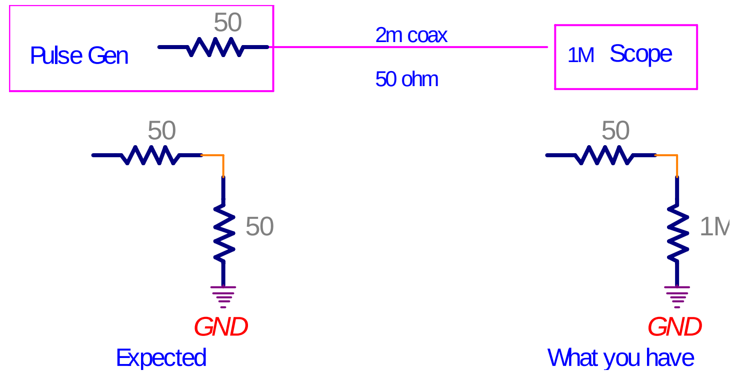
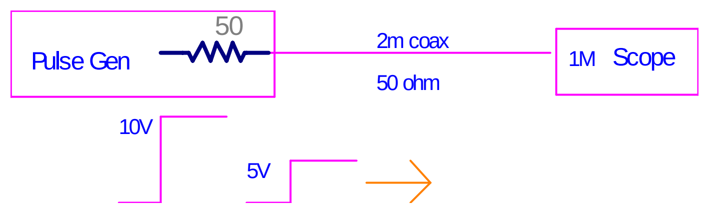
Transmission Line Example

Ex: You want to look at the output of a high speed pulse generator on the scope. You know the output impedance of the pulse generator is 50Ω and you have a 50Ω coax cable that's 2m long. You connect the pulse generator to the scope through the 50Ω cable but you forget that the input impedance of the scope is 1MΩ. The output of the function generator is a 5ns 0-5V pulse (when properly terminated). What will you see on the scope when not terminate (see picture)?

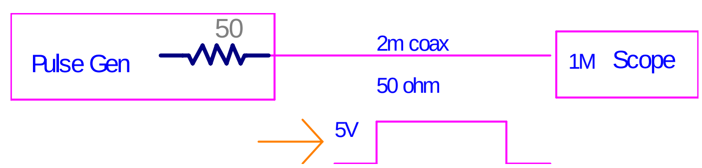


Lets say the propagation speed in the coax cable is 2/3 the speed of light. Therefore it takes 10ns for the pulse to travel through the 2m cable. The pulse generator will put out a 0-10V pulse since when properly terminated you'll drop ½ the voltage across the internal 50Ω terminating resistor (see the "expected" voltage divider).

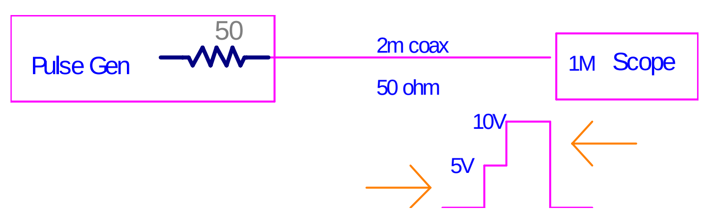
The first few ns: The pulse generator raises the output voltage from 0-10V. Half the voltage is dropped across the internal 50Ω terminating resistor and half across the coax cable (which is acting as a 50Ω resistor). The pulse hasn't reached the scope so at this point it doesn't matter whether or not the scope is terminated.



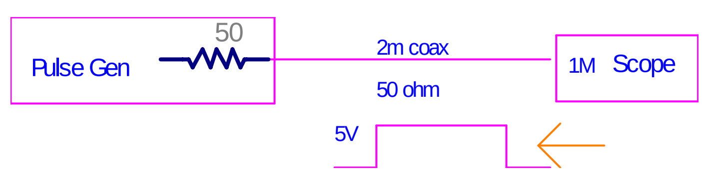
At T=7ns: The 5ns wide 5V pulse is traveling down the coax cable. The pulse generator has returned to zero volts. Again, the pulse hasn't reached the scope so at this point it doesn't matter whether or not the scope is terminated.



At T=12ns: The pulse has reached the un-terminated scope and reflected back with the same polarity and intensity. The reflection is added to the incoming wave so the scope sees a 10V pulse (the 5V pulse traveling to the right plus the 5V reflected pulse traveling to the left).



At T = 13ns: The 5V pulse is traveling back towards the pulse generator.



At T>20ns: The pulse is gone (being totally absorbed by the internal 50Ω terminating resistor in the pulse generator).