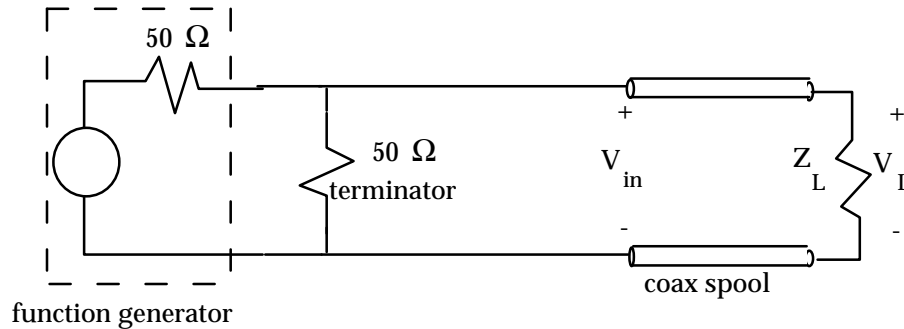Pulses and Transients on Transmission Lines

Reading assignment
Popović and Popović, Chapter 18.5

Exercise 1 - **Pulse signal with matched line**
We will examine the circuit illustrated below.

function generator

a.   Experiment - Set up the experiment and measure the voltage at the input and output of the transmission line. You need two 50 Ω terminators. One is used for Z_L and the other is placed on a tee at the function generator output. Use the following function generator parameters:
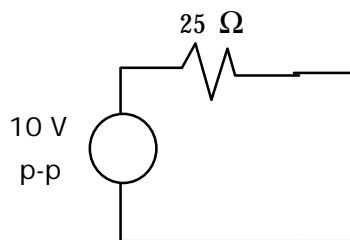amplitude   - 10 V P-P
square wave
1 MHz burst mode
(keep pulse length < 300 ns)

b.   Calculation -
The Thevenin equivalent of everything to the left of the transmission line is below.

1)   The amplitude of the initial pulse traveling down a transmission line is obtained using the same relation as a voltage divider with impedances of R_C (from the transmission line and Z_S (the source impedance). Determine the amplitude of the pulse down the line for this problem.
2)   If you assume the cable is 80 m long, how long would it take a pulse to travel down the line? (You determined the propagation speed in Lesson 4.1).
3)   The cable you used in the experiment probably has a slightly different length. Use the measured time delay to determine the length of the cable.

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Pulses and Transients on Transmission Lines

4)   Circuit analysis review. Show that the Thevenin equivalent given above is correct. Recall that the function generator amplitude readout applies when it sees a 50 Ω load. The voltage of the ideal source of our model is twice this value.

Exercise 2 - Pulsed signal with unmatched line
a.   Experiment
Change Z_L to 93 Ω by using the appropriate terminator. How do you expect this to change the experiment?
(if time permits) - Use the HP Benchlink software (HP computers only) to record your signal on the computer.

b.   Calculation
1)   What is the amplitude of the initial pulse down the line? (Hint: There is no communication yet with the load).
2)   Find the reflection coefficients at the load and source.
3)   What is the amplitude of the first reflected pulse? The second forward pulse?
4)   Make a lattice diagram (also called a reflection diagram) and calculate the signal amplitudes for several bounces.
5)   Calculate the voltage at the input and output as a function of time. For convenience, you can assume an 80 m cable if you don't know the length of your line. Compare with your measured values.

Exercise 3 - Transient signal with open circuit / capacitive load
a.   Experiment - Replace Z_L with an open circuit. Lower the frequency to about 1 kHz. Observe the response. Concentrate on the initial rise (i.e., t < 3 μs).
b.   Simulation - Run the Java applet listed on the course schedule for today. (with the appropriate parameters).
c.   Make a lattice diagram for this case.
d.   From your lattice diagram, determine $V_L(t)$ and $V_{in}(t)$ and compare with the simulation and experiment.
e.   Experiment - Replace Z_L with a capacitor of about 0.1 μF. Remove the 50 Ω terminator on the function generator. Vary the frequency and observe the response.