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 varied the load on the switch box until we saw little or no traces of reflected waves. This was at $Z_L = 50\Omega$ which is also equal to the charactertic impedance since we know that the reflections nullify when $Z_L = Z_0$. The corresponding waveforms captured at the generator input (channel 1, top) and the transmission line input (channel 2, bottom) are shown in Figure 1.

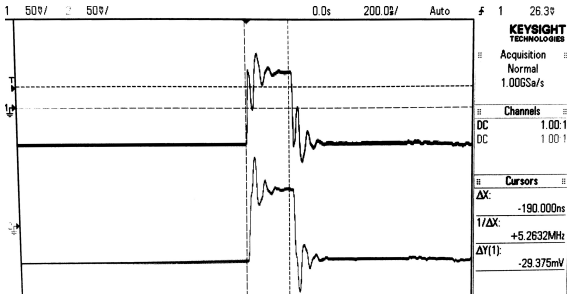


Figure 1: Transmission line terminated with load $Z_L = Z_0$

3 Determining Z_0 using $\frac{\tilde{V}^+(z=-L)}{\tilde{I}^+(z=-L)}$

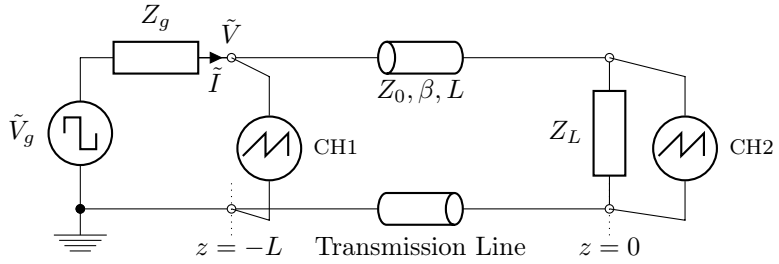
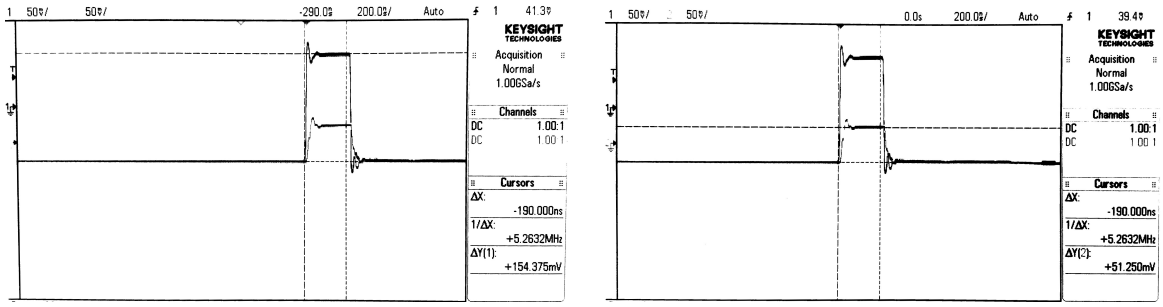


Figure 2: Laborartory setup for studying characteristcs of tranmission lines



(a) $\tilde{V}_1 \approx 154\text{mV}$ (b) $\tilde{V}_2 \approx 51\text{mV}$

Figure 3: $\tilde{V}$ measured across $R_{\text{shunt}} = 100\Omega$

As seen in Figure 3, the voltage at $\tilde{V}_1 = 154\text{mV}$ and $\tilde{V}_2 = 51\text{mV}$. Given the value of $R_{\text{shunt}} = 100\Omega$, we can calculate $\tilde{I}^+ = \frac{0.154-0.051}{100} = 1.03\text{mA}$. From Figure 4, we can see that $\tilde{V}_2 = \tilde{V}^+$, and therefore we can confirm the value of Z_0 through the relation, $Z_0 := \frac{\tilde{V}^+(z=-L)}{\tilde{I}^+(z=-L)} = \frac{51\text{mV}}{1.03\text{mA}} = 49.51\Omega \approx 50\Omega$.

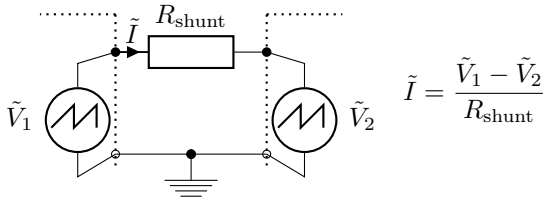


Figure 4: Estimating input current through a shunt resistance

4 Using Standing Wave Patterns for Load Calculations

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

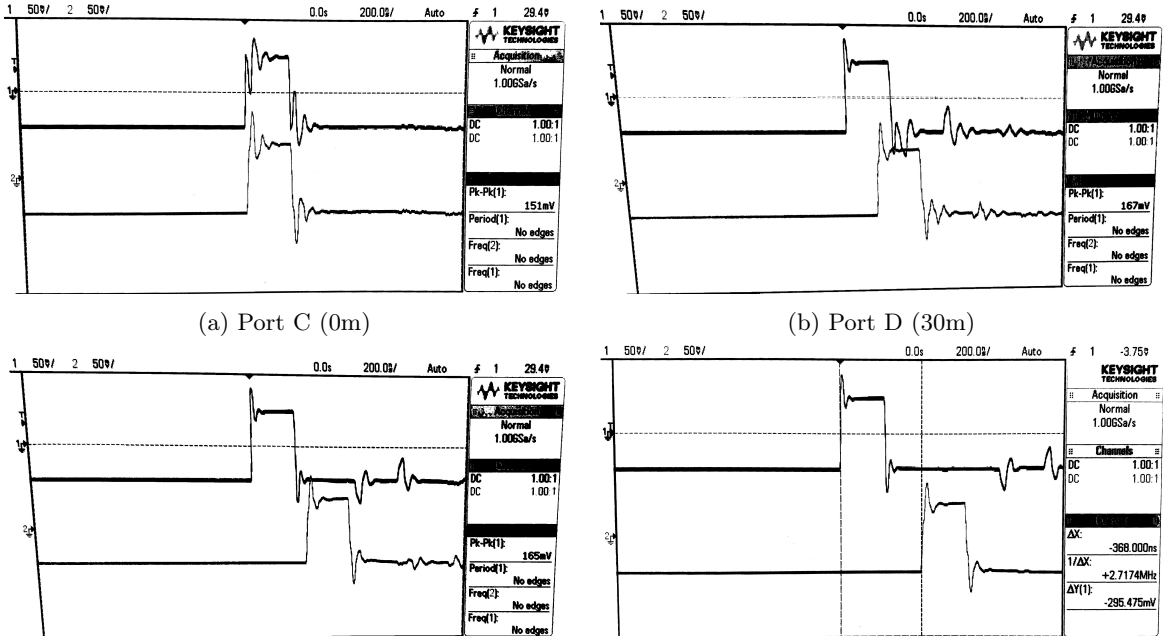
The recorded time delays, Δt, relative to the input signal are listed in Table 1.

Port	Δt **(ns)**
D	130
E	244
F	368

Table 1: Recorded time delay at different locations along the transmission line

5 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`.



(a) Port C (0m)

(b) Port D (30m)

(c) Port E (60m)

(d) Port F (90m)

Figure 5: Measured $V(t)$ at different loactions along the transmission line with $Z_L = Z_0$