Set #6

Due Monday Wednesday October 12, 2009

Problems:

1. For the offset center stripline configuration shown below, find an exact equation for the characteristic impedance using conformal mapping results available for centered stripline. Assume that the ground planes are infinitely wide and that the thickness of the center conductor is negligible.

![Offset Stripline Geometry](image)

Plot $Z_o \sqrt{\varepsilon_r}$ versus $0.1 < w/b < 1.0$ for $b_1/b_2 = 1$ and 0.5.

2. Stripline Design: For a substrate with $\varepsilon_r = 2.32$, $b = 125$ mils, and $t = 0$ find the following. You may use the MATLAB functions from the notes and/or ADS LineCalc.
   a.) Find the strip width, $w$, which gives $Z_o = 50$, 70.7, and 35.35 ohms.
   b.) Find $\lambda_g/4$ at $f = 4$ GHz for each of the striplines designed in part (a).
   c.) Recalculate $w$ for each of the $Z_o$ values specified in part (a) assuming 1-oz. copper cladding. Compare these results with those of part (a).
   d.) Does the 1-oz. copper cladding specification change the $\lambda_g/4$ calculations of part (b)? Explain.

3. (Collin 3.29) Use a computer program (MATLAB functions from the notes or ADS LineCalc) to evaluate the characteristic impedance and attenuation of a stripline with the following parameters: ground-plane spacing = 2 mm, strip width $w = 0.5$ mm, strip thickness $t = 0.01$ mm, dielectric constant $\varepsilon_r = 6$, loss tangent = 0.006, and frequency of operation = 5 GHz. What is the ratio of attenuation due to dielectric loss relative to that of conductor loss.

4. Microstrip Design: For a Rogers RO4003C copper-clad substrate having $\varepsilon_r = 3.38$, $h = 20$ mils, $t = 1.4$ mils, and $\tan \delta = 0.0027$ @ 10 GHz find the following. You may use the equations from the notes or ADS and LineCalc, other tools you have available.
   a.) The microstrip width, $w$, which gives $Z_o = 50$, 70.7, and 35.35 ohms.
   b.) The $\lambda_g/4$ length $L$ at $f = 4$ GHz and 15 GHz for each of the microstrips designed in part (a). Neglect dispersion.
   c.) Repeat part (b) including the effects of dispersion. Compare your results to those obtained in part (b). Use the dispersion formulas of Notes pp. 70–71 or ADS.
5. (Collin 3.31) In a monolithic microwave integrated circuit, a coplanar transmission line with the following parameters is used: strip width $s = 0.1$ mm, slot width $w = 0.1$ mm, strip thickness $= 0.002$ mm, substrate thickness $= 0.5$ mm, $\varepsilon_r = 12.9$, loss tangent $= 0.0008$, and frequency $= 10$ GHz. You may use ADS LineCalc to determine the characteristic impedance and attenuation. If the strip thickness is increased to 0.005 mm, will this significantly reduce the attenuation?

6. A 1.0 mm thick alumina substrate, $\varepsilon_r = 9.6$, is used for a microstrip circuit that requires a 50 ohm characteristic impedance transmission line with the impedance to be maintained within 2% of the true value. What is the line width and tolerance that must be maintained? Use the MATLAB functions from the notes and/or ADS LineCalc.

7. The characteristic impedance of an ideal 50 ohm microstrip line on a 62.5 mil thick, $\varepsilon_r = 2.5$, substrate is influenced by its proximity to side walls and top cover of a shielding box. Assuming side-wall effects are negligible, estimate the minimum distance between the substrate and top cover, assuming that the characteristic impedance is not to be reduced by more than 2%. Assume a 1 oz copper cladding. The equations given on page 5–66 of the notes deal with an enclosure top cover, this problem is best worked in ADS LineCalc.

8. **Microstrip Transformer Design in ADS:** Using a Rogers R04003C substrate design and analyze a single section quarterwave transformer for matching 50 ohms to 100 ohms at 4 GHz. You will be creating a layout from your schematic. A high-level view of the layout is shown below.

This model can be built in ADS using SmartComponents. A video tutorial will show you how this can be done. Sweep the circuit from 1 GHz to 8 GHz using at a 10 MHz step and plot $|S_{11}|_{\text{dB}}$. You will next build several other models of this circuit to compare the performance results. As you make comparisons, pay particular attention to the 20 dB return-loss bandwidth (band of frequencies for which $|S_{11}|_{\text{dB}} \leq -20$ dB) and the center frequency. By observing $|S_{21}|_{\text{dB}}$, note the insertion loss at 4 GHz and at the center frequency, if it is different.

a.) This is the SmartComponent base design described above.

b.) An ideal transmission line model design using just TLINE from the TLines-Ideal palette.

c.) A microstrip design using the MLIN and MSTEP from the TLines-Microstrip Palette.

d.) A Momentum 2.5D EM Simulation based model (this may be delayed).

e.) A EMDS 3D EM simulation base model (this may be delayed).