

Laboratory #3: Impedance Matching With A Single Stub Tuner

I. OBJECTIVES

Stub tuner transmission line impedance matching networks are designed given load components at specified frequencies.

II. INTRODUCTION

A single-stub transmission line impedance matching network is composed of a short circuited section of transmission line placed along the main signal line. The short circuited section provides an equivalent shunt susceptance. This short circuited section is attached perpendicular to the main line as shown in Figure 1. The construction of the short circuited section is similar to the main line.

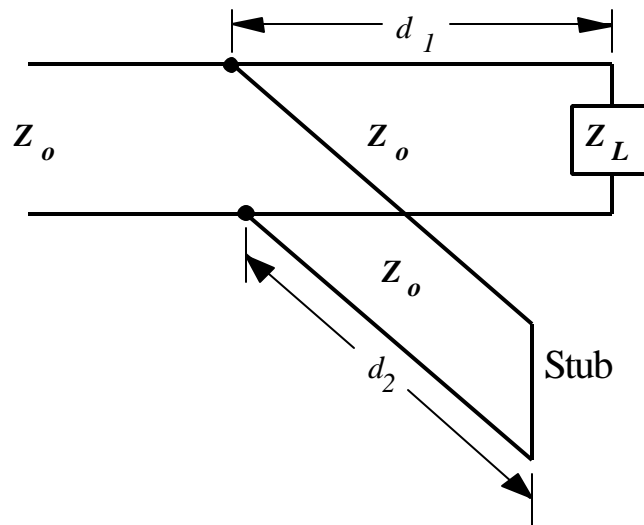


Figure 1. Terminated Transmission Line With Single-Stub Matching Stub

The load impedance is typically dependent on the frequency of operation. The distance, d_2 , can be moved back and forth to get a wide range of susceptance values. The distances d_1 and d_2 can be found in terms of fractions of wavelength of the signal being transmitted using a Smith chart.

When constructing the single-stub tuner, the stub portion must be tied to ground. This could imply either as hard ground as shown in Figure 2a or AC ground in Figure 2b. In Figure 2b, the stub is AC shorted using a capacitor which yields a low impedance path to ground for the operational frequency of interest.

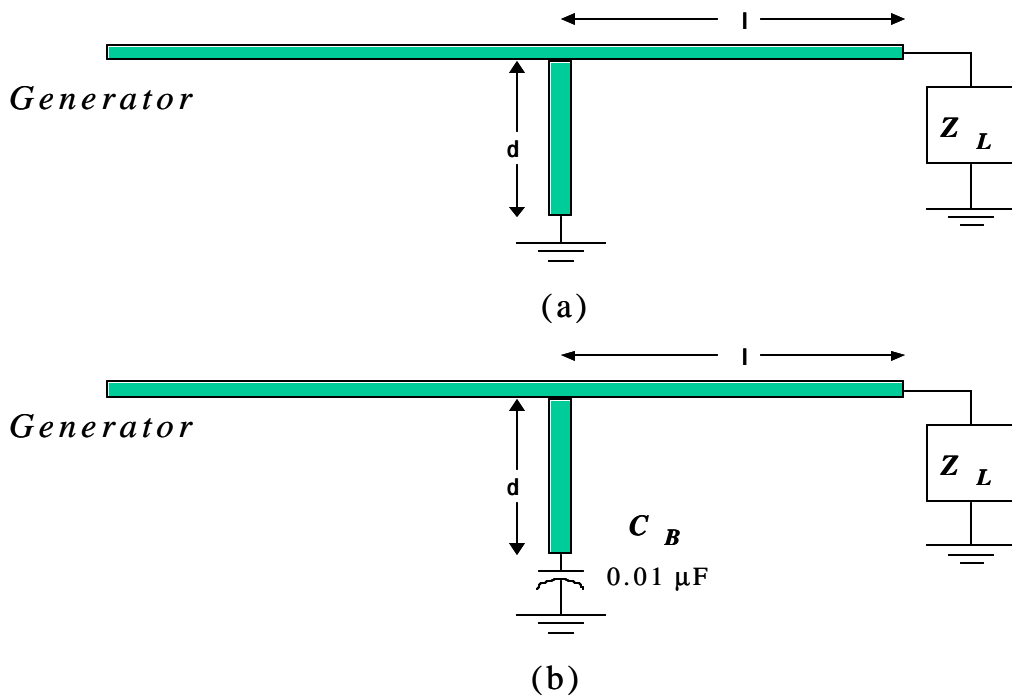


Figure 2. (a) Shorted Stub. (b) AC Shorted Stub with C_B .

In some instances, the distance determined for the single-stub tuner may not be convenient for implementation. In those cases, a double stub tuner may be required as shown in Figure 3. In designing double stub tuners, the distances l_1 and l_2 are pre-determined by the designer.

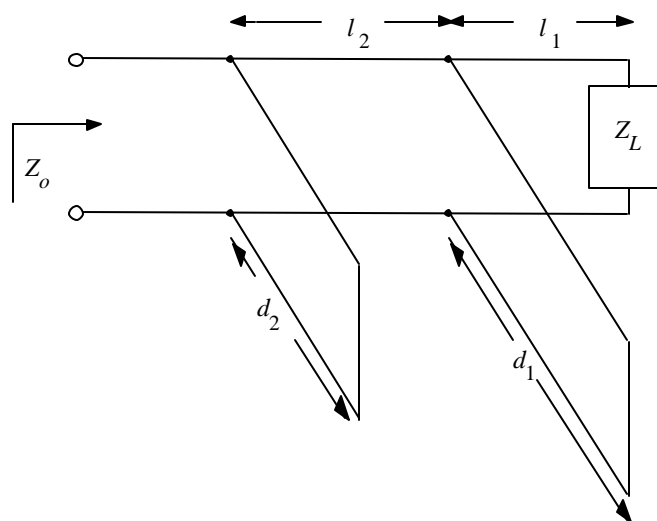


Figure 3. Double-Stub Short Circuit Tuner

The construction of the double-stub tuner is similar to the single-stub tuner. Either a direct short or capacitor coupled low impedance short may be used to short-circuit the stubs to AC ground.

III. PROCEDURE

A. *Design a Single-Stub Tuner*

Design a single-Stub transmission line impedance matching network to match a 50Ω source and line to a load with a resistance $R = 100 \Omega$ in series with a capacitance $C = 10 \text{ pF}$.

1. Use a Smith chart to design the matching network at 500 MHz.
2. Verify the matching network (at 500 MHz) using the Motorola Impedance matching network.

How reasonable will the match be at 900 MHz?

B. *Construct And Measure The Performance Of The Single-Stub Tuner*

Design a microstripline with a single-Stub tuner at 500 MHz using the board and copper tape provided. The microstripline should be matched to the 50Ω source. 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.

1. Construct a single-Stub tuner with the stub directly connected to ground. Measure the transmission coefficient S_{21} , reflection coefficient S_{11} , and SWR of the network at 500 MHz and 900 MHz.
2. Construct a single-Stub tuner with the stub connected to ground via a bypass capacitor. Measure the transmission coefficient S_{21} , reflection coefficient S_{11} , and SWR of the network at 500 MHz and 900 MHz.

C. *Comment On Your Results*