S-params For IEEE Channel Ad Hoc

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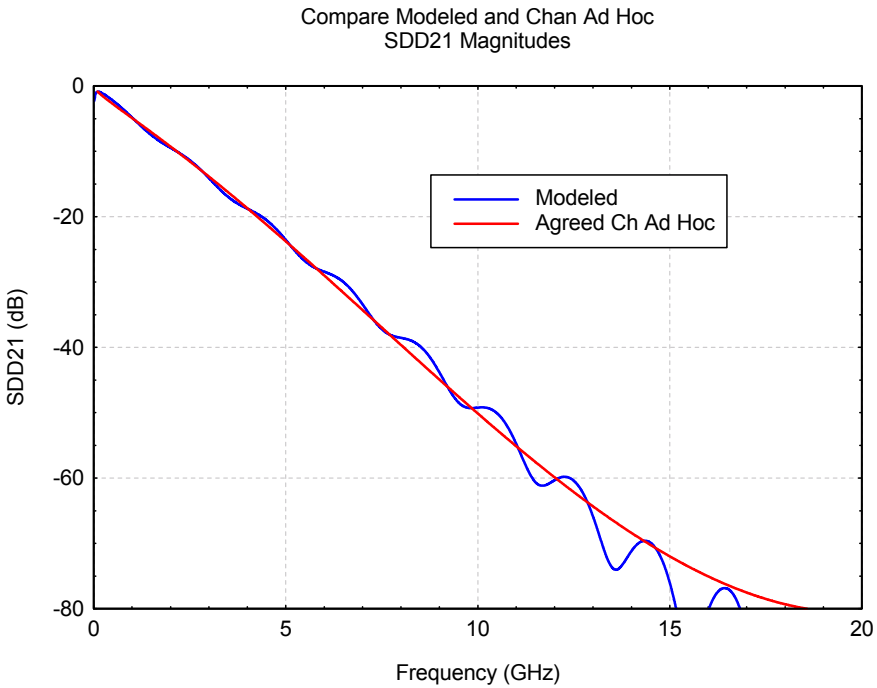
Outline

- **Develop Set of Complex S-param Files (Touchstone format) that Fit Channel Ad Hoc Templates (see goergen_02_0504.pdf)**
  - **Through**
  - **NEXT**
  - **FEXT (not done)**
- **Details of Through Channel Synthesis Procedure**

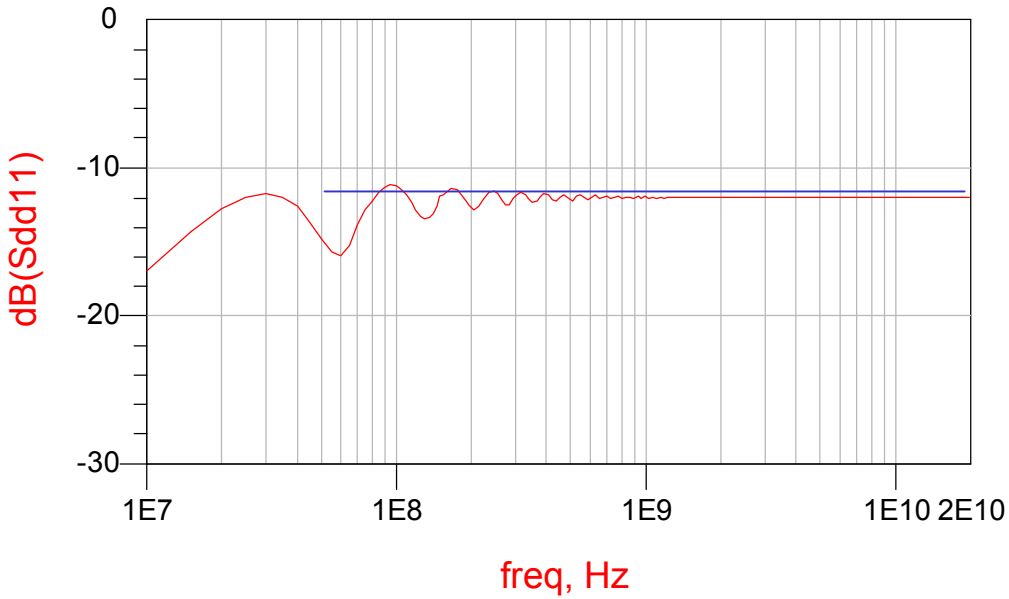
Through S-Params -- 2 Methods

- **Synthesized**
  - **Fit to SDD21 Magnitude**
  - **Fit to SDD11 Magnitude**
  - **s4p file is named “thru6.s4p”**
- **Measured**
  - **Chain together S-params of two actual channel measurements to approximate the desired SDD21 magnitude**
  - **s4p file is named “thru7.s4p”**

First Method: Synthesized Through S-Params



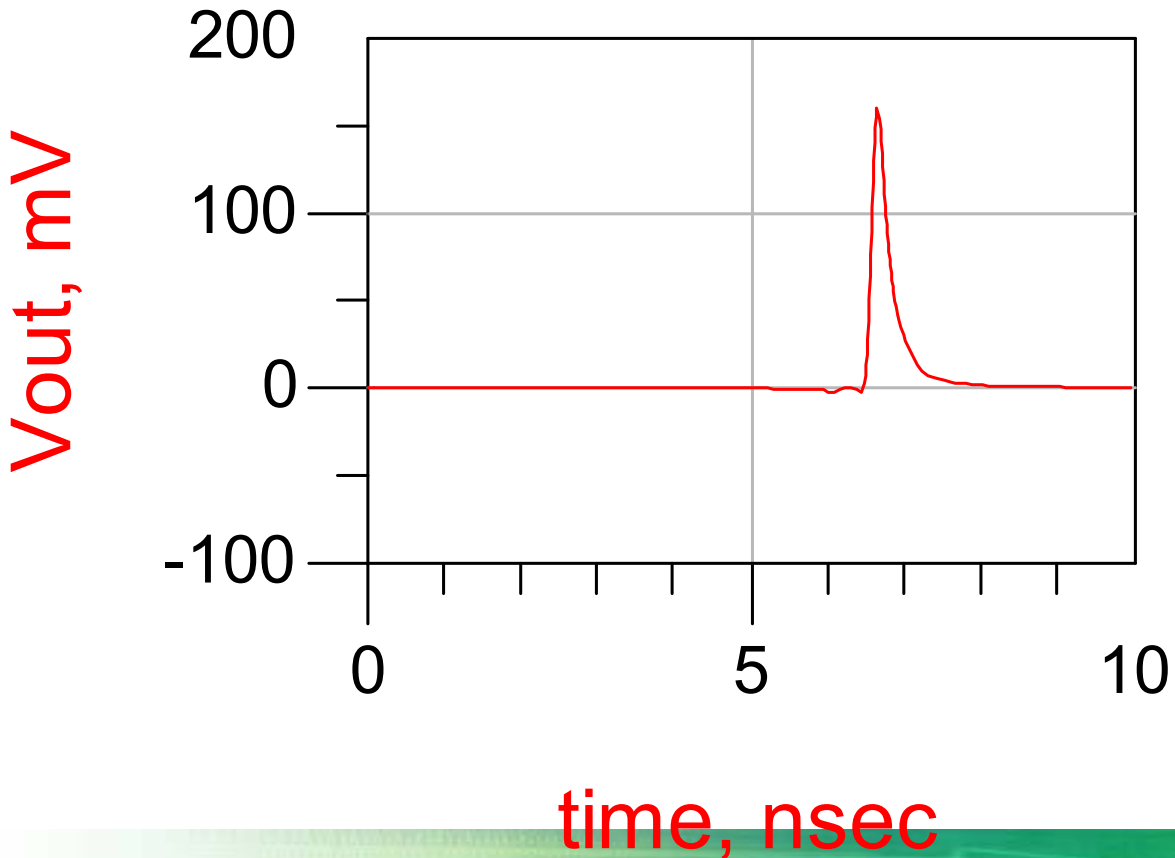
Fit to SDD21



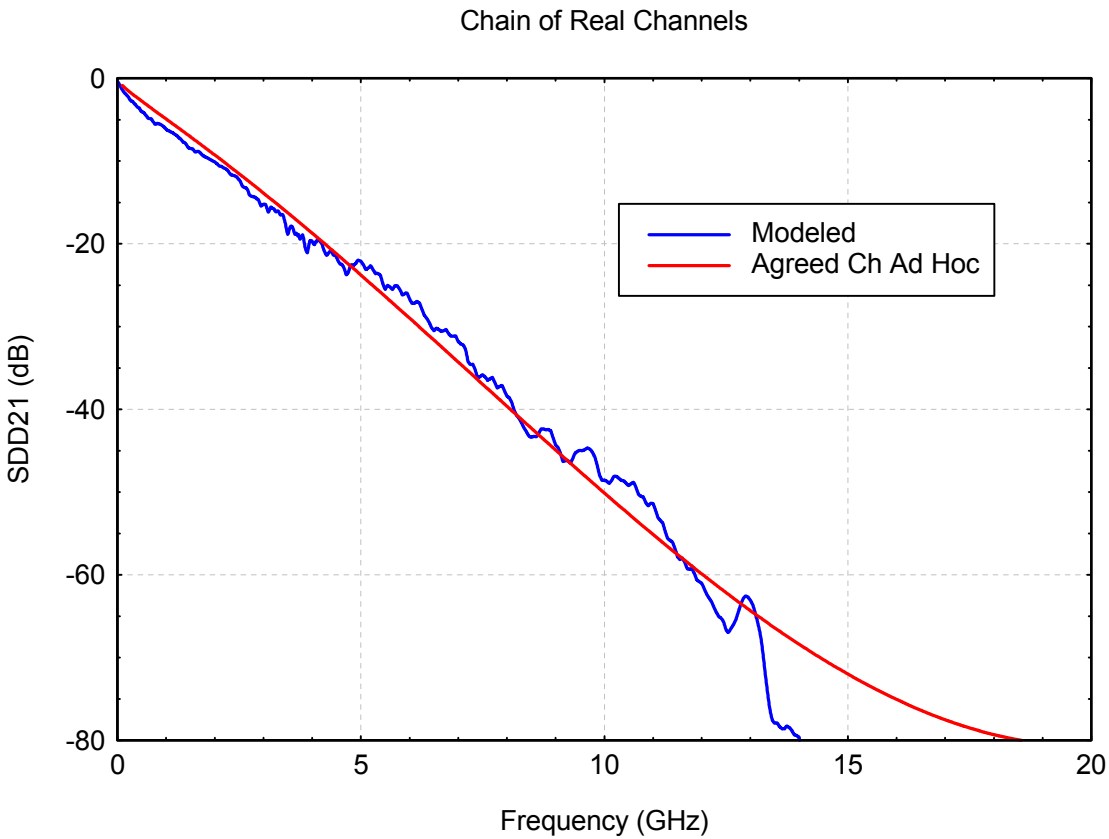
Fit to SDD11

s4p file is thru6.s4p

Pulse Response for Synthesized Through Channel



Second Method: Measured Through SDD21

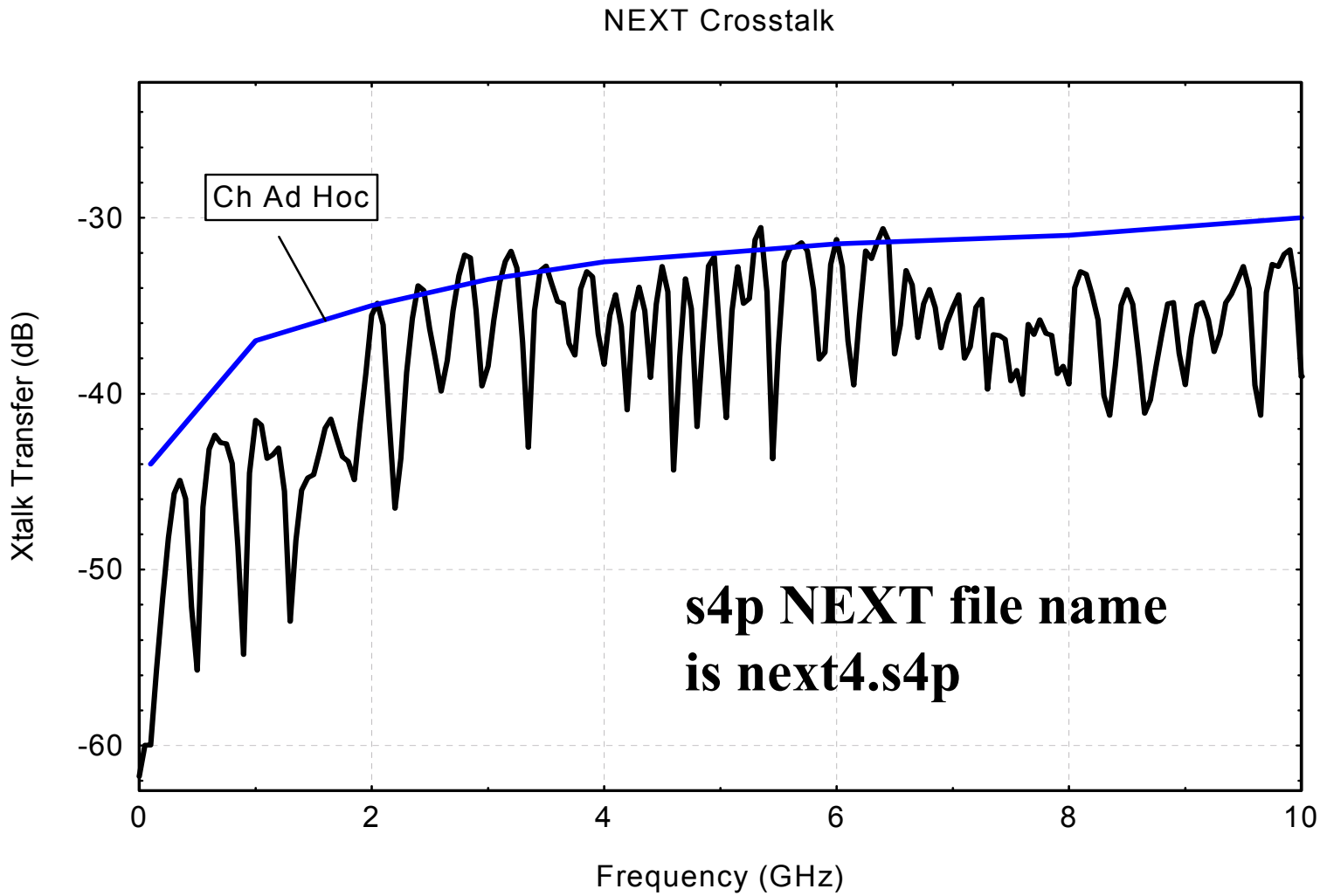


Chain together S-params of two actual channel measurements to approximate the desired SDD21 magnitude. The s4p file is named thru7.s4p (caution: contains 4 connectors)

NEXT Synthesis

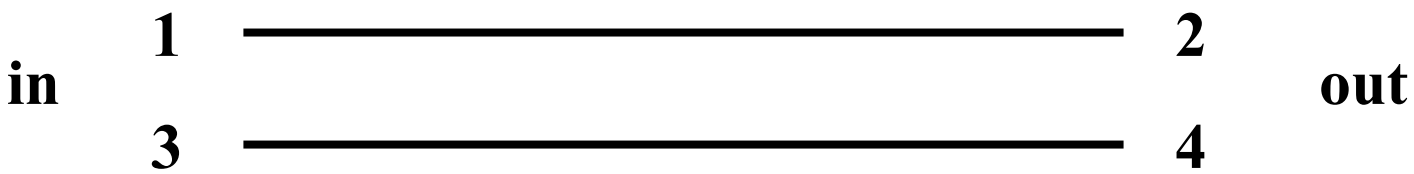
- Difficult to create NEXT that falls on the template line
- Approach is to combine measured S-params from 2 to 3 existing NEXT measurements
  - Each NEXT file approximates the desired NEXT over some frequency range
  - Get individual SDD21 magnitudes and RSS them – result is a fit across a wider freq range
  - Convert RSS sum back into complex assuming constant delay
  - Create 4-port S-parameter matrix of all zeros
  - Insert RSS sums into appropriate matrix positions to create a new SDD21
- NEXT File is “next4.s4p”

NEXT SDD21 Fit to Ch Ad Hoc



S-param Files Additional Details

- **All files are single-ended 4-port complex S-parameters in Touchstone format**
- **Arrangement:**



Details of Through Synthesis

- **The goal:**
  - **Match Overall Attenuation versus freq**
  - **Match Strange Curvature in attenuation versus freq**
  - **Create Ripples at high frequency**
  - **High freq Return Loss of –12 dB**
  - **Low freq Return Loss of –28 dB**
  - **Do all of this without introducing significant non-causal pulse response**

Overall Attenuation versus Freq

- Method is Svennson-Dermer (see Reference)
- Svennson-Dermer equations model both magnitude and phase of transmission line having skin effect and dielectric absorption losses
- Fitting these equations to the known magnitude yields a causal complex transfer function
- This is normally done for both Hodd and Heven
- Combine these with Zodd and Zeven to get a complete 4-port S-parameter description

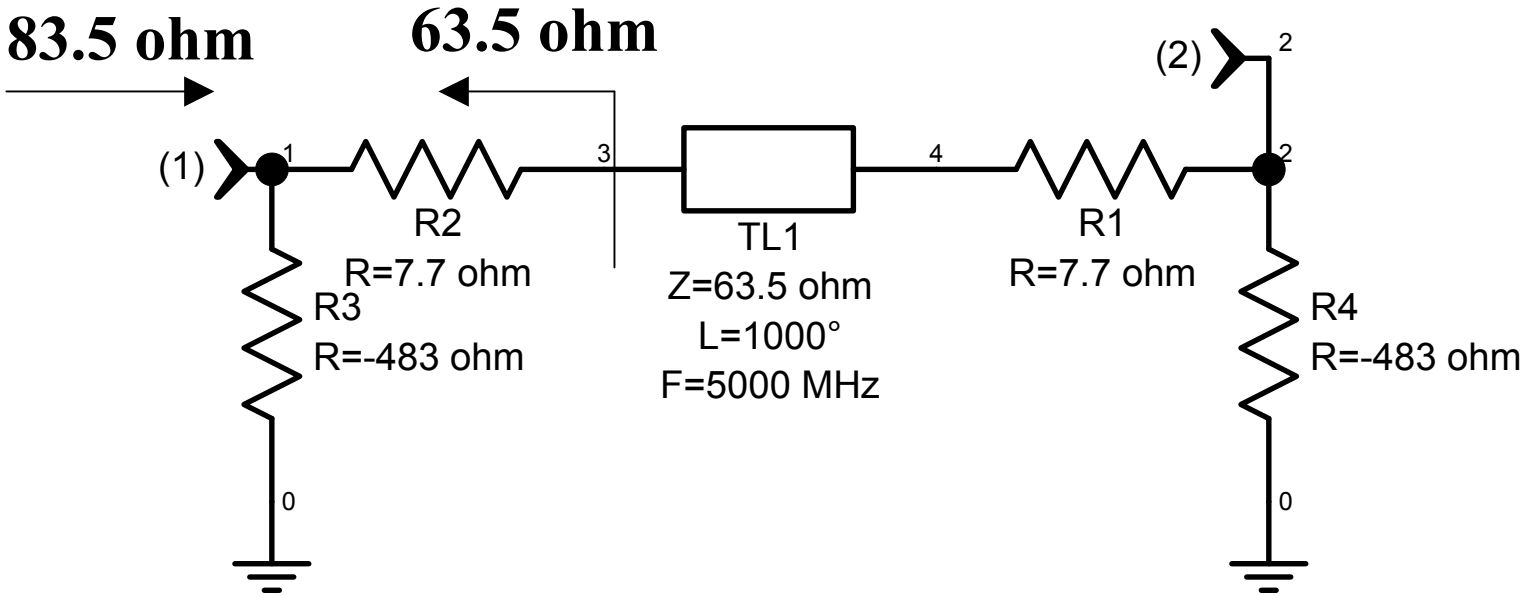
Adding Curvature and Ripple to SDD21 Magnitude

- **Multiply the complex Hodd (transfer function) by any desired real-valued function**
  - **Curvature is introduced by multiplying by a sine wave**
  - **Ripple is introduced by multiplying by a sine wave that increases exponentially with frequency**
- **Caveat: Adding curvature (in this way) makes S-parameters non-causal**

Getting SDD11

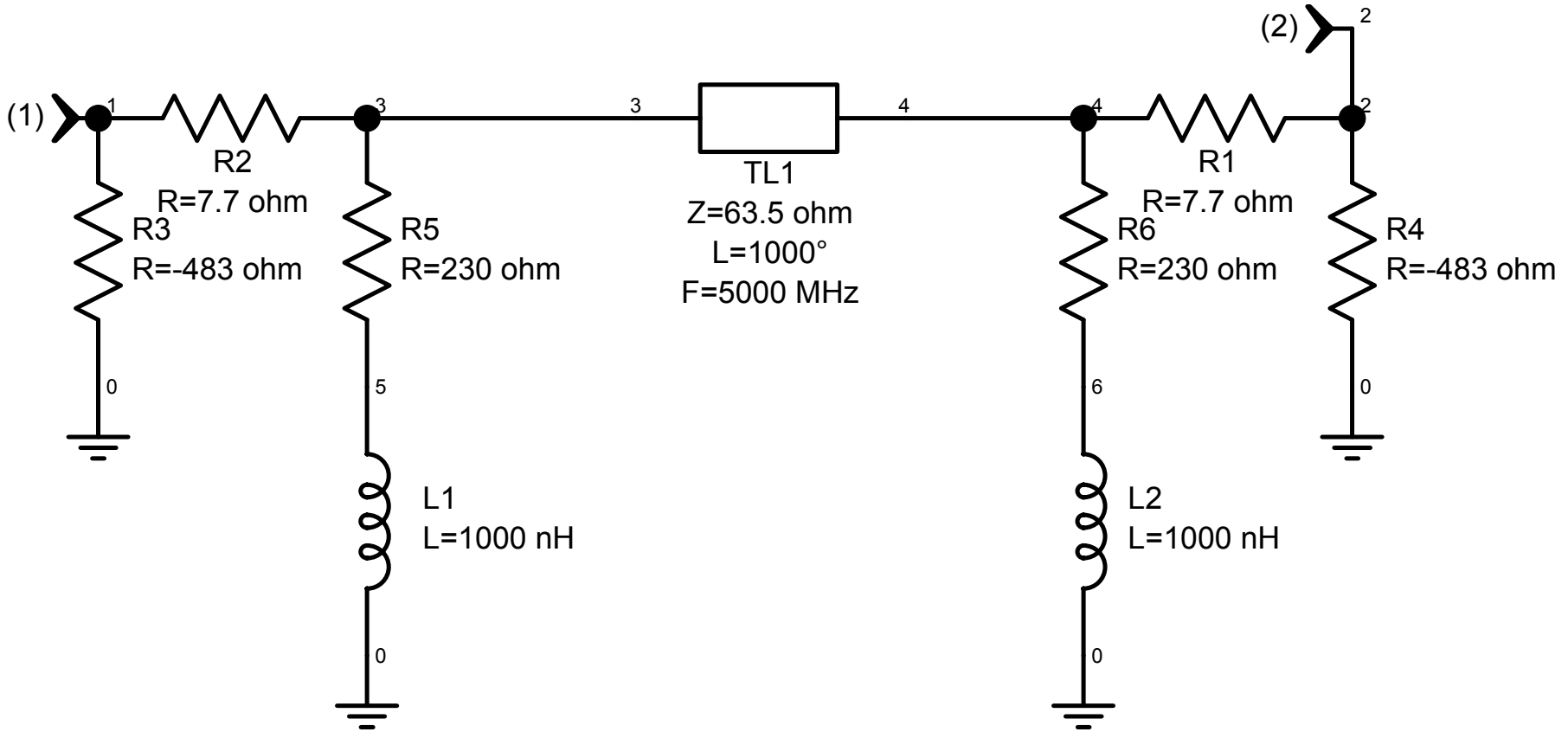
- **Goals:**
  - **83.5 ohm seen by VNA to create sdd11 magnitude = -12 dB**
  - **want better sdd11 (-28 dB) at low frequencies**
- **First idea is to set Zodd=83.5 ohm – doesn't work!**
  - **Why not? Reflection at far end shows up at measurement end**
- **Resistor network at each port – does work**
  - **Allows line to be terminated in its characteristic impedance while measurement equipment sees 83.5 ohm**

Network For Simultaneous Realization of S11, S21



Two-Port is Shown For Simplicity.
A Similar Procedure Is Used For A 4-Port

Getting Low-freq Improvement in SDD11



Two-Port is Shown For Simplicity.
A Similar Procedure Is Used For A 4-Port

References

- **Svensson C., Dermer G., "Time Domain Modeling of Lossy Interconnects", IEEE Trans. on Advanced Packaging, Vol. 24, pp. 191-196, May, 2001.**

Conclusion

- **Three S-parameter files are presented that may be useful in analyses/simulations of the backplanes based on the IEEE Channel Ad Hoc Templates**
- **The method by which each of these is derived is explained**
- **The pulse response for the synthesized through channel shows a small amount of non-causal behavior**