

Frequency domain EM simulation in COMSOL (Lecture 5)

(1) We consider sets of coupled microstrip lines as shown in figure 1.

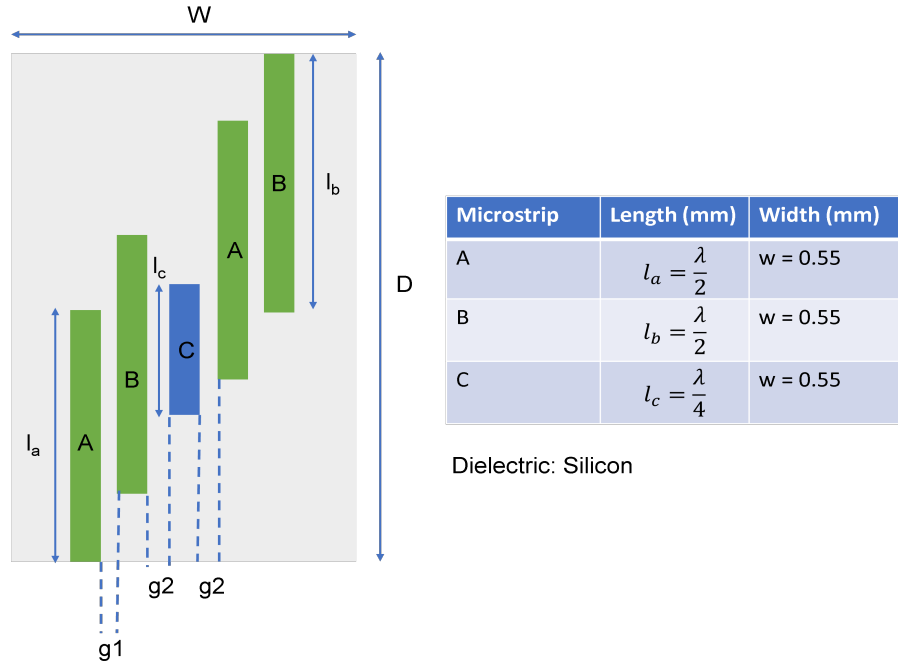


Figure 1 – Coupled microstrip lines A, B, and C with corresponding lengths l_a , l_b , and l_c . The gap between lines A and B is given by $g1$, and $g2$ for the other two. The width of the lines w are the same. We explicitly assume the strip lines on Silicon dielectric.

Perform the frequency domain simulation for this circuit with given default values defined in COMSOL file *Ex3_p1_coupled_microstrip_lines.mph*. Plot the relevant S-parameters and impedance of lumped port 1 as a function of frequency. Sweep the values for $g1$, and $g2$ and record your observation with the help of figures. What happens when you change the length of the striplines (by changing the value for λ)? What happens to the electrical length of the strip lines?

Note, you only need to change the parameters and build the geometry afterwards.

- (2) Here we will investigate microstrip resonator. The provided COMSOL file is *Ex3_p2_Microstrip_resonator.mph* and Change parameters in *Parameters* window as asked.

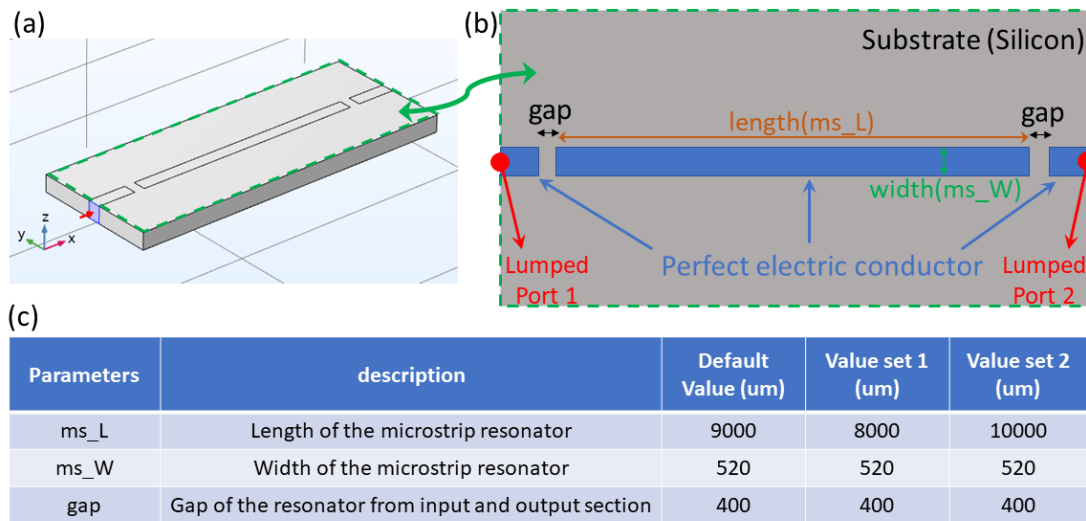


Figure 2 – (a) Microstrip resonator model in comsol. It is similar to the microstrip line(demonstrated in Lecture5), except the gap at two ends to make a resonator. (b) Top surface of the model showing the parameters of the microstrip resonator. (c) Tables with the parameter name(defined in the parameters section in COMSOL model), description of the parameters and sets of values for the parameters.

- Perform frequency domain EM simulations for the 3 sets of parameters in the table(Figure 2(c)) in the frequency range 4.5 to 6.5 GHz with 0.02 GHz steps. Plot the S-parameters(S_{11} and S_{21}) for the simulations and note the resonance frequencies for these 3 sets of parameters.
- How is the electric field distributed at the resonance frequencies? you can save the screenshots. From the field distribution, is it $\lambda/4$ or $\lambda/2$ resonator?

Hint: Check the shared COMSOL file. It has the saved results for the default parameter set. Check the S-parameters plot in the 'Result' section('Results' → 'S-parameter (emw)'). Observe at the electric field at the top surface(choose 'Results' → 'Electric field' → 'Multislice' and select the frequency from the list to see the field at that frequency. The top surface is already set in the 'Multislice' in the shared model.)

BONUS: Perform frequency domain EM simulations for the default parameter in the table(Figure 2(c)) in the frequency range 10 to 12 GHz with 0.02 GHz steps. Do you see any resonance in the S-parameters response? If you see any, from the electric field distribution can you infer about the resonant mode($\lambda/4$ or $\lambda/2$ or $3\lambda/4$ or λ)?

Note, we will continue more discussions about the exercises in Friday's session.