ENB440 RF TECHNIQUES AND MODERN APPLICATIONS

ENB440 - FILTER DESIGN

Design Milestone 1

Grant KENNEDY
n8566712

Blake FULLER
n8598819

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1 Executive Summary

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3.1 Hand Calculations

First we found the ABCD parameters for the circuit shown in Figure 1. Once found they were converted to scattering parameters.

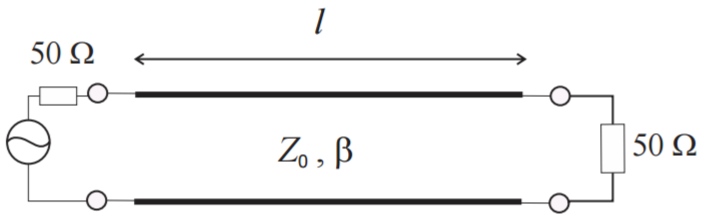

Fig. 1: Theoretical stripline circuit

This circuit consists of two 50Ω loads and two sections of transmission line with an electrical length of λ and an impedence(Z_0) of 70Ω. The wave number (β) is given by:

$$\beta = \frac{2\pi}{\lambda}$$

The unsimplified ABCD representation for this circuit is the following:

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & 50 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} cos(\beta l) & j70sin(\beta l) \\ \frac{jsin(\beta l)}{70} & cos(\beta l) \end{bmatrix} \begin{bmatrix} 1 & 50 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} cos(\beta l) & j70sin(\beta l) \\ \frac{jsin(\beta l)}{70} & cos(\beta l) \end{bmatrix}$$

As $\beta l = 2\pi$ the sin terms are 0 and the cos terms become 1. The results for the ABCD matrix are as follows:

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & 100 \\ 0 & 1 \end{bmatrix}$$

The conversion from ABCD to scattering parameters is shown here:

$$S_{11} = \frac{A + B/Z_0 - CZ_0 - D}{A + B/Z_0 + CZ_0 + D} \tag{1}$$

$$S_{11} = \frac{1 + 100/70 - 0 - 1}{1 + 100/70 + 0 + 1} \tag{2}$$

$$S_{11} = \frac{5}{12} \tag{3}$$

$$= 20log(S_{11}) = -7.6042dB \tag{4}$$

$$S_{12} = \frac{2(AD - BC)}{A + B/Z_0 + CZ_0 + D} \tag{5}$$

$$S_{12} = \frac{2(1 - 0)}{1 + 100/70 + 0 + 1} \tag{6}$$

$$S_{12} = \frac{7}{12} \tag{7}$$

$$= 20log(S_{12}) = -4.6817dB \tag{8}$$

$$S_{21} = \frac{2}{A + B/Z_0 + CZ_0 + D} \tag{9}$$

$$S_{21} = \frac{2}{1 + 100/70 + 0 + 1} \tag{10}$$

$$S_{21} = \frac{7}{12} \tag{11}$$

$$= 20log(S_{21}) = -4.6817dB \tag{12}$$

$$S_{22} = \frac{-A + B/Z_0 - CZ_0 + D}{A + B/Z_0 + CZ_0 + D} \tag{13}$$

$$S_{22} = \frac{-1 + 100/70 - 0 + 1}{1 + 100/70 + 0 + 1} \tag{14}$$

$$S_{22} = \frac{5}{12} \tag{15}$$

$$= 20log(S_{22}) = -7.6042dB \tag{16}$$

3.2 Computer Generated Results

The National Instruments (NI) program TX-Line was used to generate an approximation of the microstrip geometry. The given laminate, impedance, frequency and electrical length information were input and the program output the microstrip width and length.

These values can be seen in the TX-Line GUI screenshop in figure 2

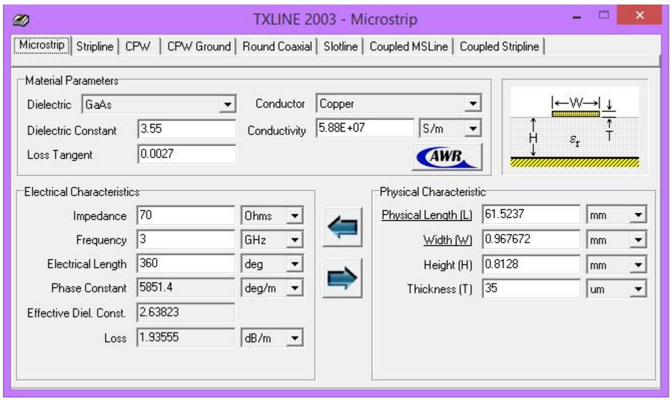

Fig. 2: Screenshot of TX-Line program

The following data was found from the results:

Characteristic	Result
Phase Constant	0.102126 rad/mm
Physical Length	61.5237 mm
Width	0.967672 mm
Eff. Diel. Const.	2.63823

4 Modeling

The stripline was modeled in CST, with a frequency range of 2GHz to 4GHz and port information at 3GHz.