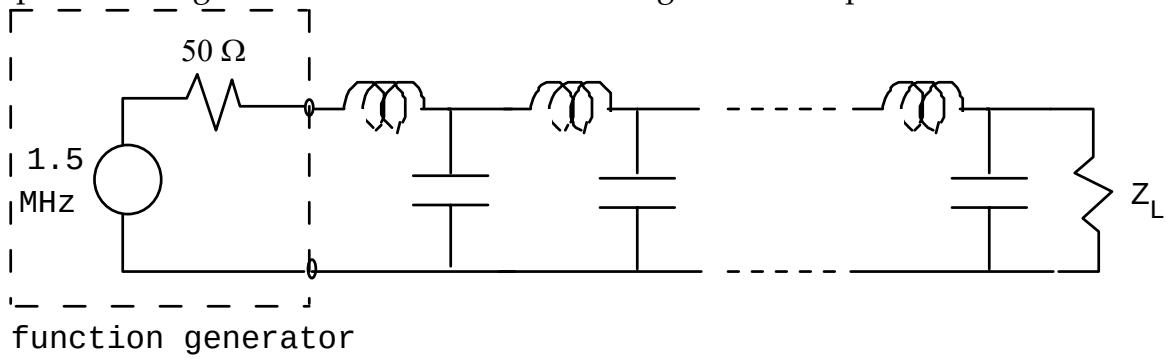
Standing Wave Patterns

Reading assignment
Ulaby, 2-5.1, 2-5.2

Experiment 1 - Standing wave pattern - lumped line
Obtain a lumped model of a transmission line and connect it as shown. This lumped line models an 80 meter length of RG-58 A/U coaxial cable and each L-C section has an equivalent length of 4 meters. Set the function generator amplitude to 1 V P-P.



a. Set $Z_L = 93\ \Omega$.

1) Measure the voltage magnitude as a function of node number and sketch the result. (Suggestion: first measure the even nodes, then the odd nodes).

2) How many nodes separate V_{max} and V_{min} locations? Convert your answer to an equivalent length in the coaxial line.

3) What is V_{max}/V_{min}?

b. Repeat part a. for $Z_L = \infty$, $Z_L = 50$, and $Z_L = 0$. To save time, you don't need to record all values. Concentrate on finding V_{max}, V_{min}, and their locations.

c. Repeat part b. with a capacitor of 3.3 nF. What hapeens to the V_{max} and V_{min} locations?

d. Run the sing_bnd.m code (Matlab file in the waves folder) which illustrates standing wave patterns.

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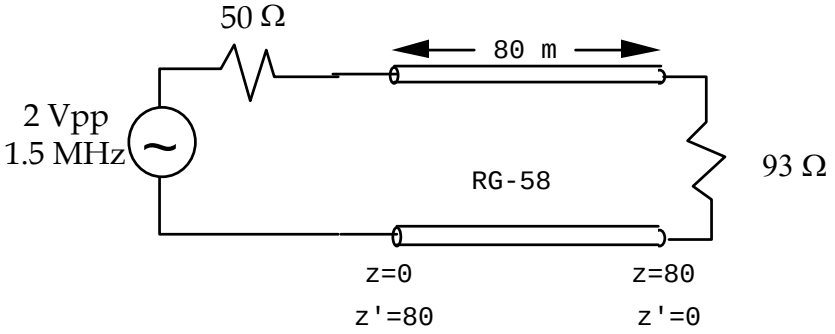
Problem 1 - Standing wave pattern - coaxial cable

The equivalent coaxial cable circuit for Experiment 1 is shown below. You should compare answers with the experiment wherever you can.



RG 58 coaxial cables have the following parameters: a = 0.4 mm, b = 1.4 mm, R_C or Z_0 = 50 Ω, l = 2.5x10^{-7} H/m, c = 1x10^{-10} F/m, and ε_r = 2.3.

a. Determine β and the wavelength λ at 1.5 MHz. Take your measurement of the distance between V_{max} and V_{min} from the experiment and express in terms of λ. What is the distance between two maxima?

b. Determine the reflection coefficient at the load, Γ_L and the standing wave ratio, VSWR.

c. Assume that the forward traveling wave has an amplitude of 1 Volt. Sketch the standing wave pattern for voltage and current. Include numbers for amplitudes and distances.

d. Under what conditions do you get a voltage maximum at the load? a minimum?

e. If the load is a 3.3 nF capacitor, what is the reflection coefficient at the load? Where is the location of the first minimum?

Experiment 2 - Input impedance, lumped line

Set Z_L = 0 on the lumped line. Examine the signal at both the input and output of the lumped line.

a. Set the frequency to 1 kHz. Does the input look like it is shorted?

b. Increase the frequency to 400 kHz. Does the input look like it is shorted?