QUARTER WAVE TRANSFORMER:

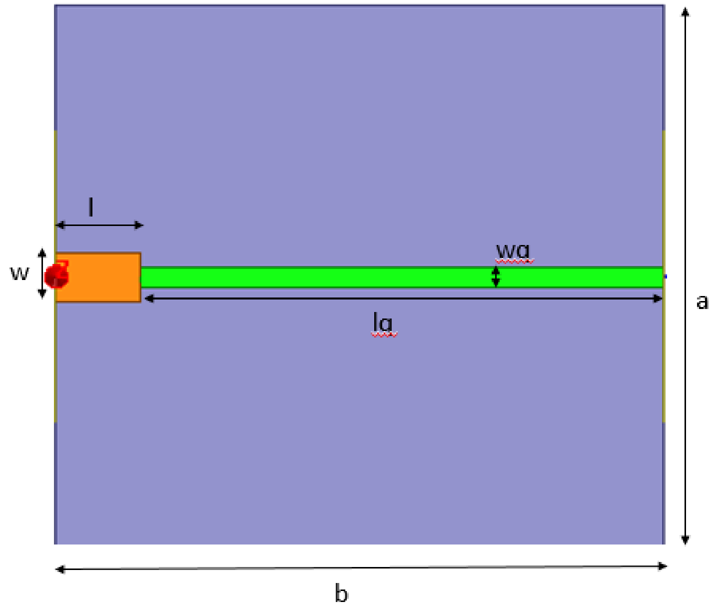


Fig.22: Layout of Quarter Wave Transformer

- **Components:**
  - Metal: **Copper**
    - Conductivity: 58000000 Siemens/m
    - Relative Permittivity (εr): 1

  - Substrate: **Rogers RO4003**
    - Relative Permittivity **(**εr): 3.55
    - Dielectric Loss Tangent ($tan\delta$): 0.0027

- **Design Specifications:**

  - a = 20mm
  - b = 22.412mm
  - h = 0.8mm (Substrate thickness)
  - t = 0.017mm (Metal thickness)
  - lq = 19.289mm
  - wq=0.779mm
  - w=1.789mm
  - l=3.123mm

- **Design Criteria:**
  - Frequency Band: 2.4 GHz

- **Results:**

Plot of Magnitude of S11 from HFSS Simulation:

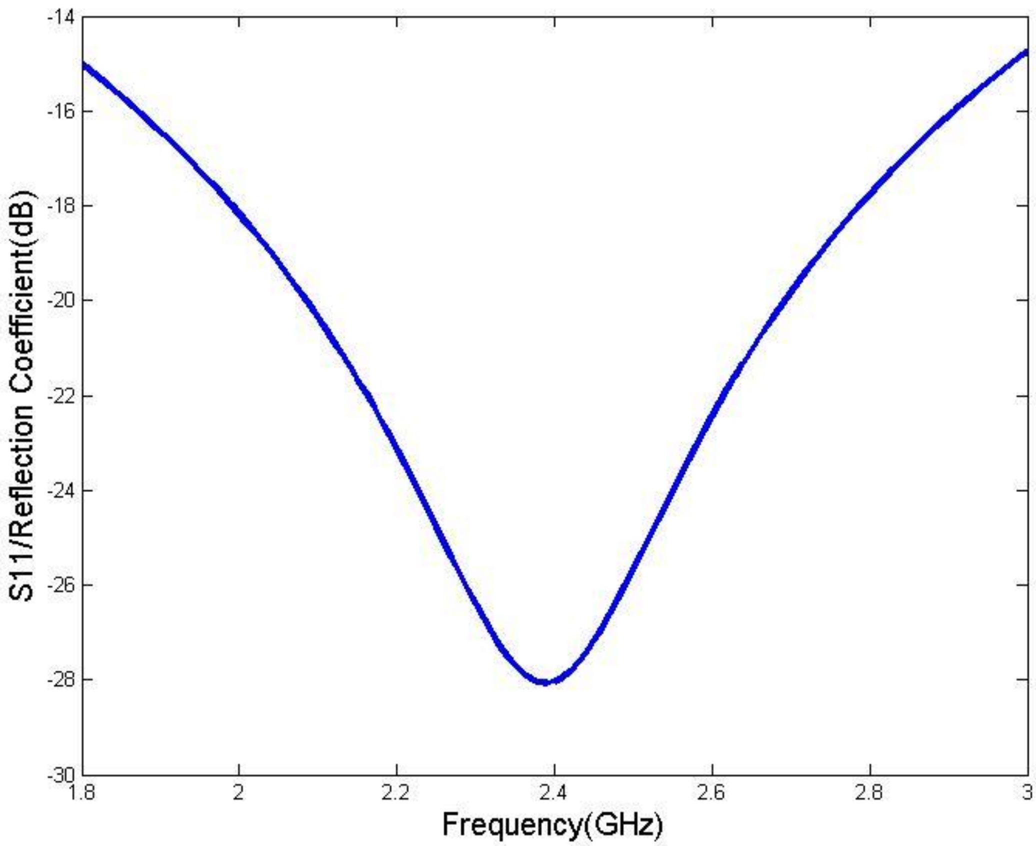


Fig. 23. Simulated S11 parameter of Quarter wave transformer

- **Plot of Magnitude of S11 parameter obtained from MATLAB Calculation:**

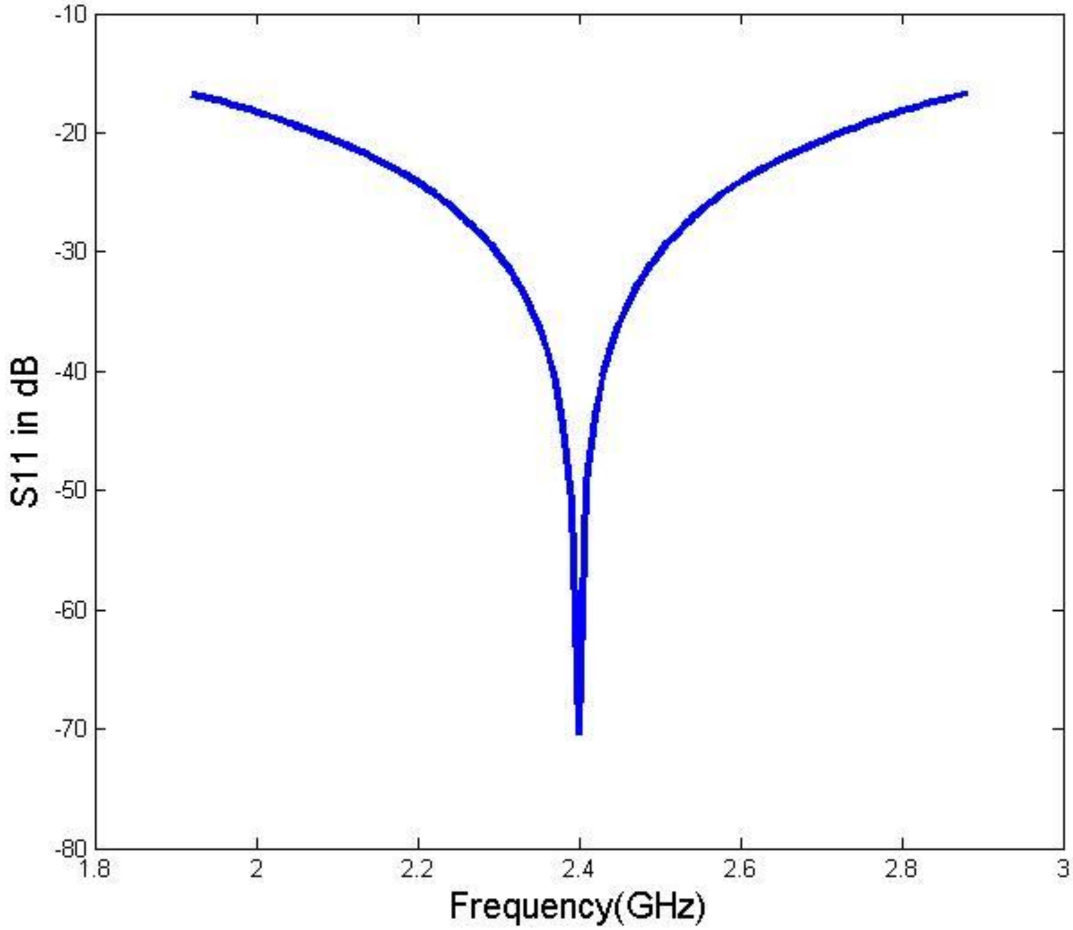
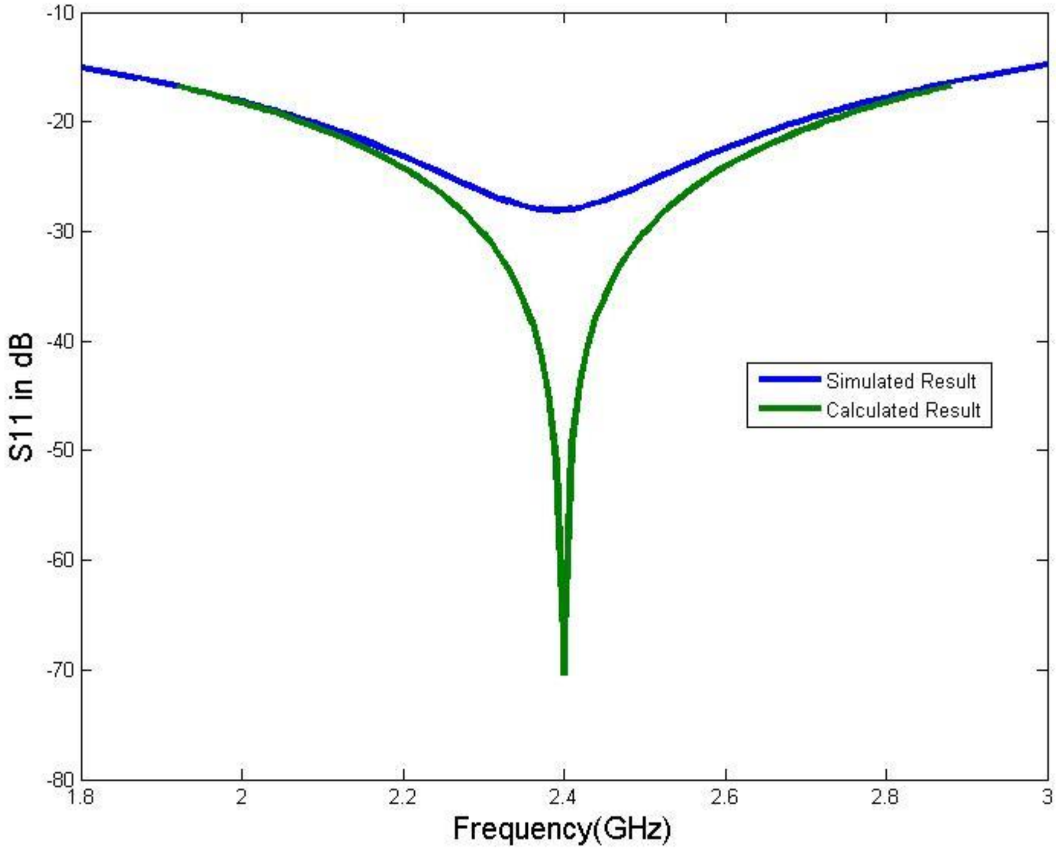


Fig. 24. Calculated S11 parameter of Quarter wave transformer

➢ Comparison of Simulated and Calculated Results:



➢ <u>Calculations</u>

The single-section quarter-wave matching transformer circuit is shown in Fig.21. The characteristic impedance of the matching section is

$$Z_1 = \sqrt{Z_0 Z_L} \qquad \textbf{(10)}$$

We know, the impedance seen towards the quarter wavelength can be calculated using the following formula, which is a function of frequency, as it will be the changing factor.

$$Z_{in} = Z_1 \times \frac{Z_L + jZ_1 \tan(\beta l)}{Z_1 + jZ_L \tan(\beta l)} \quad (11)$$

Here l is fixed as 17.63mm and the reflection coefficient can be expressed as

$$\left(S(1,1)\right) = \frac{Z_{in} - Z_o}{Z_{in} + Z_0} \quad (12)$$

Therefore,

$$\left|\left(S(1,1)\right)\right| \approx \frac{|Z_L - Z_0|}{2\sqrt{Z_0 Z_L}} |\cos \beta l| \quad (13)$$

- **Conclusion**

- The load impedance of 125 ohms is used and the microstrip line of characteristic impedance 50 ohms was used on either port of the design. The task was to match the line of 50ohm with the load impedance of 125 ohms.

- The use of a quarter-wave transformer well serves the purpose which has been used in between the 50-ohm transmission line and the port of 125-ohm load impedance for the solution frequency of 2.4 GHz.

- The matching can be verified if the applied line gives a very low reflection coefficient at the input side of the port which is 50 ohm. This implies to make the reflection coefficient i.e magnitude of the S11 parameter as low as possible

- We simulated the quarter-wave transformer with the centre frequency if 2.4 GHz. We can observe a dip at 2.4 GHz from the HFSS simulation which is evident from the plot in Fig. 23 above for the S11 parameter in dB.

- We also calculated the magnitude of the S11 parameter with the help of MATLAB using equation 10. We managed to verify the dip we observed in the simulation from the plot we obtained from the MATLAB as shown in Fig. 24.

- We can observe the difference from the Fig. 23 in the plot without the matching and after matching the load impedance with the help of a quarter-wave transformer