Lab 2 Postlab report

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From the formulas in the preliminary report we can find the width w and we get:

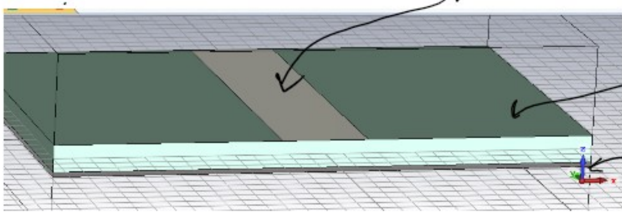
$\varepsilon_r = 2{,}1$ (Teflon)

$$w = \frac{7.48 \times h}{e^{\left(Z_0 \frac{\sqrt{\varepsilon_r + 1.41}}{87}\right)}} - 1.25 \times t$$

$w = 3{,}76\,mm$

So we end up with the following model (CST)

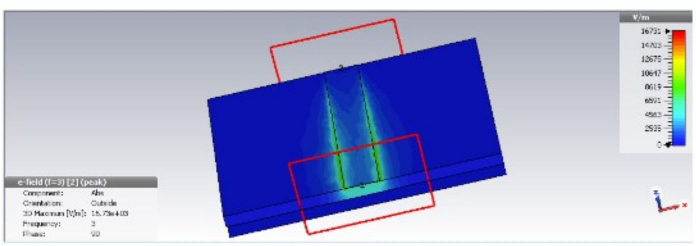
µstrip line (PEC)

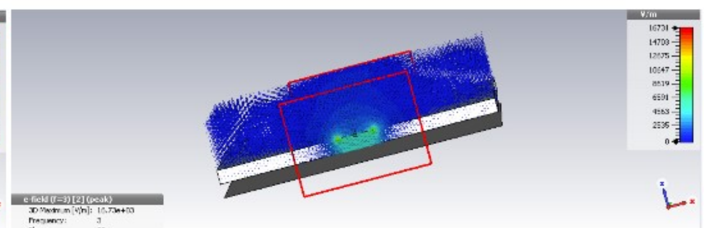


Substrate (PTFE)

ground plane (PEC)

We get the following results for the electric field.





We can see that the electric field flows through the microstrip line.

quasi TEM propagation mode.

The dielectric layer of the microstrip line makes its cross section non-homogeneous ($\varepsilon_r \neq \varepsilon_0$). Therefore ideal TEM mode cannot be supported by this model.

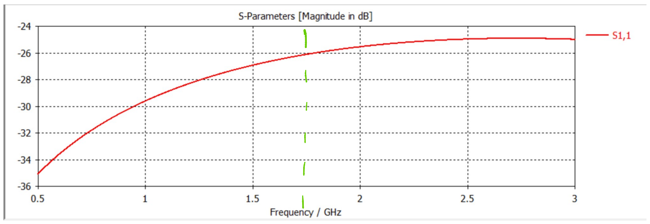
TEM mode is instead supported which resembles the regular TEM mode.

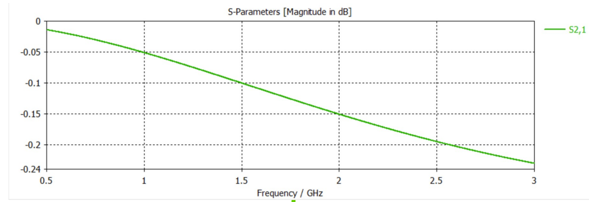
TEM mode is when the EM waves propagates with the same wave velocity, because there's only 1 medium for the wave to propagate.

A microstrip TL on the other hand propagates within 2 mediums (substrate, air) → ≠ speeds of propagation in the 2 mediums

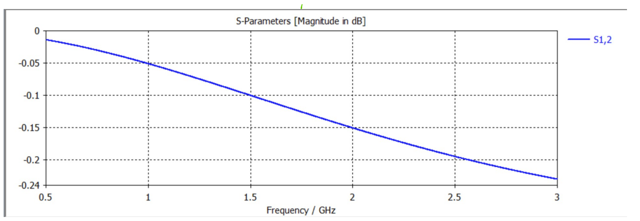
↳ quasi TEM

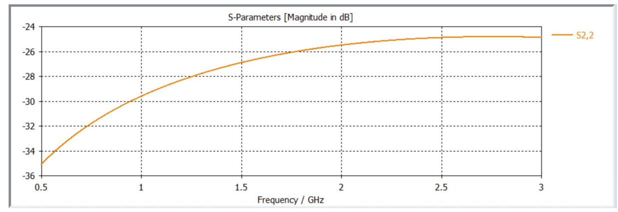
The S Parameters are as follow:





1,75GHz





1,75GHz

$\rightarrow$ We can see that $\begin{cases} S_{ij} = S_{ji} \\ S_{ii} = S_{jj} \end{cases}$ $i = 1,2$

The line is reciprocal.

For $Z_0 = 120\Omega$ now we need to recalculate the width and we have:

$$w = 0{,}78\,mm$$

$h = 1{,}5\,mm$

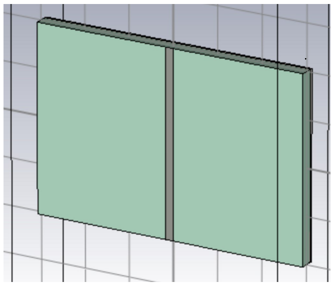
$\beta = k_0 \sqrt{\varepsilon_{eff}}$ $\qquad k_0 = \frac{2\pi f}{c} = 36{,}65$ (1,75GHz)

$\beta \cong 46{,}01$ $\qquad \varepsilon_{eff} = 1{,}576$

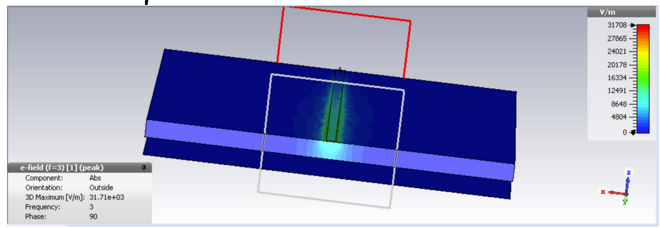
$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{1{,}75 \cdot 10^9} = 6/35 \simeq 0{,}171$$

We repeat the simulations for the following Z, w:

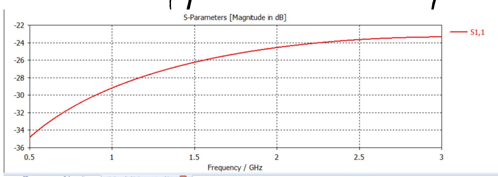
for the electric field:

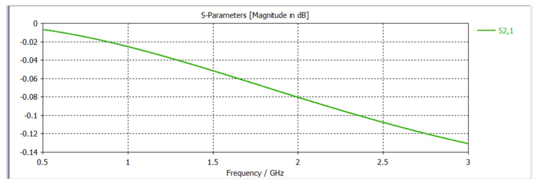


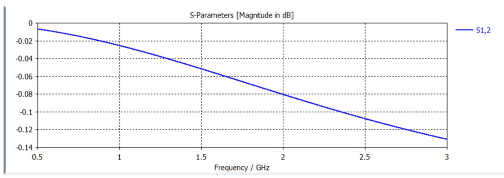
for the Electric field:

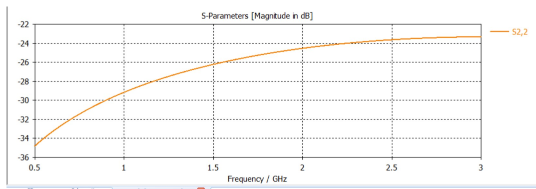


And for the S-parameters









→ We can see that this microstrip line is reciprocal: ie, the signal transmission between the 2 ports does not depend on the direction of propagation
↳ That means we can exchange the 2 ports and so for the scattering parameters we have

$$S_{21} = S_{12}$$

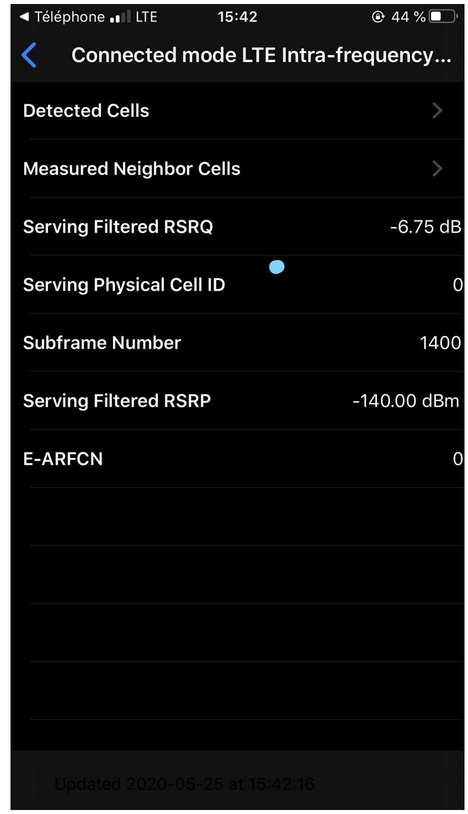
PART 2: HOME EXPERIMENT

After construction, this is what our rectangular waveguide looks like:



And when measuring the LTE Signal we get : -140dBm

→ When we try to make a call, the phone is inside the cavity and we were not able to make it because of $f_{co,\,cavity}$ = cutoff frequency



The main conductor line is made from aluminium foil and the cardboard constitutes the dialectric substrate

Dimensions for a reasonant frequency > 1,8GHz

$$(f_c)_{max} = \frac{1}{2\pi\sqrt{\mu\varepsilon}}\sqrt{\left(\frac{m\pi}{a}\right)^2+\left(\frac{n\pi}{b}\right)^2}\ [Hz]$$

$f = 1,9GHz$

microstrip dialectric using Cardboard 0,3 x 15 x 20 cm
$\varepsilon_r \simeq 1,8$

For 50Ω impedance → µstrip line width ≃ 1cm

if $(w/H) > 1$

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \left[\frac{\varepsilon_r-1}{2\sqrt{1+12\frac{H}{w}}}\right]$$

$$Z_0 = \frac{120\pi}{\sqrt{\varepsilon_{eff}}\left(\frac{w}{H}+1,393+\frac{2}{3}\ln\left(\frac{w}{H}+1,444\right)\right)}$$

We can observe that for a 50Ω impedance we get a better signal -90dBm -> -100dBm