

Transmission optimization of a lossy system.

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1 Computation of the transmission.

With the aim to compute the effective transmission of the antenna when both filter are connected to the access 1 and 2 respectively, we consider a 4-ports model of the antenna where the third and fourth port represent the transmitted signal for each polarization (efficacy of the antenna). Then the system shown in Figure 1 is obtained.

1.1 Transmission of the 3-port chain.

Now we consider the matching problem for the first filter. This filter is connected to a load "L" composed by the antenna and the second filter (Figure 2).

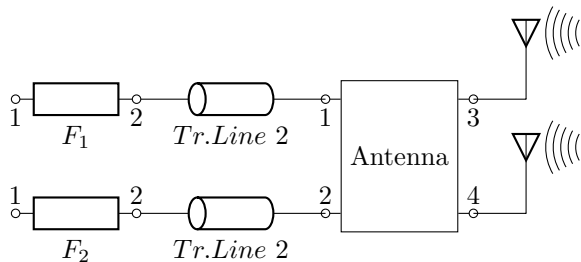


Figure 1: Complete transmission chain.

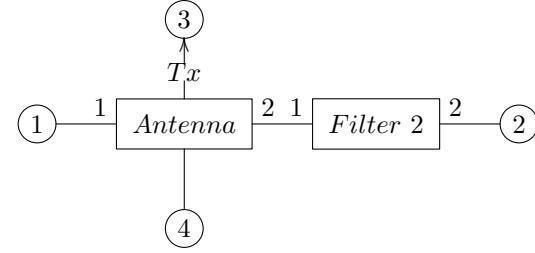


Figure 2: Load seen from the port 2 of the first filter.

The parameters S_{11}^L and S_{31}^L of the load, obtained by chaining the second filter to the port 2 of the antenna take the following expression:

$$S_{11}^L = S_{11}^A + \frac{S_{12}^A S_{21}^A S_{22}^{F2}}{1 - S_{22}^{F2} S_{22}^A} \quad (1)$$

$$S_{31}^L = S_{31}^A \quad (2)$$

where the parameters S_{ij}^A refers to the antenna and the parameters S_{ij}^{Fk} to the k-th filter including the transmission line at the port 2. The transmission parameter (efficacy) of the whole chain (connecting the filter 1 to the port 1 of the antenna) takes the expression:

$$S_{31} = \frac{S_{21}^{F1} S_{31}^L}{1 - S_{22}^{F1} S_{11}^L} \quad (3)$$

Introducing now the expression of S_{11}^L and S_{31}^L we obtain:

$$S_{31} = \frac{S_{21}^{F1} S_{31}^A (1 - S_{22}^{F2} S_{22}^A)}{(1 - S_{22}^{F2} S_{22}^A)(1 - S_{22}^{F1} S_{11}^A) - S_{12}^A S_{21}^A S_{22}^{F1} S_{22}^{F2}} \quad (4)$$

2 Results for the lower band (L2 & E6).

The objective for the application that we are interested in is to maximize the transmission to the antenna (S_{31}) with a given requirement on the rejection in the stopband. With the condition over the rejection, the problem remains:

$$\underset{S^{F1}, S^{F2}}{Max} \left(\underset{f \in I}{Min} |S_{31}| - \gamma \sum_i |S_{31}(f_{si})| \right) \quad (5)$$

where f_s are the edges of the stopband ($f_s = \{1.162GHz, 1.346GHz\}$) and γ is a positive weight (in this example $\gamma = 0.6$).

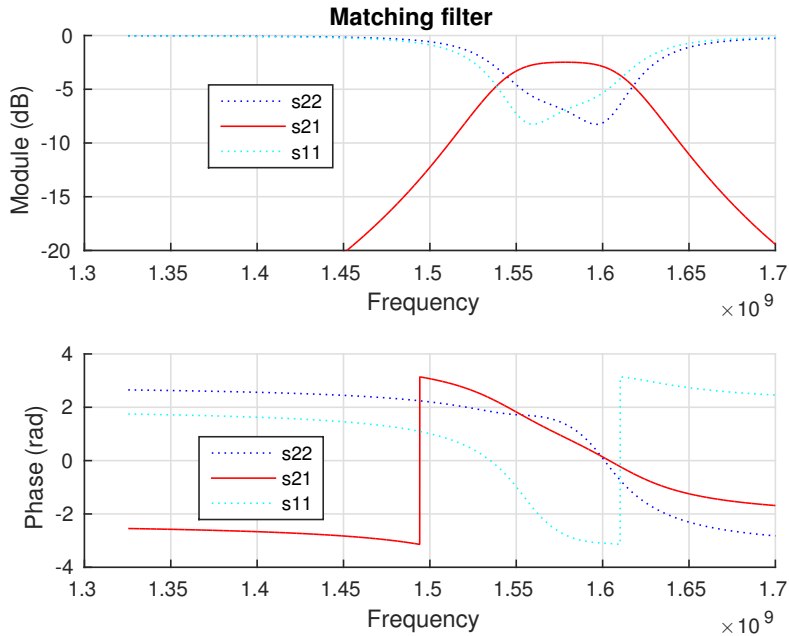


Figure 3: Matching filter for the band 2

By solving this problem the matching filter in Figure 3 is obtained.

This filter provides the best result (Figure 5) when the second port of the antenna is connected to another identical filter.

3 Required data to simulate the results

3.1 Frequency Specifications.

- $f1= 1.5504$ Ghz $f2= 1.6004$ Ghz $f_c= 1.5754$ GHz

3.2 Required files.

- Antenna touchstone
 - 30-Mar-2016_Antenne_Touchstone_4Ports.s4p
- Content of the file "08-Abr-2016_Touchstones_losses.tar.gz"

- 31-Mar-2016_Filter_lossless_band2_N2.s2p
- 31-Mar-2016_Matrix_lossless_band2_N2.txt
- 31-Mar-2016_Phase_port1_band2_N2.s2p
- 31-Mar-2016_Phase_port2_band2_N2.s2p
- 31-Mar-2016_Transmission_line_lossless_band2_N2.s2p
- 31-Mar-2016_Chaine_complete_2Ports_lossless_band2_N2.s2p
- 31-Mar-2016_Chaine_complete_4Ports_lossless_band2_N2.s4p

3.3 Interdigital filter

To simulate the response of the real interdigital filter it is necessary to consider the phase due to the input and output coupling. The full-wave response of the filter in microstrip correspond to the structure shown in Figure 4.

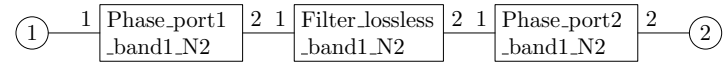


Figure 4: Equivalent model to the inter-digital filter.

3.4 Transmission line.

The touchstone of the transmission line correspond to an ideal line of length $L = 23.9mm$ with $\beta(f) = 54 \cdot \frac{f}{f_c}$ and the following scattering matrix:

$$S = \begin{pmatrix} 0 & e^{-jL\beta(f)} \\ e^{-jL\beta(f)} & 0 \end{pmatrix} \quad (6)$$

3.5 System structure.

See Figure 6.

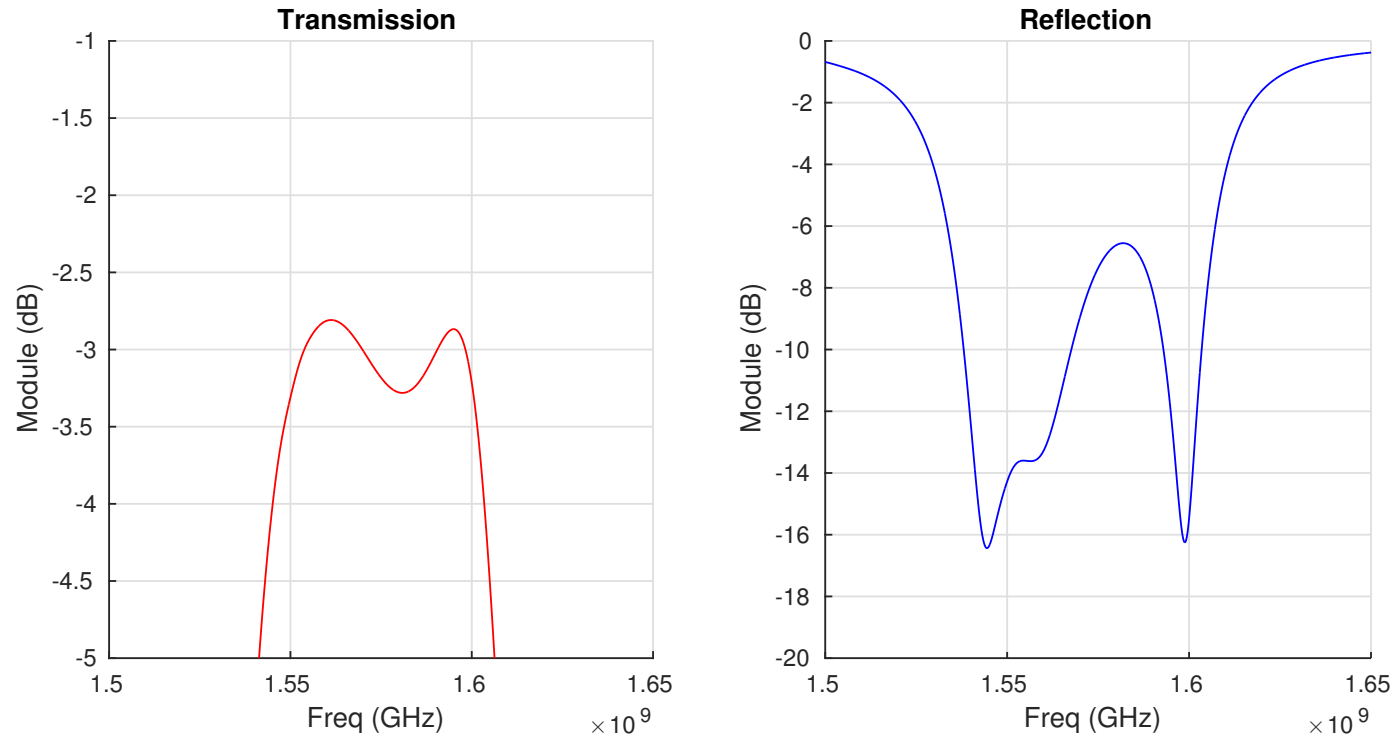


Figure 5: Final response of the global system.

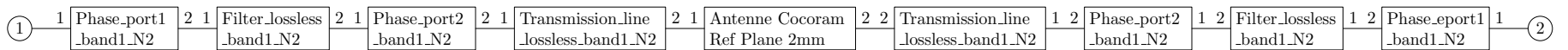


Figure 6: System structure