Laboratory #4: Passive Element and Transmission Line Circuit

I. OBJECTIVE

Design an RF circuit using passive elements and a 50 Ω microstrip transmission line, analyze using a Smith Chart and confirm the input impedance Z_{in} experimentally.

II. INTRODUCTION

Transmission lines can be used as circuit elements in RF design. Because they may be treated as components, they can also be plotted on a Smith Chart along with resistors, capacitors, and inductors.

On a Smith Chart, transmission lines are depicted using a constant SWR circle with its arc equal to the fractional wavelength corresponding to the operational frequency of the circuit. Series resistors and shunt resistors are shown on a Smith Chart as following constant resistance or conductance circles. Constant reactance X or susceptance B lines of the Smith Chart are followed for capacitors and inductors. The direction for increasing capacitance or resistance on the Smith Chart is shown in Figure 1.

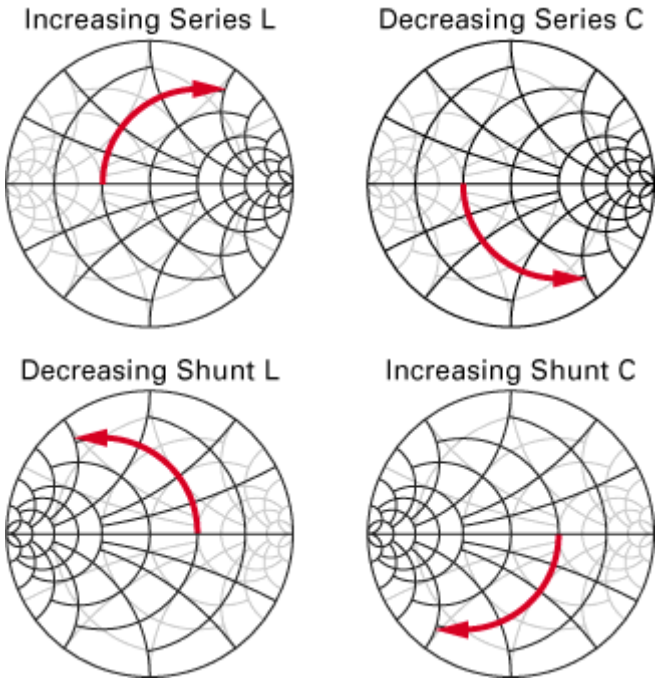

Figure 1. Directions for Increasing and Decreasing Inductors and Capacitors

The value of the normalized impedances relative to Z_o for inductors and capacitors are:

$$Z_{Cn} = \frac{-j}{\omega C Z_o} = -jX_{Cn} \qquad \text{and} \qquad Z_{Ln} = \frac{j\omega L}{Z_o} = jX_{Ln} \quad .$$

For shunt inductors and capacitors, it may be best to use the Z-Y Smith Chart for analysis.

Two circuits are used for analysis. The circuits are shown in Figure 2.

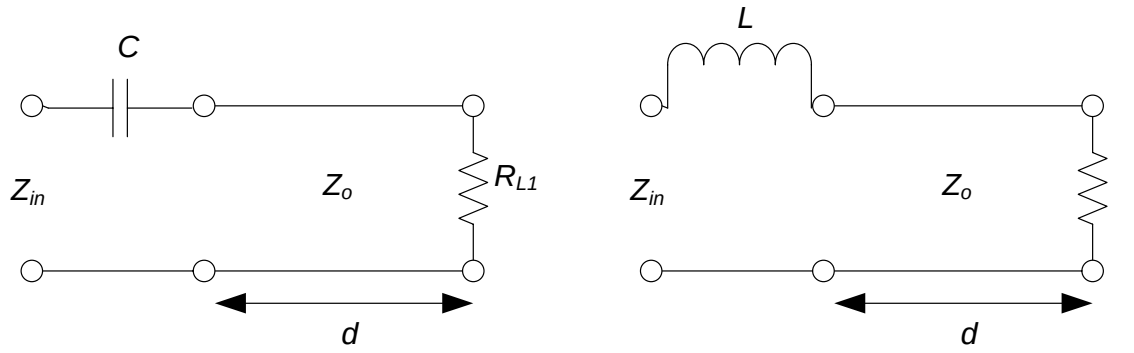

Figure 2. Circuits For Design And Analysis

III. PROCEDURE

A. Calibrate the Network Analyzer directly at Port A of the instrument
Use a length of conformable coax between the Network Analyzer Port A and the PCB.

B. Design the RF Circuit for Z_{in} = 50 Ω
Use the Smith Chart (RFDude or Berner Smith V2.01) to determine *d* and *C* and *L*. Assume Z_o = 50Ω, R_{L1} = 95.3Ω, and R_{L2} = 25.5Ω. Use an operational frequency of 1 GHz.

C. Construct Either Circuit

D. Confirm Design and Comment On Your Results
Find using S_{11}, confirm Z_{in} using the network analyzer at 500 MHz and 1.0 GHz. Plot your reflection results either on a Smith Chart or $|\Gamma|$ and phase of Γ if possible.

E. Measure and Compare to Theory. Comment on your results.