Antenna and RF Systems Lab 3: Microstrip Antenna Design

This lab consists of designing a microstrip antenna operating at 24 GHz and evaluating its performance via CST Microwave Studio simulations. Following the steps given below, students are expected to realize the design and simulations of the antenna to find out the antenna parameters and answer the theoretical or practical questions related to the antenna design.

Rectangular Microstrip Antenna Design Steps:

1. Run the CST Studio and select **new project → Microwaves & RF/Optical → Antennas → Planar (Patch, Slot, etc) → Time Domain**.
    - Save your design in C: drive due to performance problems of P: drive, and when you finish your work please copy your design to your P: drive.
2. Design the antenna microstrip antenna of which details are given in Figure 1 and Figure 2, where the antenna dimensions are specified as:
    - W = 4.08 mm
    - L = 3.08 mm
    - G = 1.54 mm
    - Width of the microstrip line = 0.2 mm
    - Substrate thickness = 0.25 mm
    - PEC thickness = 0.012 mm
    - The substrate is Rogers RO4350B (Lossy)
    - The antenna is made of PEC material
    - The bottom of the substrate is covered by the PEC material as a ground layer.
3. Change the substrate material properties- **Change Epsilon** to **3.66** as shown in Figure 3.
4. In the **Modeling** tab, click on the dropdown menu in **Picks**, and select **Pick Face**. Select the feed edge surface as shown in Figure 4.
5. Add a **wave guide port** and enter the values shown in Figure 5. These steps will add a waveguide port to the feed of the antenna. (Figure 3 shows how the port antenna should look after adding the waveguide port.)
6. Simulate the antenna. (Select normalize the impedance 50 Ohm).
7. Review the S11 parameters graph from the simulation results and find the frequency where the S11 has the minimum value. (F_{min}).
8. Find the -6 dB and -10 dB bandwidths of the antenna.
9. Add far-field at F_{min} frequency to observe the radiation pattern of the antenna.
10. Add H-field and E-field at F_{min} to observe the electric and magnetic fields of the antenna.
11. Find the input impedance of your antenna by following **2D/3D Results → Port Modes → Port1 → e1** in the left-hand side tree menu
12. Find radiation efficiency, total efficiency, directivity, gain and impedance of the designed antenna.

13. Set W=4 mm and repeat the steps given above.
14. Set W=4.2 mm and repeat the steps given above.

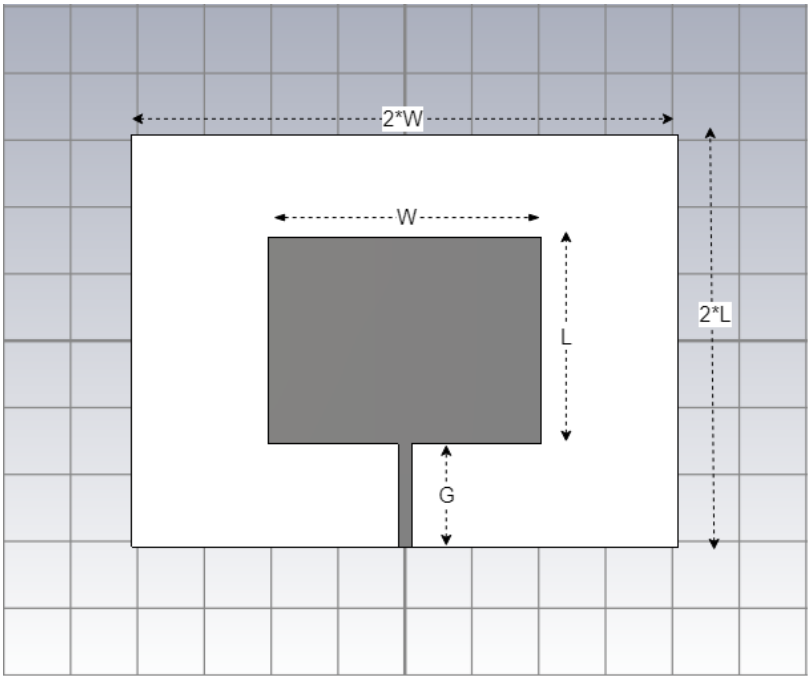

Figure 1 Front view of the microstrip patch antenna.

Figure 2 Side view of the microstrip antenna

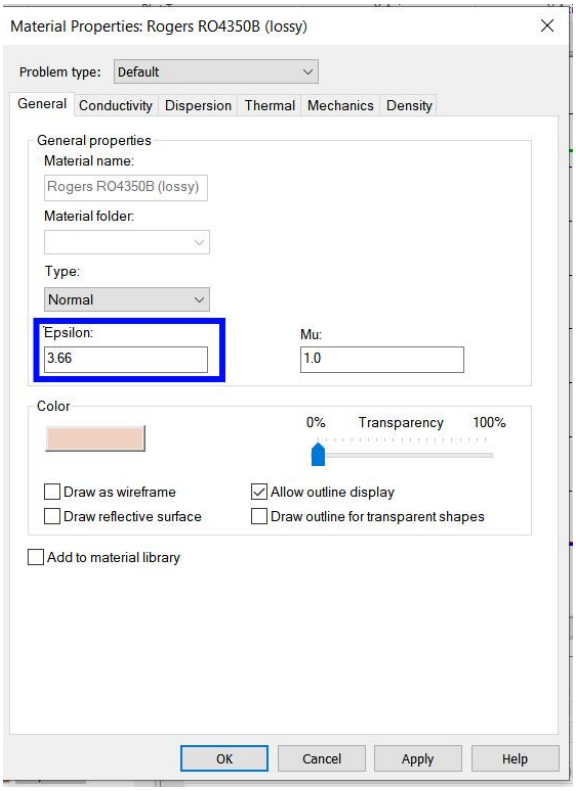

Figure 3 Side view of the microstrip antenna.

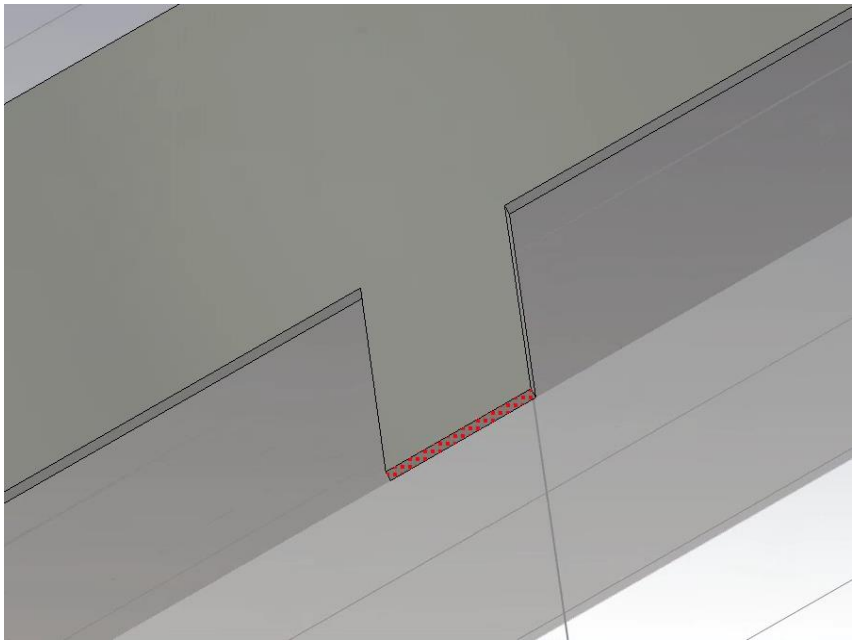

Figure 4 Selected face for antenna feed

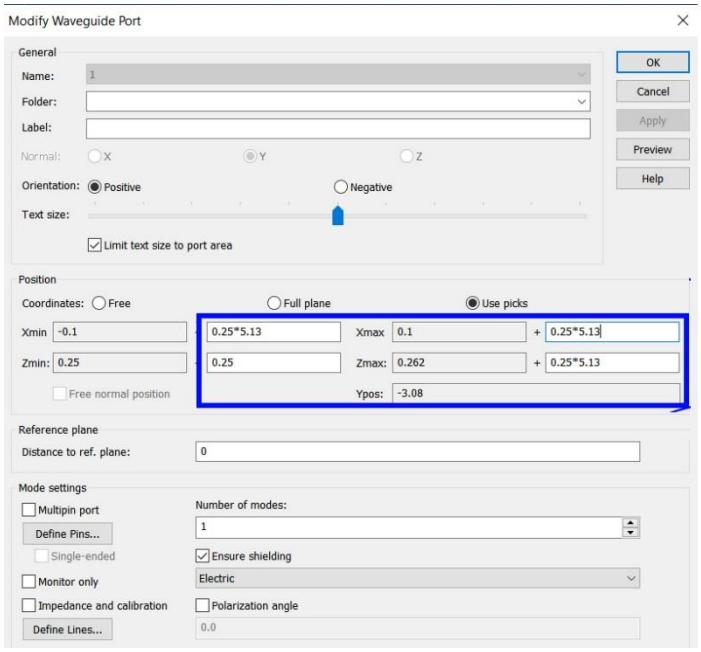

Figure 5 waveguide port settings.

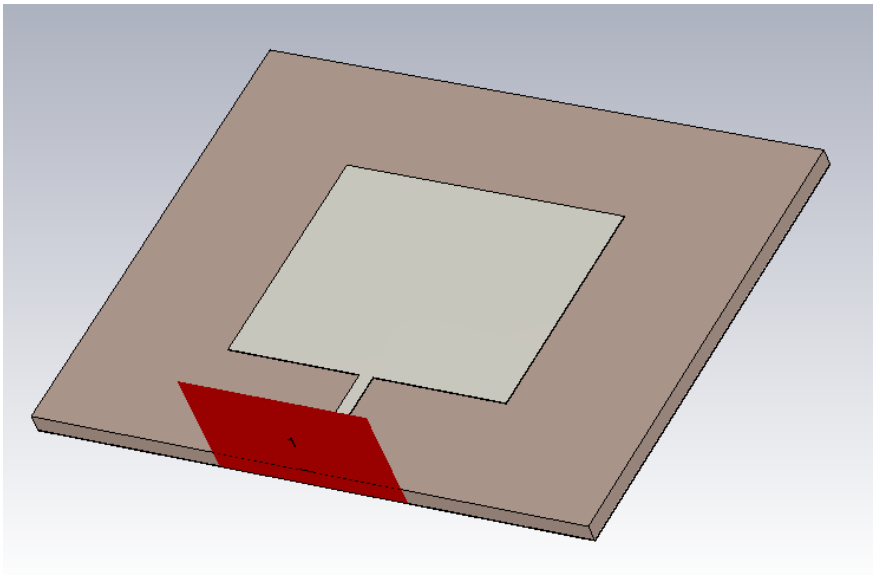

Figure 6 Perspective view of the rectangular patch antenna including the waveguide port.

Circular Microstrip Antenna Design Steps:

1. Run the CST Studio and select **new project → Microwaves & RF/Optical → Antennas → Planar (Patch, Slot, etc) → Time Domain**.
    a. Please save your design in C: drive due to performance problems of P: drive, and when you finish your work please copy your design to your P: drive.
2. Design the antenna microstrip antenna of which details are given in Figure 6 and Figure 7, where the antenna dimensions are specified as:

- Radius of the circular patch = 1.87 mm
- Slot width = 0.4 mm
- Slot length = 0.85 mm
- Feed line length = 2.08 mm
- Feed line width = 0.2 mm
- Substrate thickness = 0.25 mm
- PEC thickness = 0.012 mm
- The substrate is Rogers RO4350B (Lossy)
- The antenna is made of PEC material
- The bottom of the substrate is covered by the PEC material as a ground layer.

3. **<u>Follow the same steps in the previous section</u>**
4. Set Radius = 1.8 mm and repeat the steps given above.
5. Set Radius = 1.9 mm and repeat the steps given above.

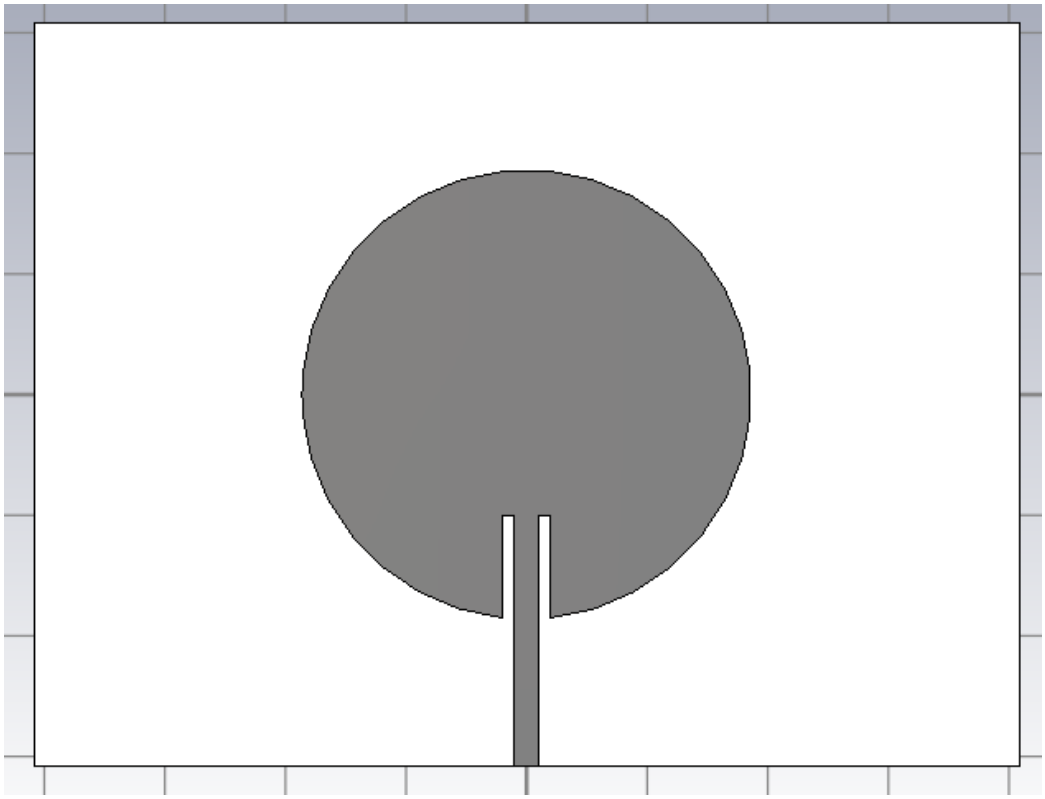

Figure 7 Circular patch antenna

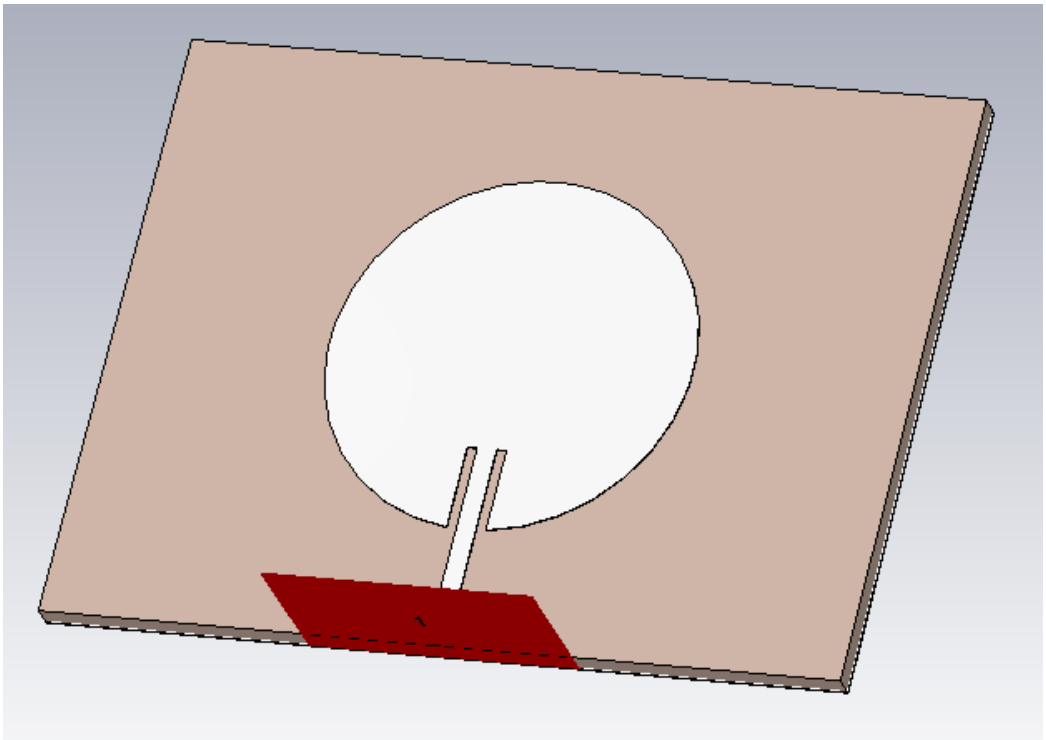

Figure 8 Perspective view of the circular patch antenna including the waveguide port.