Relatório 6 Outubro

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1 ERF Relatorio 6 Out

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1.1 Abstrato

Este trabalho serve como introdução ao *software* **ADS**, para desenho e analise de sistemas de radiofrequência e microondas. Para tal, iremos adaptar duas cargas a configuraçoes de linha diferentes, utilizabdo a ferramenta *Line Calc* para obter as dimensões fisicas da *microstrip line* implementada. Usamos ainda o diagrama de Smith presente no programa para normalizar a carga da alinea 2. Obtivemos resultados favoraveis, que demonstram um alargamento da banda afectada em torno da frequência de funcionamento, com o acréscimo de secçoes de linha, sugerindo que estas introduzem sempre alguns pequenos defeitos que se acumulam.

1.2 Para uma secção de $\lambda/4$, com $R_L = 200$

Para este caso, primeiro calculamos a impedancia caracteristica da secçao de linha adaptada, Z_{line}.

[1]:
```
import numpy as np
from IPython.display import Markdown as md
c = 3e8 #light speed
f = 2e9 # 2GHz Operating frequency
output = ""
Z_0 = 50 #Characteristic impedance of line
R_L = 200 #Load impedance
Z_line = np.sqrt(Z_0*R_L)#impedance od microstrip  line
e_r = 3.2 #from guide
wavlen = c/f
output += f'$$Z_0 = {Z_0} \Omega$$\n'
output += f'$$R_L = {R_L} \Omega$$\n'
output += f'$$Z_{{line}} = \sqrt{{Z_{{0}} \cdot R_{{L}}}}= {Z_line:.
↪0f}\Omega$$\n'

output += f'$$\lambda = {wavlen:.3f}m$$\n'
md(output)
```

[1]:

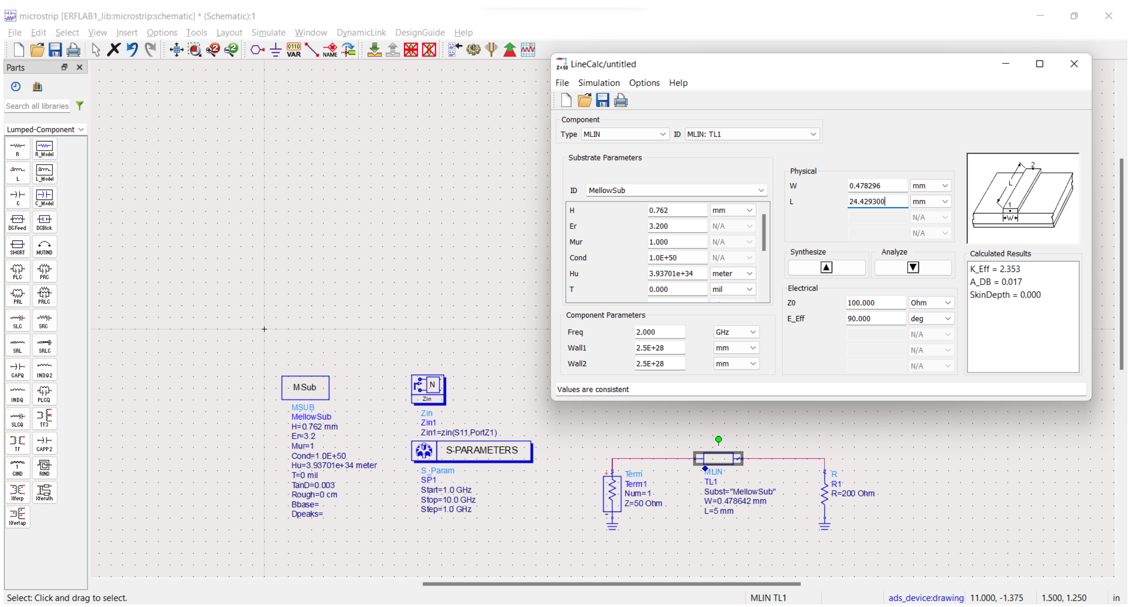
$$Z_0 = 50\Omega$$

$$R_L = 200\Omega$$

$$Z_{line} = \sqrt{Z_0 \cdot R_L} = 100\Omega$$

$$\lambda = 0.150m$$

Utilizando estes valores no *Line Calc*, com $E_{Eff} = 90$ ($\lambda/4$ corresponde a $\frac{360}{4} = 90$) e $Z_0 = Z_{line} = 100\ \Omega$ obtivemos:



[2]:

```python
output = ""
#FROM  ADS LINECALC
#-----
W = 0.478296e-3 #width
L = 24.4293e-3 #Lenght
#-----
K_eff = 2.53
A_DB = 0.017
#-----
output += f'$$W = {W} m$$\n'
output += f'$$L = {L} m$$\n'
md(output)
```

[2]:

$$W = 0.000478296m$$

$$L = 0.0244293m$$

[3]:

```python
#Depth of the substrate
H = 0.762 #from the guide
```

```
#Effective dielectric constant
#l =1e-3 #1mm should be changed to L from ads
e_ef = (e_r+1)/2+ (e_r-1)/2*1/np.sqrt(1+12*H/W)
beta = 2*np.pi*f/(c)*np.sqrt(e_ef)
Z_in = Z_line* (R_L+1j+Z_line*np.tan(beta*L))/(Z_line+1j*R_L*np.tan(beta*L))
Gamma = (Z_in - Z_0)/(Z_in + Z_0)
rho = np.abs(Gamma)
theta = np.angle(Gamma)*180/np.pi
SwR = (1 + rho)/(1 - rho)


output=''
output+=f'$$E_{{ef}} = {e_ef}$$\n'
output+=f'$$ B = {beta}$$\n'
output+=f'$$Z_{{in}}= {Z_in}$$\n'
output+=f'$$\Gamma= {Gamma}$$\n'
output+=f'$$\Rho= {rho}$$\n'
output+=f'$$\Theta= {theta}$$\n'
output+=f'$$SwR= {SwR}$$\n'
md(output)
```

[3]:

$$E_{ef} = 2.1079553921574252$$

$$B = 60.816205173346454$$

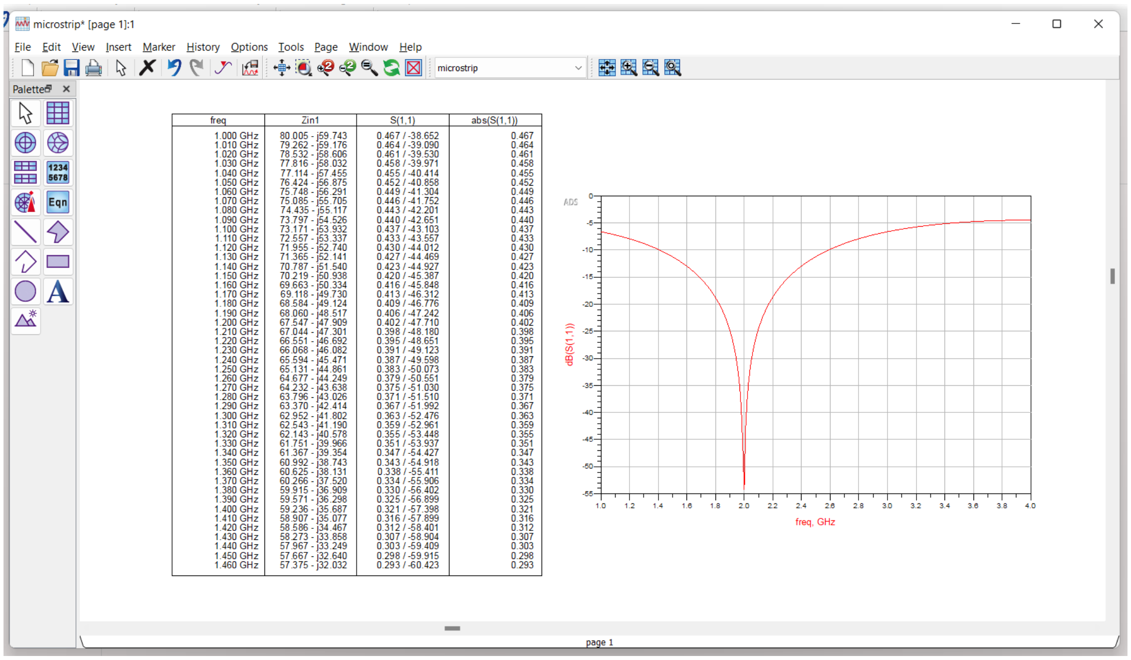
$$Z_{in} = (2.534514689002848 - 58.4223992826539j)$$

$$\Gamma = (0.1489701539673856 - 0.9464102935128225j)$$

$$R = 0.9580629157002651$$

$$\Theta = -81.05472667076315$$

$$SwR = 46.69048762917084$$



freq	Zin1	S(1,1)	abs(S(1,1))
1.000 GHz	80.005 - j59.743	0.467 / -38.652	0.467
1.010 GHz	79.262 - j59.176	0.464 / -39.090	0.464
1.020 GHz	78.532 - j58.606	0.461 / -39.530	0.461
1.030 GHz	77.816 - j58.032	0.458 / -39.971	0.458
1.040 GHz	77.114 - j57.455	0.455 / -40.414	0.455
1.050 GHz	76.424 - j56.875	0.452 / -40.858	0.452
1.060 GHz	75.748 - j56.291	0.449 / -41.304	0.449
1.070 GHz	75.085 - j55.705	0.446 / -41.752	0.446
1.080 GHz	74.435 - j55.117	0.443 / -42.201	0.443
1.090 GHz	73.797 - j54.526	0.440 / -42.651	0.440
1.100 GHz	73.171 - j53.932	0.437 / -43.103	0.437
1.110 GHz	72.557 - j53.337	0.433 / -43.557	0.433
1.120 GHz	71.955 - j52.740	0.430 / -44.012	0.430
1.130 GHz	71.365 - j52.141	0.427 / -44.469	0.427
1.140 GHz	70.787 - j51.540	0.423 / -44.927	0.423
1.150 GHz	70.219 - j50.938	0.420 / -45.387	0.420
1.160 GHz	69.663 - j50.334	0.416 / -45.848	0.416
1.170 GHz	69.118 - j49.730	0.413 / -46.312	0.413
1.180 GHz	68.584 - j49.124	0.409 / -46.776	0.409
1.190 GHz	68.060 - j48.517	0.406 / -47.242	0.406
1.200 GHz	67.547 - j47.909	0.402 / -47.710	0.402
1.210 GHz	67.044 - j47.301	0.398 / -48.180	0.398
1.220 GHz	66.551 - j46.692	0.395 / -48.651	0.395
1.230 GHz	66.068 - j46.082	0.391 / -49.123	0.391
1.240 GHz	65.594 - j45.471	0.387 / -49.598	0.387
1.250 GHz	65.131 - j44.861	0.383 / -50.073	0.383
1.260 GHz	64.677 - j44.249	0.379 / -50.551	0.379
1.270 GHz	64.232 - j43.638	0.375 / -51.030	0.375
1.280 GHz	63.796 - j43.026	0.371 / -51.510	0.371
1.290 GHz	63.370 - j42.414	0.367 / -51.992	0.367
1.300 GHz	62.952 - j41.802	0.363 / -52.476	0.363
1.310 GHz	62.543 - j41.190	0.359 / -52.961	0.359
1.320 GHz	62.143 - j40.578	0.355 / -53.448	0.355
1.330 GHz	61.751 - j39.966	0.351 / -53.937	0.351
1.340 GHz	61.367 - j39.354	0.347 / -54.427	0.347
1.350 GHz	60.992 - j38.743	0.343 / -54.918	0.343
1.360 GHz	60.625 - j38.131	0.338 / -55.411	0.338
1.370 GHz	60.266 - j37.520	0.334 / -55.906	0.334
1.380 GHz	59.915 - j36.909	0.330 / -56.402	0.330
1.390 GHz	59.571 - j36.298	0.325 / -56.899	0.325
1.400 GHz	59.236 - j35.687	0.321 / -57.398	0.321
1.410 GHz	58.907 - j35.077	0.316 / -57.899	0.316
1.420 GHz	58.586 - j34.467	0.312 / -58.401	0.312
1.430 GHz	58.273 - j33.858	0.307 / -58.904	0.307
1.440 GHz	57.967 - j33.249	0.303 / -59.409	0.303
1.450 GHz	57.667 - j32.640	0.298 / -59.915	0.298
1.460 GHz	57.375 - j32.032	0.293 / -60.423	0.293

2 Para 3 Secçoes de Linha de $\lambda/4$ de comprimento

Utilizando a tabela da pag. 254 do livro "Microwave Engineering", vemos que $N = 3$ porque temos 3 secções de linha.

[4]:
```
output = f'$$ R_{{L}}/{{Z_0}} = {R_L/Z_0}$$'
md(output)
```

[4]:

$$R_L/Z_0 = 4.0$$

Para $N = 3$:

	$\frac{Z_1}{Z_0}$	$\frac{Z_3}{Z_0}$	$\frac{Z_3}{Z_0}$
$\frac{R_L}{Z_0} = 4.0$	1.1907	2.0000	3.3594

[5]:
```
Z_1 = 1.1907 * Z_0
Z_2 = 2 * Z_0
Z_3 = 3.3594 * Z_0

output= ""
output+=f'$$Z_1 = {Z_1}$$\n'
output+=f'$$Z_2 = {Z_2}$$\n'
output+=f'$$Z_3 = {Z_3}$$\n'

md(output)
```

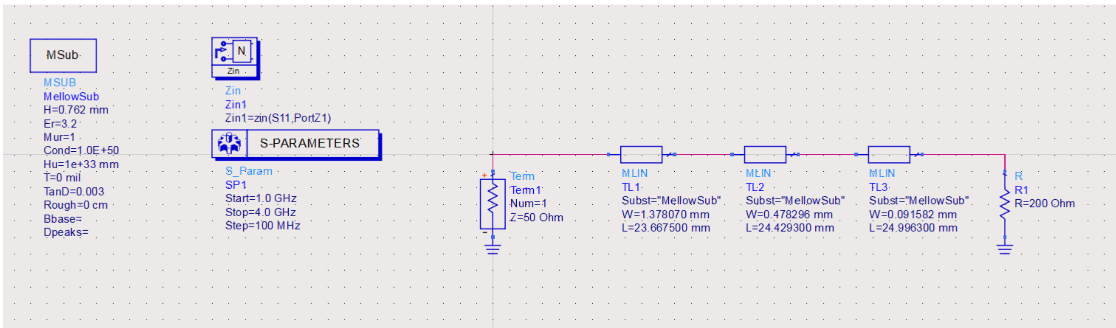
[5]:

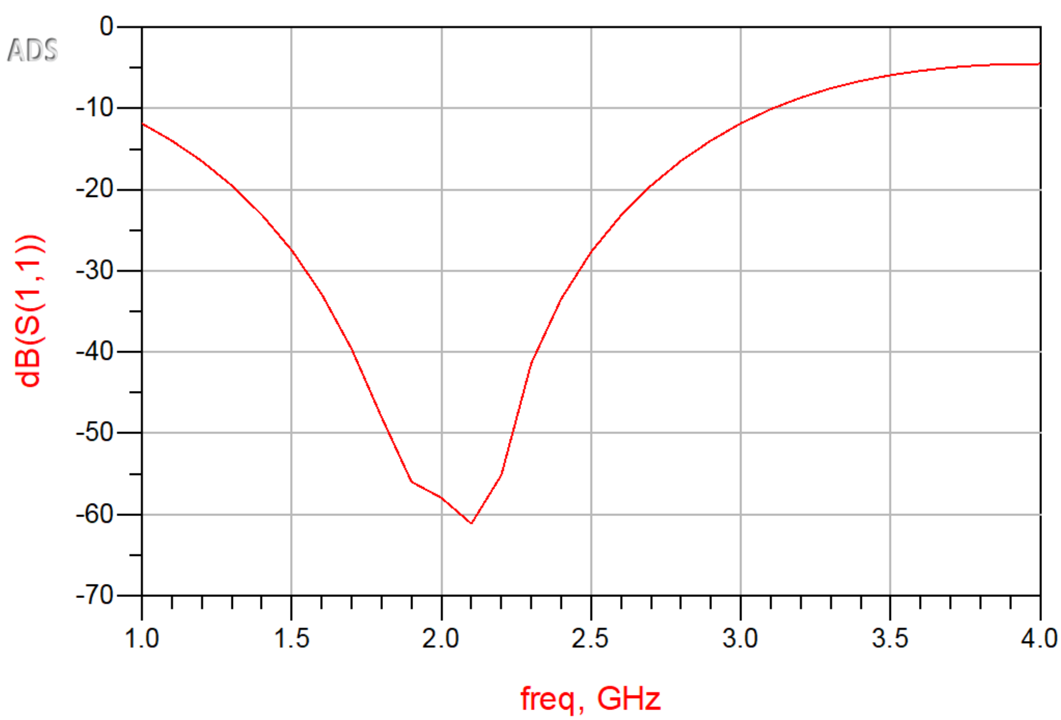
$$Z_1 = 59.535000000000004$$

$$Z_2 = 100$$

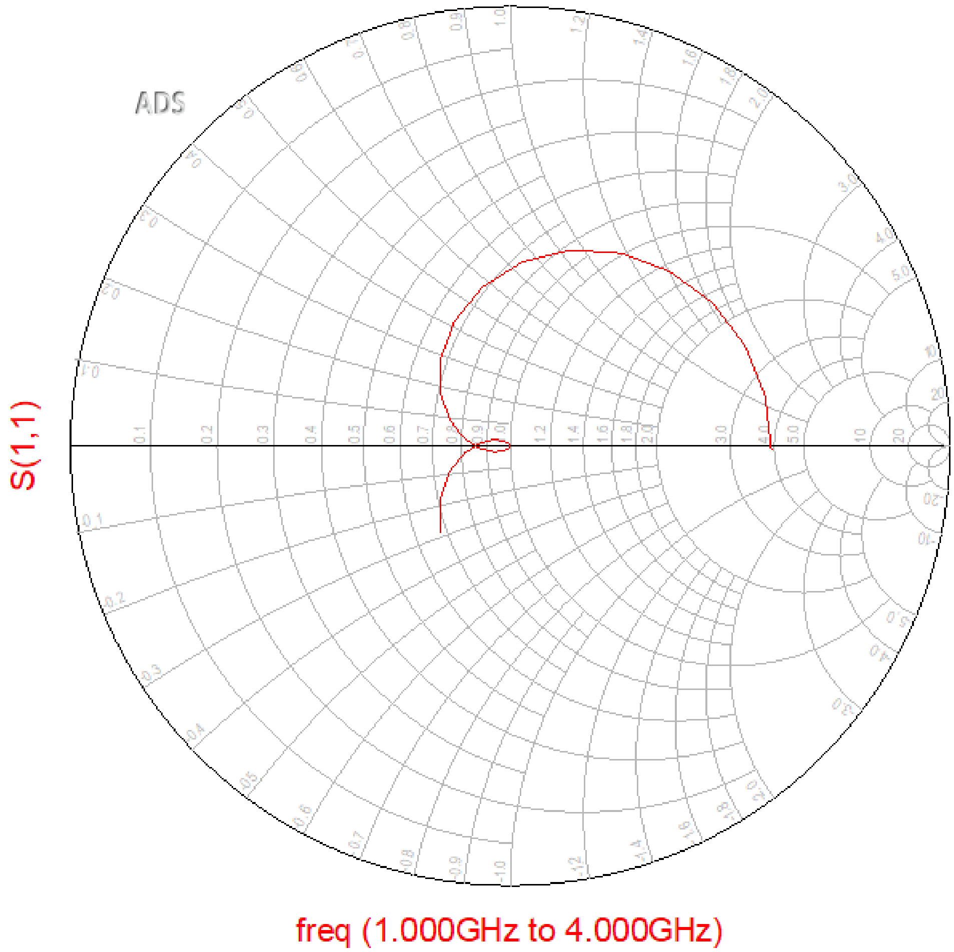
$$Z_3 = 167.97$$

Usando estes valores no **ADS** temos:





freq	Zin1	S(1,1)	abs(S(1,1))
1.000 GHz	36.690 / -...	0.254 / -1...	0.254
1.100 GHz	36.400 / -...	0.200 / -1...	0.200
1.200 GHz	37.913 / -...	0.150 / -1...	0.150
1.300 GHz	40.532 / -...	0.106 / -1...	0.106
1.400 GHz	43.499 / ...	0.070 / 1...	0.070
1.500 GHz	46.167 / ...	0.042 / 1...	0.042
1.600 GHz	48.128 / ...	0.023 / 1...	0.023
1.700 GHz	49.282 / ...	0.010 / 1...	0.010
1.800 GHz	49.792 / ...	0.004 / 1...	0.004
1.900 GHz	49.945 / ...	0.002 / 1...	0.002
2.000 GHz	49.987 / ...	0.001 / 9...	0.001
2.100 GHz	50.007 / ...	8.785E-4...	0.001
2.200 GHz	49.899 / -...	0.002 / -1...	0.002
2.300 GHz	49.405 / -...	0.009 / -1...	0.009
2.400 GHz	48.237 / -...	0.021 / -1...	0.021
2.500 GHz	46.239 / -...	0.041 / -1...	0.041
2.600 GHz	43.533 / -...	0.069 / -1...	0.069
2.700 GHz	40.545 / ...	0.106 / 1...	0.106
2.800 GHz	37.938 / ...	0.150 / 1...	0.150
2.900 GHz	36.473 / ...	0.200 / 1...	0.200
3.000 GHz	36.842 / ...	0.255 / 1...	0.255
3.100 GHz	39.494 / ...	0.312 / 1...	0.312
3.200 GHz	44.606 / ...	0.367 / 1...	0.367
3.300 GHz	52.256 / ...	0.419 / 8...	0.419
3.400 GHz	62.677 / ...	0.466 / 7...	0.466
3.500 GHz	76.453 / ...	0.506 / 6...	0.506
3.600 GHz	94.641 / ...	0.538 / 4...	0.538
3.700 GHz	118.710 /...	0.563 / 3...	0.563
3.800 GHz	149.399 /...	0.581 / 2...	0.581
3.900 GHz	181.543 /...	0.591 / 1...	0.591
4.000 GHz	196.058 /...	0.594 / -0...	0.594



2.1 Para RL = 100+50J

[6]:
```
output = ""
Z_0 = 50 #Characteristic impedance of line
R_L = 100 + 50j #Load impedance
Z_line = np.sqrt(Z_0*R_L)#impedance od microstrip  line
e_r = 3.2
wavlen = c/f

output += f'$$Z_0 = {Z_0} \Omega$$\n'
output += f'$$R_L = {R_L} \Omega$$\n'
output += f'$$Z_{{line}} = \sqrt{{Z_{{0}} \cdot R_{{L}}}}= {Z_line:.
↪0f}\Omega$$\n'

output += f'$$\lambda = {wavlen:.3f}m$$\n'
md(output)
```

[6]:

$$Z_0 = 50\Omega$$

$$R_L = (100 + 50j)\Omega$$

$$Z_{line} = \sqrt{Z_0 \cdot R_L} = 73 + 17j\Omega$$

$$\lambda = 0.150m$$