ECE320: Fields and Waves

Lab 2 Report: Standing Waves and Waveguides

PRA106

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1 Introduction

This laboratory focused on investigating the (voltage) wave propagation in a microstrip transmission lines, as well as its depedance on the nature of load impedance.

2 Measurement of Microstrip Line Characteristics

We know that since the wave travels in a compound medium: the PCB substrate and the air, we will have to consider an effective epsilon, given by:

$$\epsilon_{\text{eff}} = \frac{\epsilon_r + 1}{2} + \left(\frac{\epsilon_r - 1}{2}\right)\left(1 + \frac{10}{s}\right)^{-xy}$$

where $s = \frac{w}{h}$ and:

$$x = 0.56\left(\frac{\epsilon_r - 0.9}{\epsilon_r + 3}\right)^{0.05}$$
$$y = 1 + 0.02\ln\left(\frac{s^4 + 3.7 \cdot 10^{-4} s^2}{s^4 + 0.43}\right) + 0.05\ln\left(1 + 1.7 \cdot 10^{-4} s^3\right)$$

The characteristic impedance of a microstrip line can also be found using empiral formulae, such as:

$$Z_0 = \frac{60}{\sqrt{\epsilon_{\text{eff}}}}\ln\left(\frac{6 + (2\pi - 6)e^{-t}}{s} + \sqrt{1 + \frac{4}{s^2}}\right)$$
$$t = \left(\frac{30.65}{s}\right)^{0.75}$$

3 Using Standing Wave Patterns for Load Calculations

Observed waveforms at different points on the transmission line can be found in Figure 5.

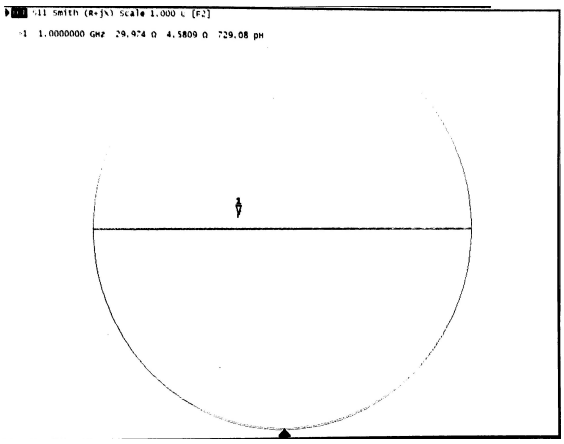


Figure 1: Transmission line terminated with load $Z_L = Z_0$

4 Notes

All images taken during the lab were post-processed in a batch using a custom script that bit-wise inverts the pixels and binarizes the resulting image based on a custom threshold. No adjustments or modifications were made to the readings, for which the oscilloscope's measurements are also shown alongside the waveforms. All scripts and related work can be found at `github.com/pranshumalik14/ece320-labs`.

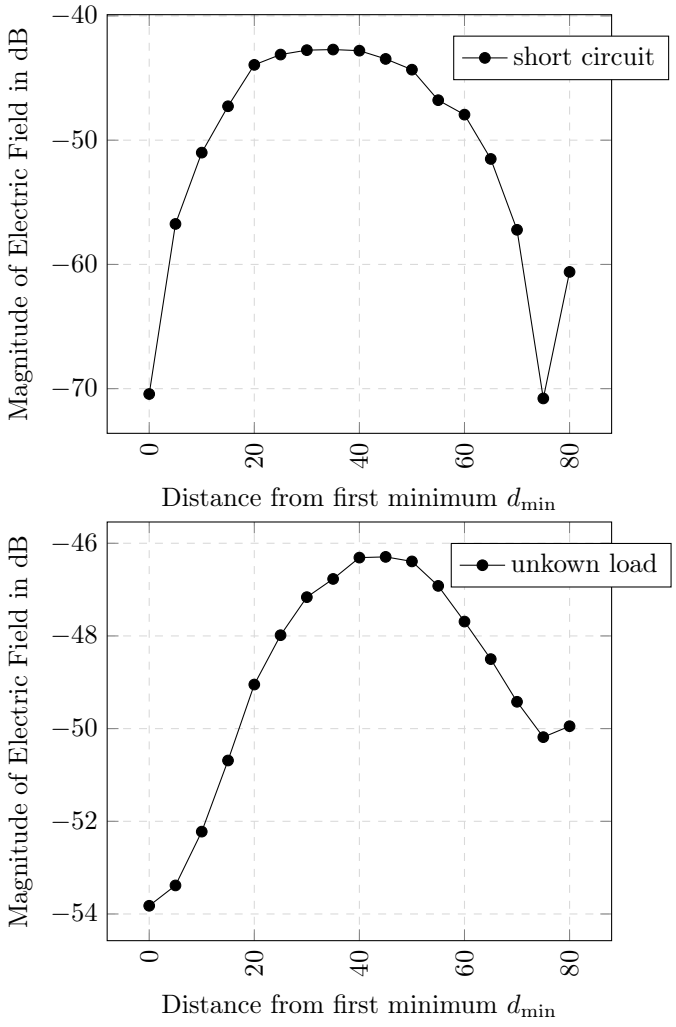
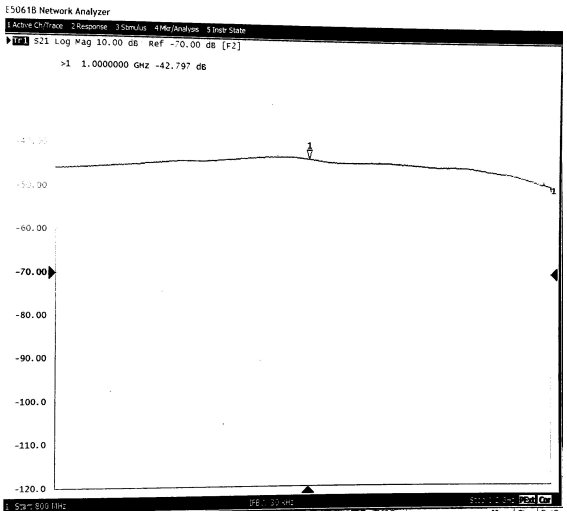
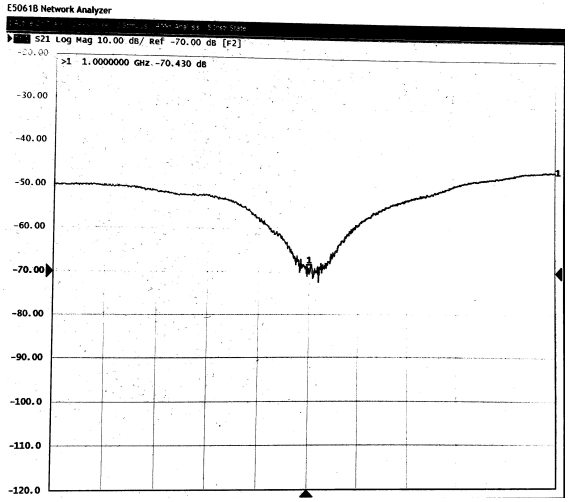


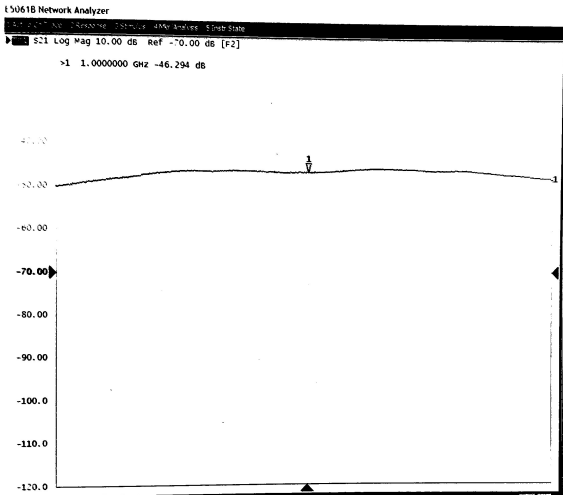
Figure 2: Volt Plots



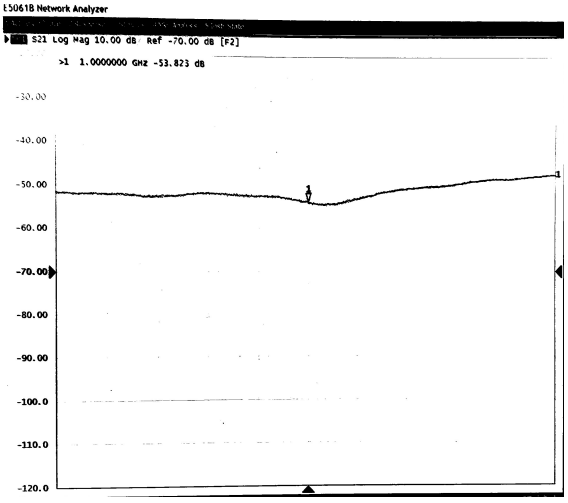
(a) Short circuit maximum



(b) Short circuit minimum



(c) Unknown load maximum



(d) Unknown load minimum

Figure 3: Measured peak and minimum values of standing wave pattern