Designing and Simulating a simple RF waveguide in COMSOL

Step by Step Instructions

Sumukh Vaidya

May 24, 2025

Note: These instruction are for COMSOL Multiphysics 6.1.

1. Open COMSOL. Click Model Wizard under New. Then Click 3D in space dimensions.

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1. Double Click Electromagnetic Waves, Frequency Domain (emw) under Select Physics.   
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2. Click study, then click Frequency Domain. A screenshot of a computer

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3. This opens up an empty project. Now we define geometry. The rough parameters for the stripline to maintain a ~50 characteristic impedance are as follows: (Use the Coplanar Waveguide Calculator on https://www.microwaves101.com/calculators/864-coplanar-waveguide-calculatorA screenshot of a calculator

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4. Write the following parameters into the parameters table. These will specify geometry.  
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5. Right click Geometry-> Work Plane. The click build selected with default values. A screenshot of a computer

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6. Right click Plane Geometry -> Rectangle. A screenshot of a computer

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7. Make the rectangle to denote the stripline. Make sure to center the base under Position.   
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8. Repeat this process to implement the right and left side gold patches. Need to specify center offsets properly. Also define a rectangle encompassing the full substrate. This will be needed to define the solid block of substrate later. A screenshot of a computer

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9. The 2D geometry should now look like this: A graph paper with lines and dots

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10. Now add the sma connector. Right click Geometry-> Parts -> Part Libraries  
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11. Find the sma connector under RF Module -> Connectors. Double click to add. Add total of 2 connectors to the geometry (for input and output).  
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12. The part is loaded from library. Only change orientation and position. Do not change any other properties. Click Build Selected.  
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    AI-generated content may be incorrect.
13. Repeat the same for the other connector. A drawing of a machine

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14. Now define 2 boxes under Geometry -> Block. One will be the air volume encompassing the entire object, the other sapphire substrate block A screenshot of a computer

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15. Click Form Union -> Build Selected. This finalizes the geometry.
16. Now add materials: Air, Gold, Sapphire. Right Click Materials -> Add Material from Library. Search Air, use Built-in -> Air. A screenshot of a computer

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17. We will add Sapphire as a blank material because it is not available in the standard catalog. Right Click Materials -> Blank material. Name it Sapphire. Select Electromagnetic Models -> dielectric Losses. Input this screenshot values.   
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18. Right Click Electromagnetic Waves, Frequency Domain (emw) -> Perfect Electric Conductor   
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19. This creates a Perfect Electric Conductor 2. Select all the metal faces and the surfaces of the SMA Connectors. This is what we use instead of defining Gold as a material (Au is a good conductor anyway).  
    A blueprint of a rectangular object

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20. Right Click Electromagnetic Waves, Frequency Domain (emw) -> lumped port. This will be used for MW excitation. Add one more port for collection.   
     A screenshot of a computer

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21. In Lumped Port 1, select the circle of the SMA port where input will be applied. Do the same thing for Lumped port 2. For type Use Coaxial.  
     A screenshot of a computer

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22. Right Click Electromagnetic Waves, Frequency Domain -> Scattering Boundary Condition. Select the 6 faces of the air block.   
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23. Go to Mesh 1 -> Build All  
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24. Go to Study 1 -> Step 1: Frequency Domain. Type the correct Frequency (2.7 GHz here). Click Compute  
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25. You get the results…   
    A blue and purple diagram

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26. This figure only shows the electric field distribution. For working with spin defects we want to see and optimize magnetic field distribution. Right Click Results -> 3D Plot Group.   
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27. In the plot group Right Click -> More Plots -> Multislice   
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28. In the multilice settings change the expression to emw.normB, click Plot.   
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As an example, here’s a picture of a thin stripline waveguide, optimizing the near surface magnetic field.

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