UNIVERSITÀ DELLA CALABRIA
DIPARTIMENTO DI INGEGNERIA INFORMATICA, MODELLISTICA, ELETTRONICA E SISTEMISTICA

Master's Degree in Telecommunication Engineering: Smart Sensing, Computing and Networking

Antennas and propagation

PROF. SANDRA COSTANZO
ASSISTANT: ALEXANDRA FLORES
ASSISTANT: FRANCESCA VENNERI

Group2
Mahmoud Mohamed
ID:252048
Papa Thiam
ID:252113
Andrea Vacca
ID: 252416

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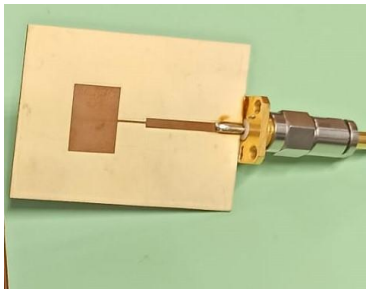
project

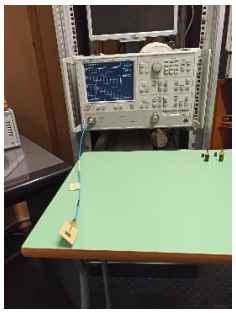
Introduction

This report presents the outcomes of two distinct projects executed using the Ansoft program, focusing on patch antennas with different feeding techniques.

The first project

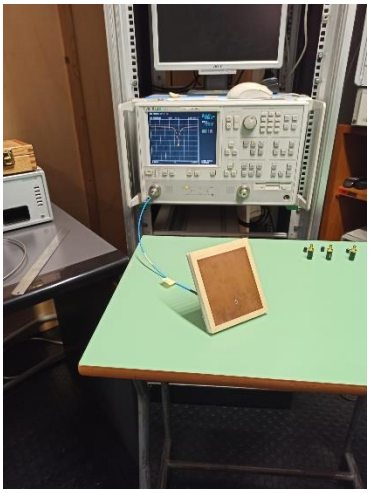
- patch antenna with a quarter-wavelength microstrip feedline and a 50-ohm impedance matching line.





The second project

- patch antenna fed by coaxial excitation. This report will outline the procedural steps for each project and conduct a comparative analysis of their bandwidths, radiation patterns, and gain patterns.



Project 1: Patch Antenna with Quarter-Wavelength Microstrip Feedline

Design Parameters:

- Substrate Material: Arlon DiClad 870 (h = 0.762 mm)
- Operation Frequency: 9.5 GHz

Implementation Steps:

1. Define substrate properties and dimensions.

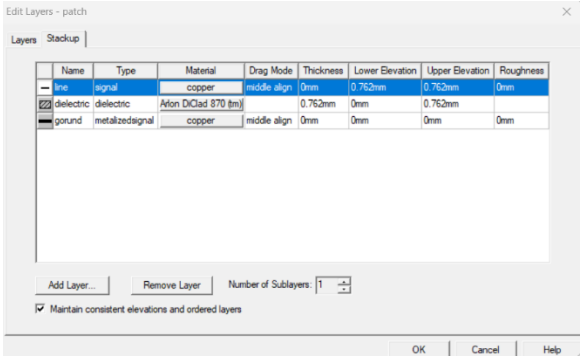
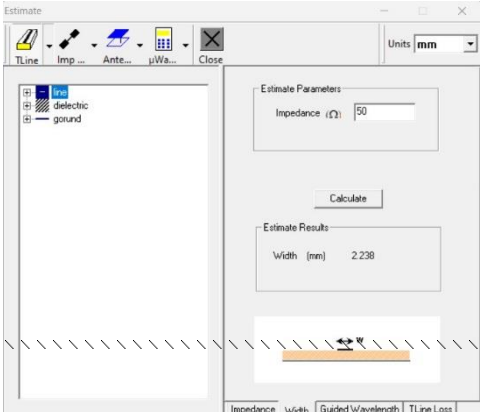
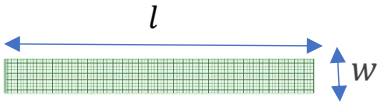


Figure 1 Edit Layers

2. Determine the Size of 50Ω line.





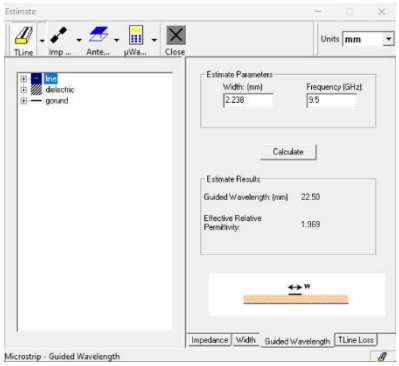
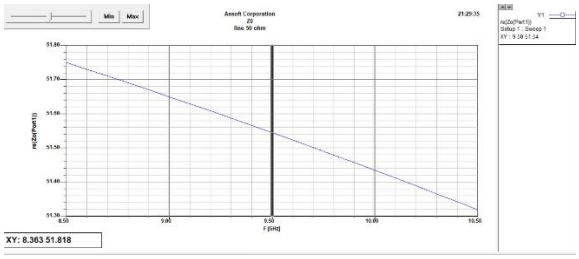


Figure 2 50Ω line Dimensions Estimation

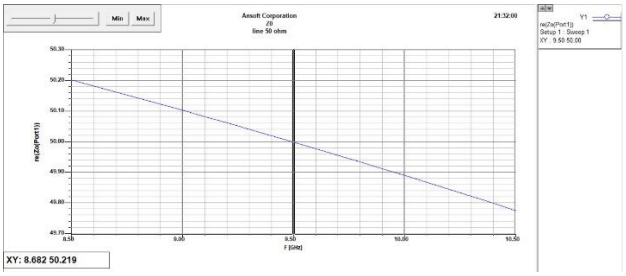
- $w = 2.238mm$
- $l = 22.50mm$

3. Simulate the line



$z_0 = 51.54\Omega$

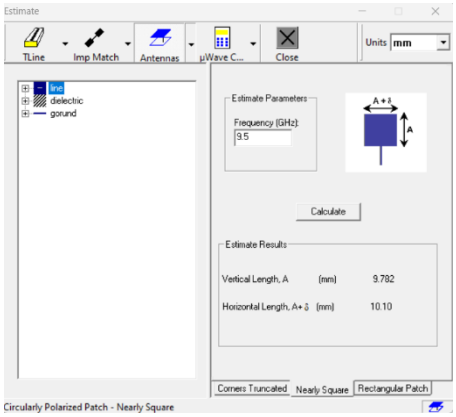
Figure 3 50Ω line before optimization



$w = 2.331\text{mm}$

Figure 4 50Ω line after optimization

4. Determine the Size of the Patch.



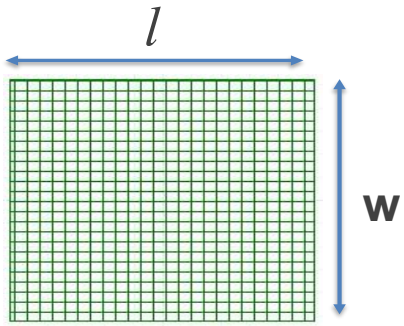


Figure 5 Patch Dimensions Estimation

- $w = l = 9.782mm$

5. Patch with 50Ω line

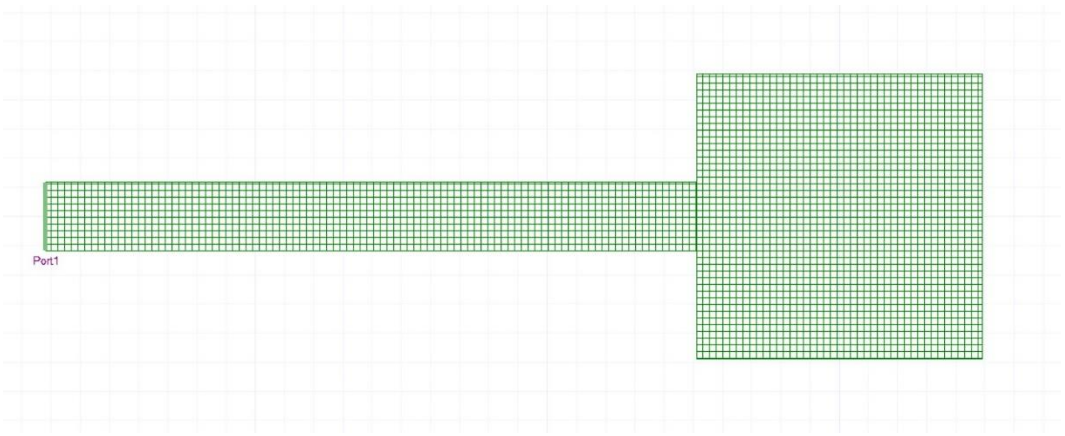


Figure 6 Patch with 50Ω line

6. Simulate Patch with 50Ω line

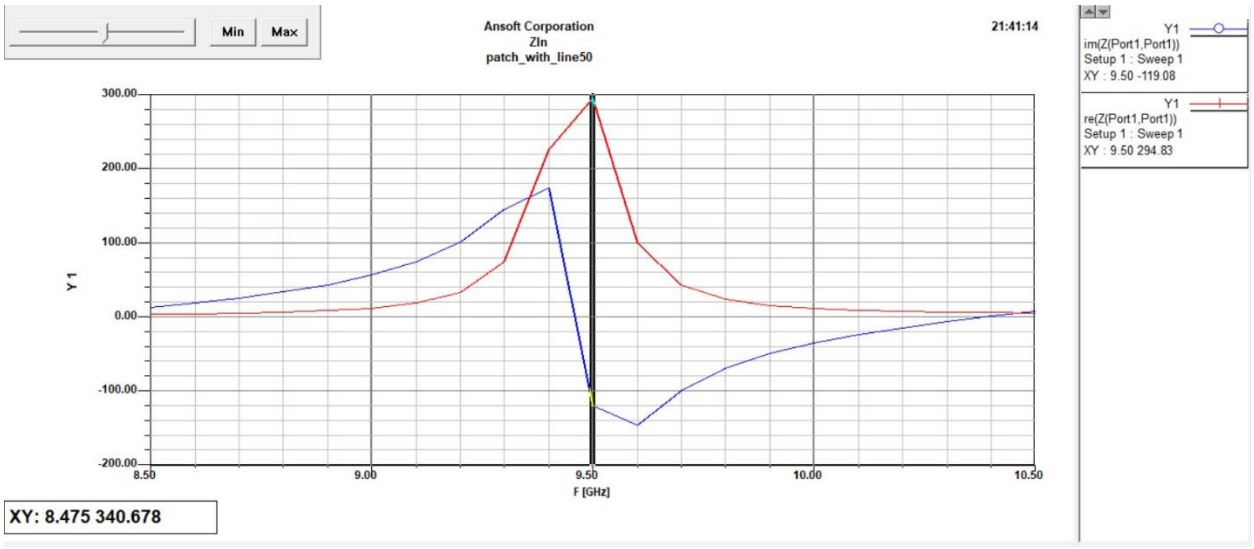


Figure 7 zin before optimization

- *Optimize l of 50 line =22.3 mm*
- *Optimize dimension of the patch=9.75 mm*
  - ***Modify the dimensions of the line so that the resonant frequency is 9.5GHz***

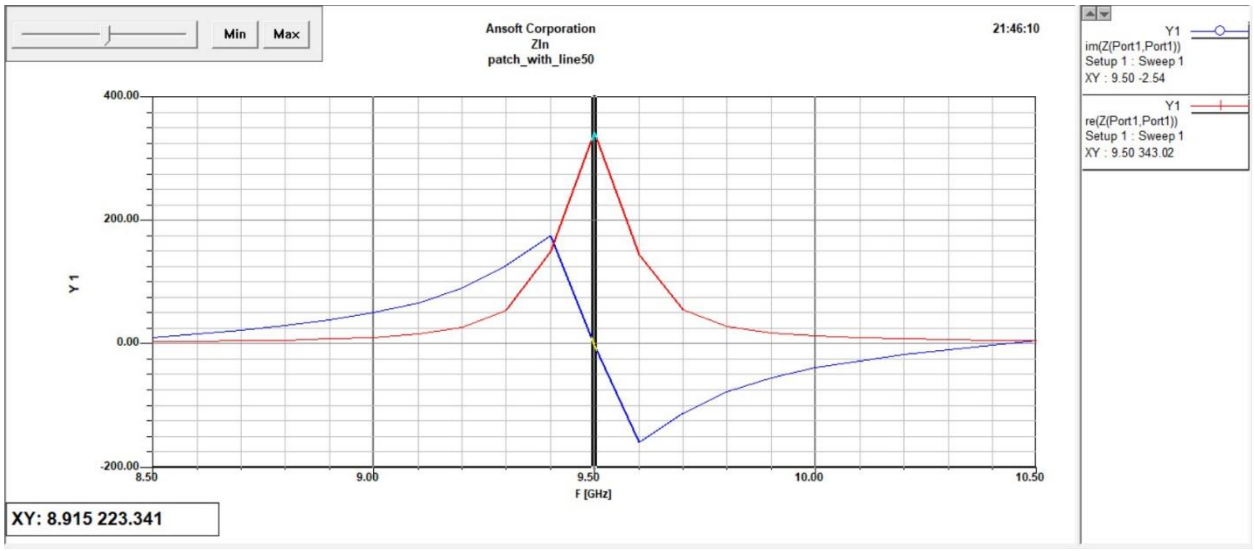


Figure 8 resonant frequency is 9.5GHz

- $Zi_n=343.02\Omega$

7. Determine the Size of the $\frac{\lambda}{4}$ transformer.

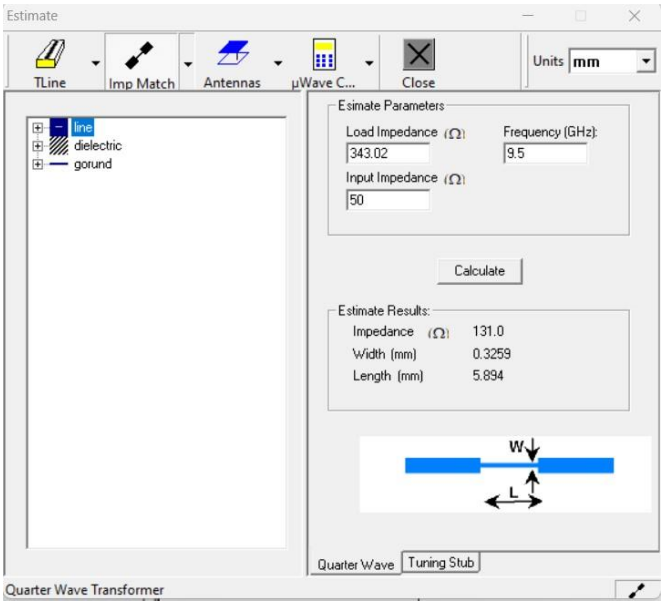


Figure 9 Determine the Size of the transformer.

8. Patch with $\frac{\lambda}{4}$ transformer.

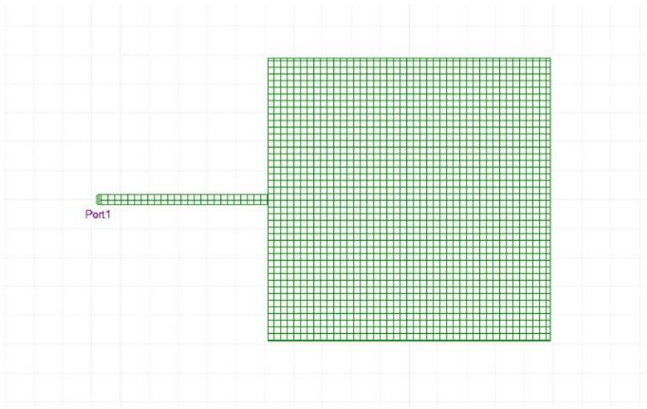
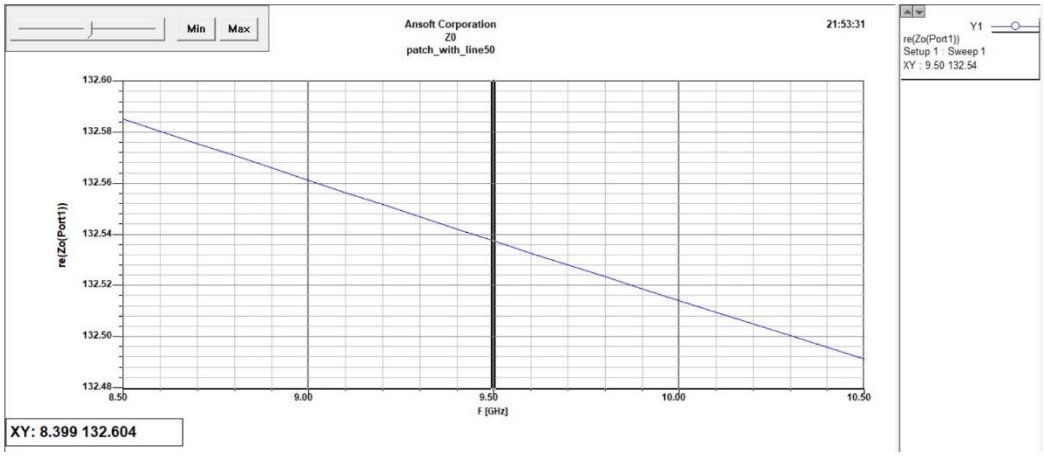


Figure 10 Patch with the transformer.

9. Simulate Patch with $\frac{\lambda}{4}$ transformer.



z_0=131Ω

Figure 11 z_0 before optimization

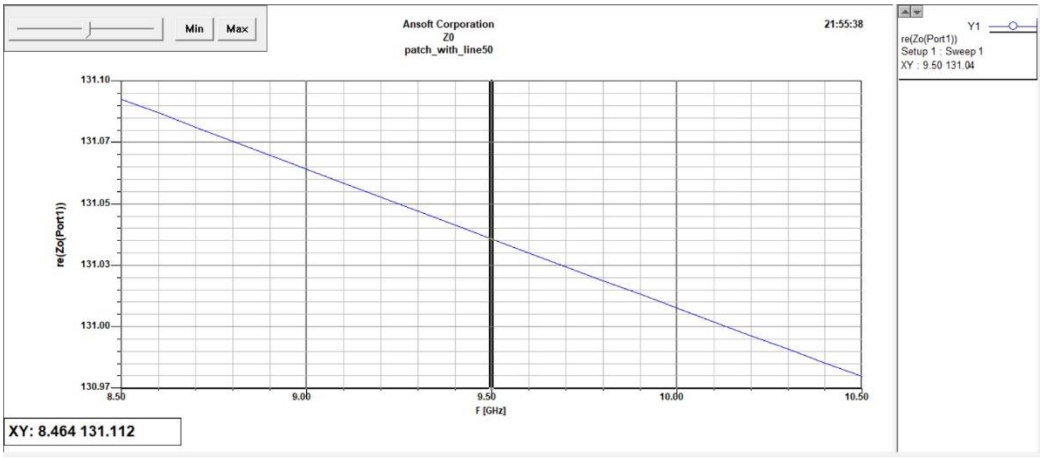


Figure 12 z0 after optimization

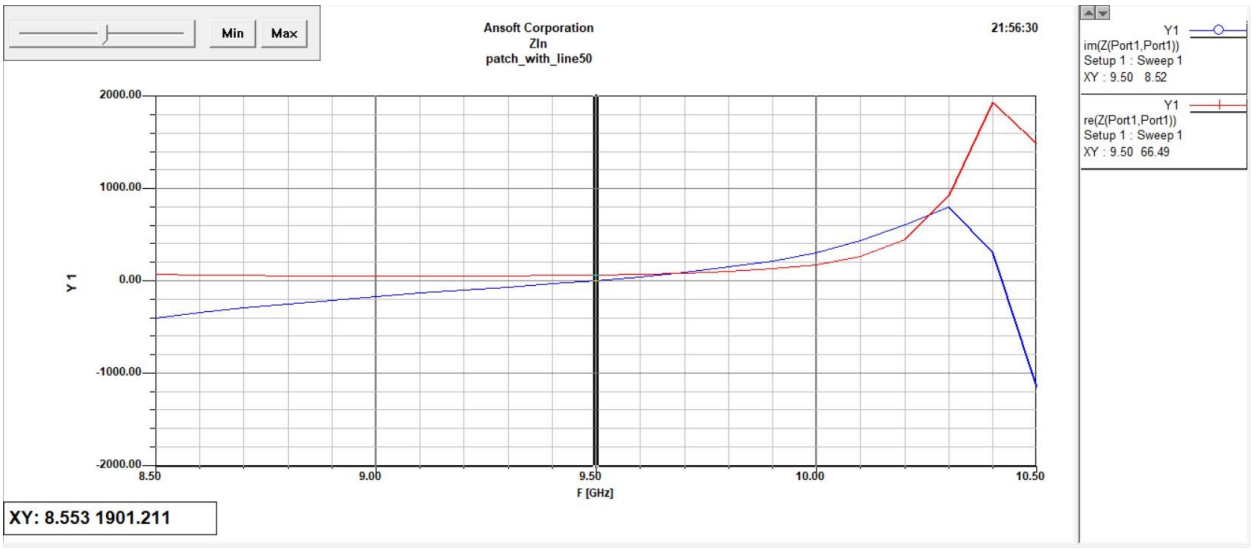


Figure 13 z_{in} before optimization

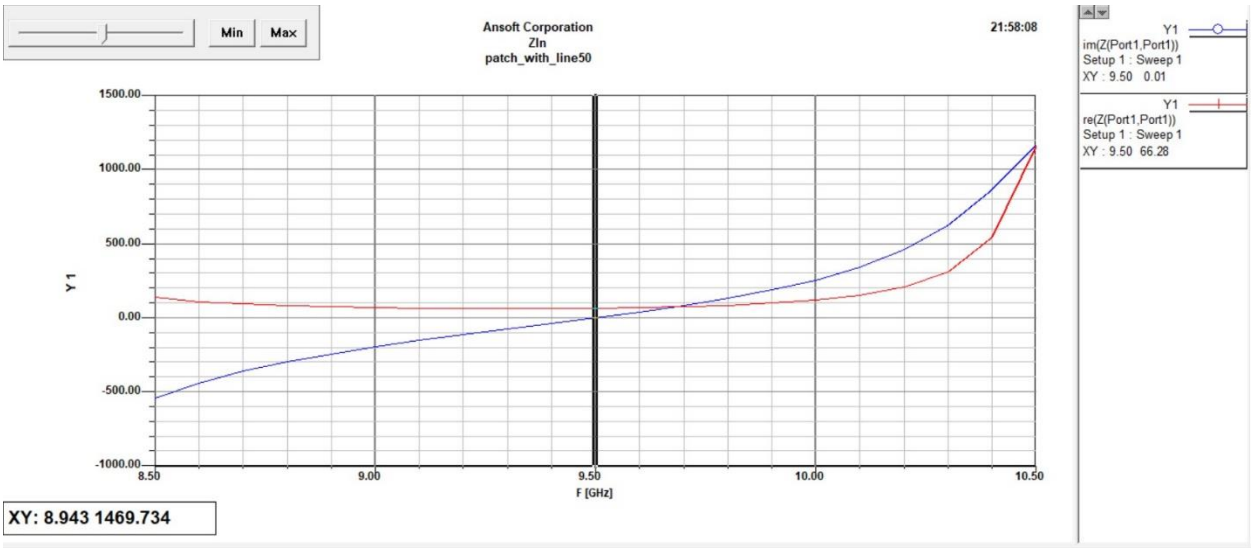


Figure 14 z_{in} after optimization

10. Final project

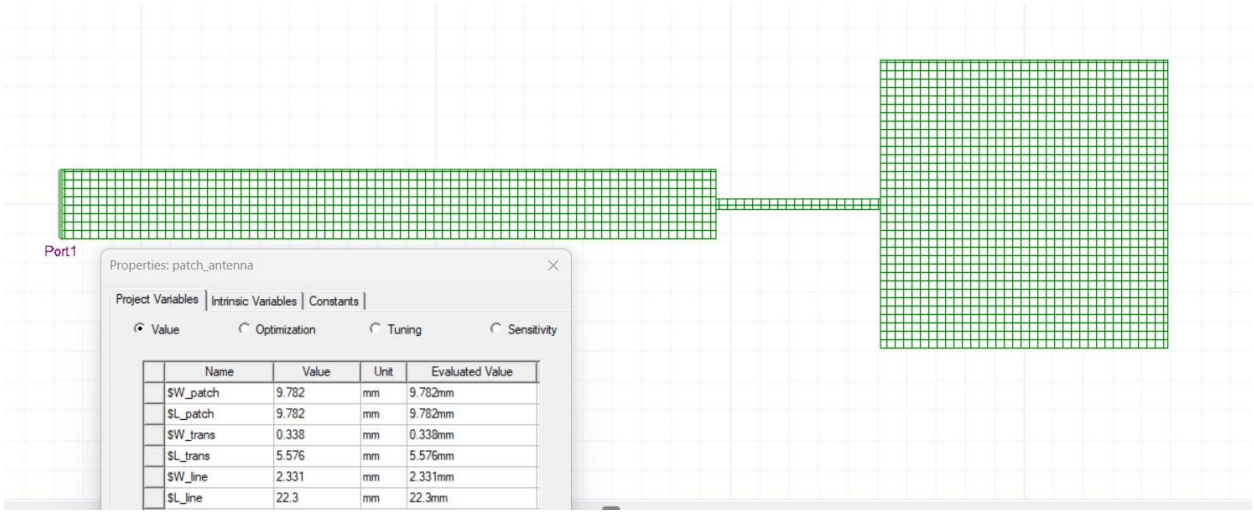


Figure 15 final Project with Specific Dimensions

11. Simulate the antenna using the Ansoft program.

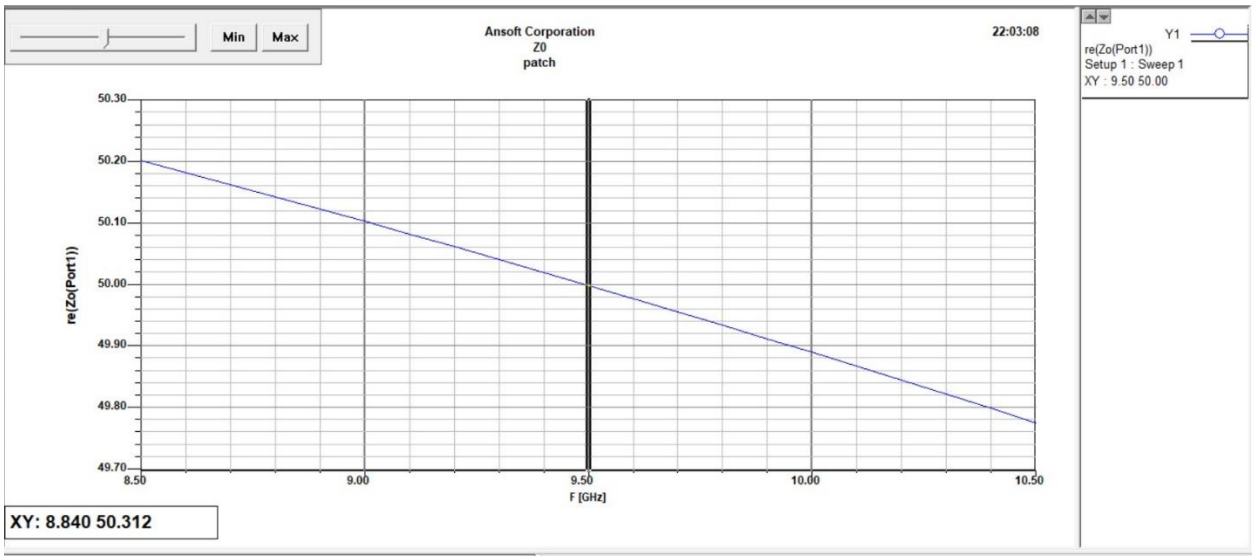


Figure 16 z_0 of the antenna

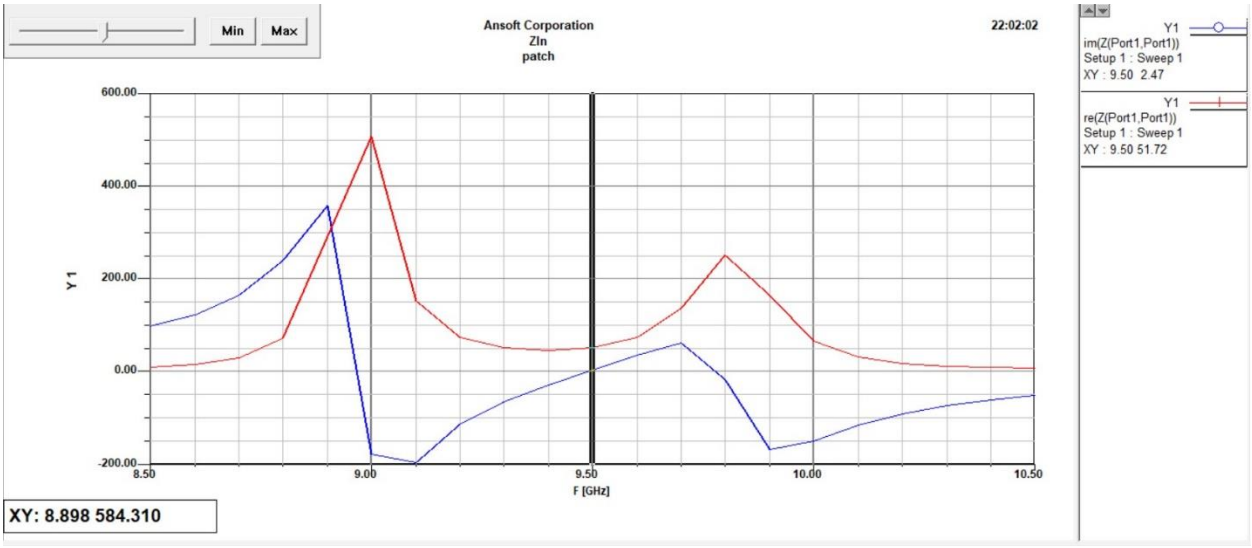


Figure 17 z_{in} of the antenna

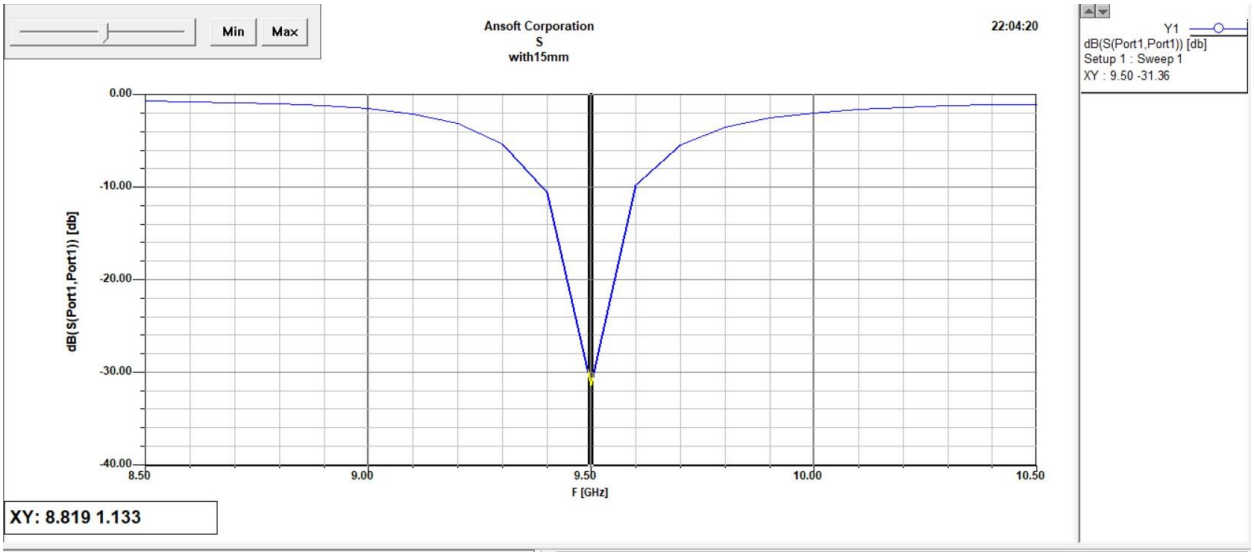


Figure 18 $s_{11}$of the antenna

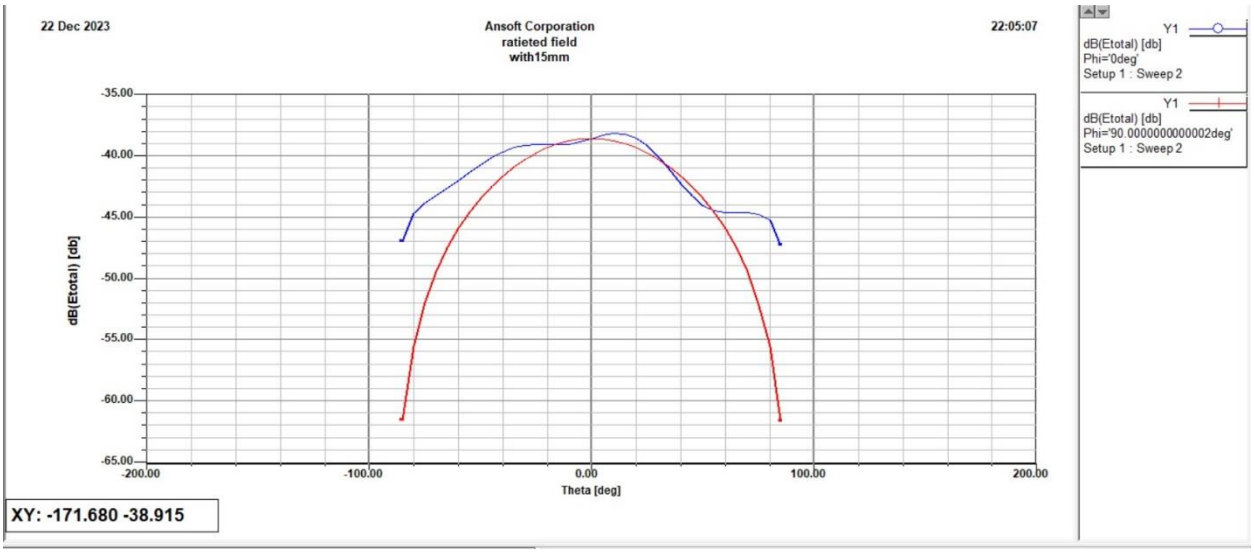


Figure 19 radiated field.

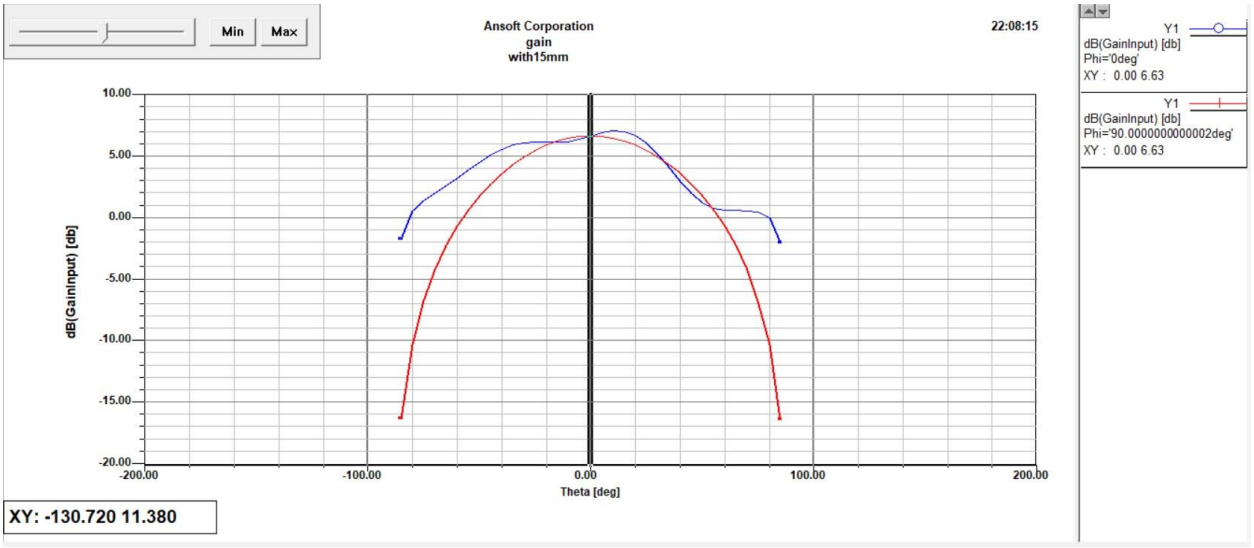


Figure 20 gain

Bandwidth:

- Analyze bandwidth.

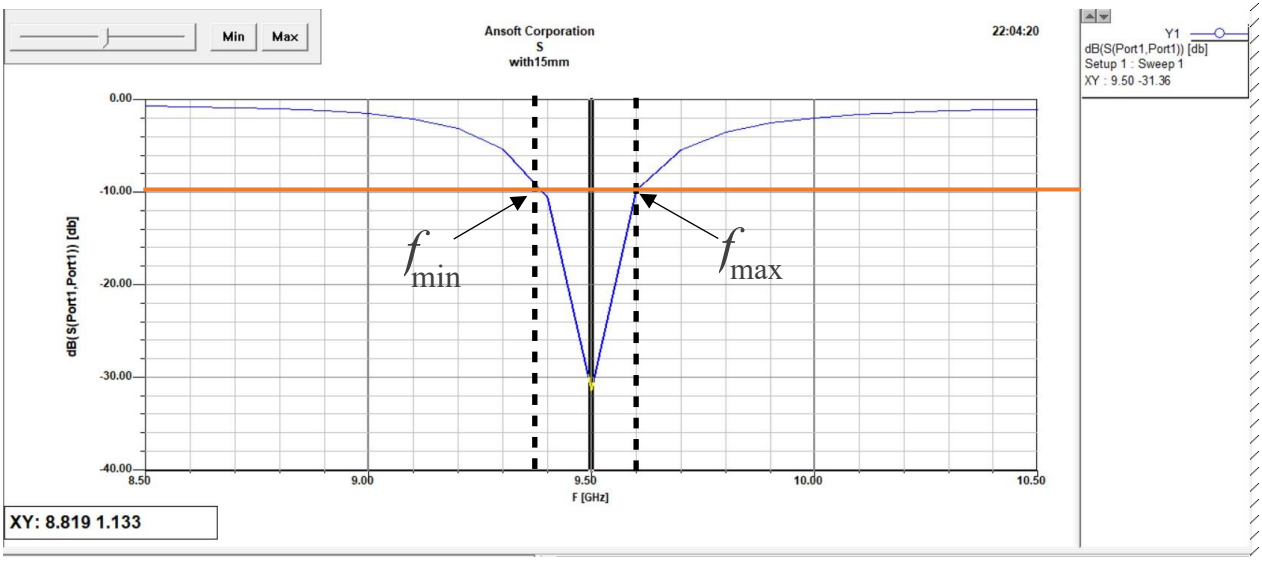


Figure 21 calculate the bandwidth of an antenna

$$B\% = \frac{f_{max} - f_{min}}{f_0} * 100 =$$

$$\frac{9.6-9.39}{9.5} * 100 = 2.21\%$$

Project 2: Patch Antenna with Coaxial Excitation

Design Parameters:

- Substrate Material: Arlon DiClad 870 (h = 0.762 mm)
- Operation Frequency: 9.5 GHz

Implementation Steps:

1. Define substrate properties and dimensions.

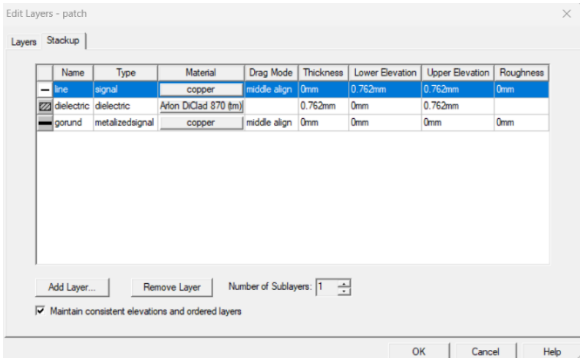
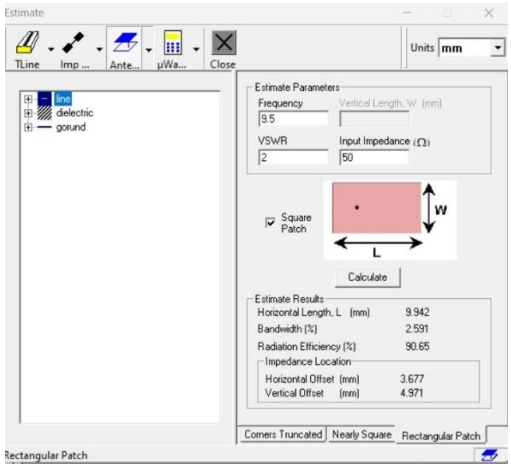


Figure 1 Edit Layers

2. Determine the Size of the Patch.



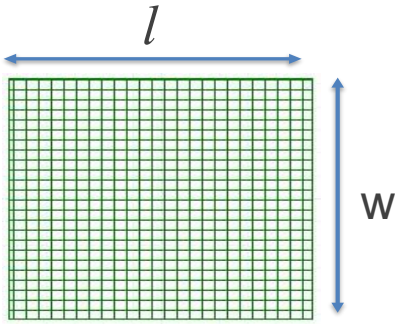


Figure 2 Patch Dimensions Estimation

- $w = l = 9.942mm$

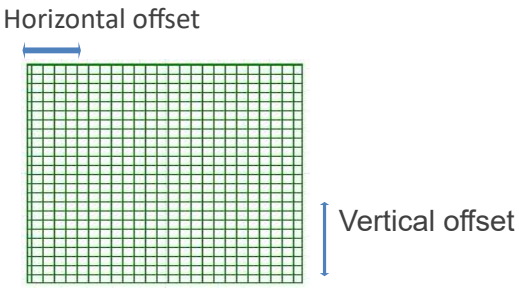
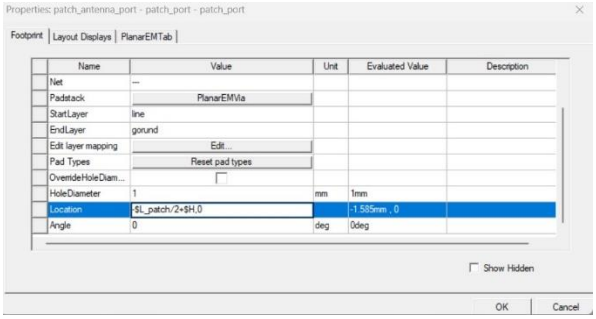


Figure 3 location of the point Estimation



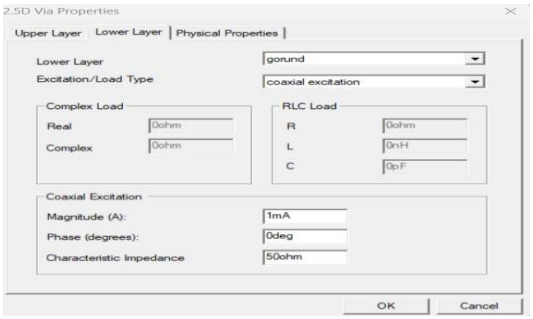


Figure 4 location of the via

3. Patch Coaxial Excitation

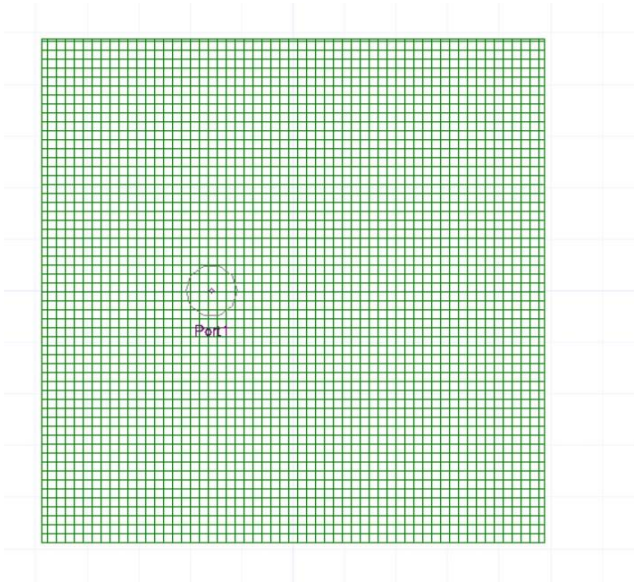


Figure 5 patch Coaxial Excitation

4. Simulate Patch with Coaxial Excitation

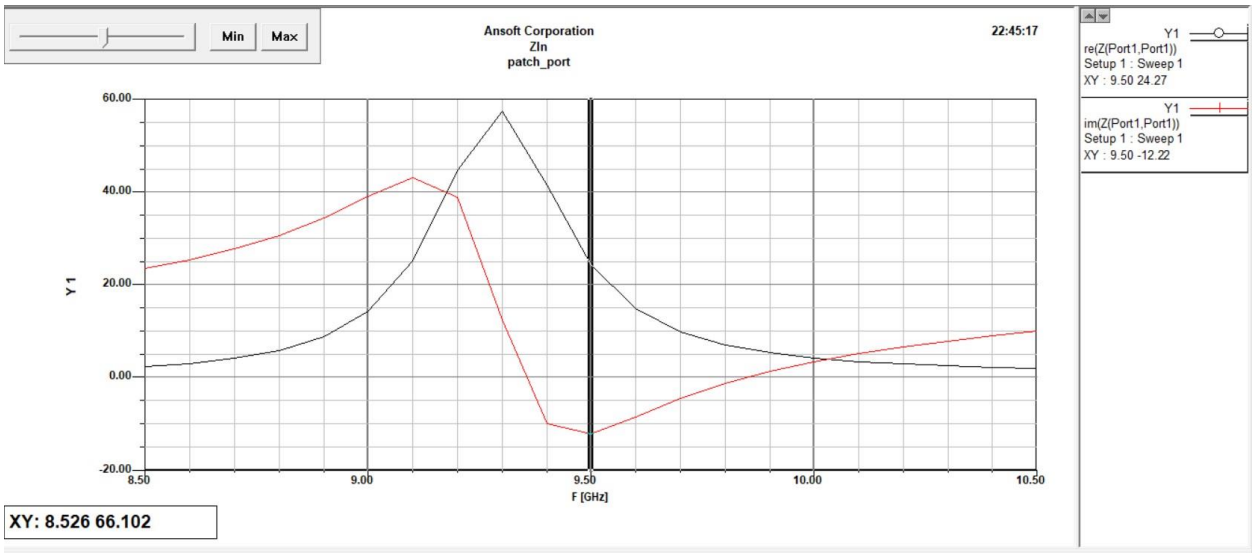


Figure 6 zin before optimization

- *Optimize H (position of the Coaxial Excitation) =3.3 mm*

- *Optimize dimension of the patch=9.77 mm*
  - ***Modify the dimensions of the patch so that the resonant frequency is 9.5GHz***

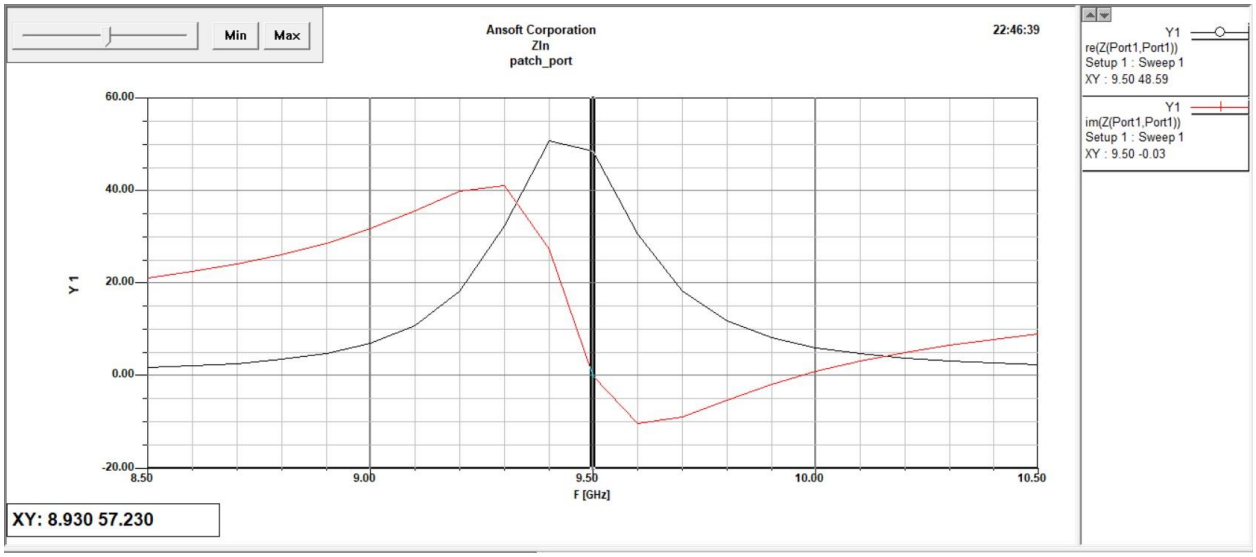


Figure 7 resonant frequency is 9.5GHz

5. Final project

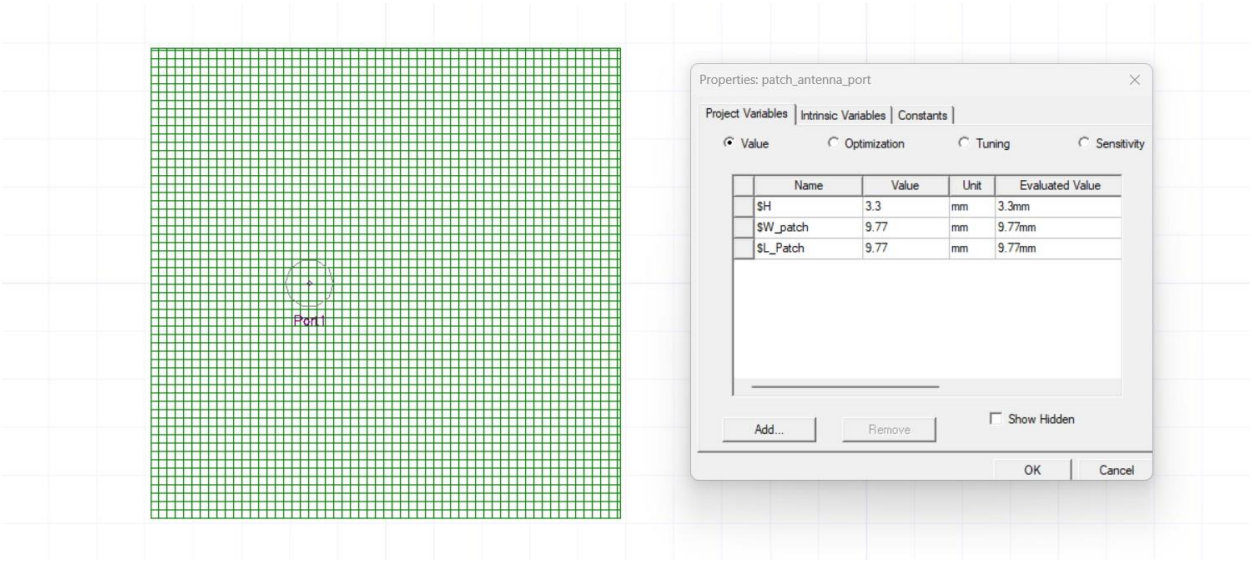


Figure 8 final Project with Specific Dimensions

6. Simulate the antenna using the Ansoft program.

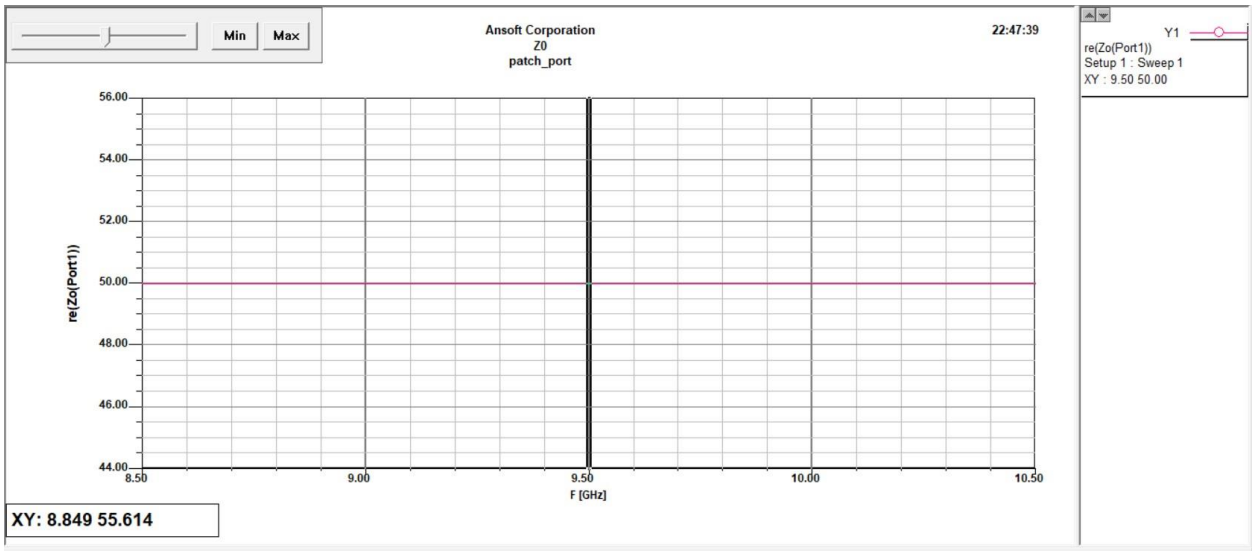


Figure 9 z_0 of the antenna

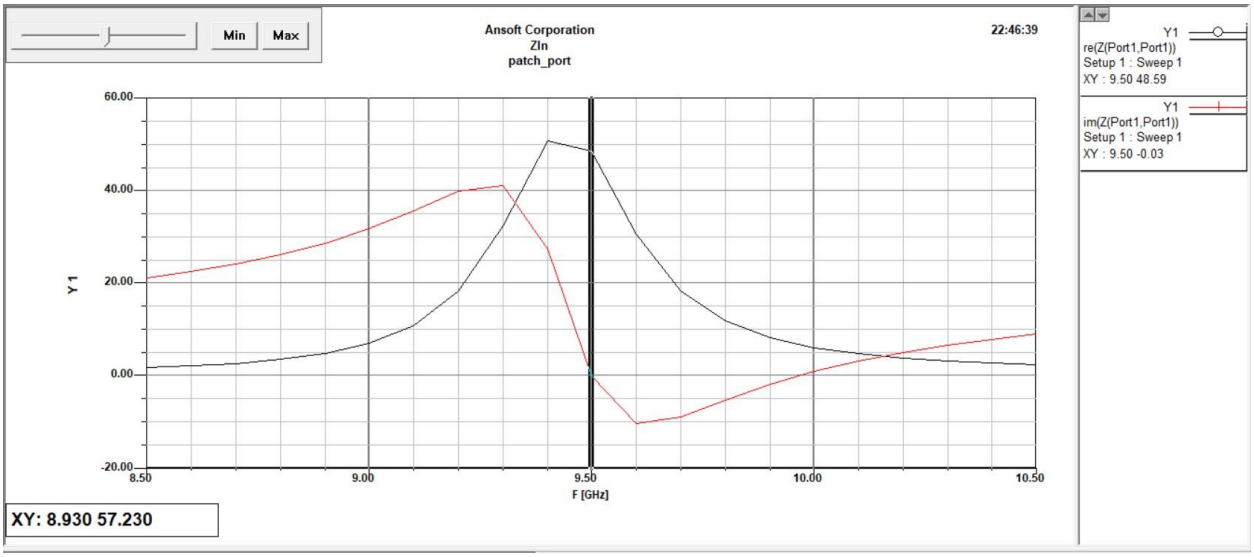


Figure 10 z_{in} of the antenna

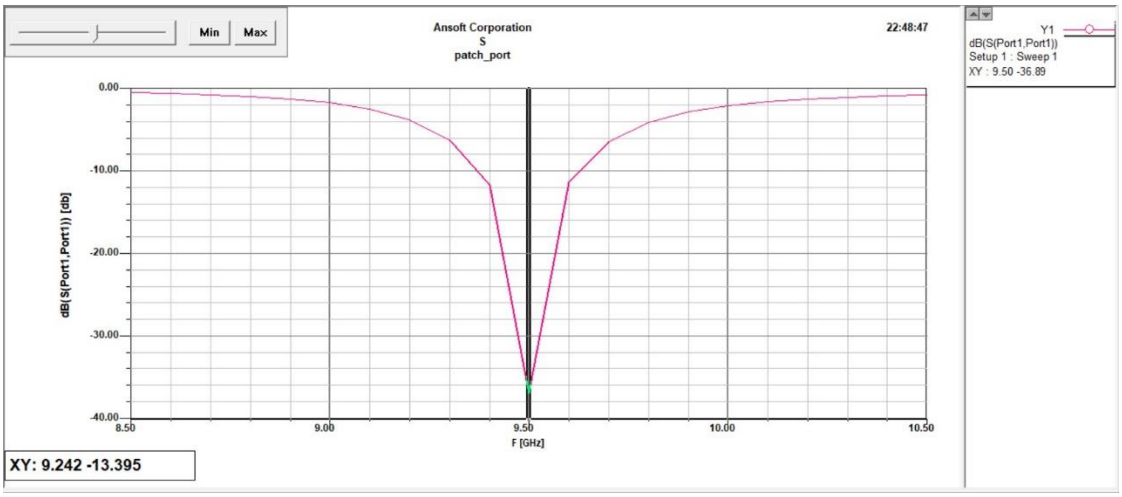


Figure 11 $s_{11}$of the antenna

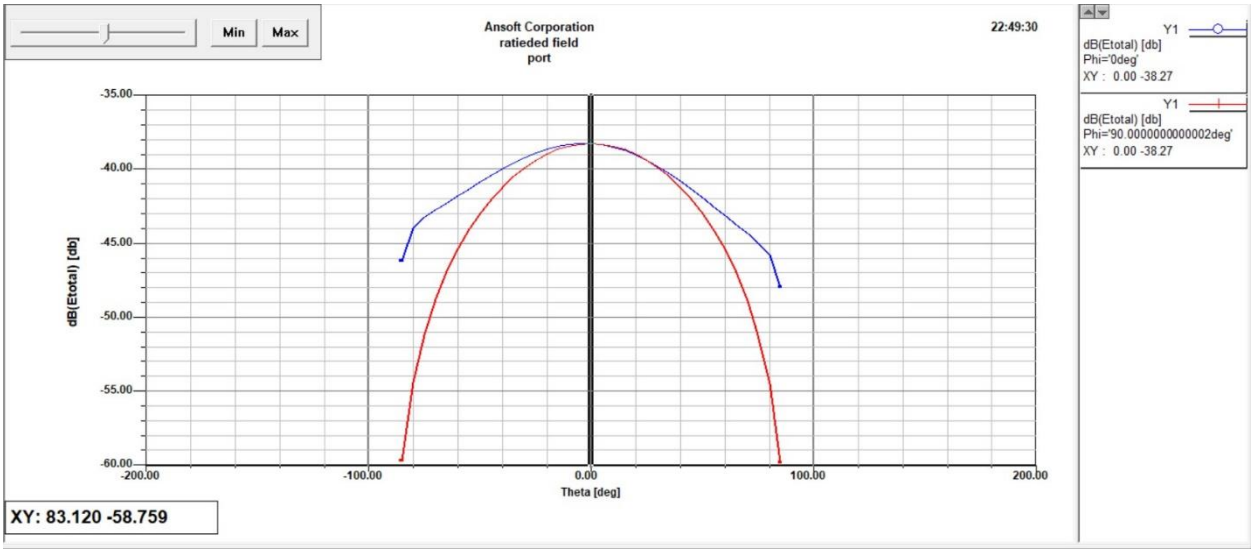


Figure 12 radiated field.

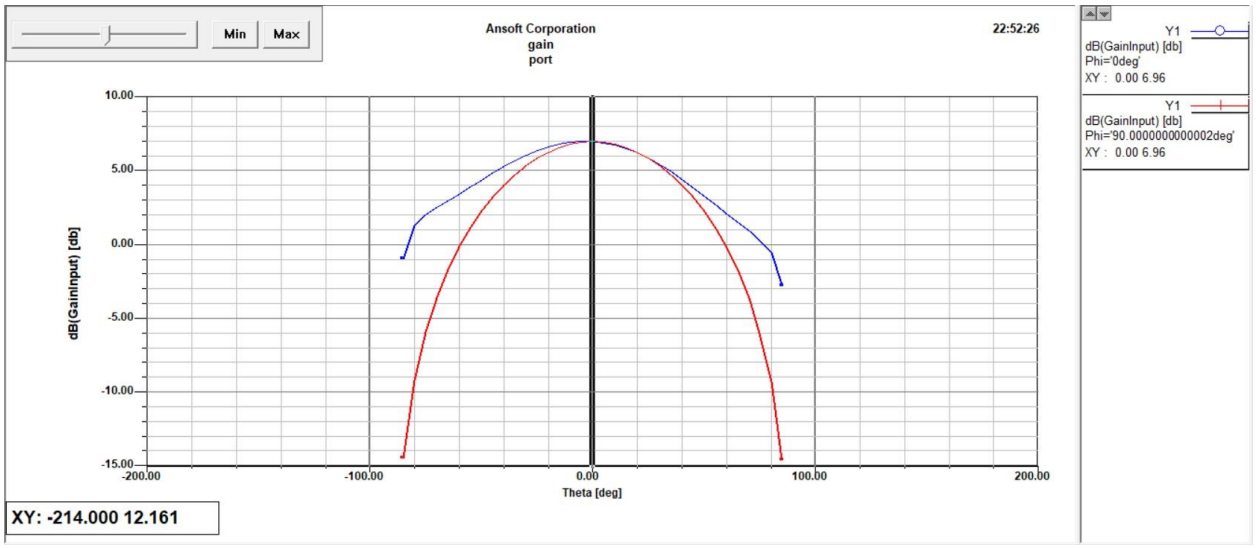


Figure 13 gain

Bandwidth:

- Analyze bandwidth

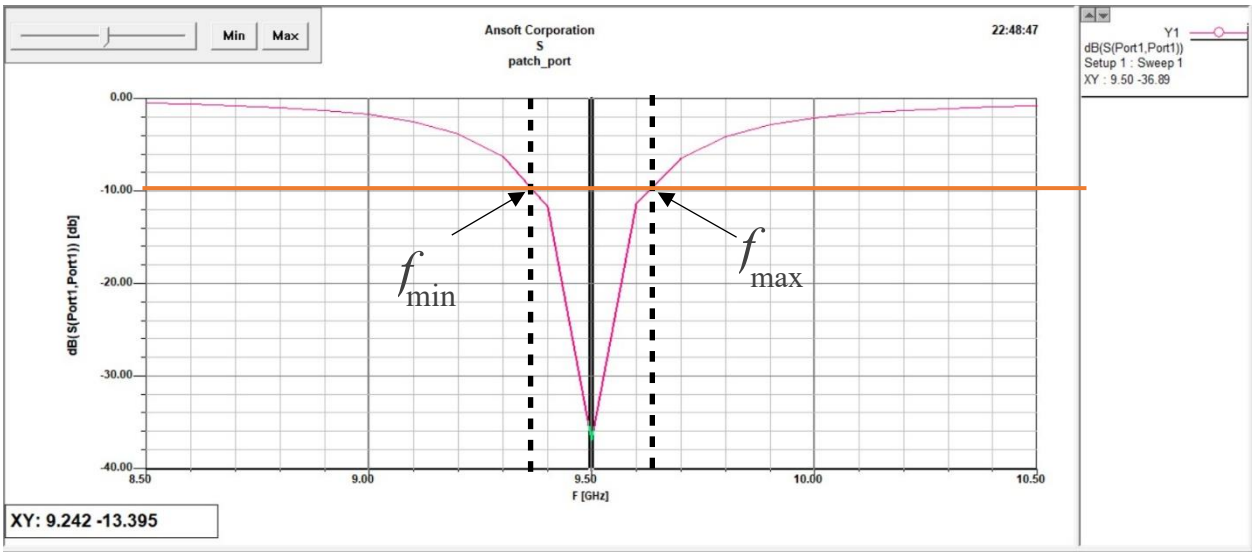


Figure 14 calculate the bandwidth of an antenna.

$$B\% = \frac{f_{max} - f_{min}}{f_0} * 100 =$$
$$\frac{9.61-9.39}{9.5} * 100 = 2.32\%$$

Conclusion:

- the comparative analysis of the two patch antenna projects employing distinct feeding mechanisms has revealed notable differences in their performance characteristics. The radiated field patterns were observed to differ significantly between the two designs. Specifically, the coaxially-excited patch antenna exhibited a symmetric radiated field, contrasting with the asymmetry observed in the quarter-wavelength microstrip feedline configuration.
- the examination of bandwidth revealed that one of the projects outperformed the other. The coaxially-excited patch antenna demonstrated a superior bandwidth compared to the quarter-wavelength microstrip feedline design. This suggests that the choice of feeding mechanism plays a crucial role in determining the antenna's ability to operate across a range of frequencies efficiently.
  - ✓ These findings underscore the importance of carefully selecting the feeding technique based on the specific requirements of the application. While the quarter-wavelength microstrip feedline may offer advantages in certain scenarios, such as simplicity or size constraints, the coaxial excitation appears to be a favorable choice when broader bandwidth and symmetric radiation patterns are essential.