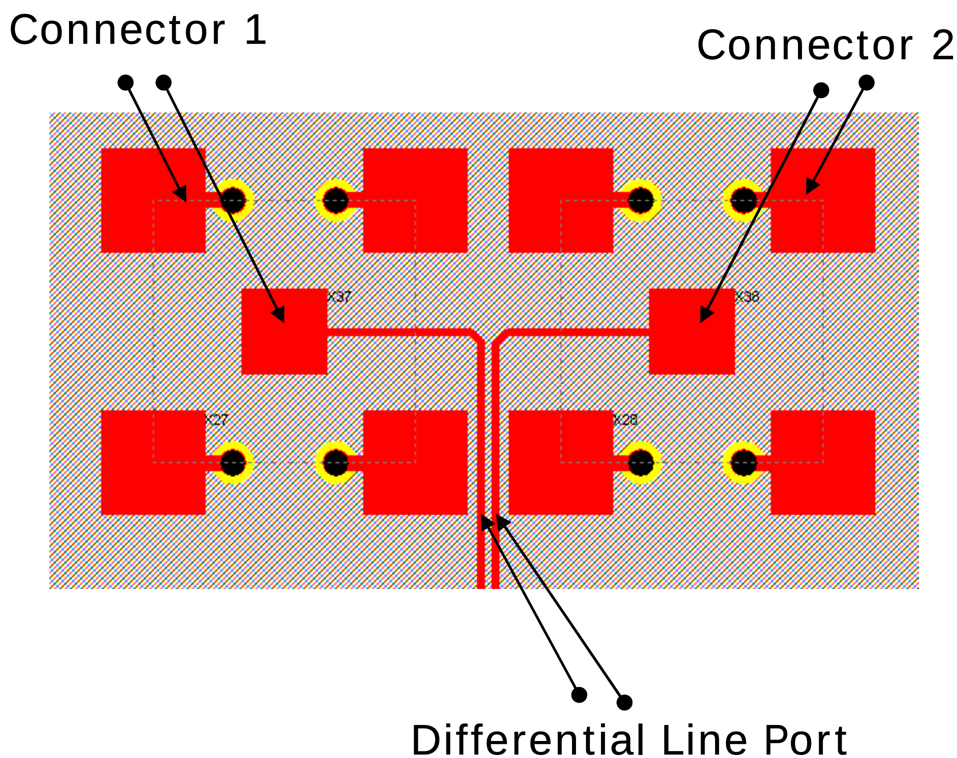
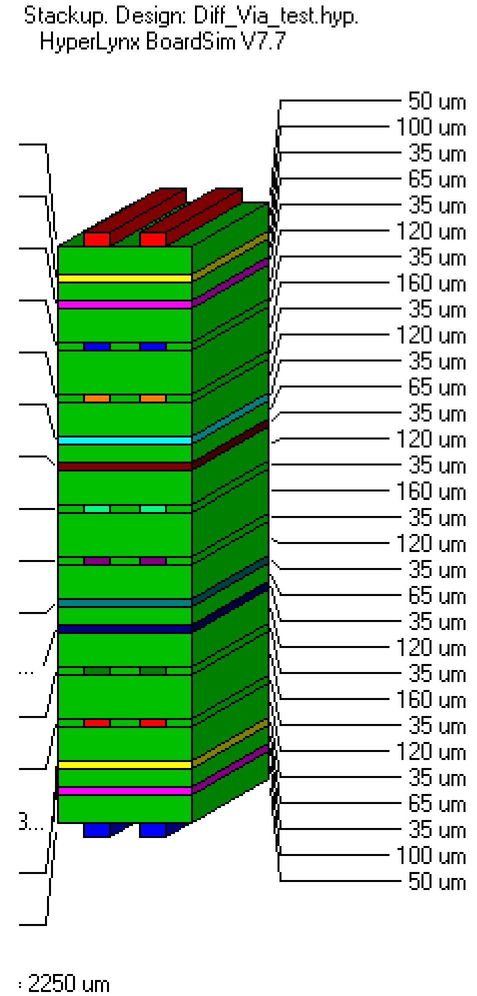
Problem statement

Compute transmission of 10 Gbps differential signal through the following transition from 2 connectors to differential line





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Solution steps

1. Decompose structure into three simple discontinuities
2. Create model for coaxial to microstrip line transition
3. Create model for single microstrip line to differential microstrip transition
4. Create model for differential microstrip line transition through two pads
5. Create HyperLynx schematics of the complete problem with S-parameter models
6. Simulate transition of 10 Gbps signal through the structure

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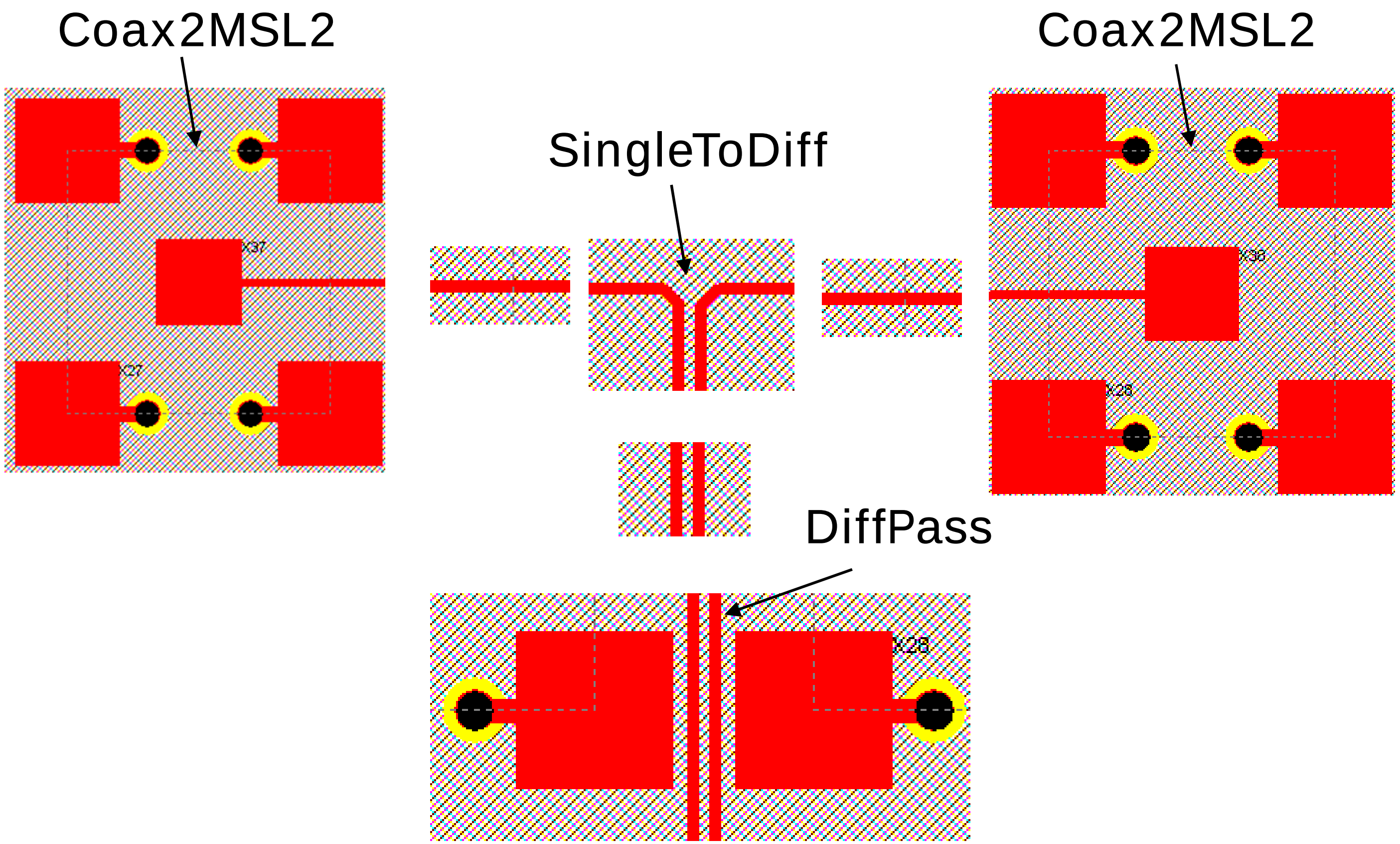
Step 1: Decompose structure into simple discontinuities or components



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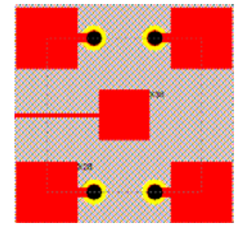
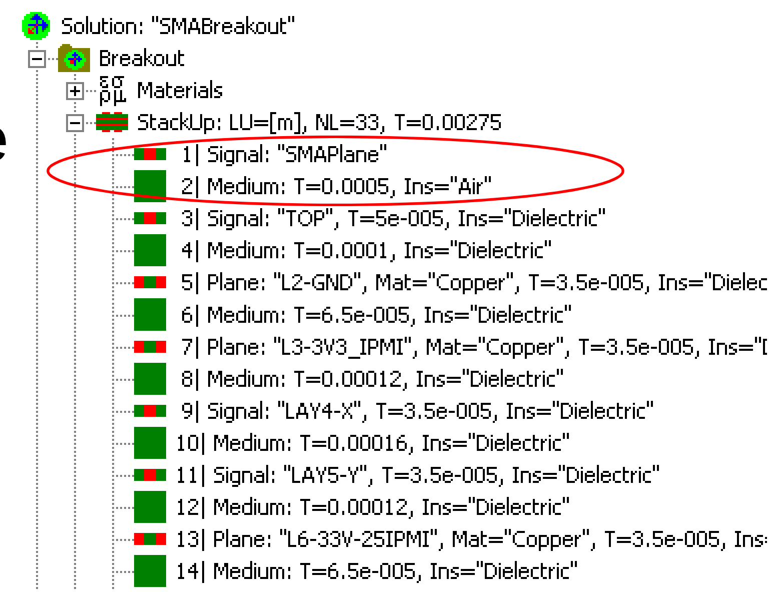
Step 2: Create model of coaxial to microstrip line transition with Simbeor

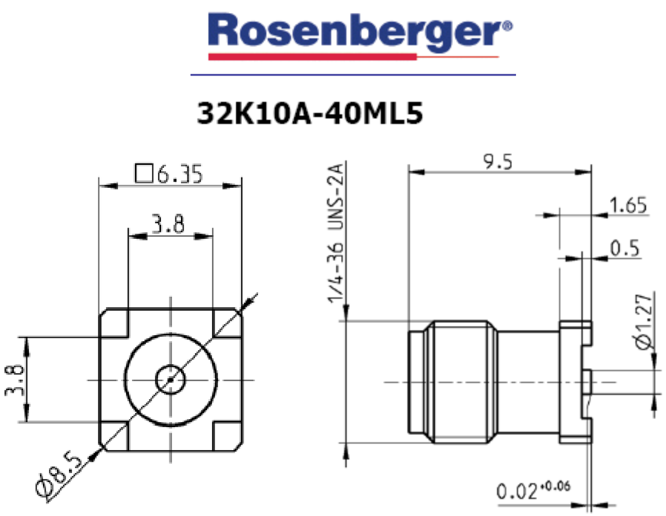


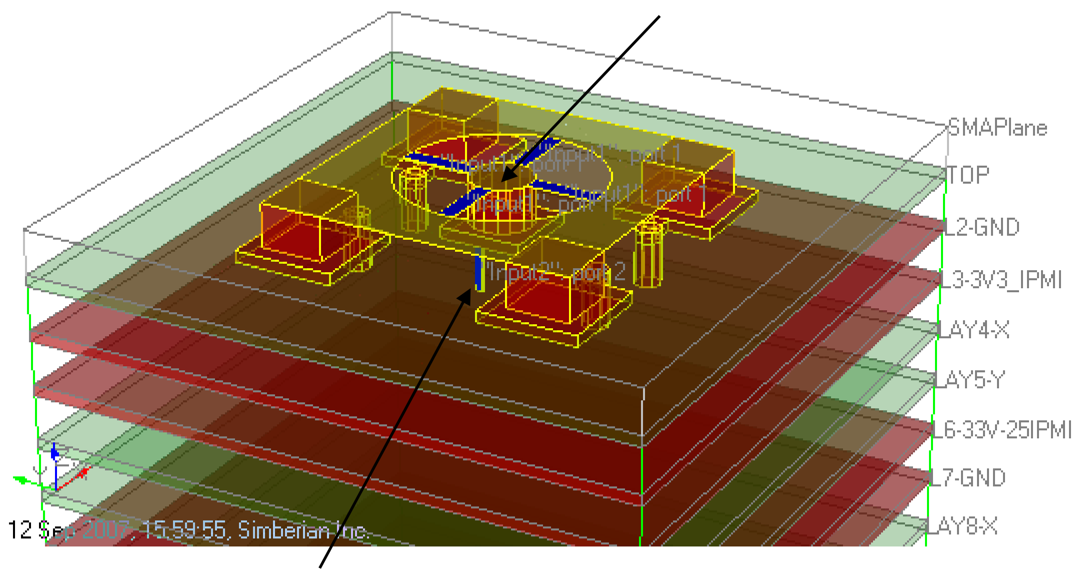
- Export StackUp structure from HyperLynx to Simbeor project Breakout (available only in HL 8.0 pre-alpha)
- Create solution BreakOutElements
- Add project Breakout
- Add additional layers on top of the stackup to simulate the coaxial connection
  - Add layer filled with 0.5 mm of air
  - Add layer of Signal type “SMAPlane”



Coaxial to microstrip line transition geometry

- Add circuit 31K10A to simulate breakout 32K10A-40ML5
- Define geometry object by object
- Define TLine Input (port 1) and component port 2 to simulate the coaxial connection



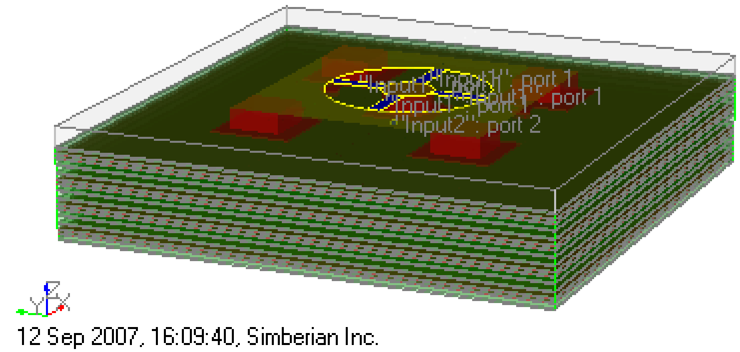


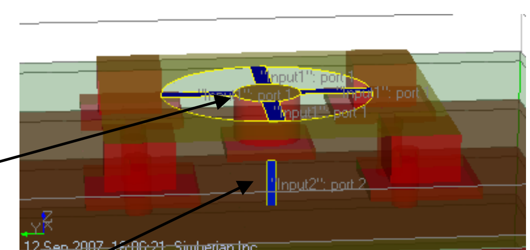
Coaxial Input in SMAPlane

Input to simulate connection to micro-strip line (z-port at the edge of pad)

Coaxial to microstrip line transition geometry elements

- Solution: "BreakOutElements"
  - Breakout
    - Materials
    - StackUp: LU=[m], NL=33, T=0.00275
    - 32K10A
      - CircuitData: LU=[mm]
        - Multiport: 2 inputs, 2 ports
        - LatticeBox
        - Geometry
          - Composite Object, XC=0, YC=0
            - Rectangle: "TOP", "Copper", Xmin=-0.825, Ymin=-0.825, Xmax=0.825, Ymax=0.825
            - "PDN_Pads", XC=0, YC=0
              - Rectangle: "TOP", "Copper", Xmin=-3.5, Ymin=-3.5, Xmax=-1.5, Ymax=-1.5
              - Rectangle: "TOP", "Copper", Xmin=1.5, Ymin=1.5, Xmax=3.5, Ymax=3.5
              - Rectangle: "TOP", "Copper", Xmin=1.5, Ymin=-3.5, Xmax=3.5, Ymax=-1.5
              - Rectangle: "TOP", "Copper", Xmin=-3.5, Ymin=1.5, Xmax=-1.5, Ymax=3.5
            - "PDN_Vias", XC=0, YC=0
              - "Via1", XC=-1.1235, YC=-2.5
              - "Via2", XC=1.1235, YC=-2.5
              - "Via3", XC=1.1235, YC=2.5
              - "Via4", XC=-1.1235, YC=2.5
            - "Connector", XC=0, YC=0
              - Rectangle: "SMAPlane", "Ideal", Xmin=-3.15, Ymin=-3.15, Xmax=3.15, Ymax=3.15
              - Cuboid: "TOP" to "SMAPlane", "Copper", Xmin=-3.15, Ymin=-3.15, Xmax=-1.9, Ymax=-1.9
              - Cuboid: "TOP" to "SMAPlane", "Copper", Xmin=1.9, Ymin=-3.15, Xmax=3.15, Ymax=-1.9
              - Cuboid: "TOP" to "SMAPlane", "Copper", Xmin=-3.15, Ymin=1.9, Xmax=-1.9, Ymax=3.15
              - Cuboid: "TOP" to "SMAPlane", "Copper", Xmin=1.9, Ymin=1.9, Xmax=3.15, Ymax=3.15
              - Cylindroid: "TOP" to "SMAPlane", "Copper", XC=0, YC=0, D=1.27
          - TLines
          - Inputs
            - "Input1", 4 Ports
            - "Input2", 1 port
              - ZPort 2: Zsig="TOP", Zref="L2-GND", XC=-0.825, YC=0, XS=0.01, YS=0.15





Coaxial Input with 4 ports in parallel: Port 1

Component Input with 1 z-port: Port 2

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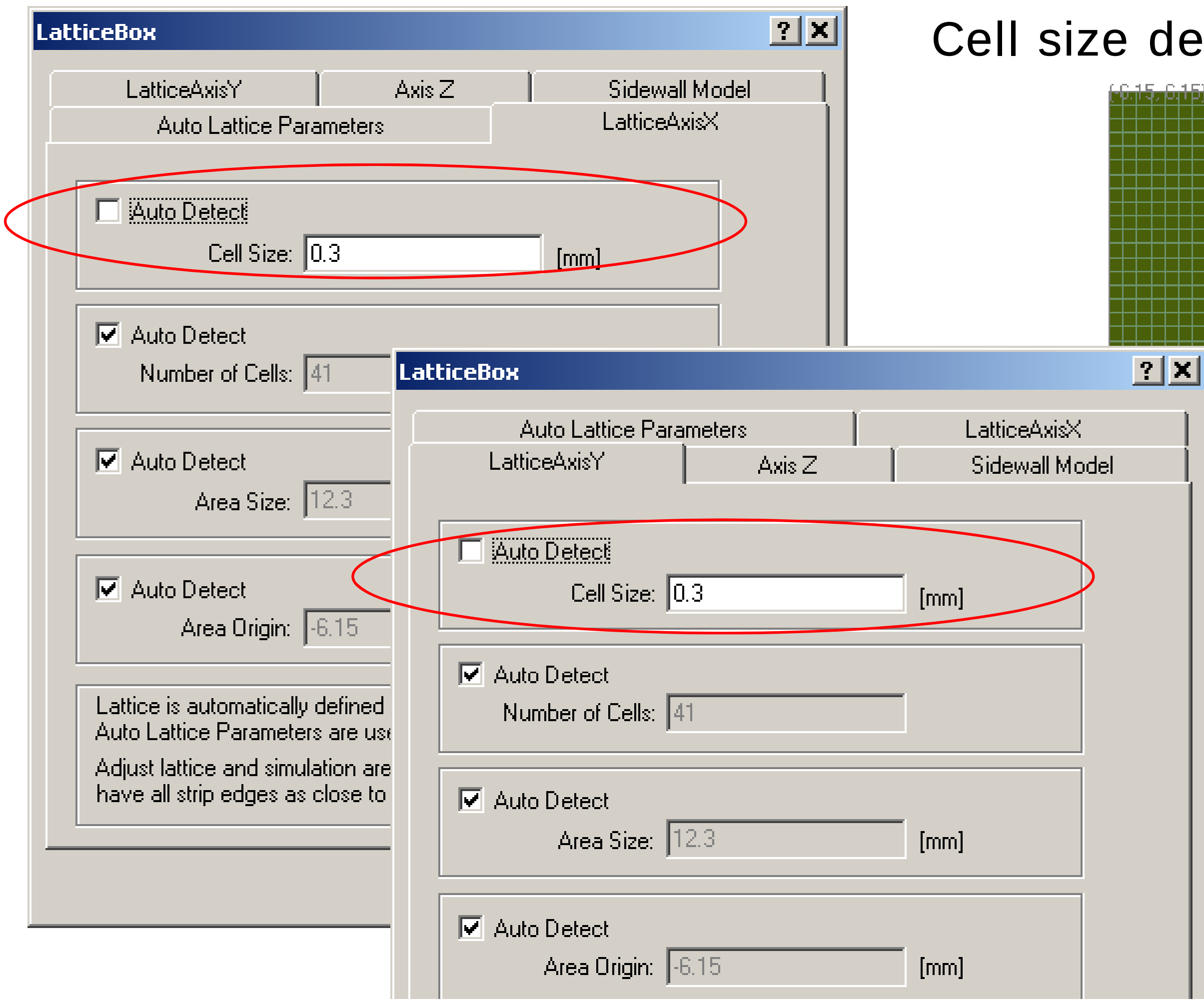
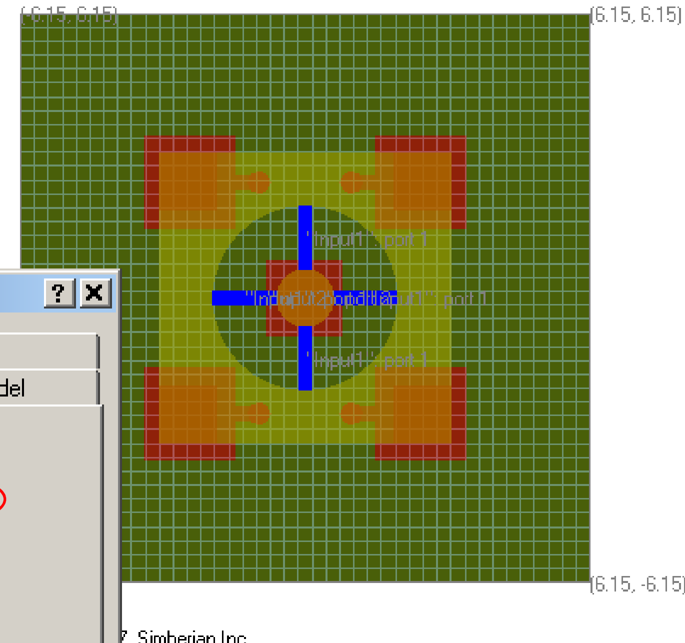
Lattice box definition for coaxial to microstrip transition

Cell size defined as 0.3 mm





All other parameters set to auto-detect

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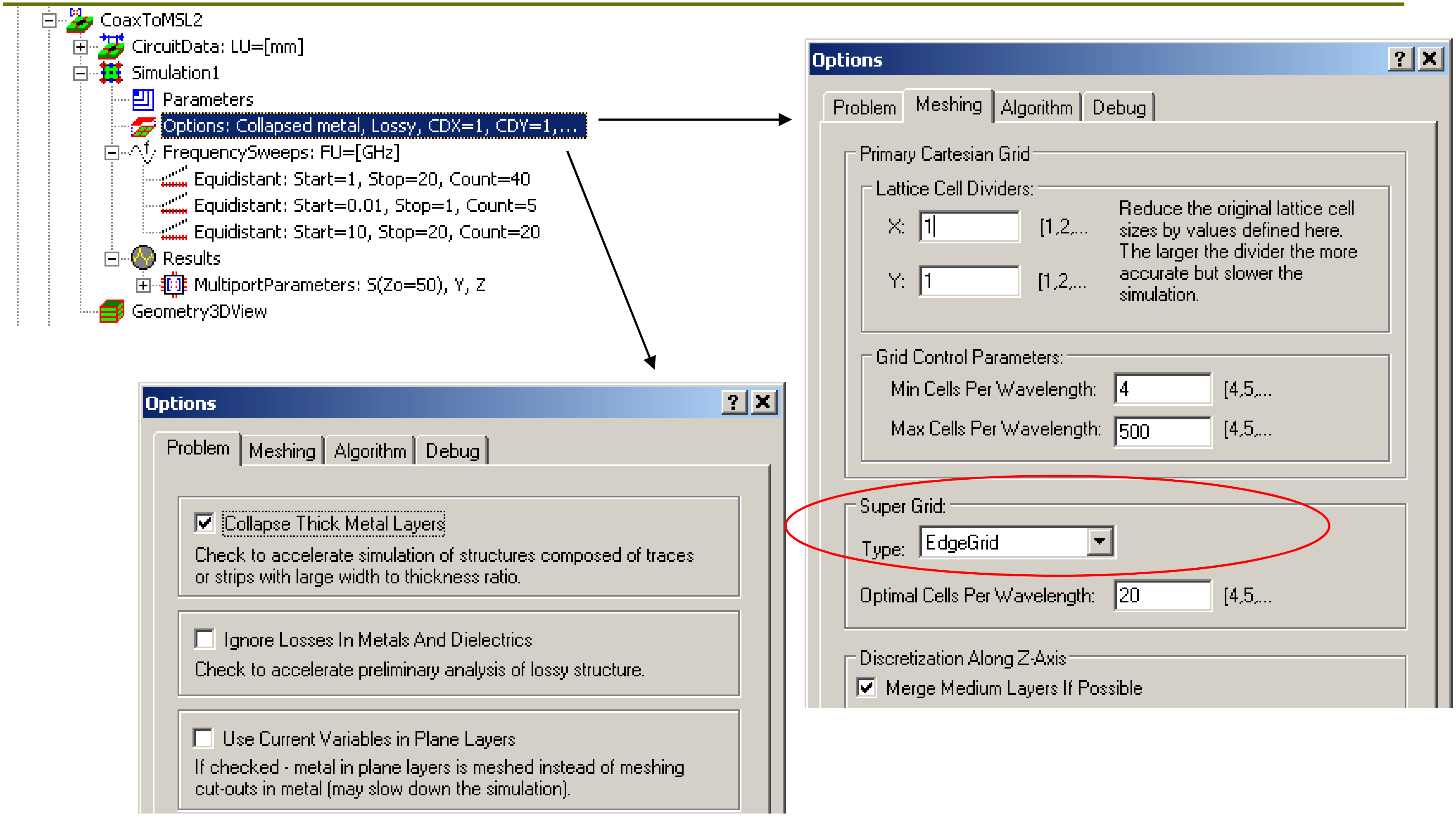
Simulation setup for the coaxial to microstrip line transition



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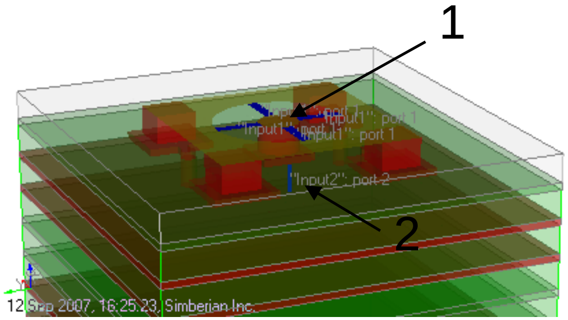
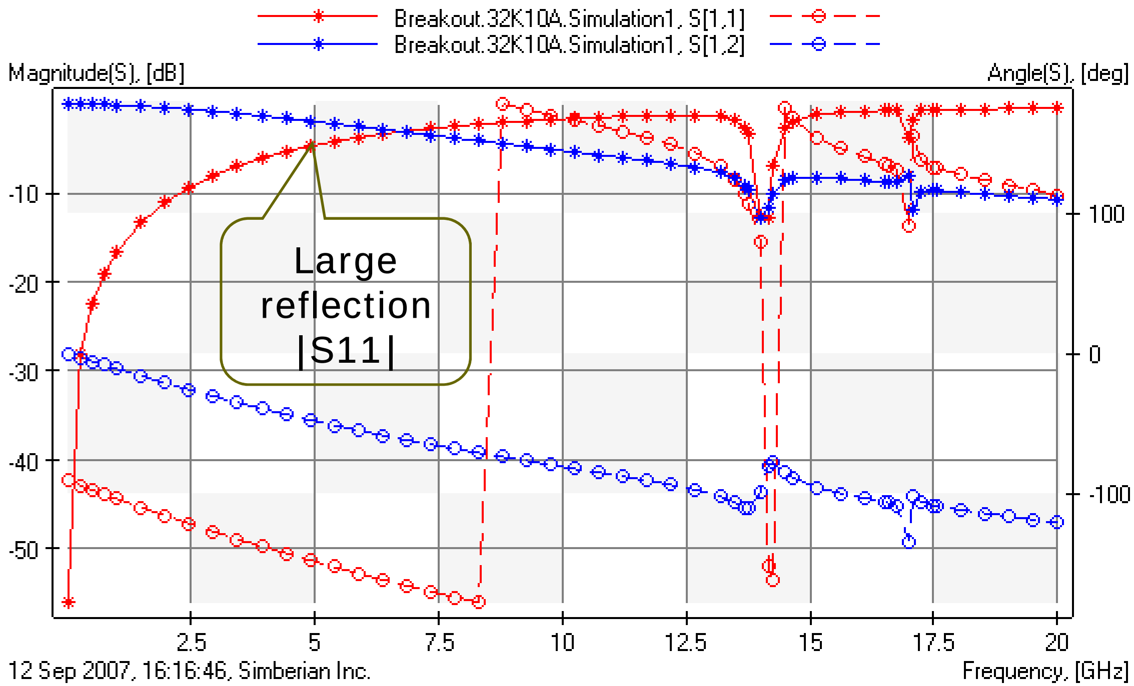
Coaxial to MSL transition simulation results





The structure is oversized and not matched to 50-Ohm

Overall the structure behaves as low-pass filter

Output Results into Touchstone file Breakout_32K10A_Simulation1.s2p

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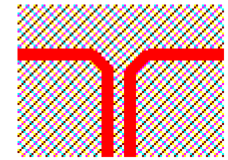
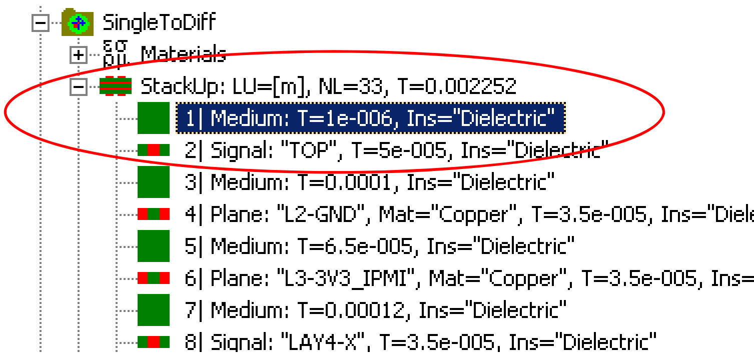
Step 3: Create model of single microstrip line to differential microstrip transition

- Export stackup from HyperLynx into SingleToDiff Simbeor project (or copy stackup from the previous project)
- Add small layer on top to increase accuracy of analysis the solder mask with the collapsed metal model





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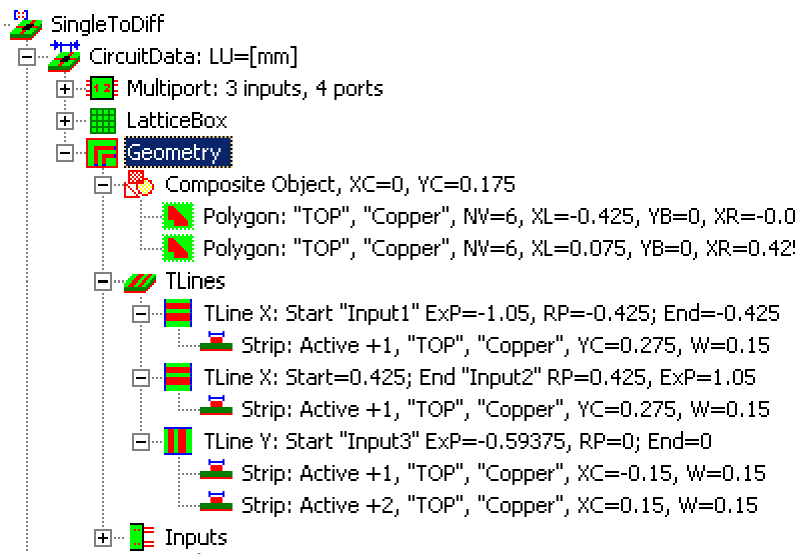
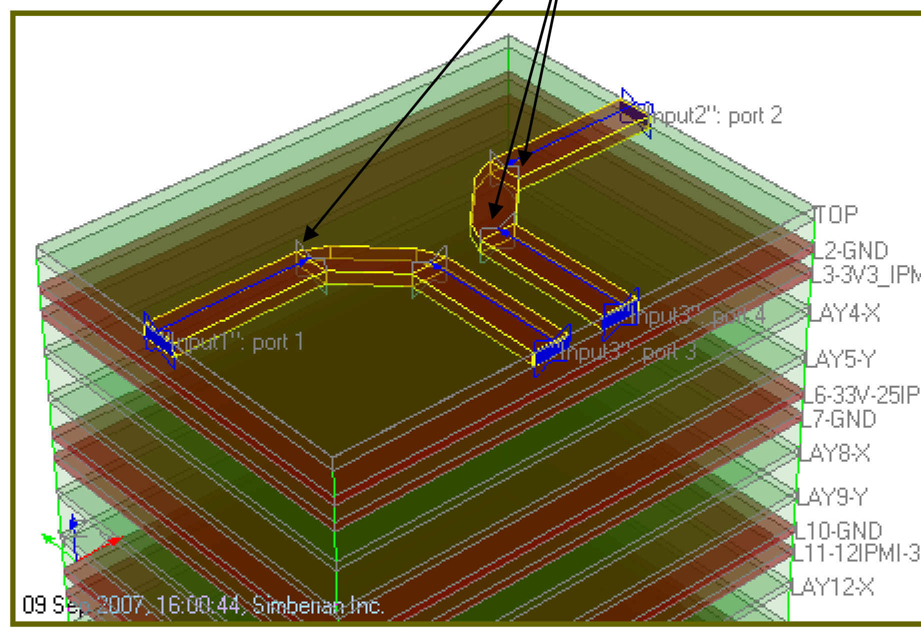
Define geometry of single microstrip line to differential microstrip transition

- Add circuit SingleToDiff
- Define two single t-lines with inputs
- Define one differential line with inputs
- Add two polygons to simulate two 45-degree segments

Reference plans shifted toward discontinuity (de-embedding)





Inputs defined automatically

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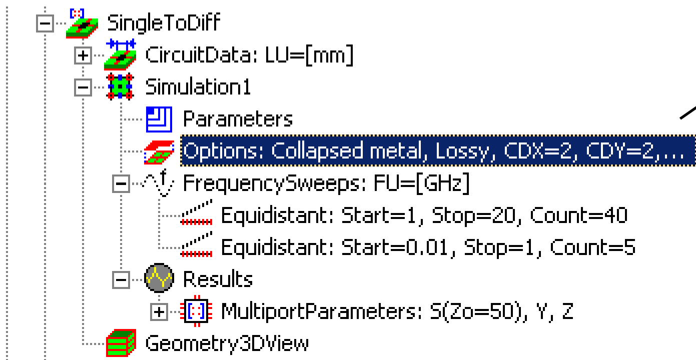
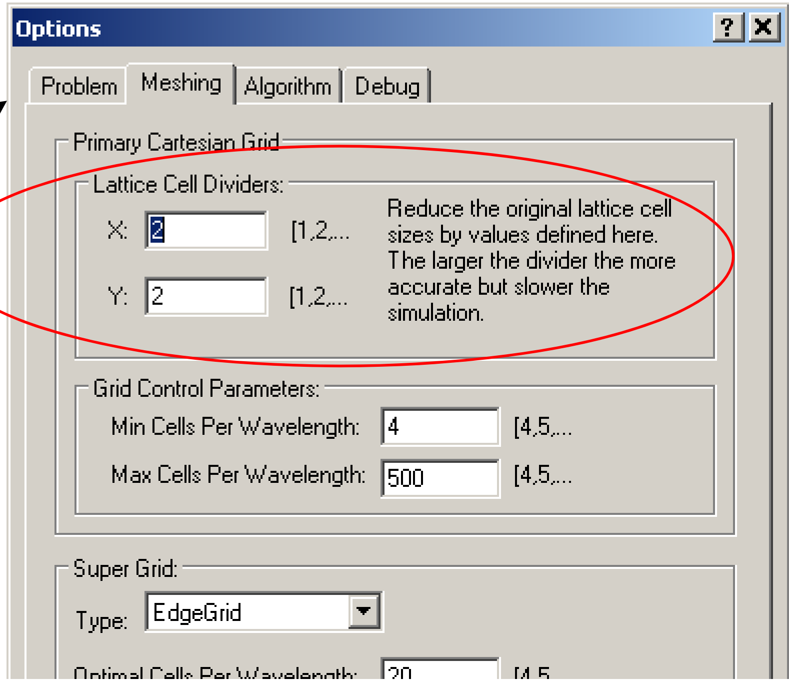
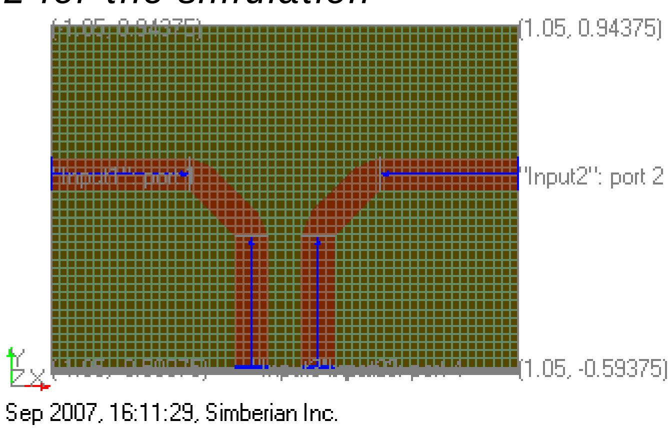
Simulation setting for single microstrip line to differential microstrip transition

Refine automatically defined cell size – divide it by 2 to increase accuracy

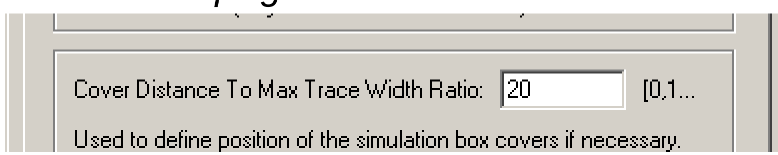




Original cell size will be divided by 2 for the simulation



Increase distance to top cover on Problem page



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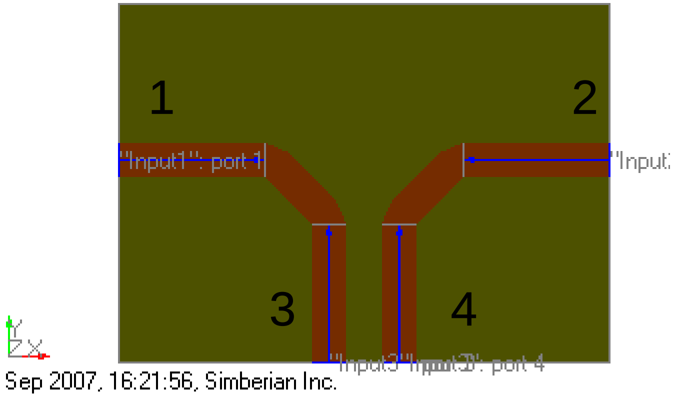
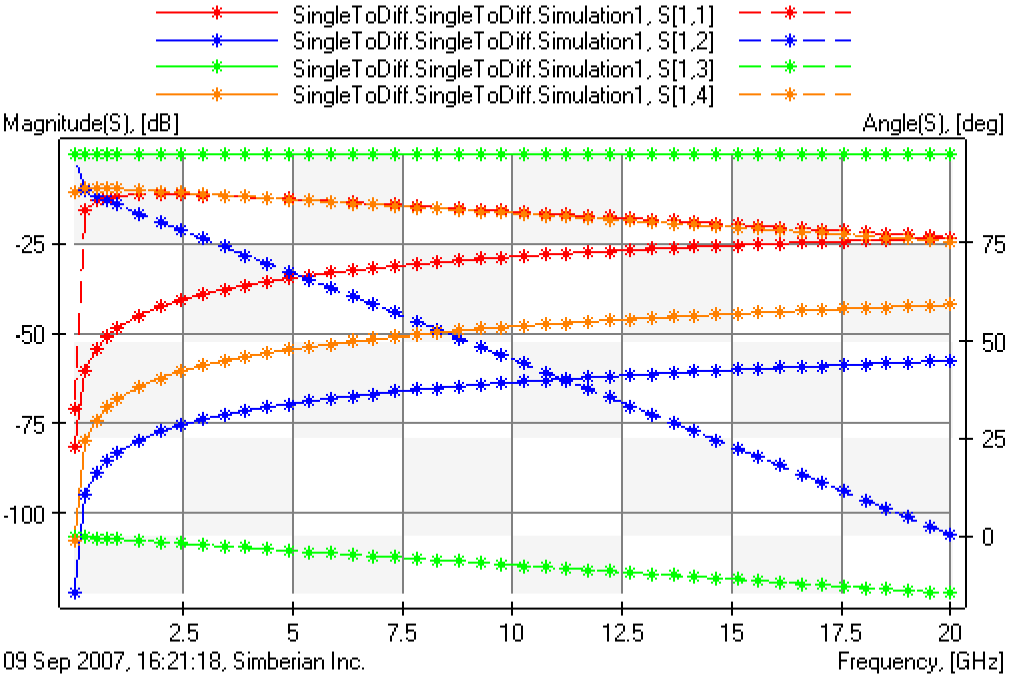
Simulation results for single microstrip line to differential microstrip transition





Output Results into Touchstone file SingleToDiff_SingleToDiff_Simulation1.s4p

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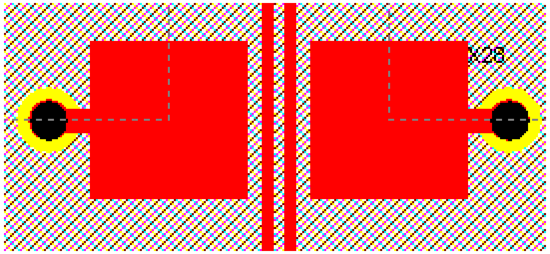
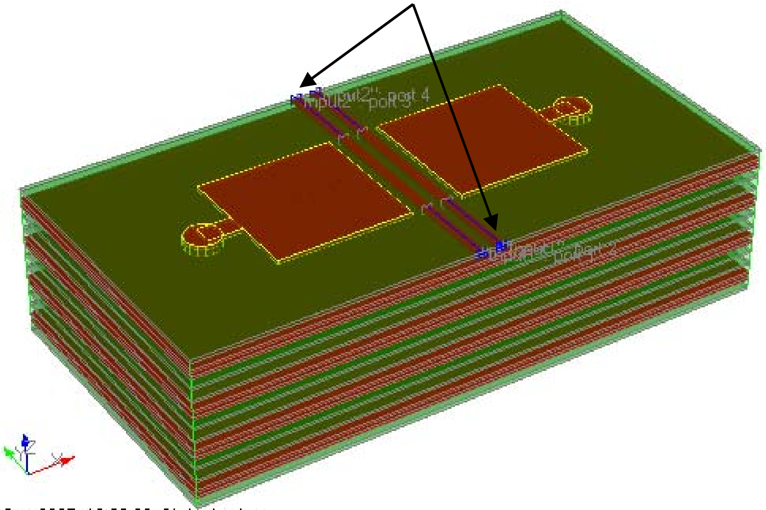
Step 4: Create model of differential microstrip line transition through two pads

- SingleToDiff Project can be used to simulate the structure
- Create DiffPass circuit
- Define geometry elements



Differential inputs with phase ref. plane shifted to the pads edges



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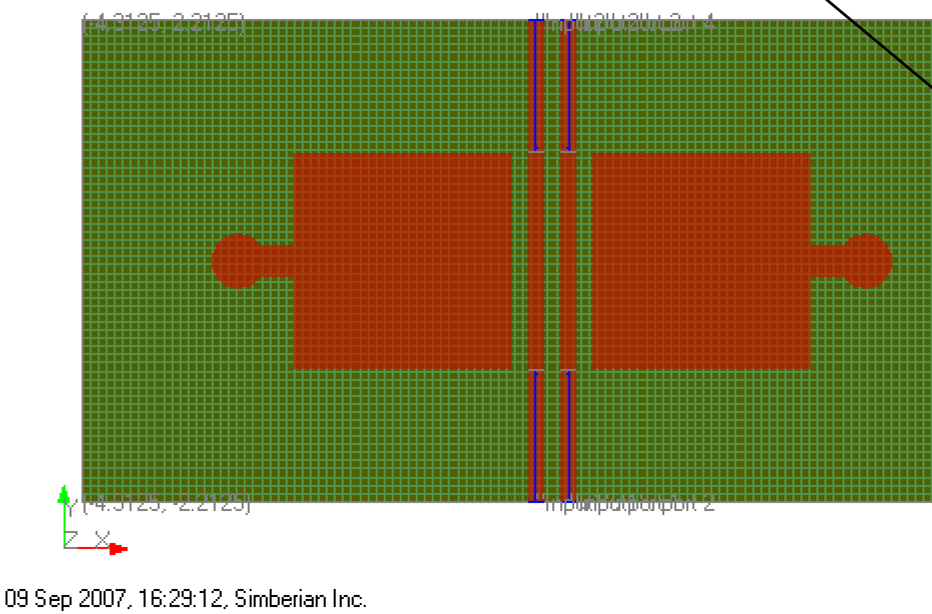
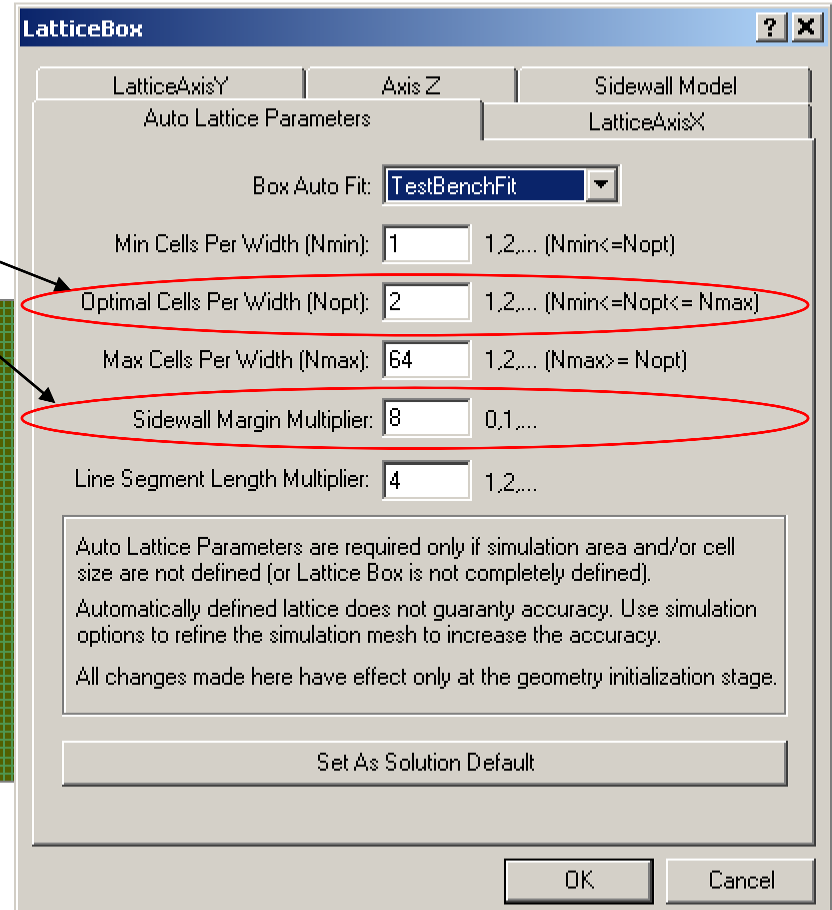
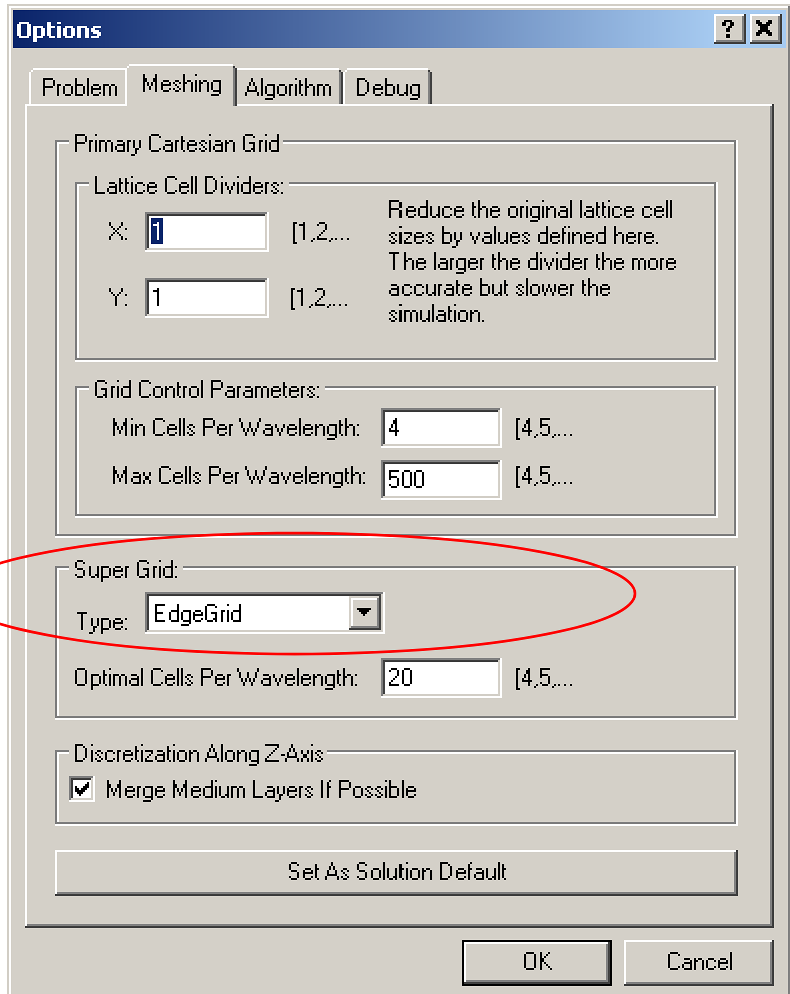
Lattice Box setup for differential microstrip line transition through two pads

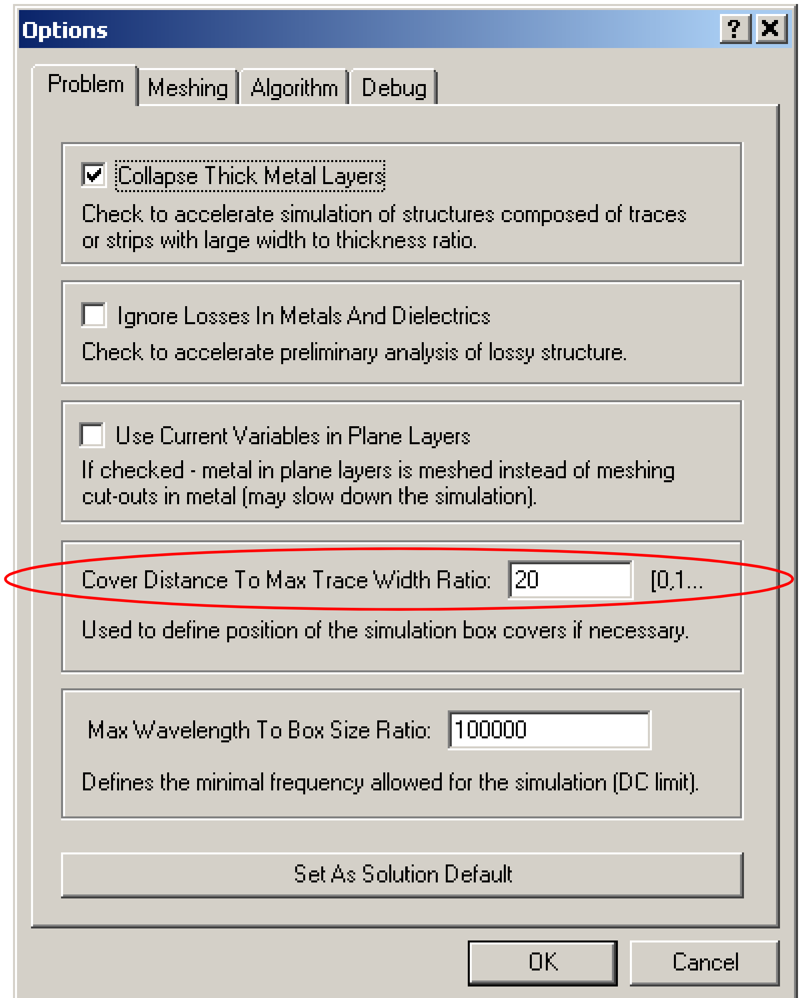
Use 2 cells per strip width and increase default distance to sidewalls with the two auto-lattice parameters





Simulation setting for differential microstrip line transition through two pads





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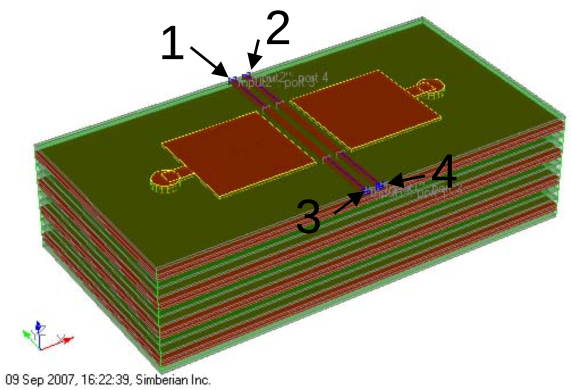
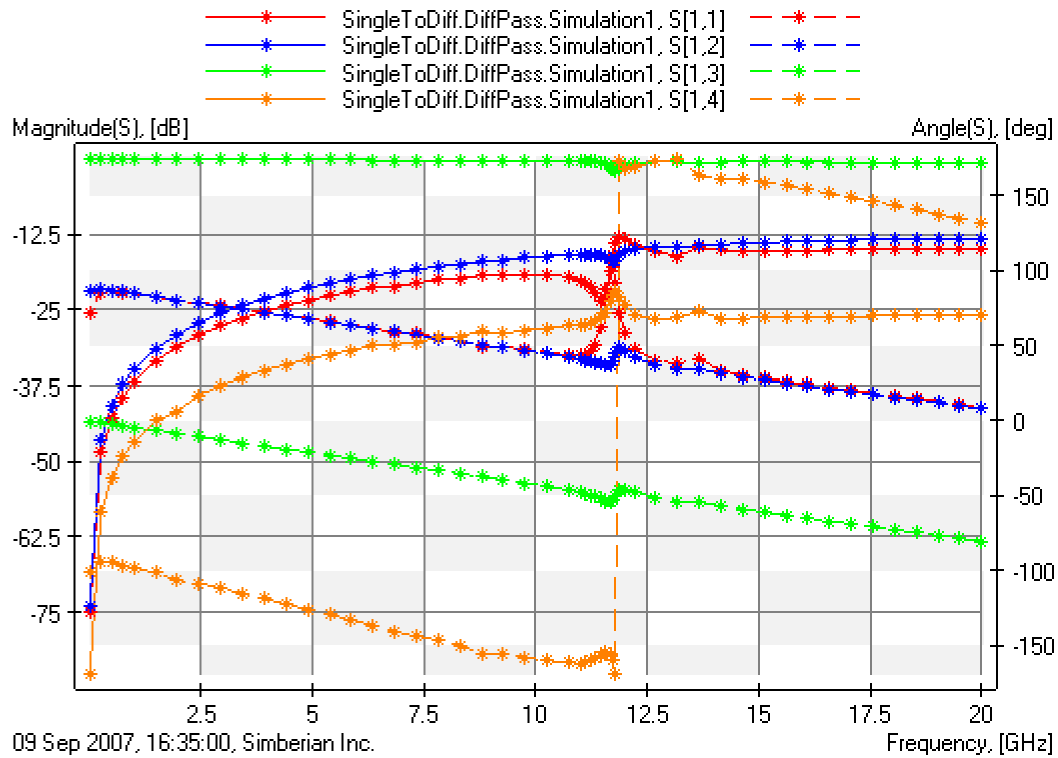
Simulation results for differential microstrip line transition through two pads





Resonance is observed around 11.5 GHz

Output Results into Touchstone file SingleToDiff_DiffPass_Simulation1.s4p

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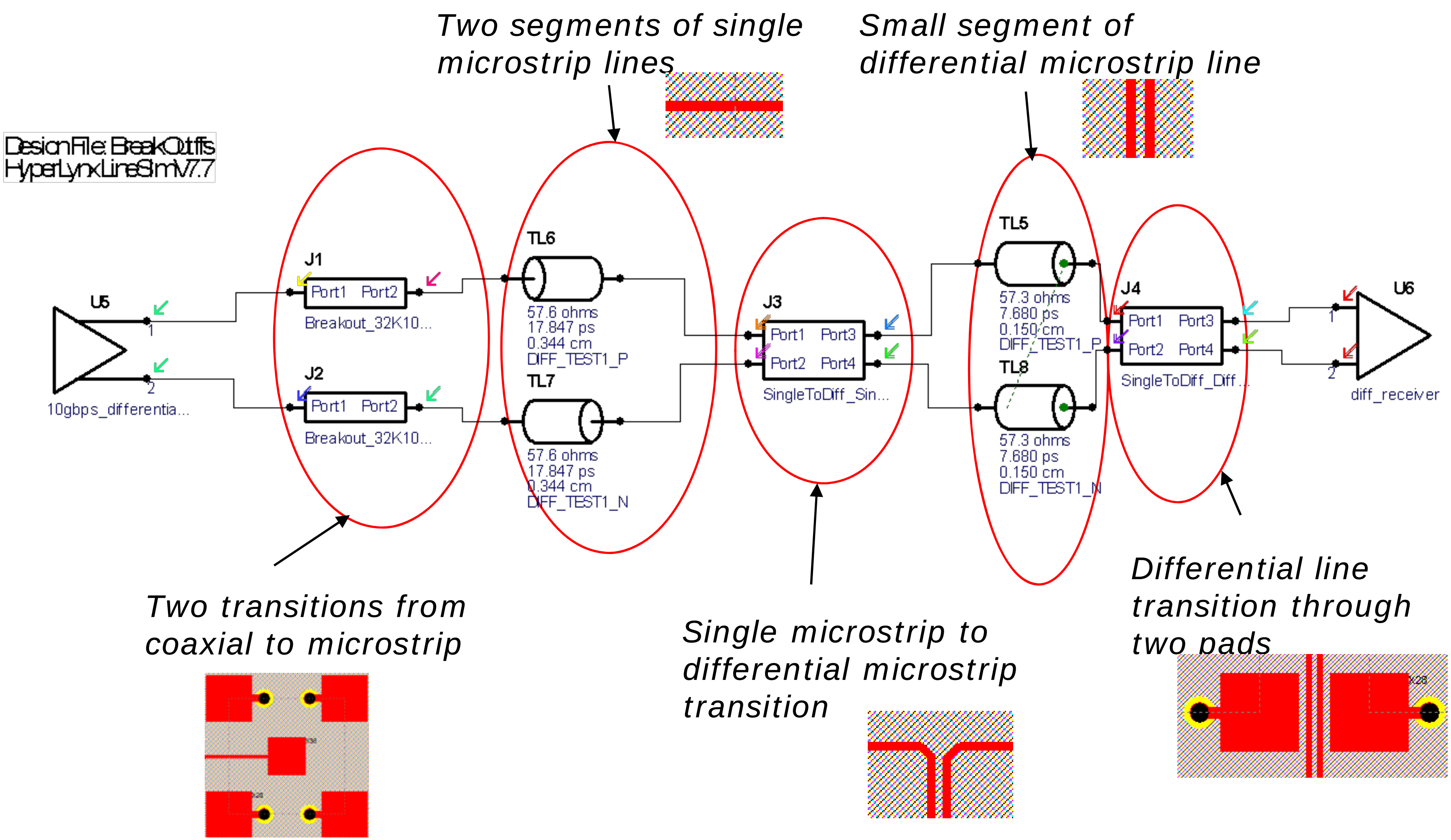
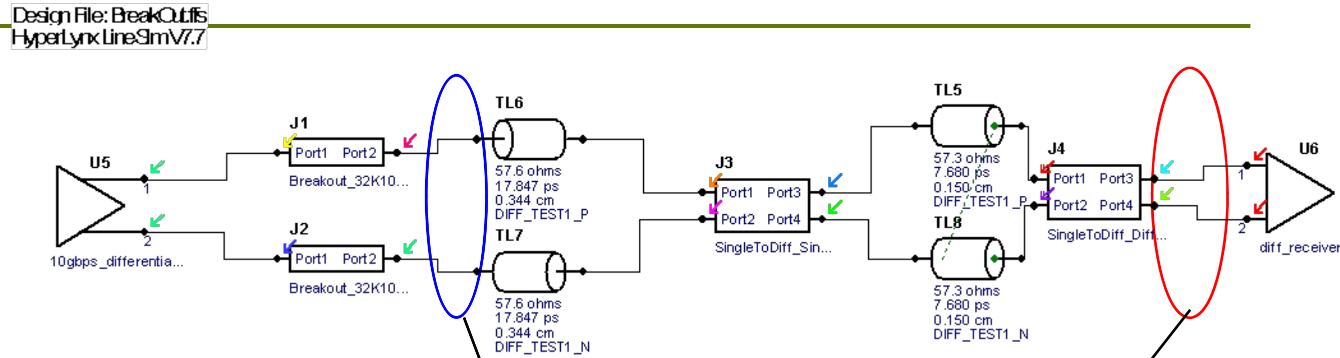
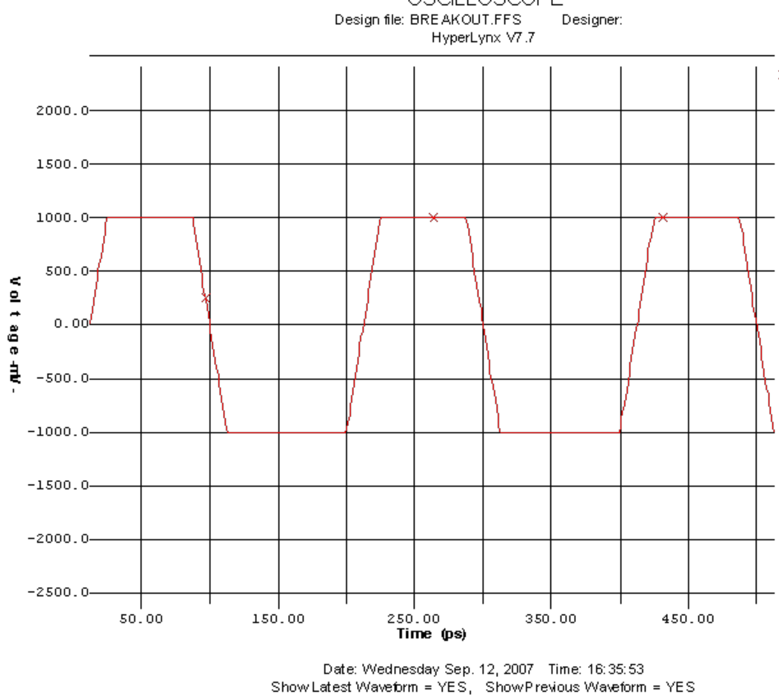
Step 5: Create HyperLynx schematics

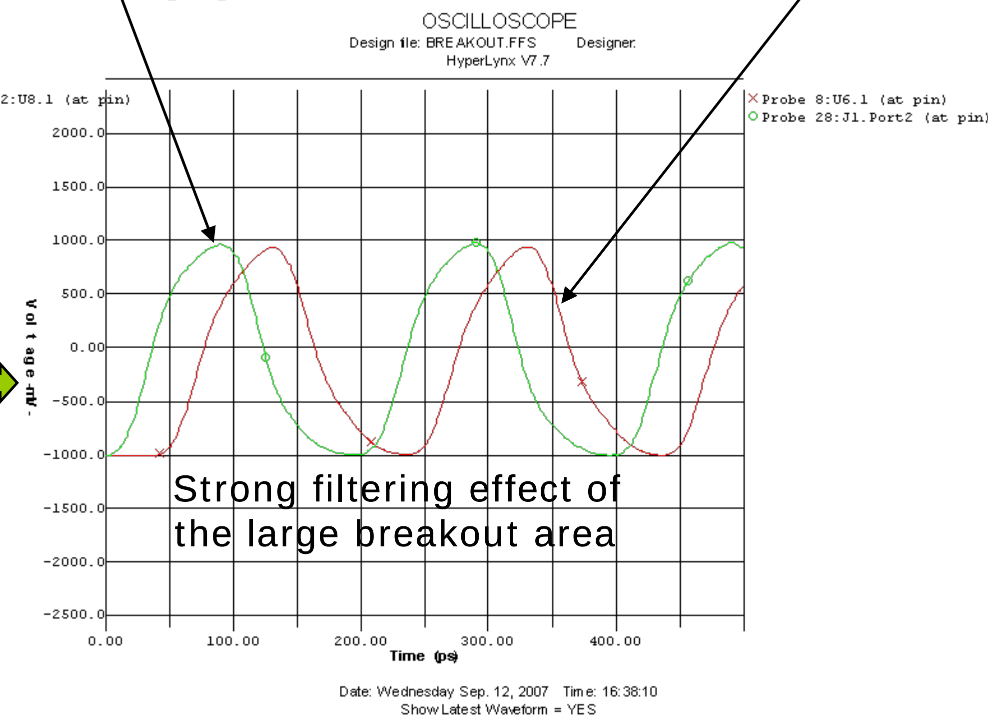


Step 6: Simulate transition of 10 Gbps signal through the structure



Signal generated by differential driver





Strong filtering effect of the large breakout area

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Conclusion on the breakout design

- The large breakout area might be a problem for 10 Gbps signal – it filters out the high-frequency harmonics
- Optimization of the breakout area or different connection geometry is required
- Differential microprobes have to be considered as an alternative to the SMA connector

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Conclusion

- De-compositional analysis is the fast and accurate way to estimate performance of a serial data channel
- S-parameter models of discontinuities generated with a 3D full-wave solver have to be used to increase accuracy of the system-level signal integrity analysis tools

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Solutions and contact

- Simbeor solution files and HyperLynx schematic file are available for download at:
  - http://www.simberian.com/AppNotes/Solutions/BreakOutAnalysisSimbeorAndHL_2007_05.zip
- Send questions and comments to
  - General: info@simberian.com
  - Sales: sales@simberian.com
  - Support: support@simberian.com
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