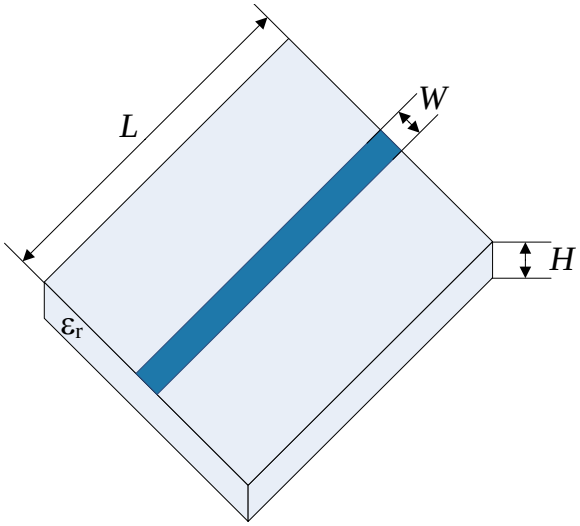
Dr. J. E. Rayas-Sánchez

LOSSLESS MICROSTRIP LINE



Consider the microstrip line shown to the left. A dielectric substrate with thickness H = 0.794 mm and relative dielectric constant ε_r = 2.2 is used. A width W = 2.45 mm is used to achieve a 50-Ω line. The microstrip length is L = 27.2 mm.

Both metallic and dielectric losses are neglected. Metals are considered infinitesimally thin.

This microstrip line is used in [1] and reported in [2] with small variations.

Create a Sonnet project using the following setup:

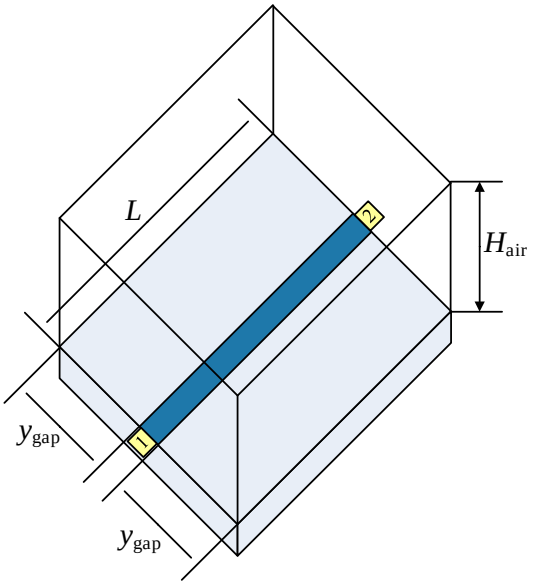
Parameters related to Sonnet box:
$y_{gap} = 2W = 4.9$ mm $\approx 6.2H$
$H_{air} = 5H = 3.97$ mm

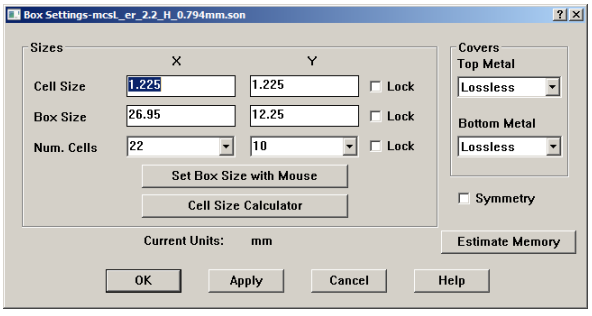
Bottom and top cover: lossless metal.

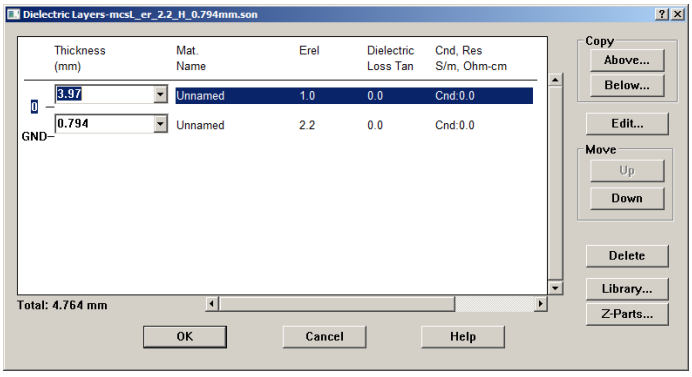
Initial resolution (cell sizes):
$C_x = W/2 = 1.225$ mm
$C_y = W/2 = 1.225$ mm

Initial length $L = 22C_x = 11W = 26.95$ mm (approximating the actual length with the selected resolution).

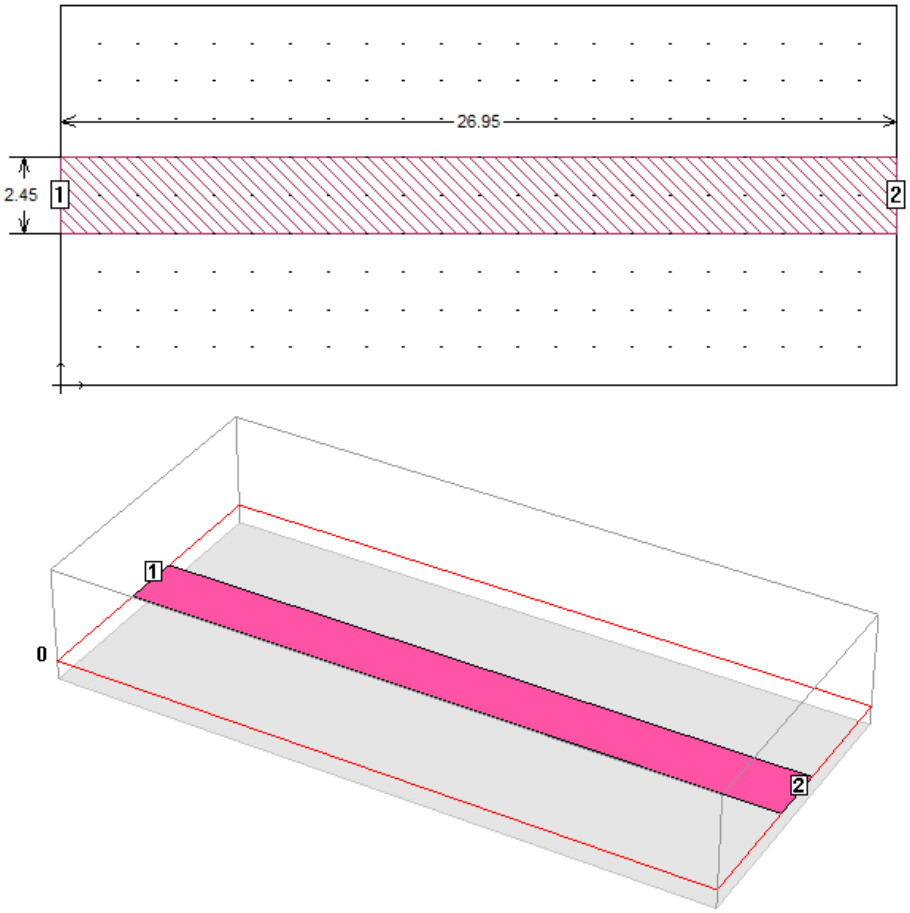
Sonnet box size: L by $(W + 2y_{gap})$



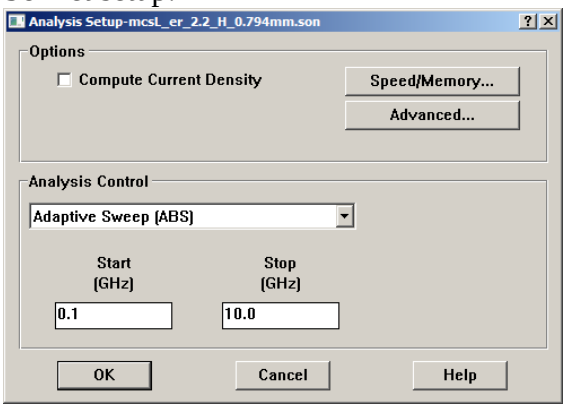




Sonnet geometry:



Sonnet setup:



Estimate memory and box resonances:

```
Estimated memory:      2 MB
Subsection total:      68

No box resonances predicted below or within
the specified frequency sweep.
```

Timing Info:

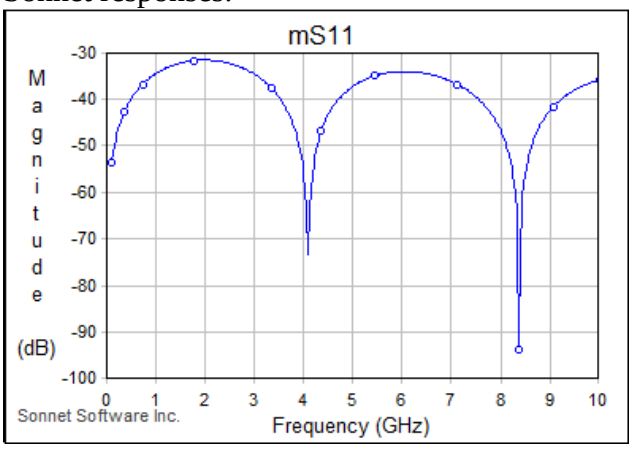
```
Post-Analysis:
Total time for 11 frequencies:
1 second.
```

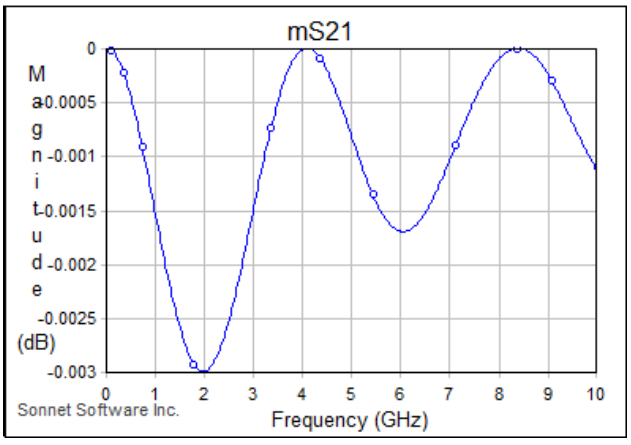
Errors/Warnings

```
Sonnet Warning EG2530:
Potential problem with box parameter. The Y cell size
(1.225 mm) is greater than 1/20 wavelength (1.18503 mm) at
10 GHz. You must decrease the cell size or reduce the
required number of subsections per wavelength to resolve
this conflict.

Post-Analysis:
Errors detected: 0    Warnings detected: 2.
```

Sonnet responses:





Increasing resolution (decreasing cell sizes):
$C_x = W/4 = 0.6125$ mm
$C_y = W/4 = 0.6125$ mm

Estimate memory:

```
Estimated memory:       3 MB
Subsection total:       312
```

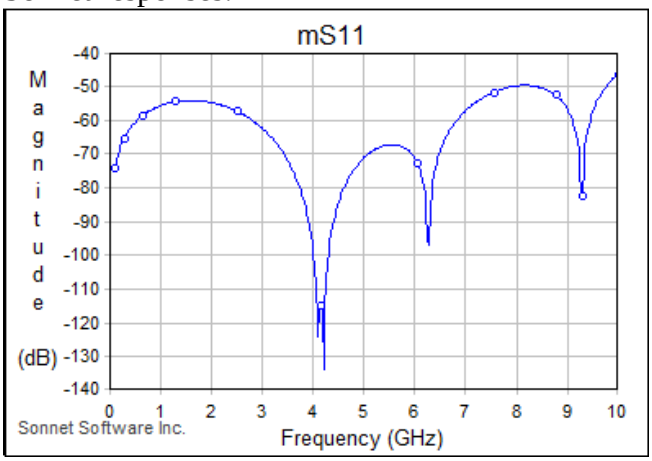
Timing Info:

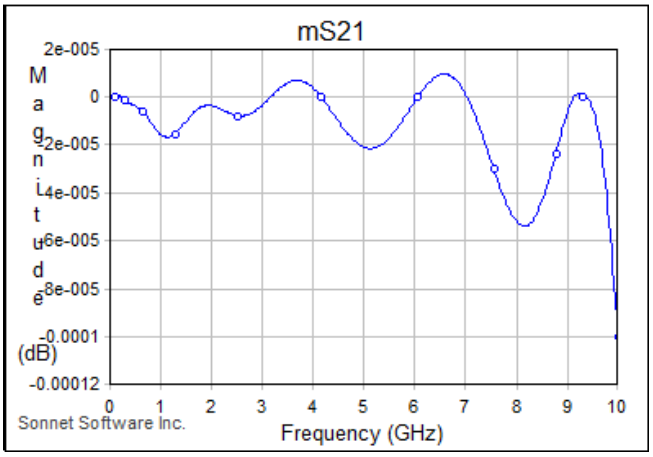
```
Post-Analysis:
Total time for 11 frequencies: 3 seconds.
```

Errors/Warnings

```
Post-Analysis:
Errors detected: 0    Warnings detected: 0.
```

Sonnet responses:

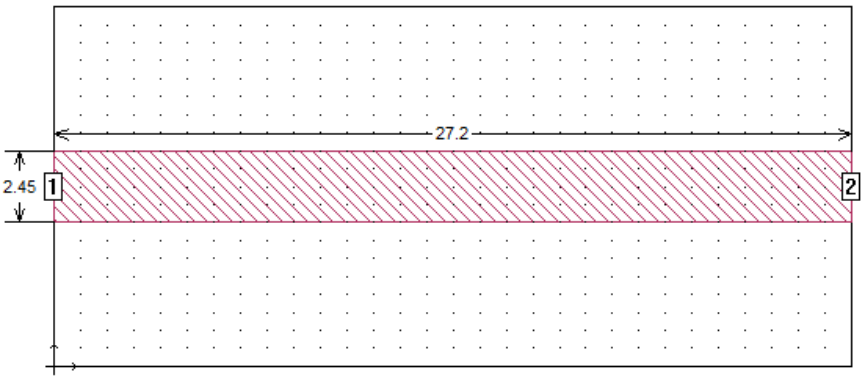


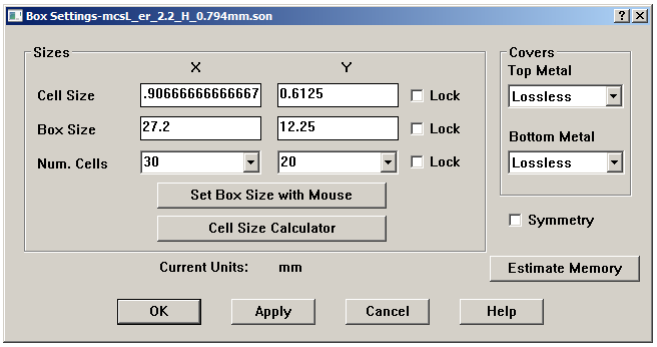


It is seen that by increasing the resolution, the level of reflection $|S_{11}|$ becomes closer to zero, and the level of transmission $|S_{21}|$ gets closer to one, as expected.

For very accurate results in Sonnet, it is more important to have small cell size the transversal direction (C_y) than in the longitudinal direction (C_x). This means that we can use a very small C_y, and a $C_x = kC_y$, with $k > 1$. This allows having accurate results with lower computational cost.

For this microstrip line, a better way to define resolution would be:
$C_y = W/4 = 0.6125$ mm
$C_x = L/\text{round}(L/(1.5C_y)) = 0.906666667$ mm
This value of C_x allows implementing L with its exact value:





Estimate memory:

```
Estimated memory:       3 MB
Subsection total:       214
```

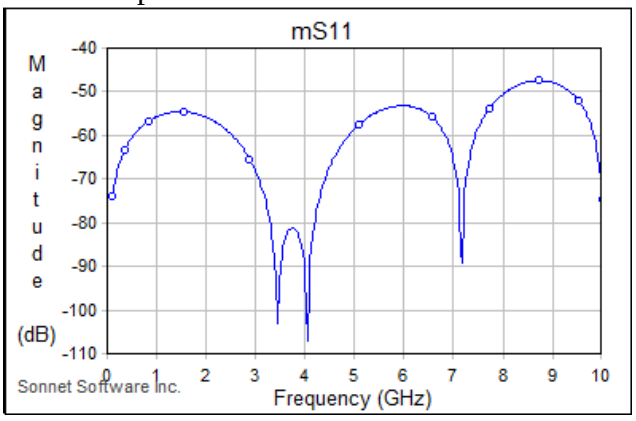
Timing Info:

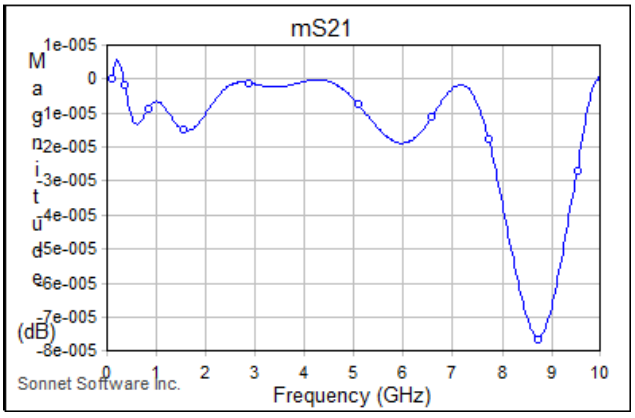
```
Post-Analysis:
Total time for 11 frequencies: 2 seconds.
```

Errors/Warnings

```
Post-Analysis:
Errors detected: 0    Warnings detected: 0.
```

Sonnet responses:





[1] J. E. Rayas-Sánchez and Z. Brito-Brito, "Optimal configuration of lumped ports in COMSOL for non-resonant planar structures," Internal Report *CAECAS-12-11-R*, ITESO, Tlaquepaque, Mexico, Jun. 2012.

[2] D. M. Sheen, S. M. Ali, M. D. Abouzahra and J. A. Kong, "Application of the three-dimensional finite-difference time-domain method to the analysis of planar microstrip circuits," *IEEE Trans. Microwave Theory Tech.*, vol. 38, pp. 849-857, July 1990.