RF Lab Module #4 — Microstrip Transmission Lines

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***Abstract*—Microstrip transmission lines are of utmost importance to RF engineers around the globe due to their ease of design and fabrication. In this lab, microstrip transmission lines are designed, fabricated, measured, and analyzed in order to gain insight and build trust in the theoretical model of the microstrip transmission line.**

I. Introduction

AN An online calculator was used to design the microstrip transmission line. Using the width provided by this calculator the microstrip was able to be fabricated. Several fabrication materials utilized in this lab include a dielectric board laminated with a copper sheet and copper tape. With the microstrip transmission line constructed, its S-parameters were measured using the Agilent VNA utilized in previous labs. Using this data, the characteristic impedance was determined and compared to the desired value.

II. Analysis

If your line is 4" (or write your length) long, how long is that electrically at 5 GHz?

$$L = 4\text{in}$$
$$L = 4\text{in}\frac{2.54 \cdot 10^{-2}\text{m}}{1\text{in}}$$
$$L = 1.016 \times 10^{-1}\text{m}$$
$$f = 5 \times 10^{9}$$

Free Space

$$c = \lambda f$$
$$\lambda = \frac{c}{f}$$
$$\lambda = \frac{3 \times 10^{8}}{5 \times 10^{9}}$$
$$\lambda = 6 \times 10^{-2}\text{m}$$
$$\frac{L}{\lambda} = \frac{1.016 \times 10^{-1}\text{m}}{6 \times 10^{-2}\text{m}}$$
$$\frac{L}{\lambda} = 1.6833$$
$$L = 1.6833\lambda$$

How did you check for DC connectivity? What things did you connect together to ensure proper connections?

To check for DC connectivity a multimeter was used. The multimeter was placed in the ohmmeter mode and a single connection was checked per board. The signal layer i.e. the copper tape was connected to one lead and the bottom ground plane layer was connected to the other lead. The ohmmeter was read and confirmed not to be 0 ohms or shorted. If it the connection was shorted then our microstrip transmission lines would not behave as expected. Thus to ensure it worked as expected, the ground and signal layers were confirmed not to be connected.

What are the pros and cons of using microstrip transmission lines? There are many advantages and disadvantages to manufacturing transmission lines with microstrip. Many of the advantages of microstrip are:

- Ease of manufacture
- Ease of design
- Wide availability
- Overall Cost

Some of the disadvantages microstrip are:

- Susceptibility to electromagnetic interference
- Can become significantly lossy at highs frequencies

III. Discussion and Summary

Overall, considering the fabrication tolerances utilized in this procedure the measurements seen in this lab accurately correspond to the theoretical model discussed in lecture. Some errors may include:

- Accuracy and consistency of the width of the cut microstrip line
- Poor SMA-board connections due to poor soldering

Appendix A
Pre-Lab

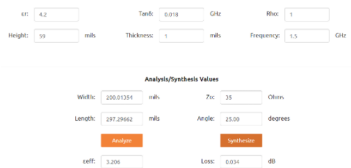

Fig. 1. 35 Ohm Microstrip Transmission Line Prelab Design Calculation

$$Z_0 = 35 \rightarrow w = 200.01354\text{mils}$$
$$w = 200.01354\text{mils}\frac{1\text{in}}{1000\text{mil}}\frac{2.54\text{cm}}{1\text{in}}\frac{10\text{mm}}{1\text{cm}}$$
$$= 5.08034\text{mm}$$

$$Z_0 = 50 \rightarrow w = 115.446\text{mils}$$
$$w = 115.446\text{mils}\frac{1\text{in}}{1000\text{mil}}\frac{2.54\text{cm}}{1\text{in}}\frac{10\text{mm}}{1\text{cm}}$$
$$= 2.93233\text{mm}$$

APPENDIX B
EXTRA PHOTOS

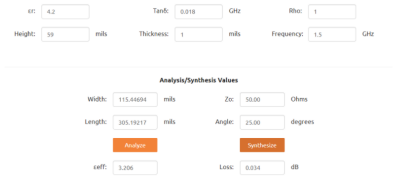

Fig. 2. 35 Ohm Microstrip Transmission Line Prelab Design Calculation

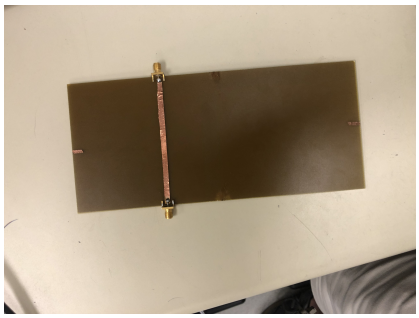

Fig. 3. 35 Ohm Microstrip Transmission Line

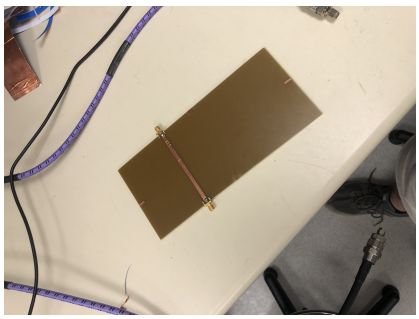

Fig. 4. 50 Ohm Microstrip Transmission Line