Laboratory #4: Two Element Impedance Matching

I. OBJECTIVE

A two element impedance matching network is designed for a 50 ? source given load specifications.

II. INTRODUCTION

Passive *LC* networks are used to match impedances between the source (generator) and a load. These matching networks are designed using combinations of inductors and capacitors. Two simple *LC* impedance matching networks are shown: two element *LC* high-pass and *LC* low-pass networks. Smith Charts , in particular the Z-Y Smith Chart, can be used as a tool to design of these networks. There are eight possible LC, CC, and LL combinations that can be used for two element impedance matching: Each of these configurations has an associated *forbidden area* where the load cannot be matched to the generator.

Unfortunately, simple two element *LC* impedance matching networks cannot be used for all possible load impedances, Z_L . The limitation of the two element *LC* impedance matching networks are shown as *forbidden areas*. Load impedances that lie in the forbidden area cannot be matched to the source impedance, Z_O, using the simple two element *LC* impedance matching networks discussed in this laboratory. Other configurations and their associated forbidden areas are provided in the attached handout.

<u>Two Element *LC* Low-Pass Impedance Matching Network</u>

A two-element Shunt *C* –Series *L* low-pass impedance matching network is shown in Figure 1. The Z-Smith or Z-Y Smith Chart is used to determine the component values for *L* and *C*. As is costumary, the impedances of *L* and *C* are normalized to the source impedance of Z_O.

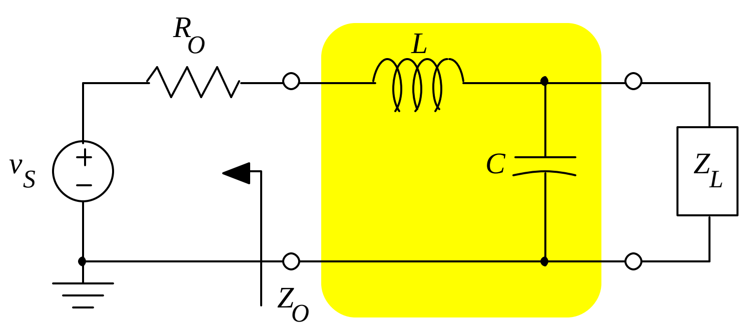


Figure 1. Two Element Shunt *C* - Series *L* Low-Pass Impedance Matching Network

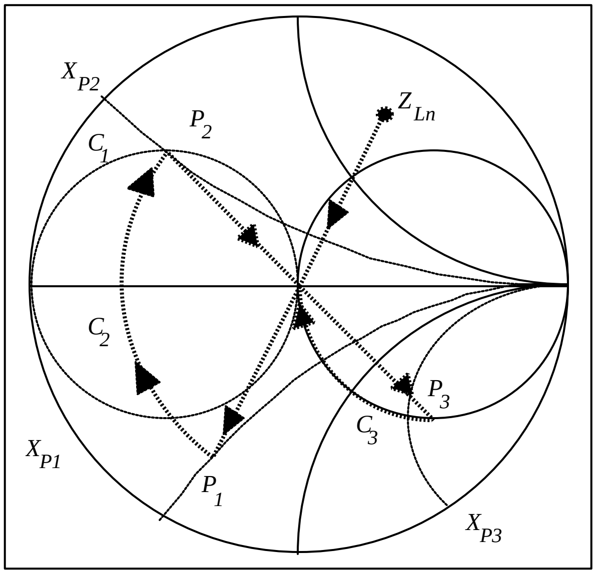


Figure 2. Z-Smith Chart for Determining Matching Component Values for the Configuration of Figure 1.

In order to use the Shunt C – Series L matching network, the load must lie outside of the forbidden area as shown in Figure 3.

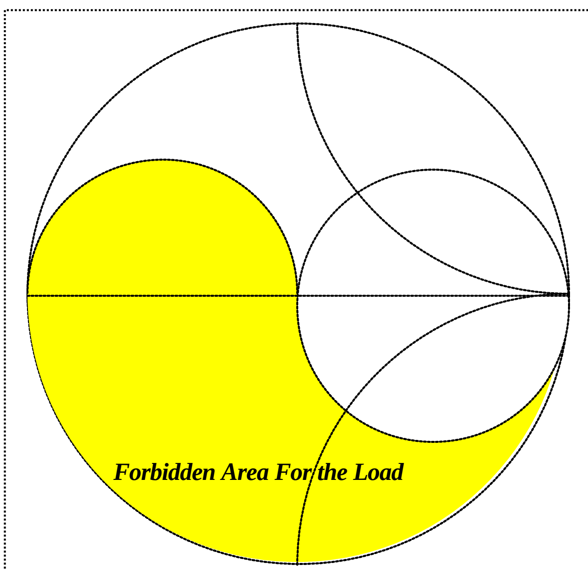


Figure 3. Associated Forbidden Area for the LC Matching Configuration of Figure 1.

A two-element Shunt *L* –Series *C* high-pass impedance matching network is shown in Figure 4. Again, the Z-Smith or Z-Y Smith Chart is used to determine the component values for *L* and *C*.

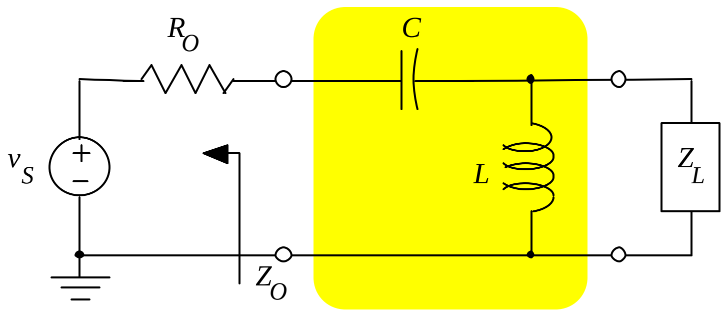


Figure 4. Two Element Shunt *L* – Series *C* High-Pass Impedance Matching Network

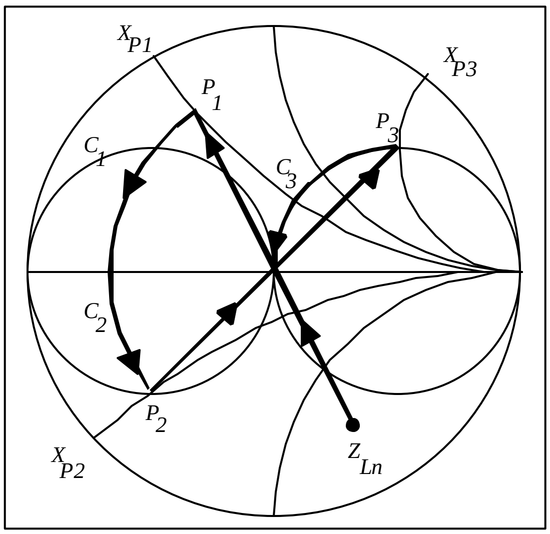


Figure 5. Z-Smith Chart for Determining Matching Component Values for the Configuration of Figure 4.

In order to use the Shunt *L* – Series *C* matching network, the load must lie outside of the forbidden area as shown in Figure 6.

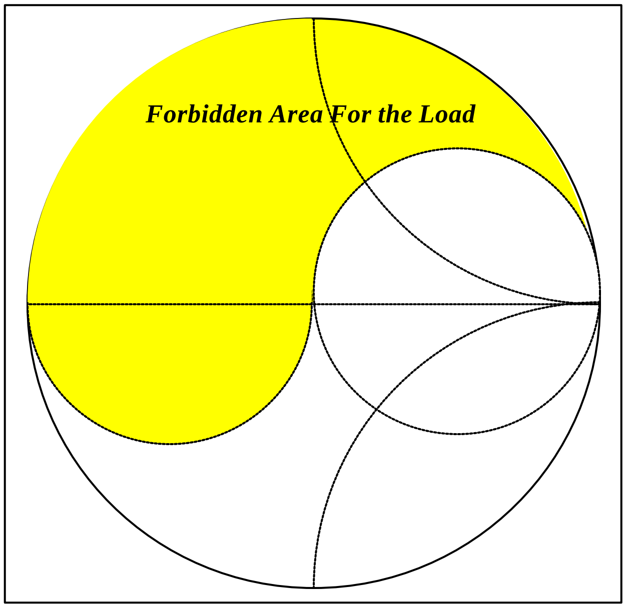


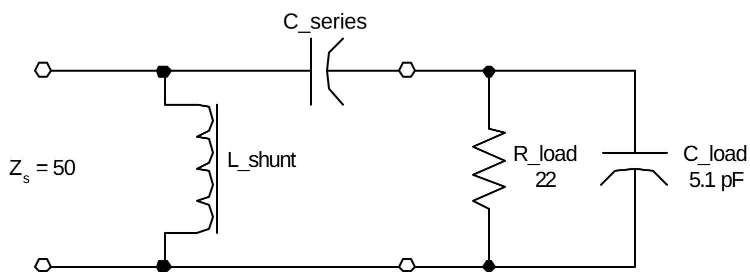
Figure 6. Associated Forbidden Area for the LC Matching Configuration of Figure 4.

The attached hand out provides the other two element matching configurations and their associated forbidden areas.

III. PROCEDURE

A. Design a Two Element LC Matching Network

Design a *LC* impedance matching network to match a 50 ? source and line to a load with a resistance *R* = 22 ? in parallel with a capacitance *C* = 5.1 pF.



1. Use a Smith chart to design the matching network at 500 MHz.
2. What series combination of load resistance and capacitance yields the same complex load impedance?

How reasonable will the match be at 500 MHz?

B. Simulate the Two Element LC Matching Network

Use Agilent ADS to verify your design.

1. Plot your result on a Smith Chart (ADS plot)
2. Plot S11 magnitude and phase in rectangular form (ADS plot)

C. Construct The Impedance Matching Network

Design and construct the impedance matching network and its load at 500 MHz using the single-sided PC board provided. The underlying assumption is that the metal conductors are significantly thinner than the dielectric. Metal thicknesses of 1.37 mils (0.00137 inches) is typical for 1 oz. copper plating. The board is made of FR-4 (or G-10) material with a nominal relative dielectric of 4.5. Use the conformal coax pigtails to introduce signal to the circuit.

Use surface mount capacitors and resistors. Wind inductors using appropriate toroidal cores. You may also choose to use Kapton tape to aid in the construction of your circuit.

D. Measure the Impedance Matched Network

Determine the transmission and reflection coefficients matched network using the network analyzer.

1. Plot your result on a Smith Chart from 100 MHz to 900 MHz highlighting your result at 500 MHz.
2. Plot S11 magnitude and phase in rectangular form from 100 MHz to 900 MHz highlighting your result at 500 MHz.

E. Comment On Your Results