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 forth port represent the transmitted signal for each polarization (efficacy of the antenna). Then the system shown in Figure 1 is obtained.

1.1 Transmision 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).

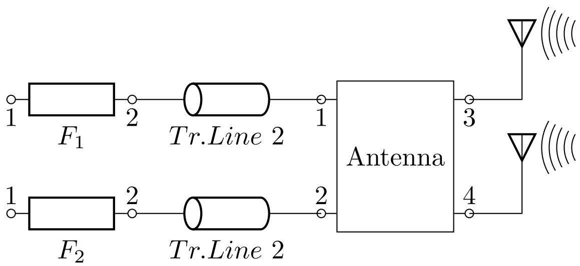

Figure 1: Complete transmission chain.

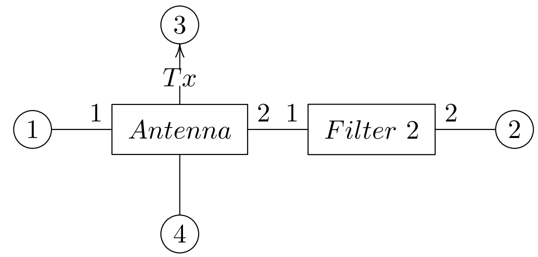

Figure 2: Load seen from the port 2 of the first filter.

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

$$S^L_{11} = S^A_{11} + \frac{S^A_{12} S^A_{21} S^{F2}_{22}}{1 - S^{F2}_{22} S^A_{22}} \tag{1}$$

$$S^L_{31} = S^A_{31} \tag{2}$$

where the parameters S^A_{ij} refers to the antenna and the parameters S^{Fk}_{ij} 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:

$$S_{31} = \frac{S^{F1}_{21} S^L_{31}}{1 - S^{F1}_{22} S^L_{11}} \tag{3}$$

Introducing now the expression of S^L_{11} and S^L_{31} we obtain:

$$S_{31} = \frac{S^{F1}_{21} S^A_{31} (1 - S^{F2}_{22} S^A_{22})}{(1 - F^{F2}_{22} S^A_{22})(1 - S^{F1}_{22} S^A_{11}) - S^A_{12} S^A_{21} S^{F1}_{22} S^{F2}_{22}} \tag{4}$$

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:

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

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

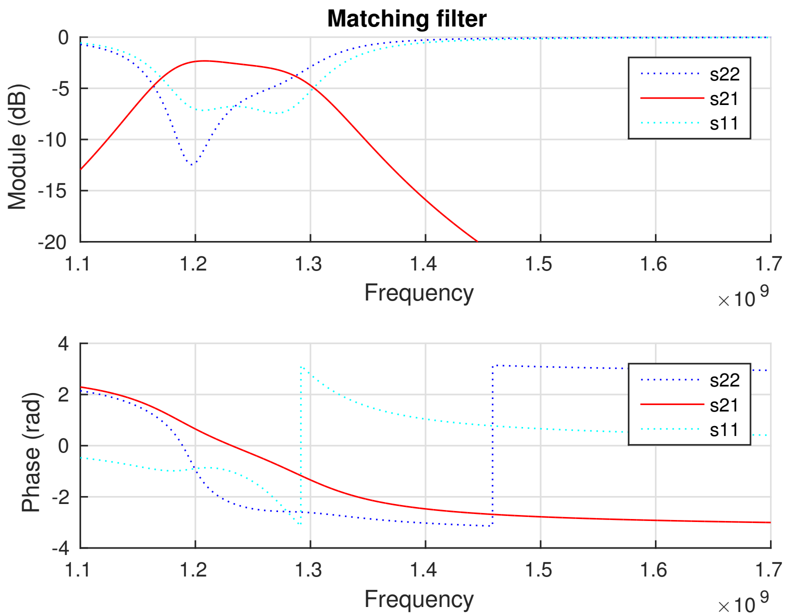

Figure 3: Matching filter for the band 1

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= 1.2126 Ghz   f2= 1.30375 Ghz   fc= 1.2582 GHz

3.2 Required files.

- Antenna touchstonne
  - 30-Mar-2016_Antenne_Touchstone_4Ports.s4p
- Content of the file "31-Mar-2016_Touchstones_losses.tar.gz"
  - 31-Mar-2016_Filter_lossless_band1_N2.s2p
  - 31-Mar-2016_Matrix_lossless_band1_N2.txt
  - 31-Mar-2016_Phase_port1_band1_N2.s2p
  - 31-Mar-2016_Phase_port2_band1_N2.s2p
  - 31-Mar-2016_Transmission_line_lossless_band1_N2.s2p
  - 31-Mar-2016_Chaine_complete_2Ports_lossless_band1_N2.s2p
  - 31-Mar-2016_Chaine_complete_4Ports_lossless_band1_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.

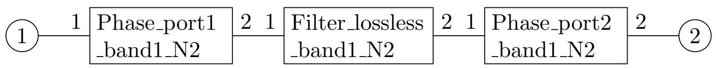

Figure 4: Equivalent model to the inter-digital filter.

3.4 Transmission line.

The touchstone of the transmission line correspond to an ideal line of lenght $L = 63.3335mm$ with $\beta(f) = 44.3582 \cdot \frac{f}{fc}$ and the following scattering matrix:

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

3.5 System structure.

See Figure 6.

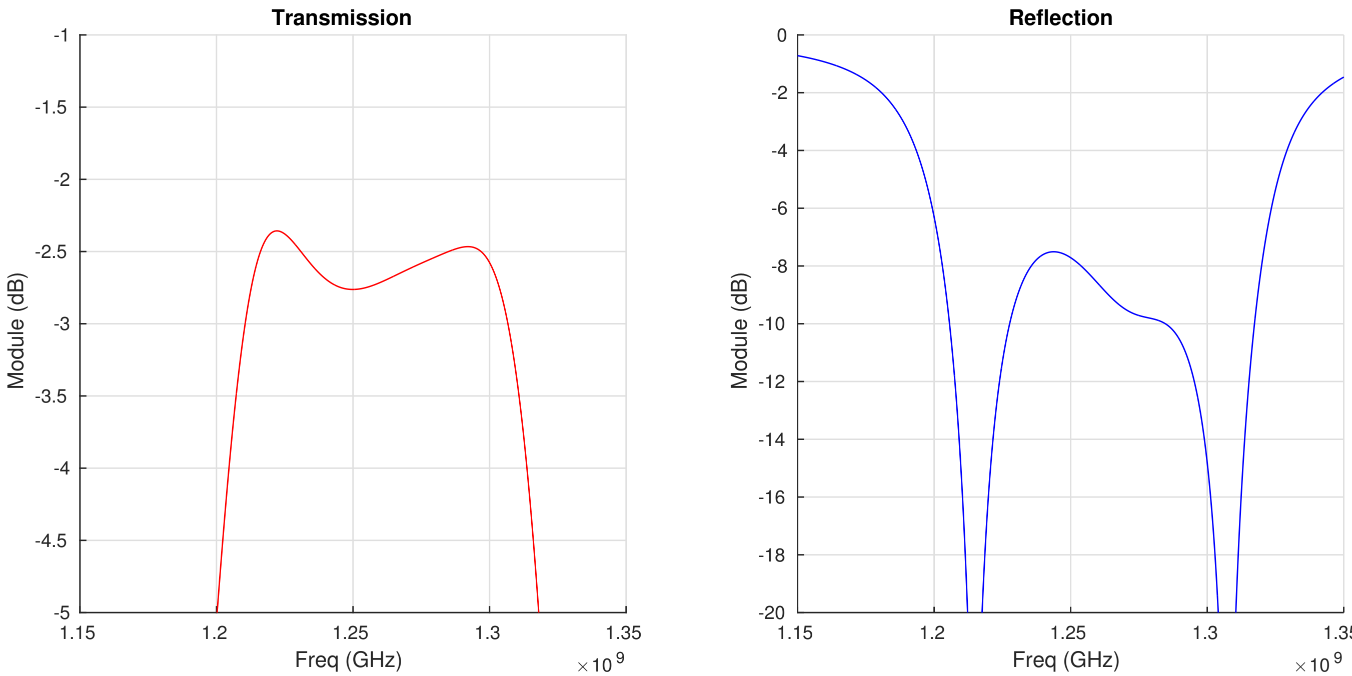

Figure 5: Final response of the global system.

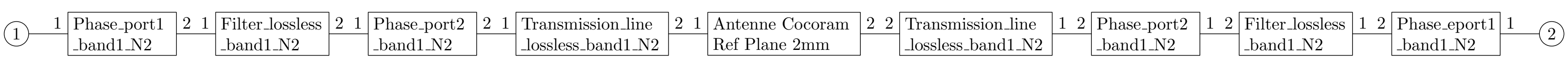

Figure 6: System structure