ECE 435

INTRODUCTION TO CAD OF MICROWAVE CIRCUITS

Latest revision: October 2000

This lab will introduce you to computer-aided microwave circuit design using the program Sonnet Lite.

Pre-Lab Exercises
You must perform the following tasks prior to the lab session:

1. Review and design a 50 Ohm microstrip transmission line assuming you will be using a GML 1000 board (dielectric constant = 3.2, thickness = 30 mils).
2. Review the hand-out concerning side coupled filter design.

If possible, download a copy of Sonnet Lite to a computer (http://www.sonnetusa.com) and perform as much of the tutorial as possible. Doing so will likely reduce the time you require to complete this laboratory experiment!

1. Place your floppy disk into the appropriate drive in the computer.

2. CHECK YOUR DISK FOR VIRUSES! -- Type scan a: (or scan b:). If your disk contains viruses, **REMOVE IT IMMEDIATELY!**

NOTE: Sonnet Lite requires that both ports be on the edge of the box!!!

Microstrip Transmission Design and Test

In this exercise, you will analyze the microstrip transmission line you designed in the pre-lab using Sonnet Lite. First, start Sonnet Lite on one of the lab PCs. If asked to register, hit cancel (the copy is already registered by the Department).

1. Build the circuit
   1.1. Parameters/Units: mm
   1.2. Parameters/Box: set the box size to 254x40 mm and cell size to 1x1 mm
   1.3. Parameters/Dielectric Layers: set the air thickness, layer 0, to 100 mm, and set layer 1 thickness to be 0.762 mm and the dielectric constant to 3.2
   1.4. Toolbox/Add Polygon: trace a rectangular strip in the center of the board with ends along the ends of the board (e.g. along the length of the board)
   1.5. Move the trace to the center of the board

1.6. Toolbox/Add port (twice): put a port on either end of the trace
1.7. SAVE

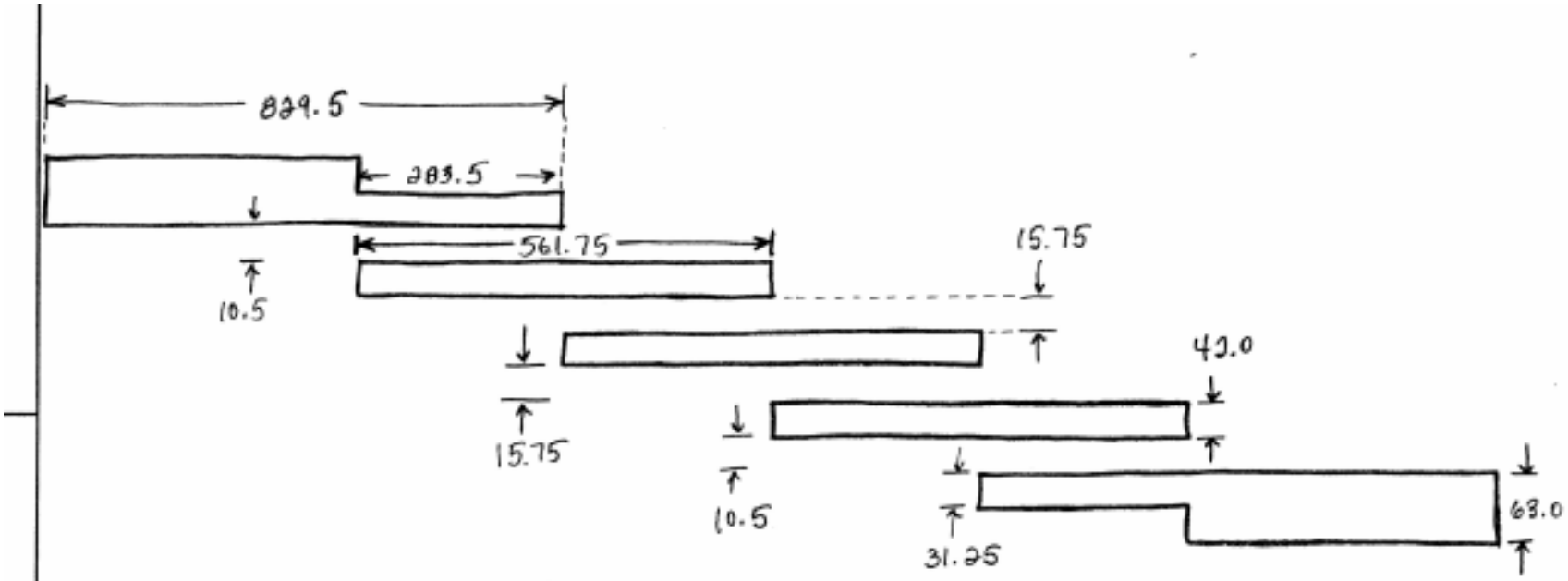
2. Analyze the circuit
   2.1. Choose the analyze pull-down menu and choose frequency sweep from 4.5 to 7.5 GHz every 100 MHz.
   2.2. Mark the box labeled "Make emvu file"
   2.3. Run the program (and wait ~ 5 minutes)
   2.4. Print the S_{11} and S_{12} Magnitude and Phase as a function of frequency (make the figures attractive by changing the scales, labels, etc as necessary – make it look professional!)
   2.5. Print the current for: 4.5,5.5,6.5, and 7.5 GHz.
   2.6. Measure the S_{11} and S_{12} for the provided microstrip line using the HP 8720 VNA (perform a full 2-port calibration if necessary). PRINT YOUR RESULTS!

3. Now "detune" the transmission line
   3.1. Re-size the width of the transmission line by 20% (e.g. change the delta-y spacing to 1.2 mm)
   3.2. Re-run and record all the information requested above with the new circuit. Comment on your observations (particularly look at the current at 6.5 GHz)

4. Side Coupled Filter
   4.1. Reverse Engineer the filter provided in class (complements of GIL Technology).
   4.2. Measure the line widths, lengths, etc.
   4.3. Enter the box size (2220.75x609 mils w/ 5.25x5.25 mil cell size = 423x116 cells)
   4.4. Use the attached figure (Compliments of Derik Love) to enter the circuit into a new Sonnet design page (note: you only need to make one "L-shaped" trace and one "rectangular" trace. The rest of the geometry may be entered by copy/past/rotate commands. Play around until you get it right.
      4.4.1. Copy+Paste+Place the rest of the cells
      4.4.2. Right most "L" make by Copy+Paste+Modify/Rotate=180 degrees + place
      4.4.3. Add ports
   4.5. Note run times are long (~ 20 minutes or more, so you may want to measure the circuit while the program is running).
   4.6. Perform the same sweep and data recording tasks as above (don't "de-tune it")
   4.7. Measure the S_{11} and S_{12} of the provided filter using the HP 8720 VNA. PRINT YOUR RESULTS!

<u>Report</u>

For each Sonnet Lite exercise, give a brief summary of what you learned. Answer any questions posed in the exercises. For the microstrip line and filter, compare your Sonnet Lite results with the measured and theoretical results. Comment on the reasons for differences. Be sure to include your printouts in your report.



dimensions in mils (1 mil = 0.001 inch)

for box cell size → use 5.25 x 5.25 mil cells

erel for dielectric = 3.2