

This problem is due Tuesday April 21 at 11:00 AM.

This assignment is to explore various matching techniques that would be useful for matching small antennas to transmission lines (or waveguides) and designing feed networks for arrays. We will be thinking in terms of TEM lines like coaxial cable, microstrip or two-wire line. The bandwidth over which an acceptable match is maintained is very important and difficult to determine by hand. In fact matching is the primary design issue with small antennas. A sophisticated theory of optimal matching over a finite bandwidth is very useful [ref e.g. Pozar, Microwave Engineering, 1990]. In this assignment you will determine the bandwidth by simulating the matching section using the freeware linear simulator “RFsim99” (or any other you prefer).

The basic problem is to match a 200- Ω load to a 50- Ω transmission line. This can be done many ways and the different methods have different bandwidths. We will assume that the bandwidth is measured at a reflected power level of -20 dB. The center frequency is 1 GHz and the dielectric constant of the transmission line is $\epsilon_R = 4$.

1. The first methods involve placing a reactive element at some distance from the load, either in series or in parallel. The reactive element can be a capacitor or an inductor, so there are four different possibilities, each of which have secondary properties that might be of interest. For example a series capacitor will also block DC and a shunt inductor will provide a DC ground. These properties might be useful when biasing an amplifier for example. The actual reactive element could be a lumped element capacitor or inductor, or it could be realized with a short section of open or short circuit transmission line called a *stub*.

(a) Find the location and element value for all four possibilities.

(b) Simulate each of the four matching arrangements with RFsim99 and find the -20 dB bandwidth.

(c) Put your results in a table and explain, roughly, why the bandwidth varies.

2. The second method involves putting a quarter wavelength section of transmission line between the two impedances to be matched. The reflections from the two ends will be 180° out of phase and will therefore tend to cancel. If the characteristic impedance of the quarter wave section is the geometric mean of the source and the load impedances the reflections will cancel exactly.

(a) Find the characteristic impedance for a single quarter wave section, then simulate it with RFsim99 and find the -20 dB bandwidth.

(b) Put two quarter wave sections in cascade, where each match to the geometric mean of the source and load impedance at the center. Find the characteristic impedances, simulate, and find the bandwidth.

(c) Add the results for one and two quarter wavelength sections to those you tabulated in part 1.