# Home Assigment Week 3

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## 1 Task 1

The circuit in Figure 1 will be used to design a 3 dB attenuator.

### 1.1 a

Looking at Figure it can be concluded that if the transmission line is lossless and the circuit must be matched to the input impedance, this circuit can not function as a 3 dB attenuator. Assuming reflections will not be a problem for this system, the potential at the output of the circuit can be acquired using voltage division (1).

$$V_{\text{out}} = V_{\text{in}} \frac{Z_c}{Z_{\text{in}}} = V_{\text{in}} \frac{Z_c}{R + \frac{Z_c^2}{R+Z_c}} \tag{1}$$

Since we require that the circuit is a 3 dB attenuator we end up with (2).

$$R = \frac{\sqrt{2} - 1 + \sqrt{2\sqrt{2} - 1}}{2} Z_c \approx 0.88 Z_c \tag{2}$$

The Smith chart for the circuit using the value of $R$ from (2) can be seen in Figure 3.

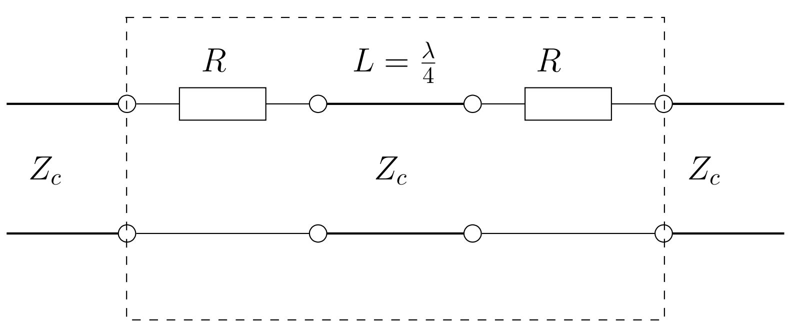



Figure 1: The figure depicts a circuit that will be used as 3 dB attenuator.

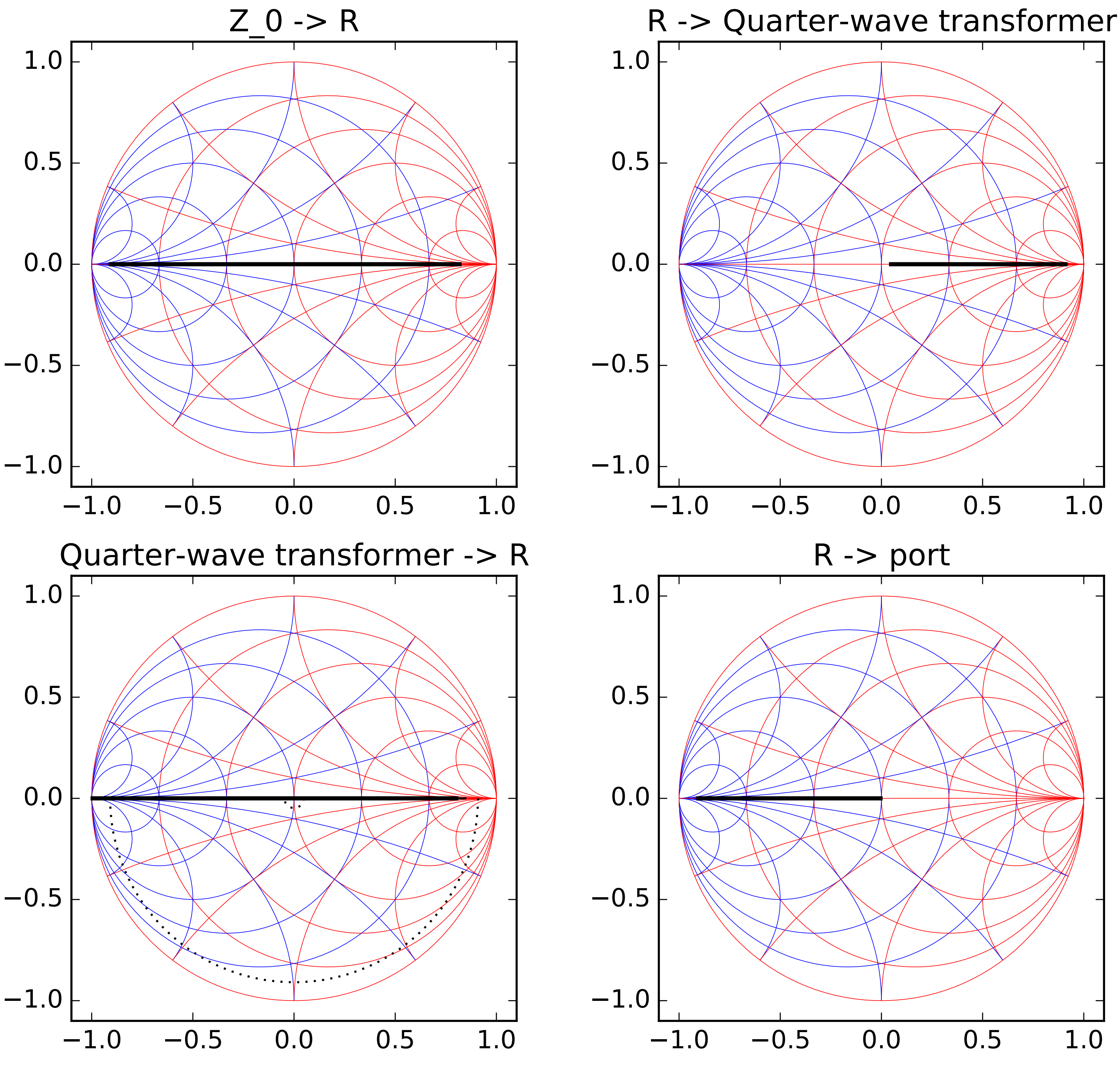





Figure 2: The figure depicts $\Gamma/Z_{\text{in}}$ for values of $R$ ranging from $5\,\Omega$ to $1\,\text{k}\Omega$ at each interface between neighbouring components in the circuid show in Figure 1. A characteristic impedance of $50\,\Omega$ was used and the Smith chart on the lower right-hand side is $Z_{\text{in}}$ at the port.

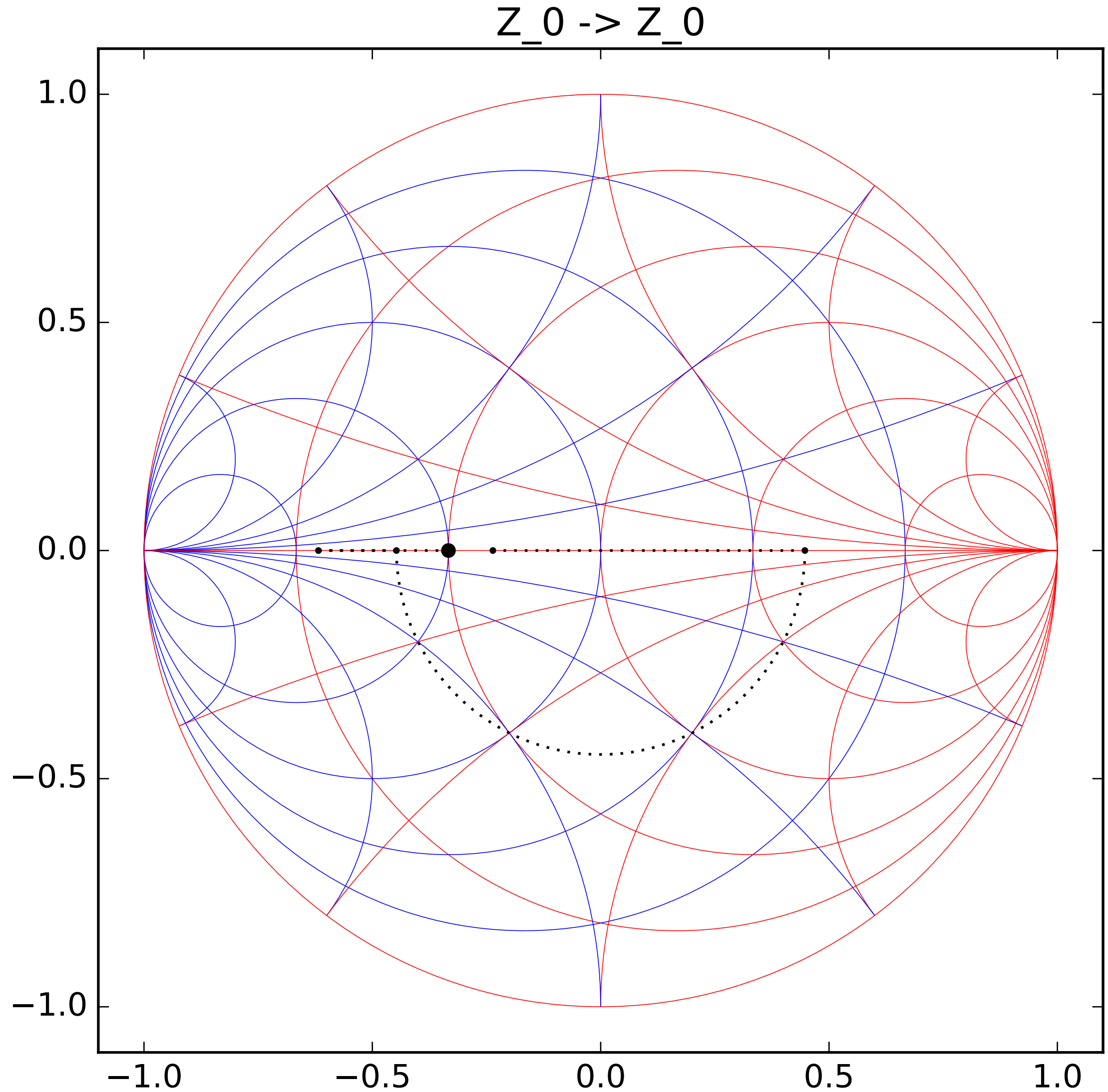



Figure 3: The figure depicts $\Gamma/Z_{\text{in}}$ for the value of $R$ from (2) at each interface between neighbouring components in the circuid show in Figure 1. The chart is independent of characteristic impedance.

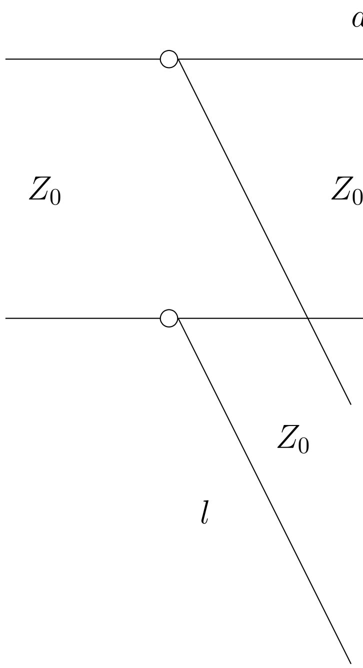
### 1.2 b

The return input reflection is $\Gamma = -0.17$ and return loss is 15.3 dB.

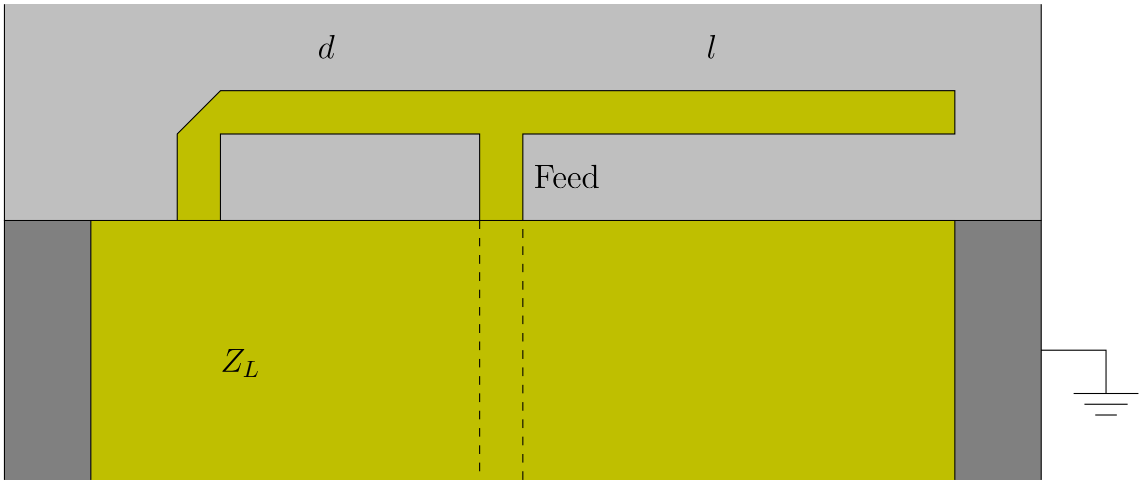
## 2 Task 2

The solution to the matching system in Figure 4 can be seen in Figure 5. In order to get a broaded wideband the solution that had the shortest components was used. The resulting values at 1800 MHz are $d = 0.258\lambda = 42.9\,\mathrm{mm}$ and $l = 0.171\lambda = 28.4\,\mathrm{mm}$.

As I do not have access to *ADS* and is therefor unable to calculate the dimensions of the microstrip circuit.




(a) The equivalent circuit that will be used to match an inverted-F antenna.




(b) An example of a microstrip realization of the matching circuit for an inverted-F antenna.

Figure 4: The figure depicts the matching curcuit for the inverted-F antenna.

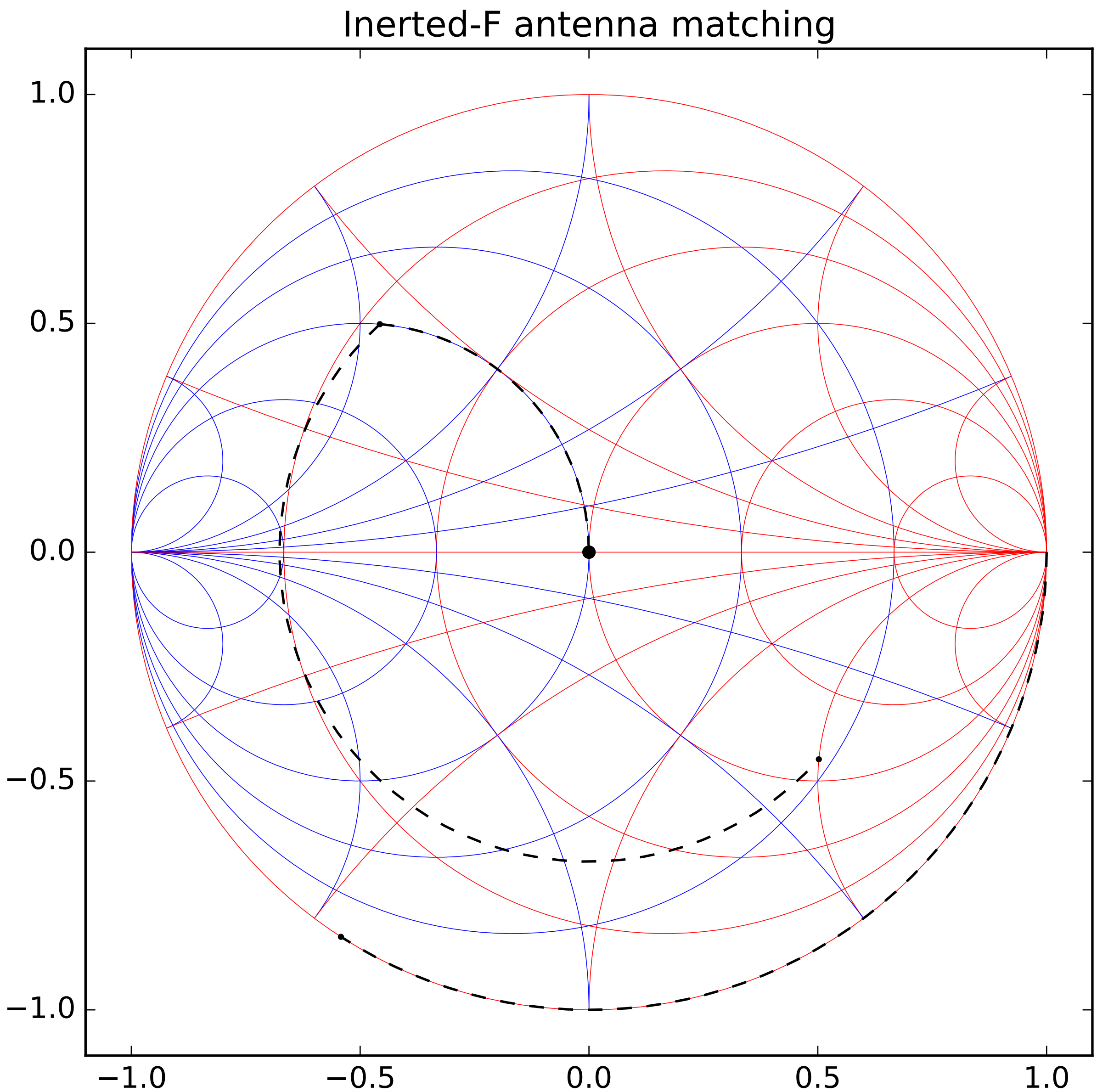



Figure 5: The figure depicts the Smith chart for matching an inverted-F antenna with an antenna impedance of $(60-100\mathrm{i})\,\Omega$ to a $50\,\Omega$ line at $1800\,\mathrm{MHz}$.