Matching filters of degree 1.

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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).

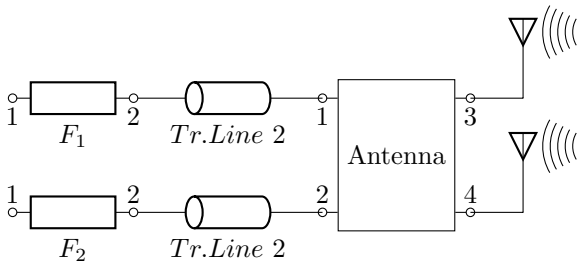

Figure 1: Complete transmission chain.

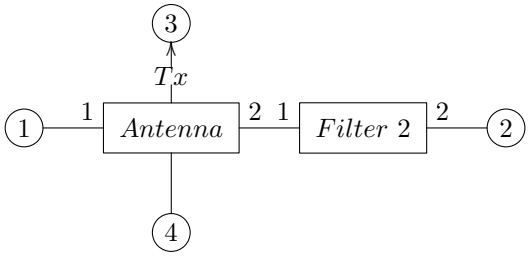

Figure 2: Load seen from the port 2 of the first filter.

The parameters S_{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:

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

$$S_{31}^L = S_{31}^A \tag{2}$$

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:

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

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

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

1.2 Practical implementation

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 and γ is a positive weight (for the one-pole filters we consider $\gamma = 0$).

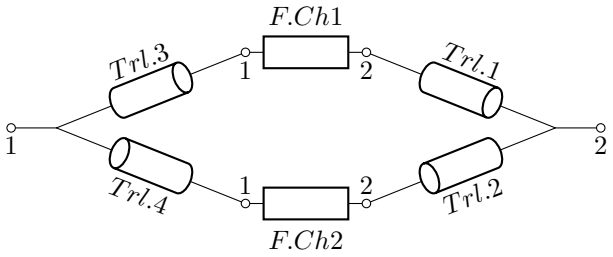

Figure 3: Dual-band filter structure.

Transmission line	Length (mm)
Trl. Ant	40
Trl. 1	9.8
Trl. 2	49.9
Trl. 3	29.9
Trl. 4	36.2

Table 1: Length of the transmission lines.

2 Dual-band filter

The dual-band filter is designing by implementing a diplexed solution and performing a fix point algorithm over both channels.This filter is composed by an input diplexer, both single-band filters in parallel and an output diplexer. Figure 3 shows the structure of the dual-band filter and Figure 5 the obtained response. This filter provides the result shown in Figure **??** when the antenna is connected to the port 2 through the transmission line *Trl. Ant.* (Figure 4).

The length of each transmission line is listed in Table 1.

2.1 Transmission lines.

The transmission lines shown before correspond to ideal lines with $\beta(f) = 44.3582$ at the frequency $f = 1.2582$ and $\beta(f) = 54$ at $f = 1.5754$. This lines are implemented with the following scattering matrix:

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

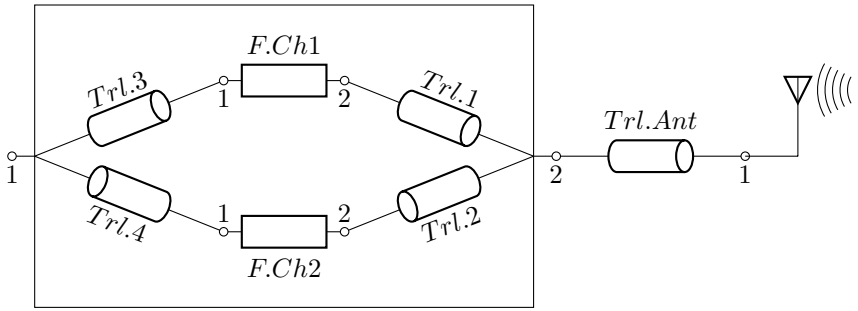

Figure 4: Dual-band filter with the antenna at the port 2.

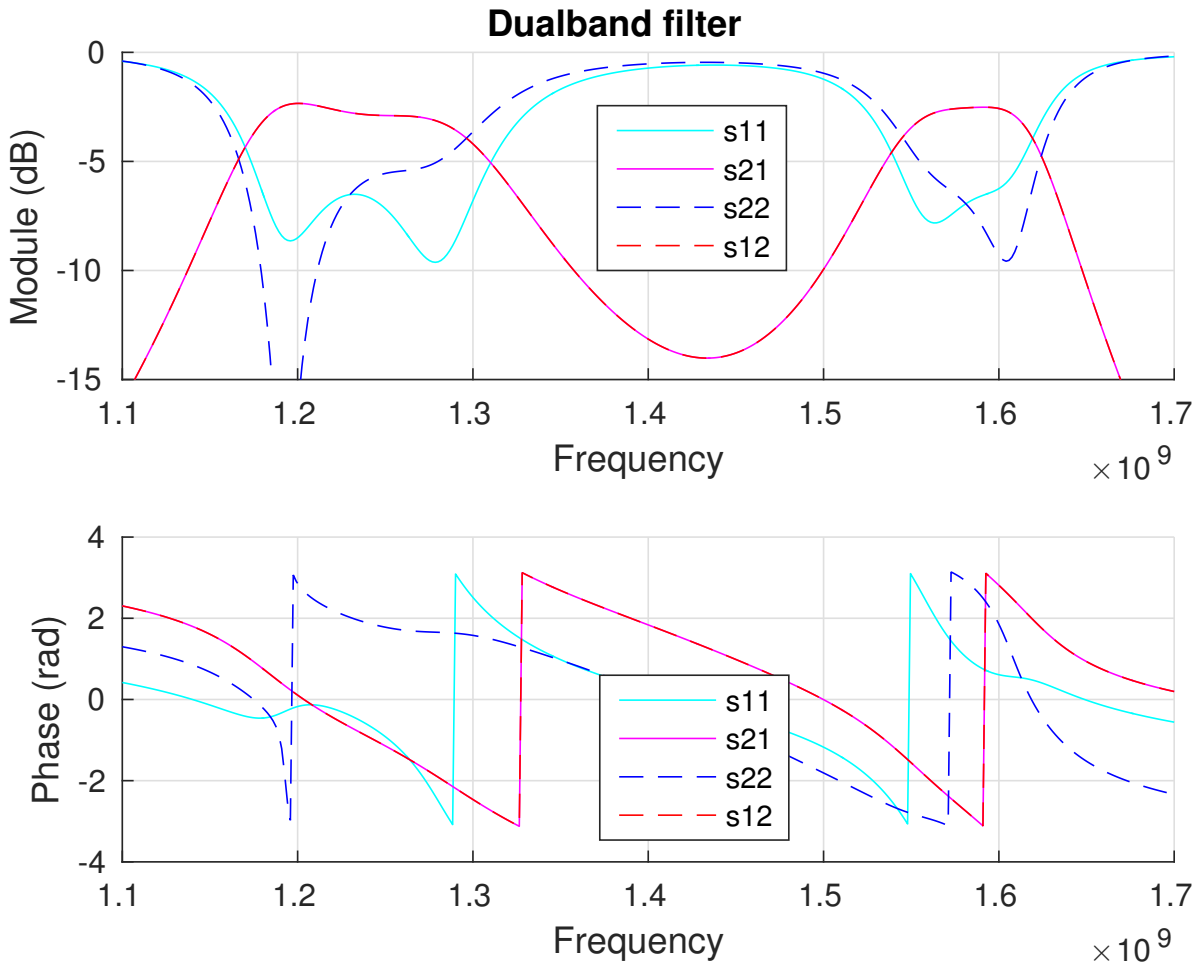

Figure 5: Response of the dual-band filter.

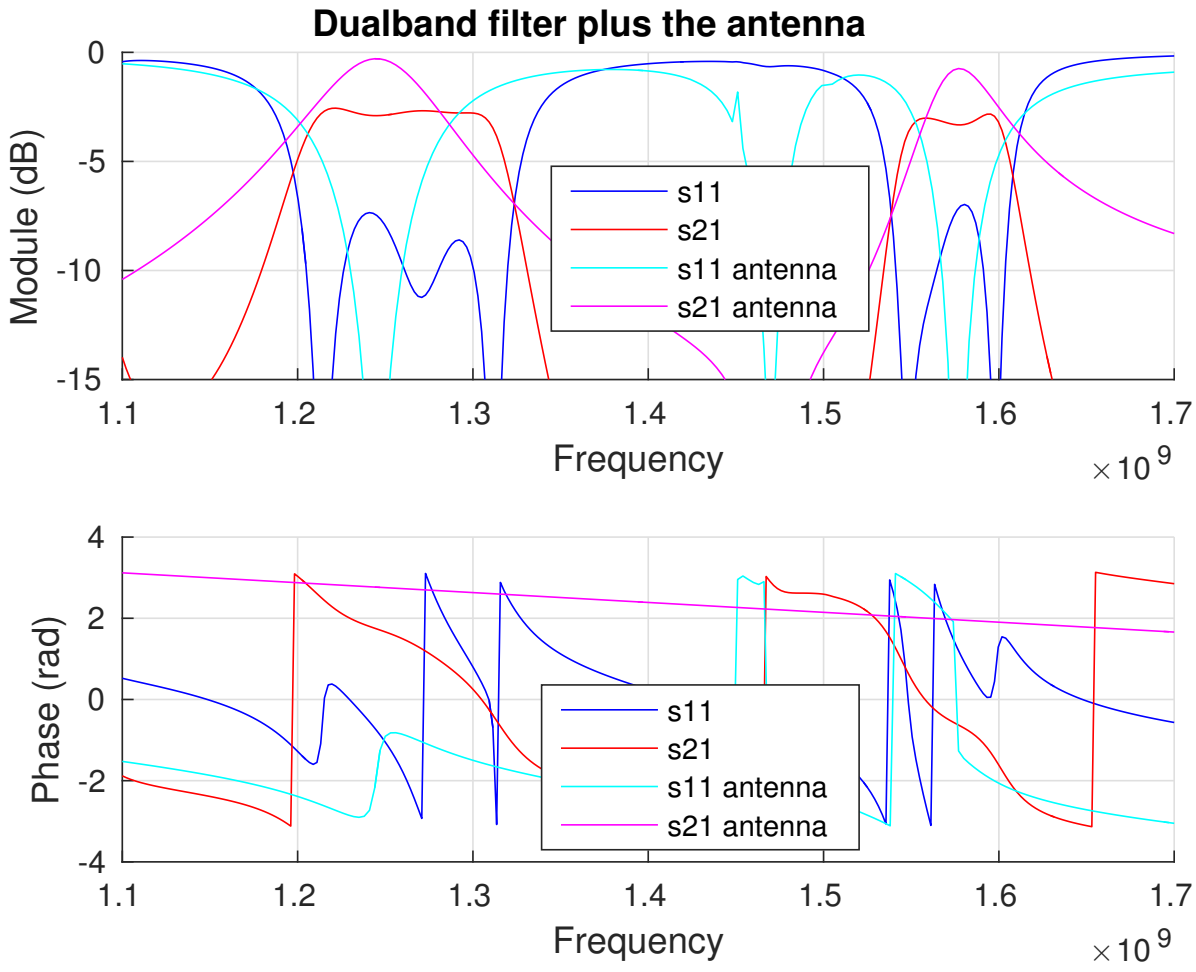

Figure 6: Global response of the dual-band filter connected to the antenna.