Lab 4: Measurement of the speed of light in matter

Goal: Use an oscilloscope to measure the propagation speed along an RG-58 cable and compare to c/n, where c is the speed of light and n = index of refraction, which for polyethylene is $n = 1.54$.

The signal that travels in the long cable in the experimental set-up shown in Fig. 1 will be delayed with respect to the signal that travels over the shorter cable. By measuring this delay as a function of the length of the cables, the propagation speed can be measured. The delay is most easily measured using a square wave (sharp edges) with a short period. Make sure to make measurements with several lengths of cables. For stable measurements it is useful to connect the "sync" out from the waveform generator to the external trigger and trigger on this line using the trigger menu on the oscilloscope.

One important experimental detail is the use of 50 ohm terminators at the input to the scopes. These are necessary for the wave travelling through the cable to be absorbed and not reflected at the oscilloscope. You will explore this aspect as part of the experiment. A bi-directional coupler, shown in Fig. 2, can be used to sample both the forward (D port) and reflected (B port) waves if these measurements ports are themselves terminated in 50 ohms, as shown with the oscilloscope in Fig. 1. Note, according to the data sheet, https://cdn.macom.com/datasheets/CH-132.pdf, the D port has a 180 degree phase flip associated with it. Measure the reflection coefficient for the following cases:

1. Open
2. Short
3. 50 ohms

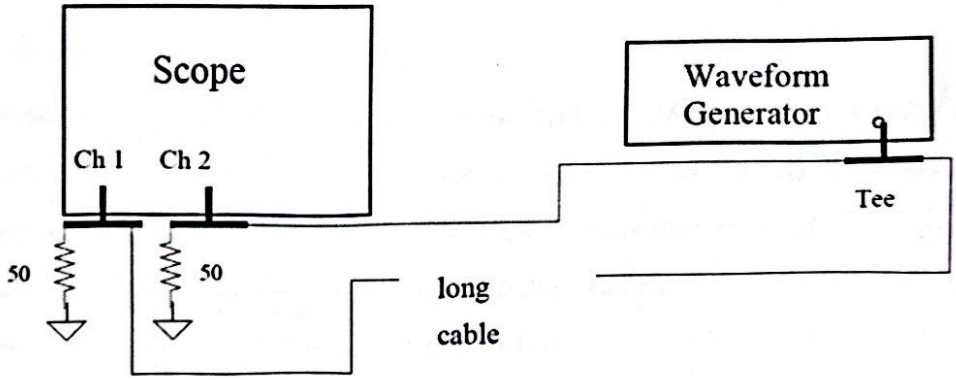

Figure 1. The set-up for the experiment.

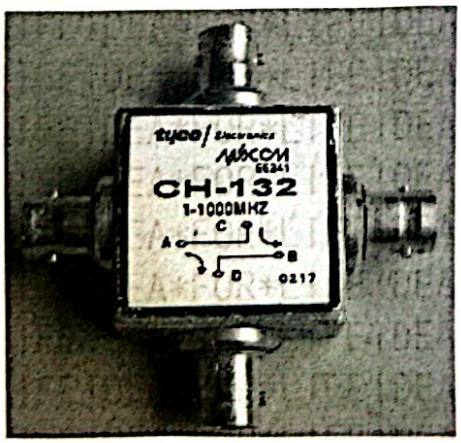

Figure 1. Bi-directional coupler for measuring the forward (D port) and reflected (B port) waves in a cable with BNC connectors. These measurements are a small fraction or the input signal (port A) so that there is little loss of power travelling to the output (port B), due to these measurements.