

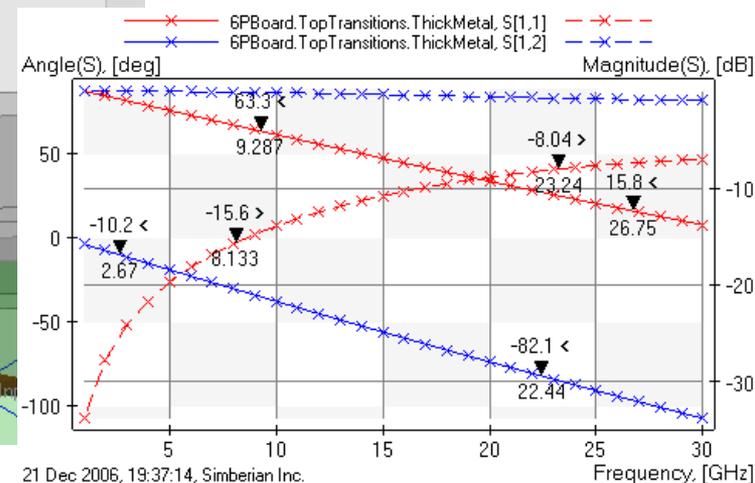
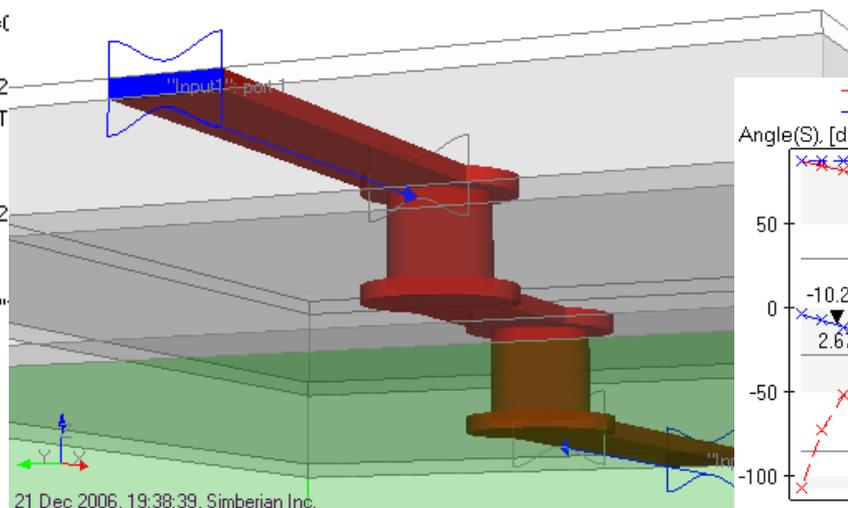
# De-compositional analysis of a connector breakout with Simbeor and HyperLynx

Solution: "MicroVias"

- 6PBoard
  - Materials
    - "copper", RRes=1, Rough=0.01
    - "IdealMetal"
    - "prepreg", DK=4.7, LT=C
    - "Vacuum"
    - "FR4", DK=4.2, LT=0.02
  - StackUp: LU=[mil], NL=15, T
  - TopTransitions
    - CircuitData: LU=[mil]
      - Multiport: 2 inputs, 2
      - LatticeBox
      - Geometry
        - GeoComposite: "
        - TLines
        - Inputs
      - ThickMetal
      - CollapsedMetal
    - BottomTransition
  - Graph1(MultiportParameters vs. 21 Dec 2006, 19:38:39, Simberian Inc.)
  - Graph2(MultiportParameters vs. Frequency)

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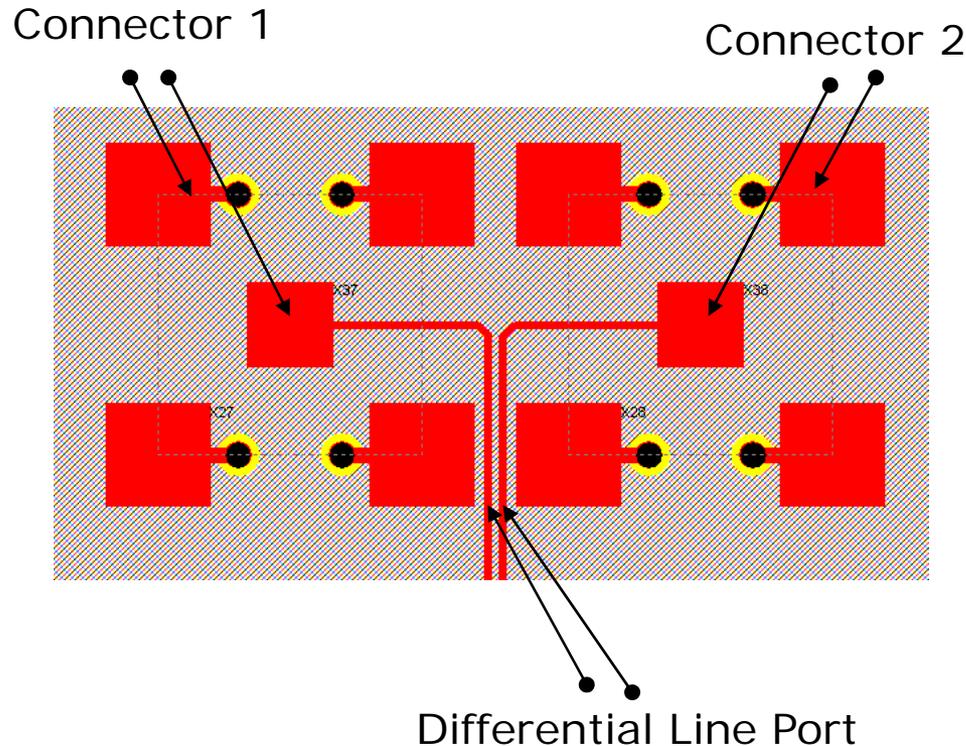
# Introduction

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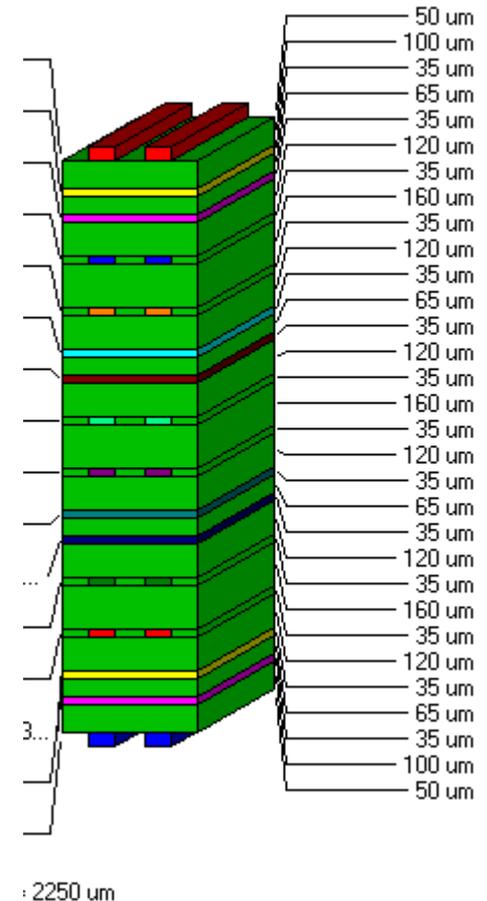
- Show step-by-step how to use S-parameters models of discontinuities generated with Simbeor in a system-level analysis
- Use HyperLynx 7.7 with Eldo from Mentor Graphics corporation for the system-level analysis

# Problem statement

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



Stackup. Design: Diff\_Via\_test.hyp.  
HyperLynx BoardSim V7.7

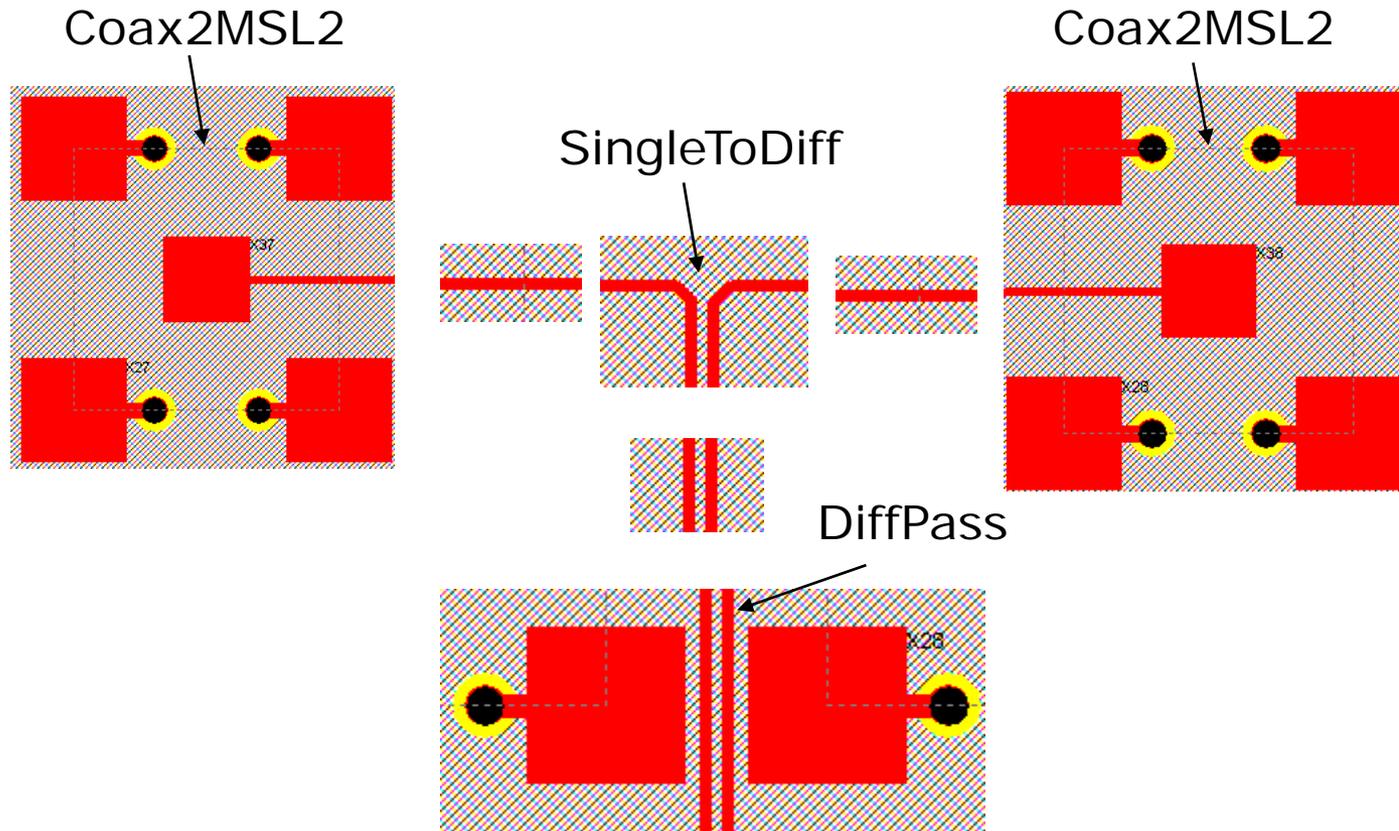


# Solution steps

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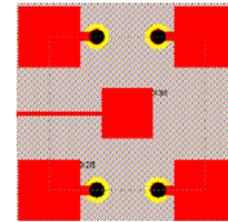
1. Decompose structure into three simple discontinuities
2. Create model for coaxial to microstrip line transition
3. Create model for single microstrip line to differential microstrip transition
4. Create model for differential microstrip line transition through two pads
5. Create HyperLynx schematics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

# Step 1: Decompose structure into simple discontinuities or components



# 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"



Solution: "SMABreakout"

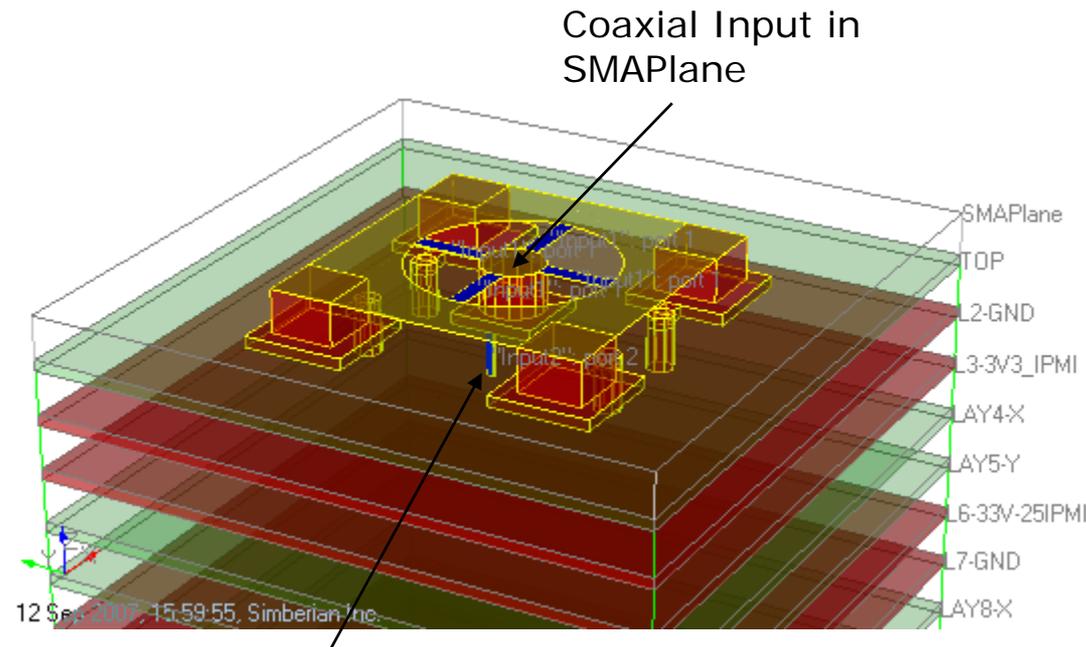
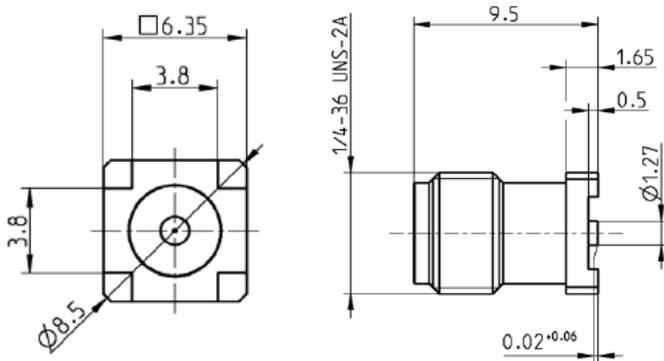
- Breakout
  - Materials
  - StackUp: LU=[m], NL=33, T=0.00275
    - 1| Signal: "SMAPlane"
    - 2| Medium: T=0.0005, Ins="Air"
    - 3| Signal: "TOP", T=5e-005, Ins="Dielectric"
    - 4| Medium: T=0.0001, Ins="Dielectric"
    - 5| Plane: "L2-GND", Mat="Copper", T=3.5e-005, Ins="Dielec"
    - 6| Medium: T=6.5e-005, Ins="Dielectric"
    - 7| Plane: "L3-3V3\_IPMI", Mat="Copper", T=3.5e-005, Ins="t"
    - 8| Medium: T=0.00012, Ins="Dielectric"
    - 9| Signal: "LAY4-X", T=3.5e-005, Ins="Dielectric"
    - 10| Medium: T=0.00016, Ins="Dielectric"
    - 11| Signal: "LAY5-Y", T=3.5e-005, Ins="Dielectric"
    - 12| Medium: T=0.00012, Ins="Dielectric"
    - 13| Plane: "L6-33V-25IPMI", Mat="Copper", T=3.5e-005, Ins:
    - 14| Medium: T=6.5e-005, Ins="Dielectric"

# 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

**Rosenberger®**

**32K10A-40ML5**

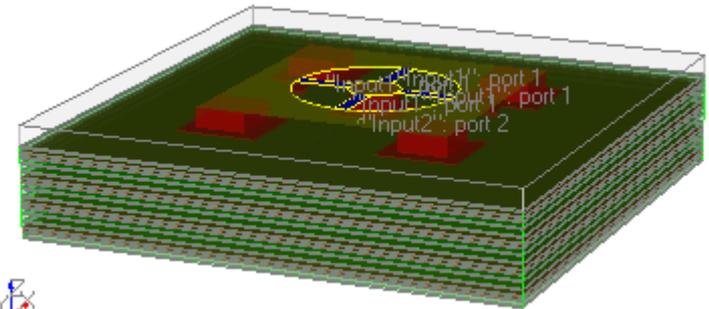


Input to simulate connection to micro-strip line (z-port at the edge of pad)

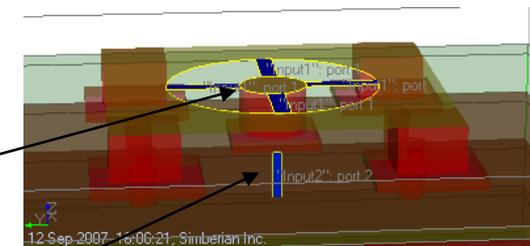
# Coaxial to microstrip line transition geometry elements

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



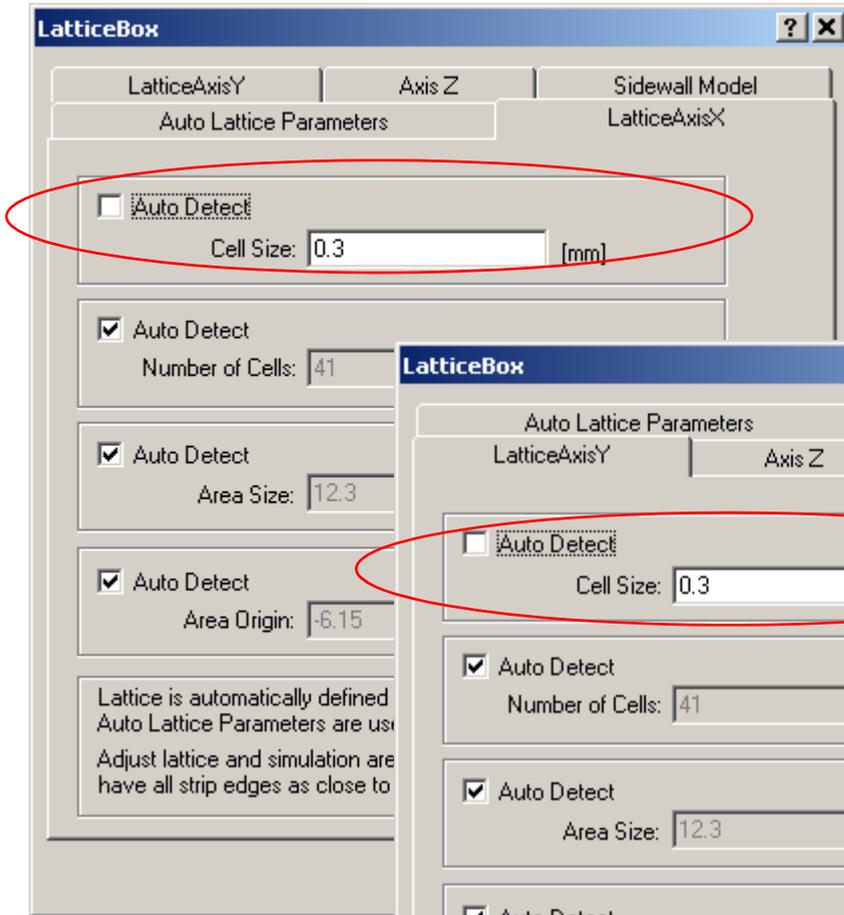
12 Sep 2007, 16:09:40, Simberian Inc.



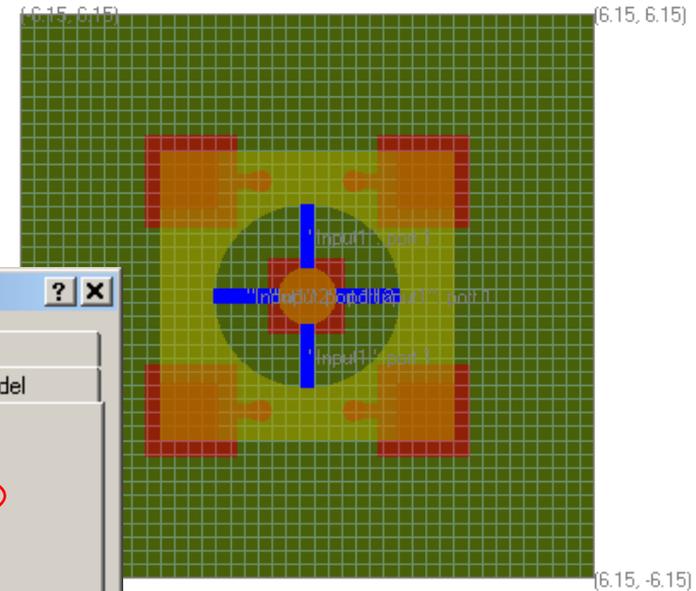
Coaxial Input with 4 ports in parallel: Port 1

Component Input with 1 z-port: Port 2

# Lattice box definition for coaxial to microstrip transition



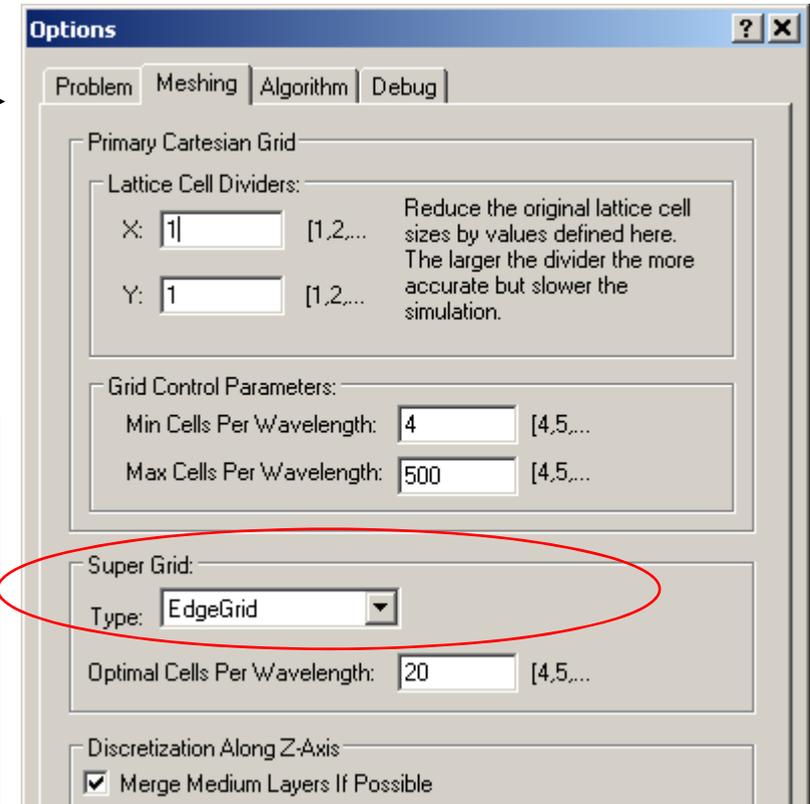
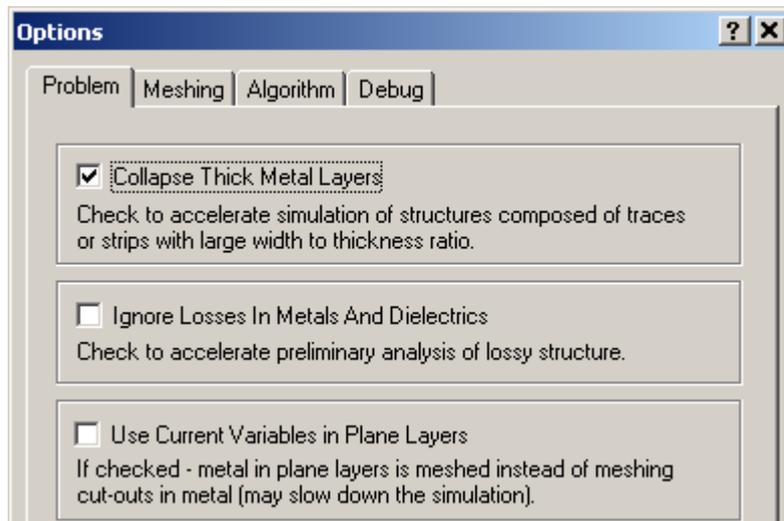
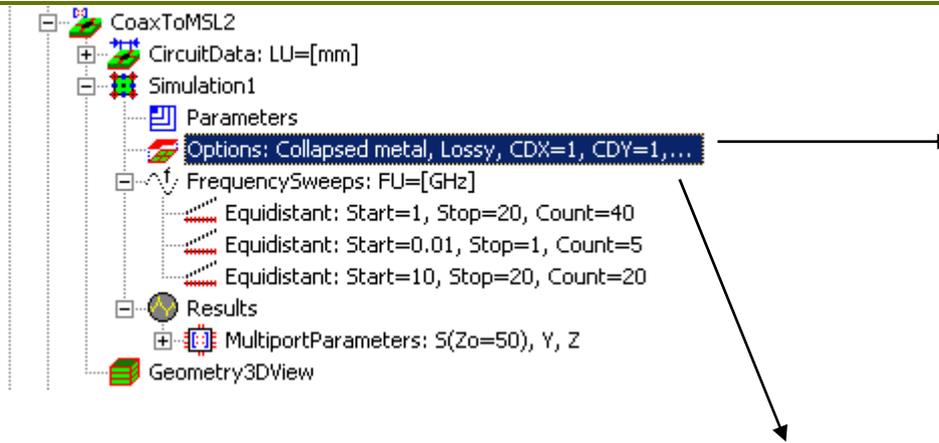
Cell size defined as 0.3 mm



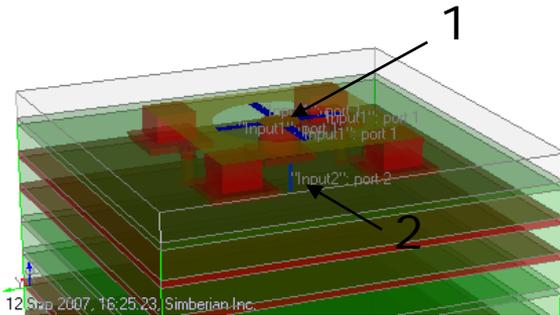
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All other parameters set to auto-detect

# Simulation setup for the coaxial to microstrip line transition

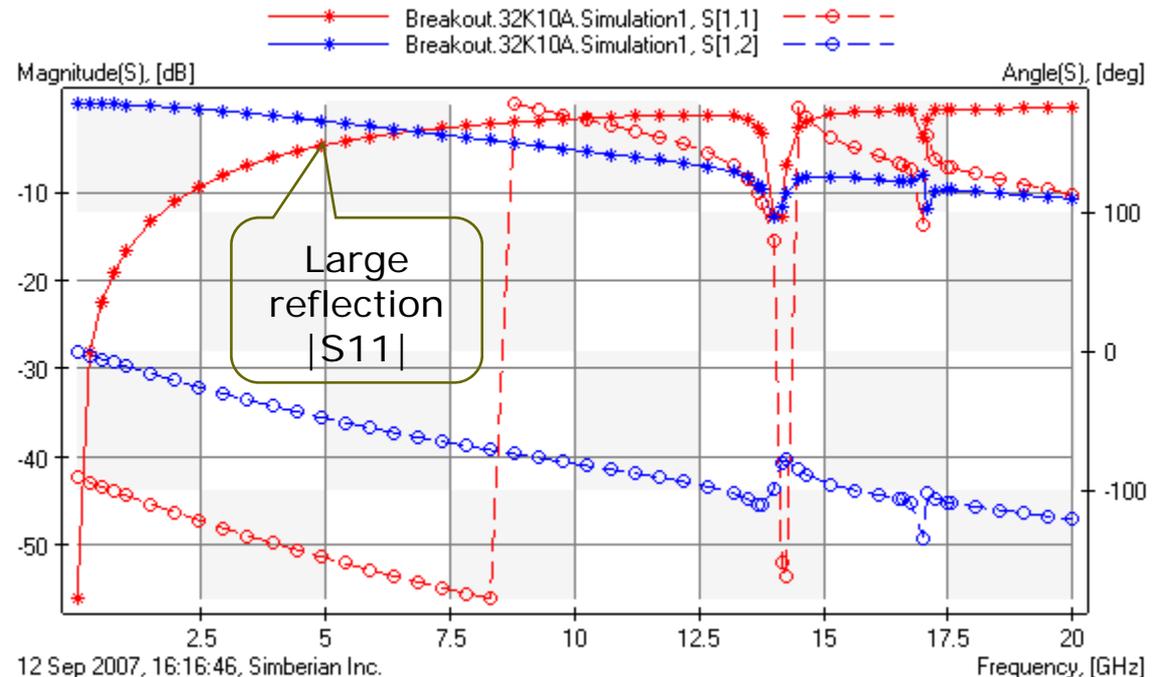


# Coaxial to MSL transition simulation results



The structure is oversized and not matched to 50-Ohm

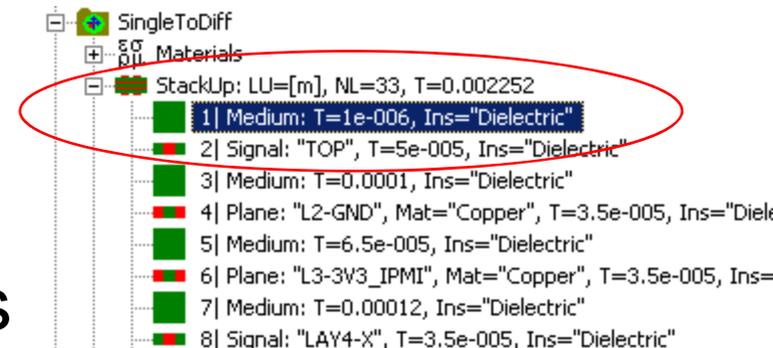
Overall the structure behaves as low-pass filter



*Output Results into Touchstone file  
Breakout\_32K10A\_Simulation1.s2p*

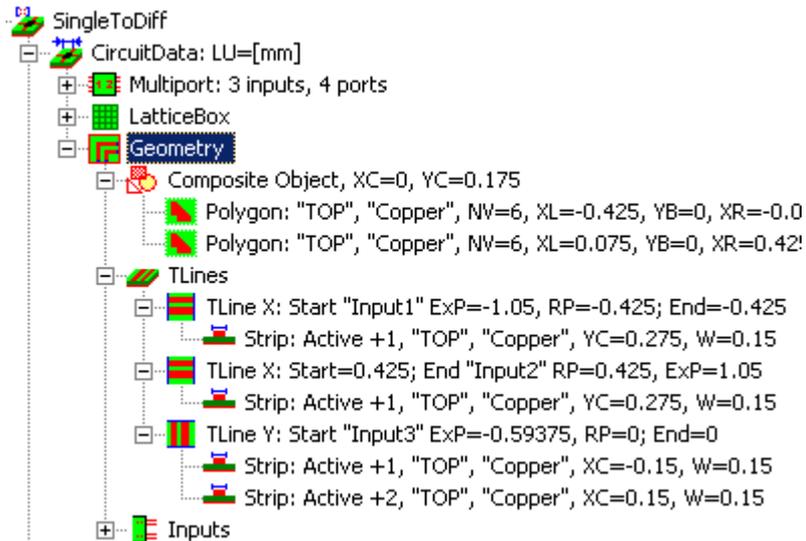
# Step 3: Create model of single microstrip line to differential microstrip transition

- 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



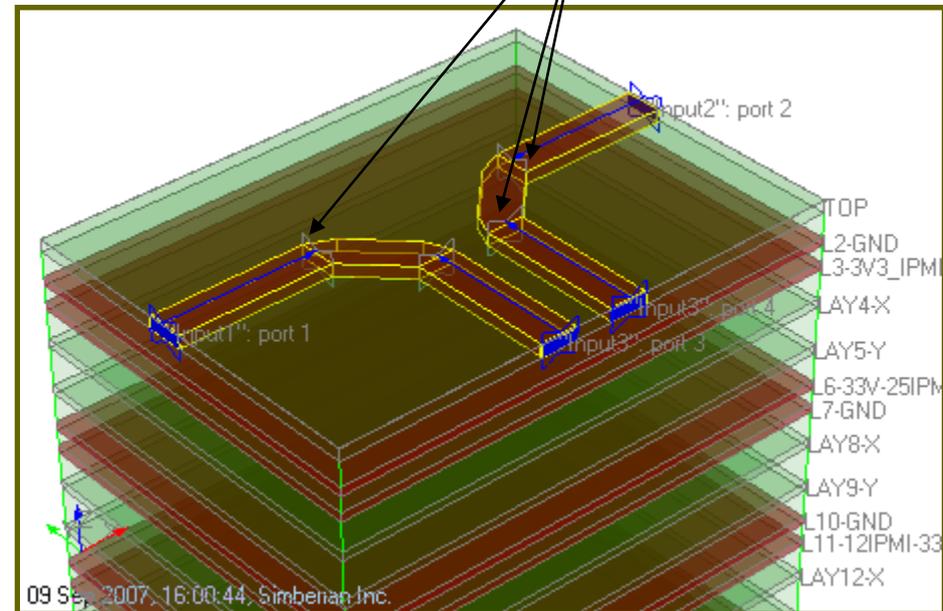
# Define geometry of single microstrip line to differential microstrip transition

- 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



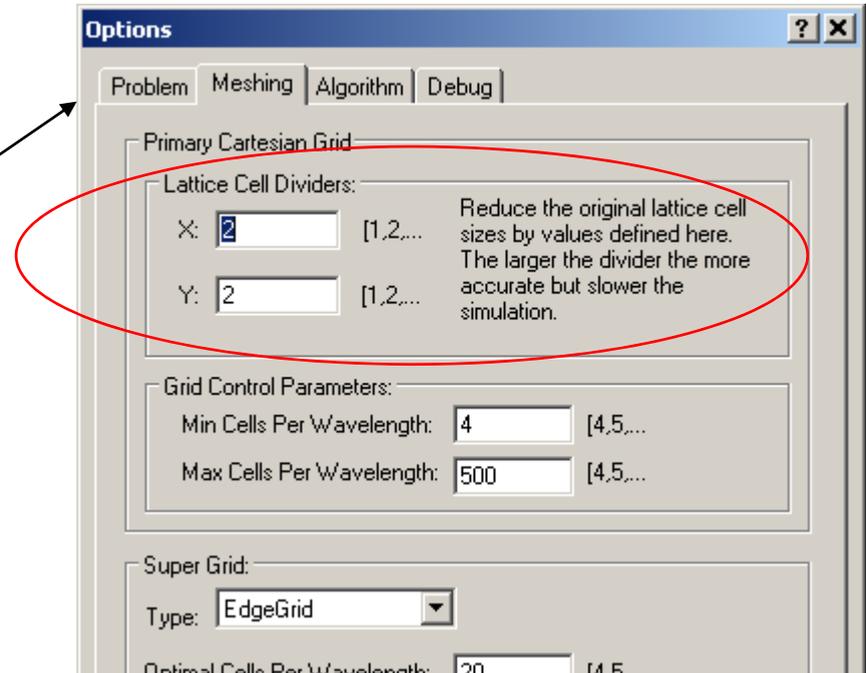
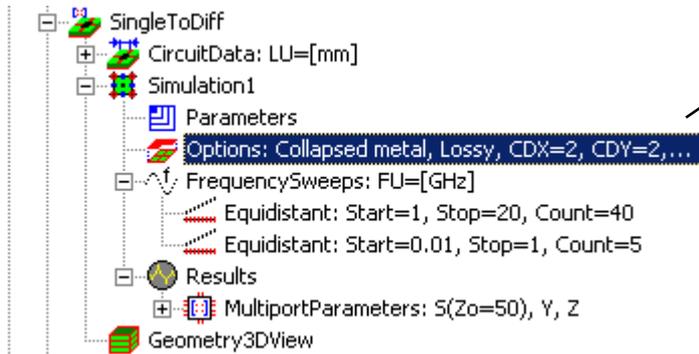
*Inputs defined automatically*

*Reference plans shifted toward discontinuity (de-embedding)*

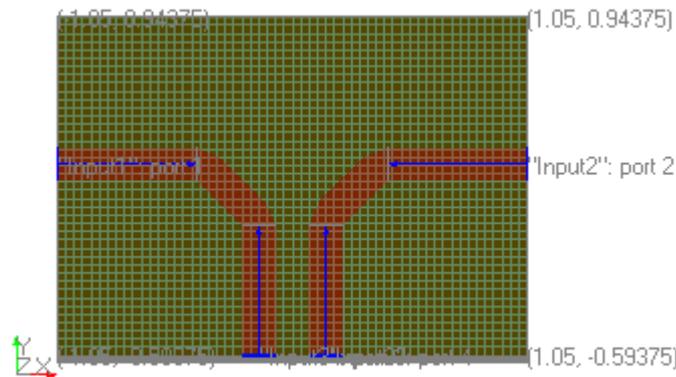


# Simulation setting for single microstrip line to differential microstrip transition

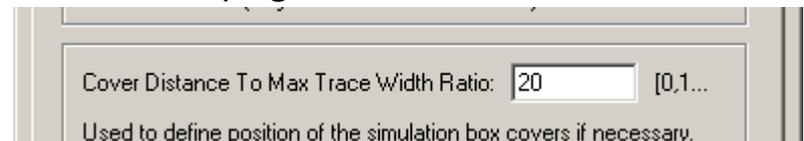
Refine automatically defined cell size  
– divide it by 2 to increase accuracy



Original cell size will be divided by 2 for the simulation

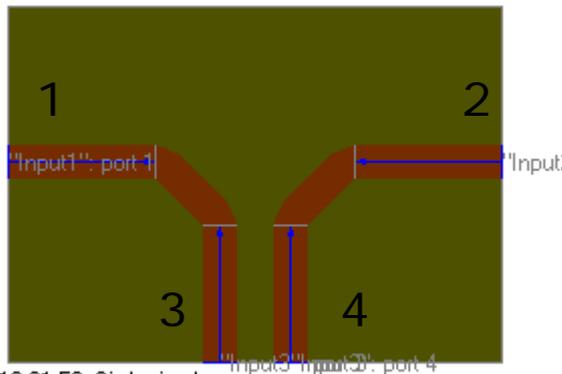


Increase distance to top cover on  
Problem page

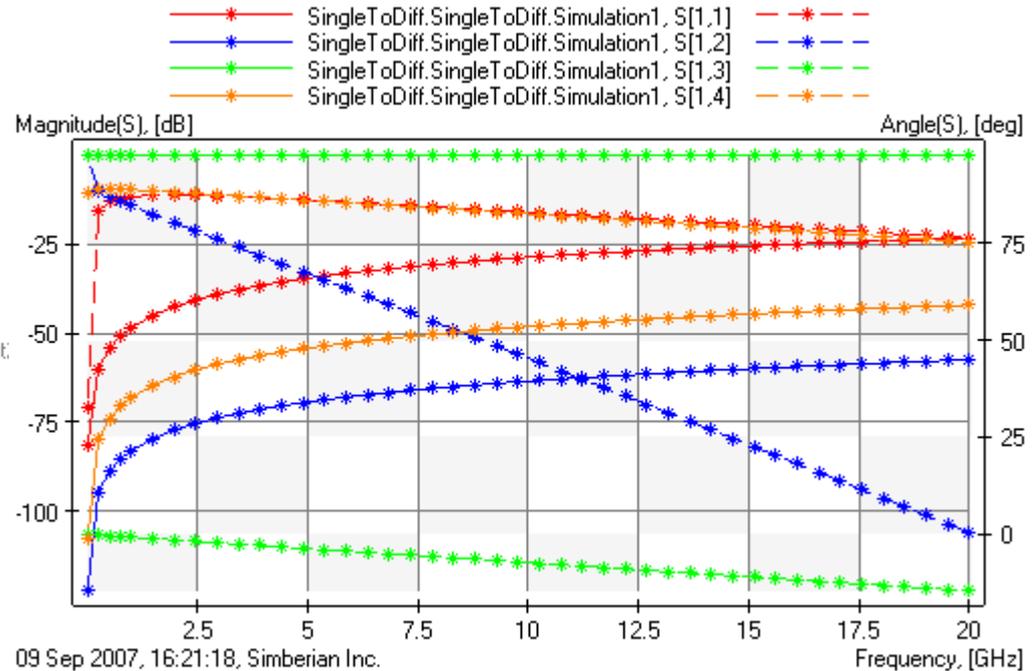


09 Sep 2007, 16:11:29, Simberian Inc.

# Simulation results for single microstrip line to differential microstrip transition



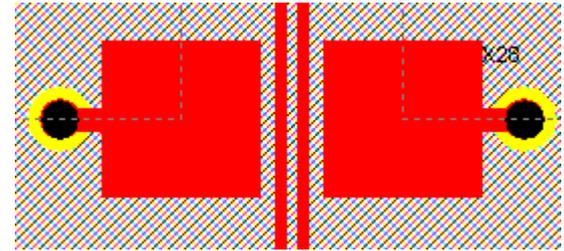
12 Sep 2007, 16:21:56, Simberian Inc.



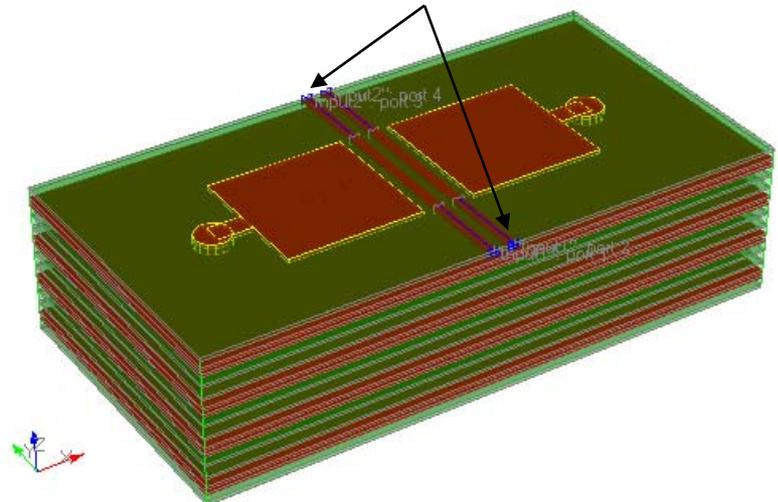
Output Results into Touchstone file  
*SingleToDiff\_SingleToDiff\_Simulation1.s4p*

# 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



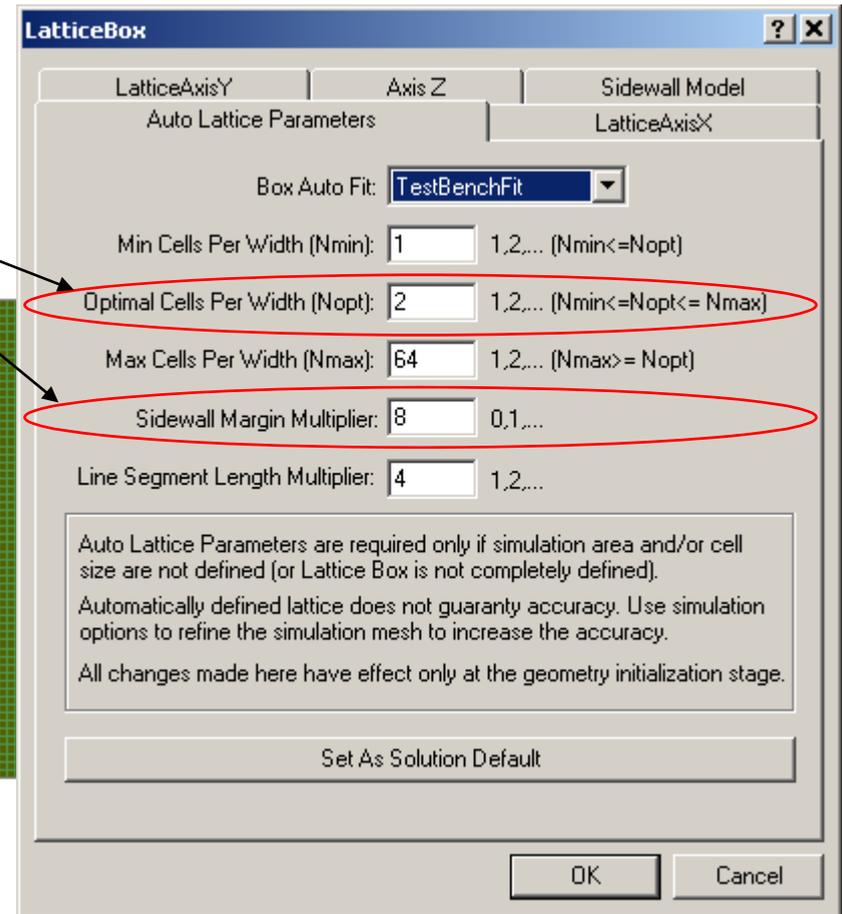
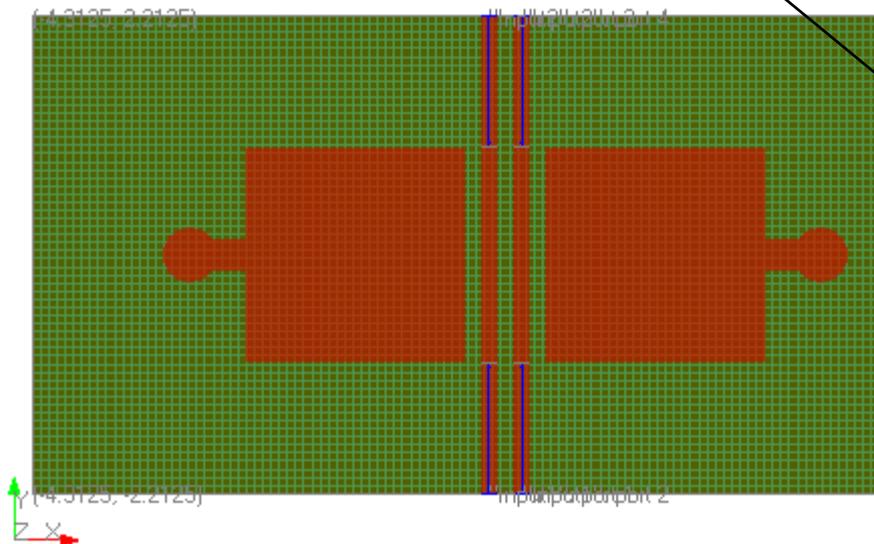
Differential inputs with phase ref. plane shifted to the pads edges



09 Sep 2007, 16:22:39, Simberian Inc.

# 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*



09 Sep 2007, 16:29:12, Simberian Inc.

# Simulation setting for differential microstrip line transition through two pads

**Options** [?] [X]

Problem | Meshing | Algorithm | Debug

Primary Cartesian Grid

Lattice Cell Dividers:

X:  [1,2,...] Reduce the original lattice cell sizes by values defined here. The larger the divider the more accurate but slower the simulation.

Y:  [1,2,...]

Grid Control Parameters:

Min Cells Per Wavelength:  [4,5,...]

Max Cells Per Wavelength:  [4,5,...]

Super Grid:

Type:  [v]

Optimal Cells Per Wavelength:  [4,5,...]

Discretization Along Z-Axis

Merge Medium Layers If Possible

Set As Solution Default

OK Cancel

**Options** [?] [X]

Problem | Meshing | Algorithm | Debug

Collapse Thick Metal Layers  
Check to accelerate simulation of structures composed of traces or strips with large width to thickness ratio.

Ignore Losses In Metals And Dielectrics  
Check to accelerate preliminary analysis of lossy structure.

Use Current Variables in Plane Layers  
If checked - metal in plane layers is meshed instead of meshing cut-outs in metal (may slow down the simulation).

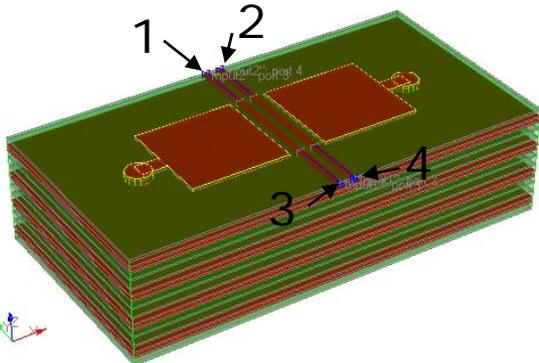
Cover Distance To Max Trace Width Ratio:  [0,1,...]  
Used to define position of the simulation box covers if necessary.

Max Wavelength To Box Size Ratio:   
Defines the minimal frequency allowed for the simulation (DC limit).

Set As Solution Default

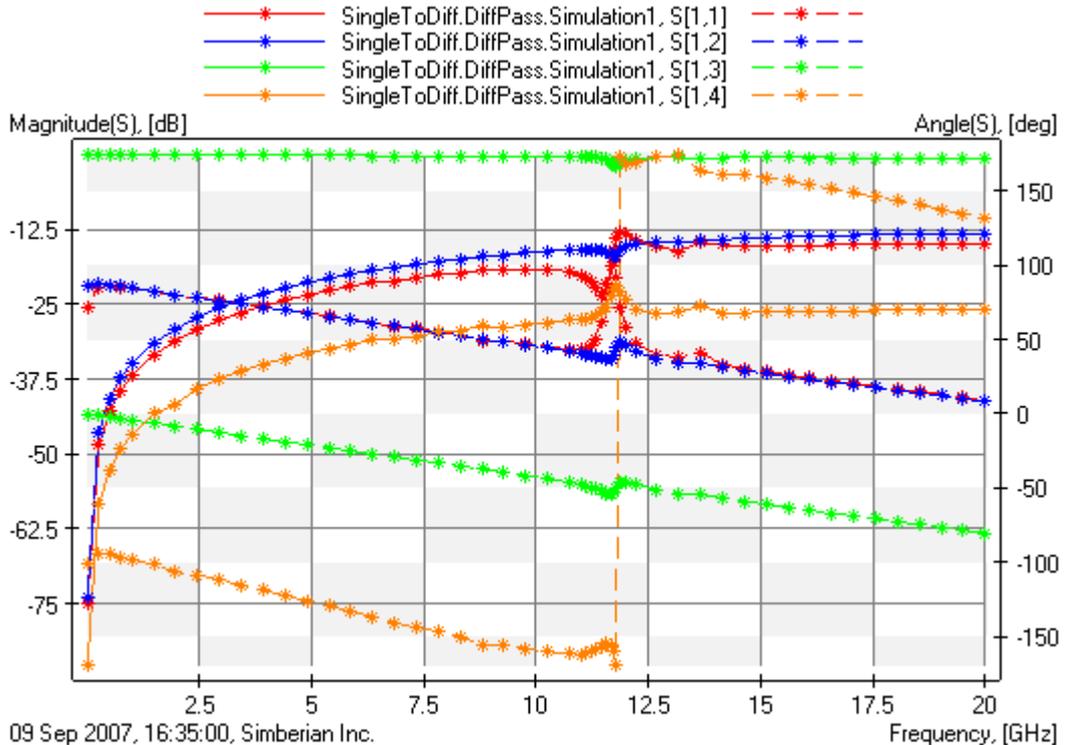
OK Cancel

# Simulation results for differential microstrip line transition through two pads



09 Sep 2007, 16:22:39, Simberian Inc.

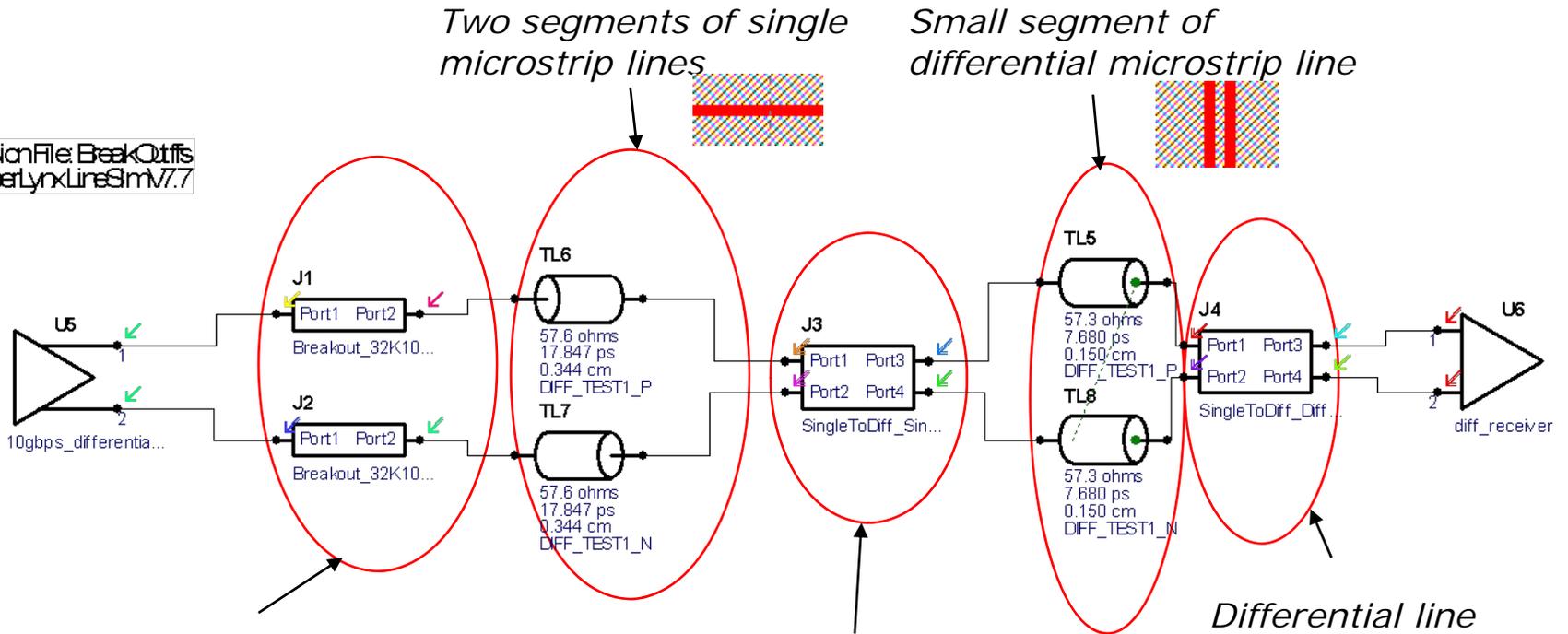
*Resonance is observed around 11.5 GHz*



*Output Results into Touchstone file  
SingleToDiff\_DiffPass\_Simulation1.s4p*

# Step 5: Create HyperLynx schematics

DesignFile BreakOut.s  
HyperLynxSimV7.7



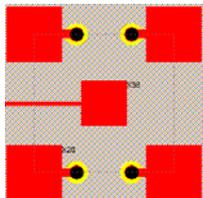
Two segments of single microstrip lines



Small segment of differential microstrip line



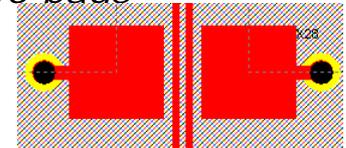
Two transitions from coaxial to microstrip



Single microstrip to differential microstrip transition

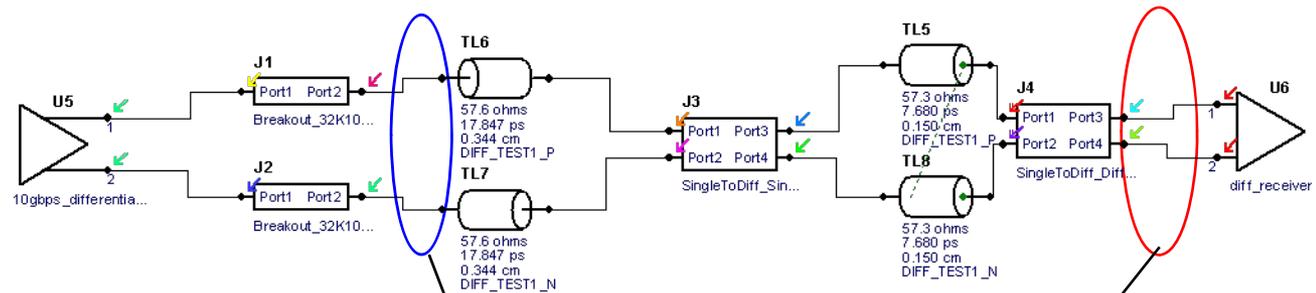


Differential line transition through two pads

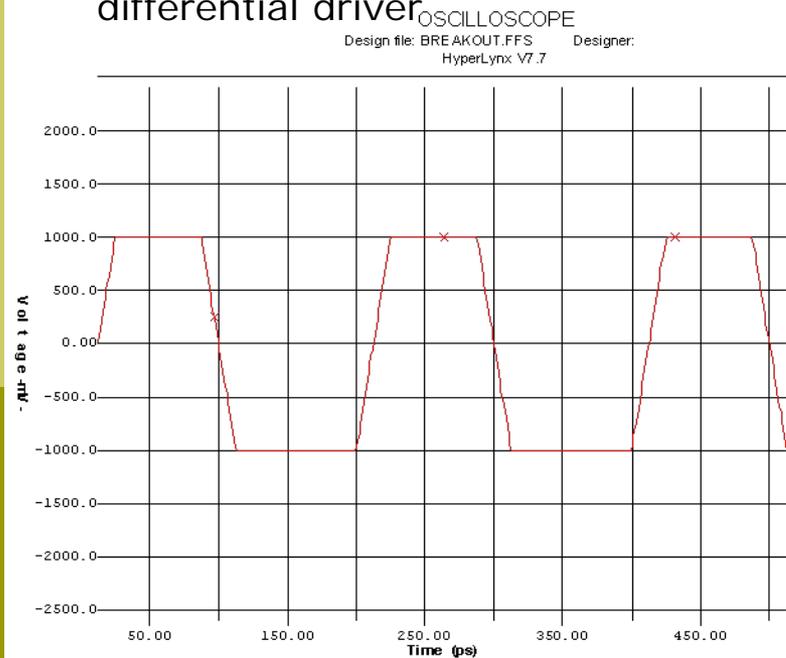


# Step 6: Simulate transition of 10 Gbps signal through the structure

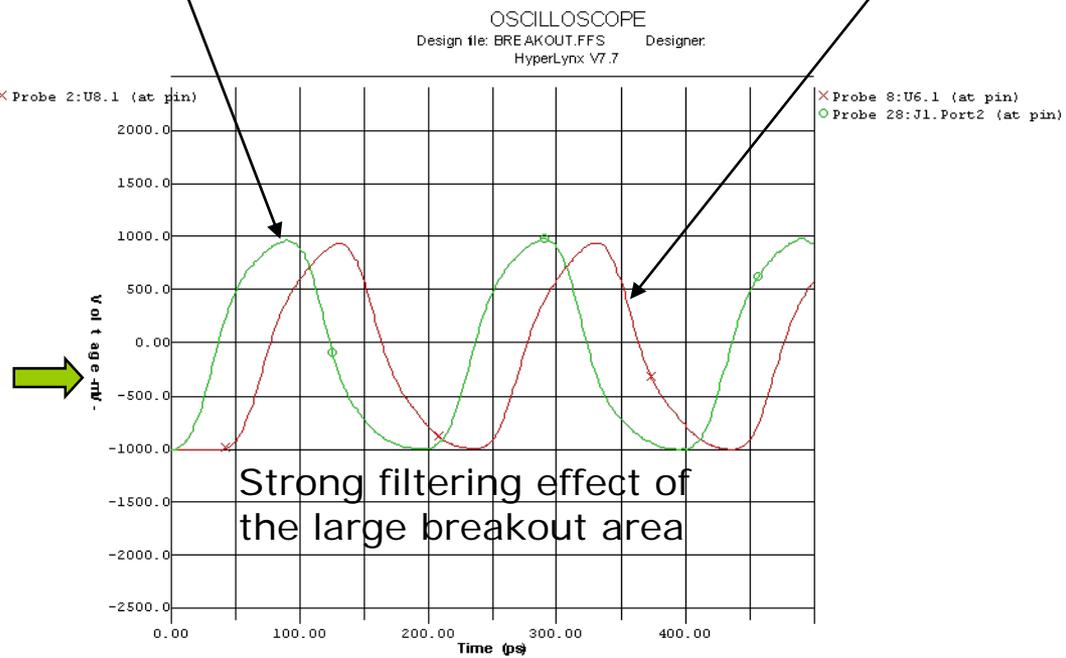
Design File: BreakOut.tffs  
HyperLynx LineSim V7.7



Signal generated by differential driver



Date: Wednesday Sep. 12, 2007 Time: 16:35:53  
ShowLatest Waveform = YES, ShowPrevious Waveform = YES



Strong filtering effect of the large breakout area

Date: Wednesday Sep. 12, 2007 Time: 16:38:10  
ShowLatest Waveform = YES

# Conclusion on the breakout design

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- ❑ 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

# Conclusion

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- ❑ 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

# Solutions and contact

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- Simbeor solution files and HyperLynx schematic file are available for download at:
  - [http://www.simberian.com/AppNotes/Solutions/BreakOutAnalysisSimbeorAndHL\\_2007\\_05.zip](http://www.simberian.com/AppNotes/Solutions/BreakOutAnalysisSimbeorAndHL_2007_05.zip)
- Send questions and comments to
  - General: [info@simberian.com](mailto:info@simberian.com)
  - Sales: [sales@simberian.com](mailto:sales@simberian.com)
  - Support: [support@simberian.com](mailto:support@simberian.com)
- Web site [www.simberian.com](http://www.simberian.com)