University of Pennsylvania
Department of Electrical and System Engineering
Circuit-Level Modeling, Design, and Optimization for Digital Systems

ESE370, Fall 2021 — Transmission Line Lab — Sunday, November 28

In Ketterer Lab: Monday, November 29, 12:00PM
Due: Handin will be part of HW 8

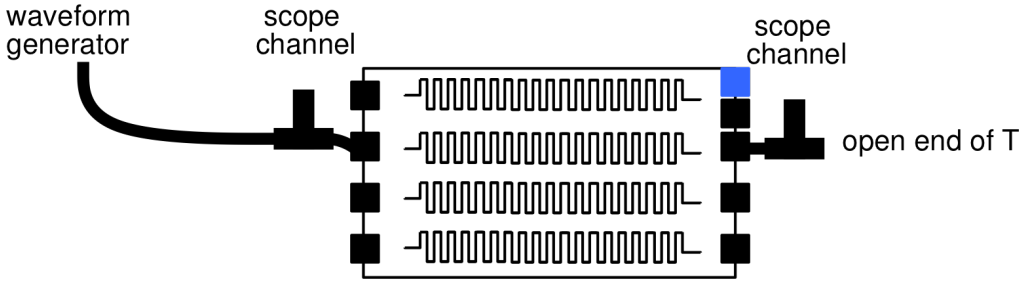
Work individually with board from instructor:

We suggest you collect the answers on this sheet and capture screenshot waveforms on scope. The data is not needed.

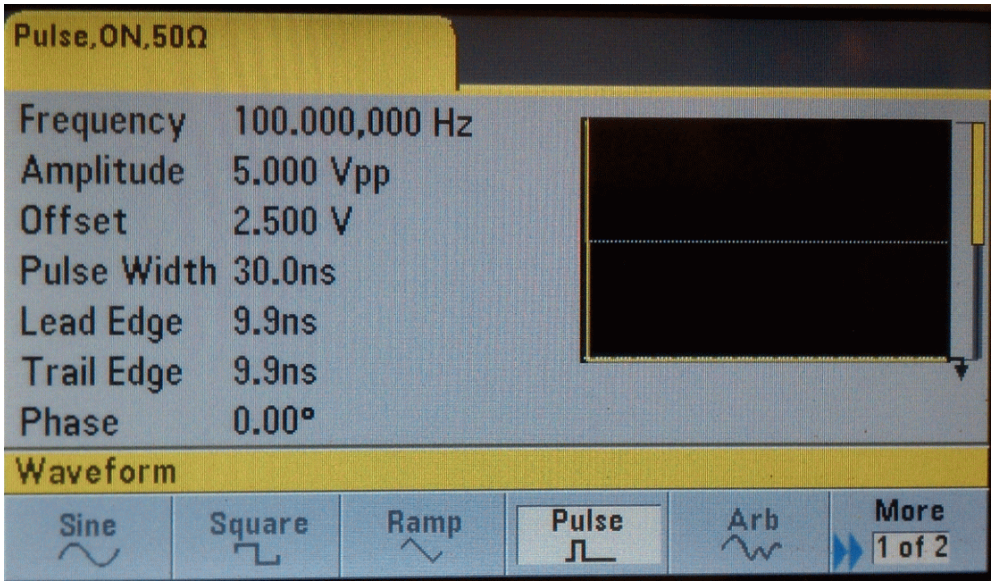
You only need to capture voltages and resistances to 2 decimal significant figures.

1. Setup to drive a pulse into the long (5.34m) PCB stripline trace and watch both ends of the transmission line.

   - Waveform generator drives short coaxial cable
   - Use T-junction to couple short coaxial cable to long trace and observe this source end on one channel of oscilloscope
   - Use T-junction to observe sink end of long trace on a second oscilloscope channel
   - Initially, leave this final T-junction unterminated



   - Set waverform generator to generate a small pulse of 30ns with a long period between pulses.
   - Set the waveform generator for internal termination at 50Ω (not high-Z). This gives you a series termination at the source. (see next page for setup)



2. Observe and characterize the result.

   (a) You should see the pulse at the far end of the long trace. You may need to adjust the trigger level for the associated scope channel. You might need to adjust the time/div to view your signals (eg. 5ms/div, 200ns/div, and 50ns/div).

   (b) What is the delay between the two ends of the trace? Measure from 50% rise to 50% rise.

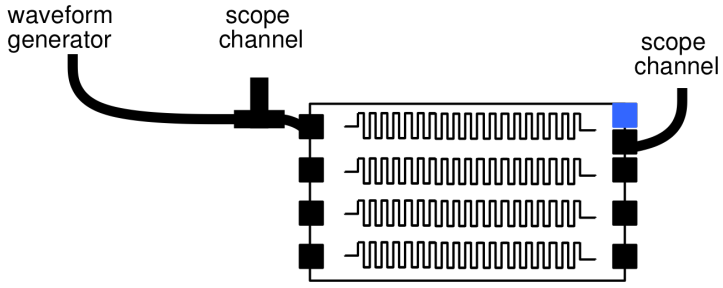
   (c) How does the pulse at the far end of the trace compare to the source end? (shape? voltage compared to original pulse?)

Shape	
Voltage	

   (d) What reflections (if any) can you see at either end (source or sink) of the line? What is the shape? What is the peak voltage? How does this relate to the peak voltage of the original pulse?)

Source	Number	
	Shape	
	Voltage (each pulse)	
Sink	Number	
	Shape	
	Voltage (each pulse)	

3. Change trace lines using the topmost one with a potentiometer terminator.



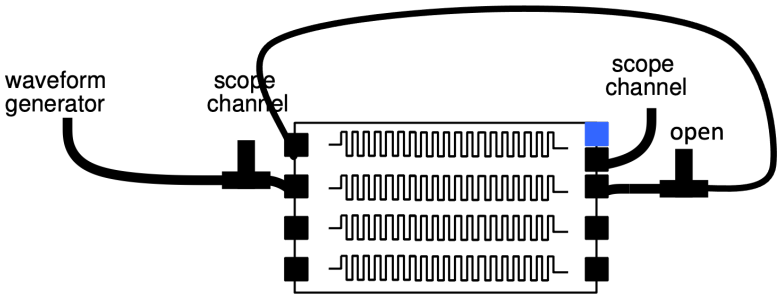
   (a) For what resistance do you see minimal or no reflection? Use the multimeter to measure the potentiometer resistance. [ ]

   (b) For what resistances do you get a negative reflection? [ ]

   (c) For what resistances do you get a positive reflection? [ ]

4. Retune the potentiometer termination for no reflection and leave attached for the remainder of the lab.

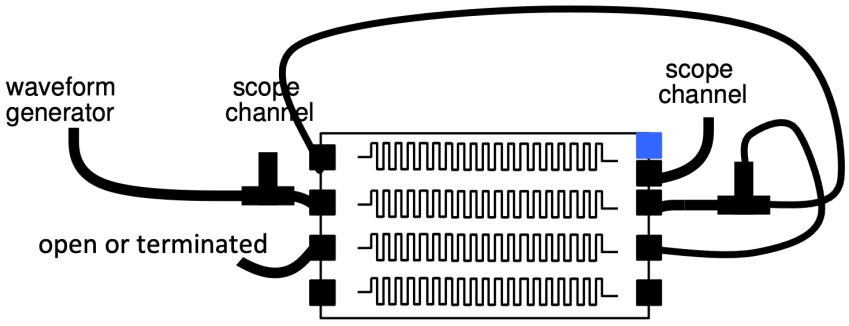
5. Use short cables and t-junctions to place another 5.34m trace between the 5.34m trace and the oscilloscope T-junction.



   (a) How does this change the waveforms? (delay? reflections? shape and peak voltages of reflections?)

Delay?	
Reflections?	
Reflections Shape?	
Reflections Voltage?	

6. Add another 5.34m trace to the new T-junction between the two 5.34m traces (so the two 5.34m traces branch in parallel).



(a) When this trace is unterminated, how does this change the waveforms? (delay? reflections? shape and peak voltages of reflections?)

Delay?	
Reflections?	
Reflections Shape?	
Reflections Voltage?	

(b) When this trace is properly terminated (Use 50Ω terminators available from Detkin), how does this change the waveforms? (delay? reflections? shape and peak voltages of reflections?)

Delay?	
Reflections?	
Reflections Shape?	
Reflections Voltage?	