

Comparision Of Different Parameters On Cpw Fed Bowtie Antenna

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Abstract

Here we used a lumped port excitation for the Co-Planar Waveguide (CPW) feed. We used copper cladding for cutout and for substrate dielectric material named Arlon Cu Clad 217(tm).The CPW slots and antenna shape acts as openings in a metallized plane. The antenna has been analyzed over frequency ranges of S-band (2.20-3.95(GHz)), C-band(4.90-8.20(GHz)) and X-band (8.20-12.40(GHz)). Their return loss, gain, directivity, VSWR and impedances have been compared. It is covered with air box depending on the minimum distance between the air wall and the radiating aperture at the starting frequency i.e., (9.375mm). Though experiments with bow-tie antennas of various extended angles, the bow-tie antenna with a 90° extended angle exhibits the widest bandwidth in the desired frequency band which has a bandwidth of 25% for a VSWR <1.5:1, 16.96% for a VSWR <1.2:1 and 9.19% for a VSWR <1.4:1

Key words: CPW, Bow-Tie, Return loss, Gain, Directivity, VSWR

Introduction:

Printed slot antennas fed by coplanar waveguide (CPW) have many pros over microstrip antennas. Apart from small size, light weight, low cost, good performance, ease of fabrication and installation, and low profile, they expose wider bandwidth, lower dispersion and lower radiation loss than microstrip antennas besides the ease of being shunted with active and passive elements required for matching and gain improvement. Bow-Tie and bow-tie slot antennas are good performers for wideband applications.

Generally waveguide refers to any linear structure that conveys electromagnetic waves between its end points. Most commonly is a hollow metal pipe used to carry radio waves. So, this type of wave guide is used as a transmission line mostly at microwave frequencies, for such purposes as connecting microwave transmitters and receivers to their antennas, in equipment such as microwave

ovens, radar sets, satellite communications, and microwave radio links. The electromagnetic waves in waveguide travel down the guide in a zig-zag path, being repeatedly reflected between opposite walls of the guide.

In this paper, bow-tie slot antenna geometry with lumped port feed is studied and designed for wideband applications. The related simulation and analysis are performed using the using BGA, QFP, Flip-Chip package, Ansoft HFSS. This is based on Finite Element Method (FEM), adaptive meshing to give unparalleled performance. This is integrated with simulation, visualization, solid modeling and automation. This can calculate parameters such as S-parameters, Resonant Frequency, and Fields.

Element Geometry and Analysis:

The geometry of the CPW fed bowtie antenna is shown in Fig. 1. The tapering from the CPW to the bow-tie slot is to achieve better matching with lumped port. The antenna is studied for 2mm substrate with $\epsilon_r = 2.17$ and to create a ground for substrate we use copper cladding as its dielectric material in XY-plane. We assign a finite conductivity boundary to the copper cladding. Then we create Feed cut out with dimensions 13mm X 0.6mm and later we create bowtie arms, unite them. Then we take mirror image of it and create two bowtie arms. Next we have subtracted the Bowtie from the cladding and then assign a mesh operation on the bowtie along the length. Then assign lumped port excitation with resistance 50 ohm and reactance 0 ohm with a single mode.

The analysis is performed between various frequency bands but we consider better air volume which suits better i.e., 8-12 GHz. Therefore the minimum distance between the air volume wall and the radiating aperture should be one quarter wavelength at 8 GHz, or $0.25(c/f) = 9.375\text{mm}$. The dimension is rounded to 9.5mm spacing.

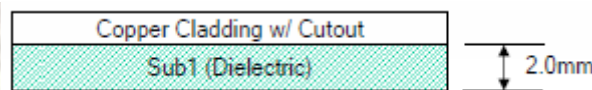
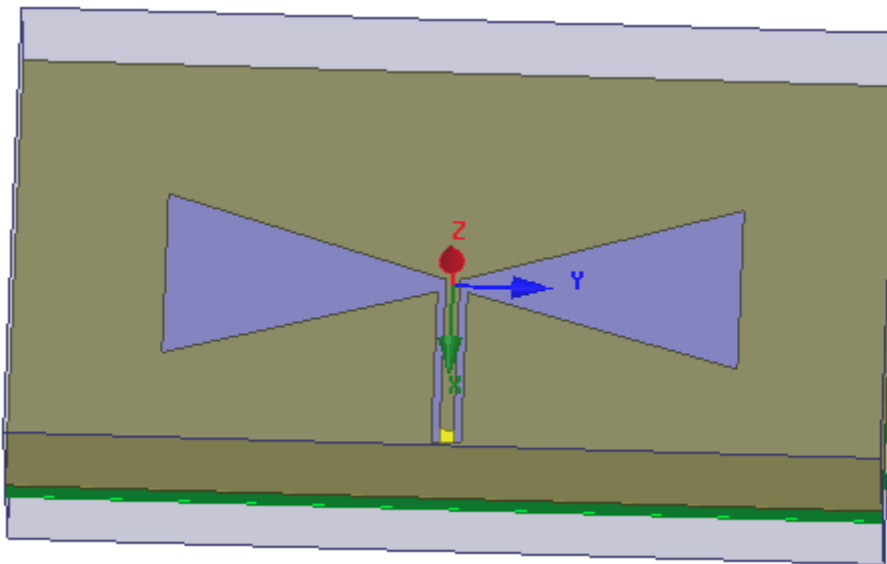


Fig1: CPW FED BOWTIE ANTENNA

Boundaries:

Finite Conductivity of CuClad- by default the outer edge of a wave port is defined to have a Perfect E boundary. With this assumption, the port is defined within a waveguide. For transmission line structures that are enclosed by metal, this is not a problem. For unbalanced or non-enclosed lines, the fields in the surrounding dielectric must be included. Improper sizing of the port definition will result in erroneous results.

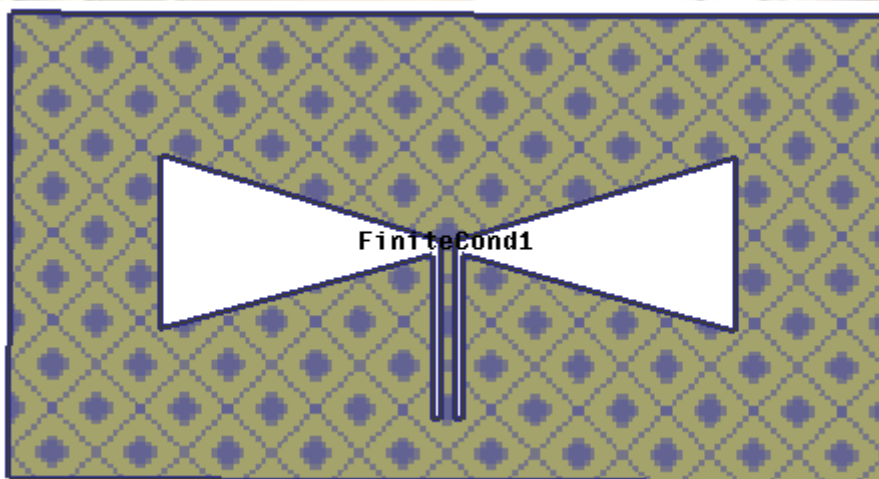


Fig2: Finite conductivity of Copper cladding

Radiation of Airbox- also known as absorbing boundaries enables to model a surface as electrically open: waves can then radiate out of the structure and toward the radiation boundary. It absorbs the wave at the radiation boundary, essentially ballooning the boundary infinitely far away from the structure and

into space. When radiation boundaries are placed close to a structure relatively, this eliminates the need of a spherical boundary. When a radiation boundary is included, far-field calculations are performed as part of the simulation.

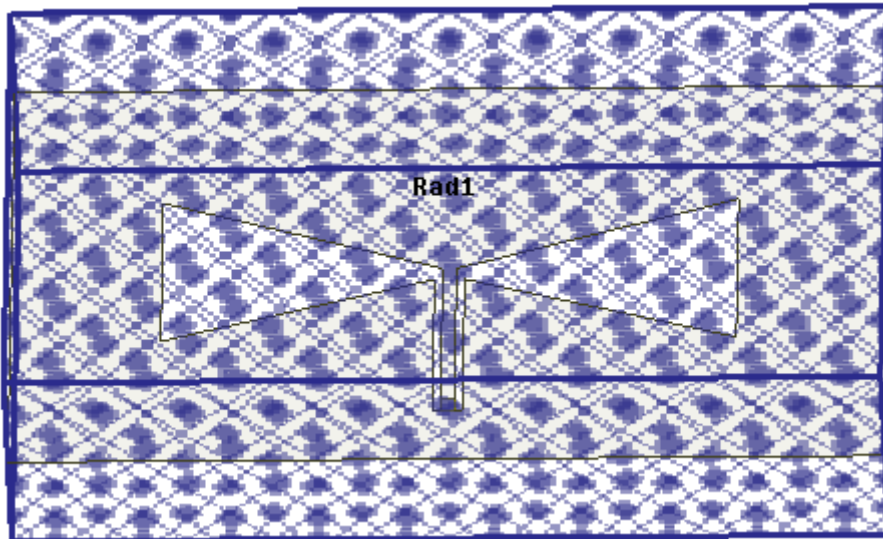


Fig3: Radiation boundary of air box

Excitation of lumped port- Generally an excitation port is a type of boundary condition that permits energy to flow into and out of a structure. Lumped port is generally an internal excitation. Port must lie in a single plane. This simplifies the description of the behavior of spatially distributed physical systems.

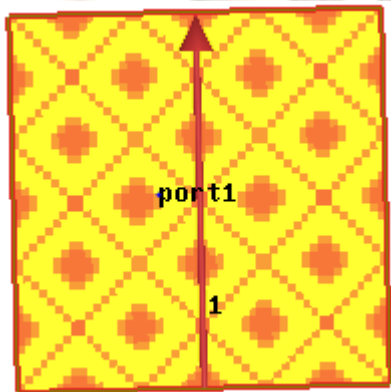


Fig4a: Excitation of Lumped Port

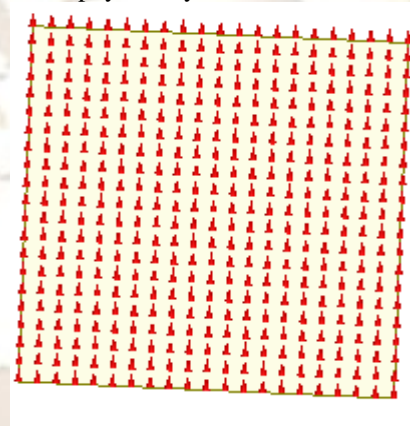


Fig4b: Single Mode of Port

Single mode of port shows how field has been displayed over the defined port.

Results and Simulation:

Return loss - Reflection coefficient $\Gamma = \frac{V_{\text{reflected}}}{V_{\text{incident}}} = \rho \angle \phi = (Z_L - Z_0) / (Z_L + Z_0)$

$$\text{Return loss} = 20 \log(\rho), \quad \rho = |\Gamma|$$

Return loss can be of as the number of dB that the reflected signal is below the incident signal. Return loss varies between infinity for Z_0 impedance and 0 dB for an open or short circuit.

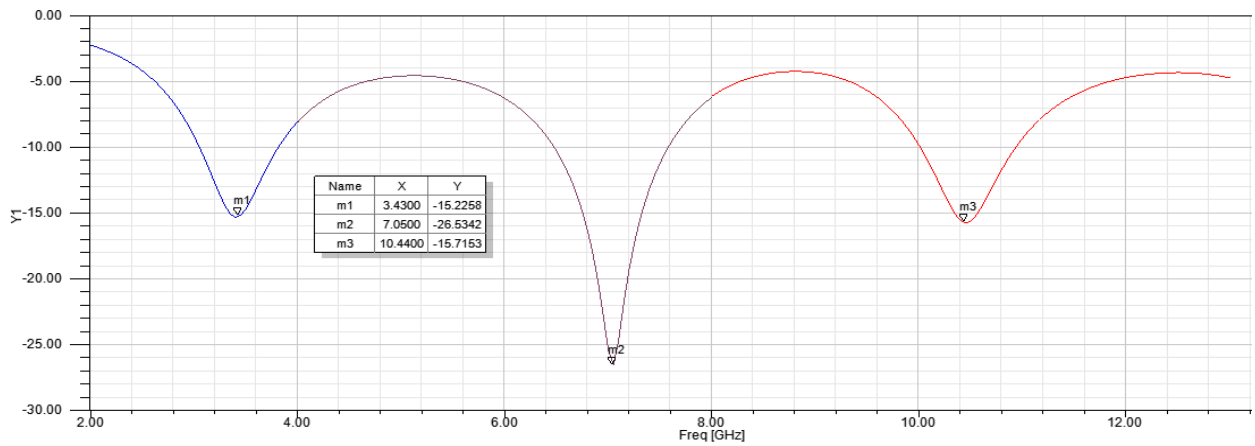


Fig5: Return loss at various frequency bands

Comparison of return loss:

Frequency Band(GHz)	Centre Frequency(GHz)	Return loss(dB)
2.20-3.95	3.43	-15.2258
4.90-8.20	7.05	-26.5342
8.20-12.40	10.44	-15.7153

From the table we can observe more return loss is obtained in frequency band of 4.90-8.20GHz. If we observe return loss has been 70% increase in 4.90-8.20 and 40% decrease in 8.20-12.40 GHz.

Comparison of bandwidth:

Frequency Band(GHz)	Bandwidth(GHz)	Change in bandwidth (%)
3.055-3.882	0.767	25.1
6.4765-7.575	1.0985	16.96
10.01-10.93	0.92	9.2

Input Impedance:

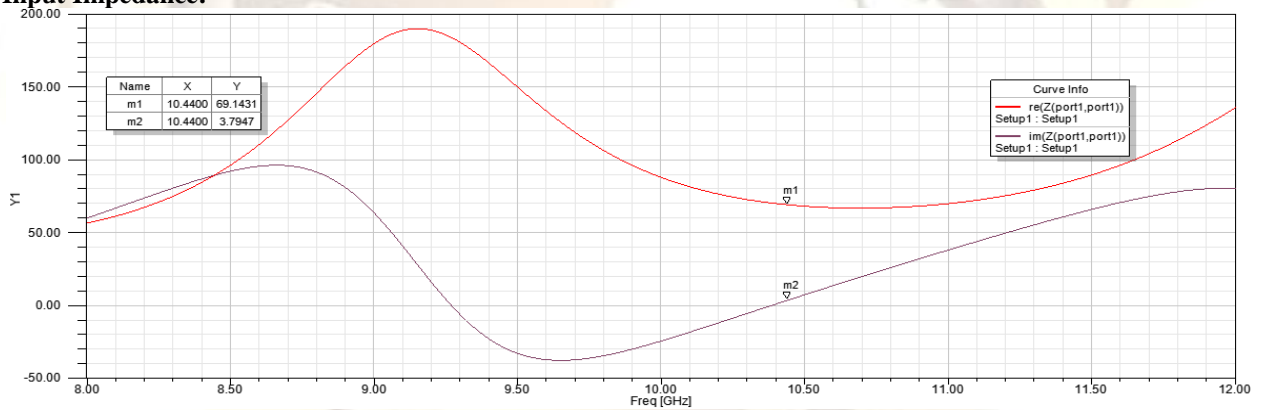
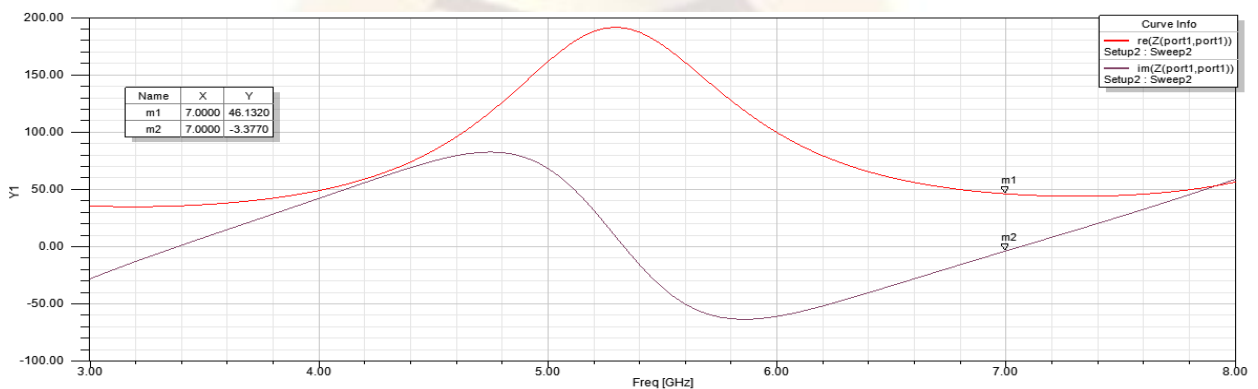


Fig6a: Input Impedance of the antenna at 10.44GHz



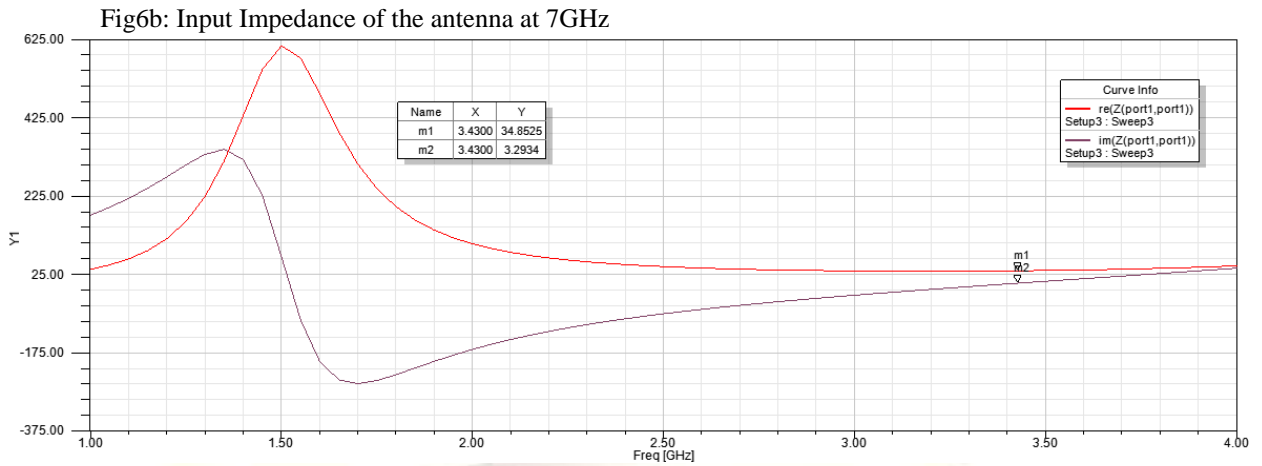


Fig6c: Input Impedance of the antenna at 3.43GHz

Comparison of Input impedance at its center frequency:

Centre Frequency (GHz)	Real Part (X_R)	Imaginary Part(X_I)
3.43	34.85	3.29
7.00	46.13	-3.37
10.44	69.14	3.79

Where the real part has been increased but imaginary part has been varied from inductor to capacitor and to inductor. If we observe inductor also has been increased.

Radiation Pattern:

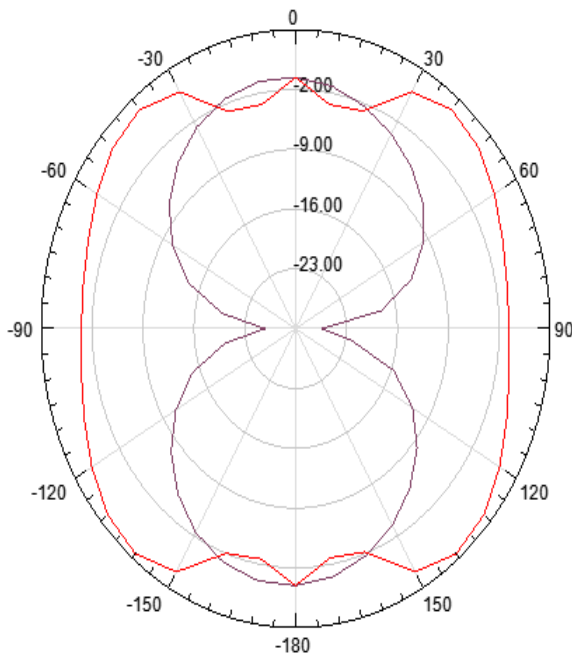


Fig7a: Radiation pattern at 10.44GHz at 0° & 90°

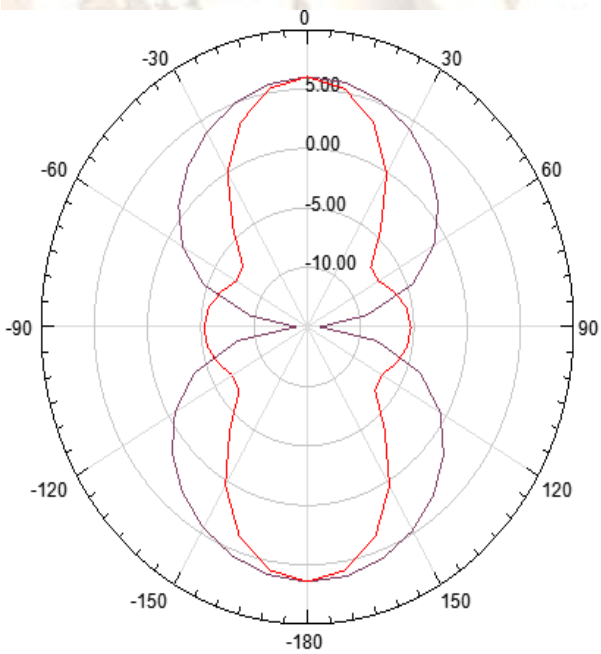


Fig7b: Radiation pattern at 7GHz at 0° & 90°

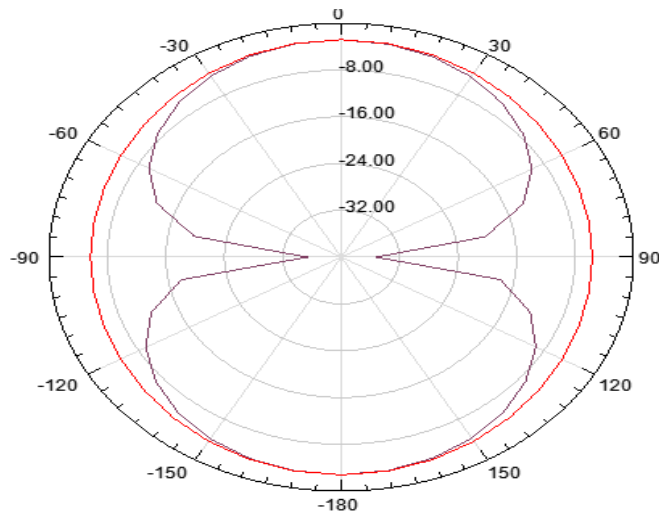


Fig7c: Radiation pattern at 3.43GHz at 0° & 90°

From Fig7a, Fig7b, Fig7c we observed that directivity has been increased as frequency increased which is happened in Fig7b and Fig7c we want even coverage area to be increased which is happened in Fig7a.

Gain(dB):

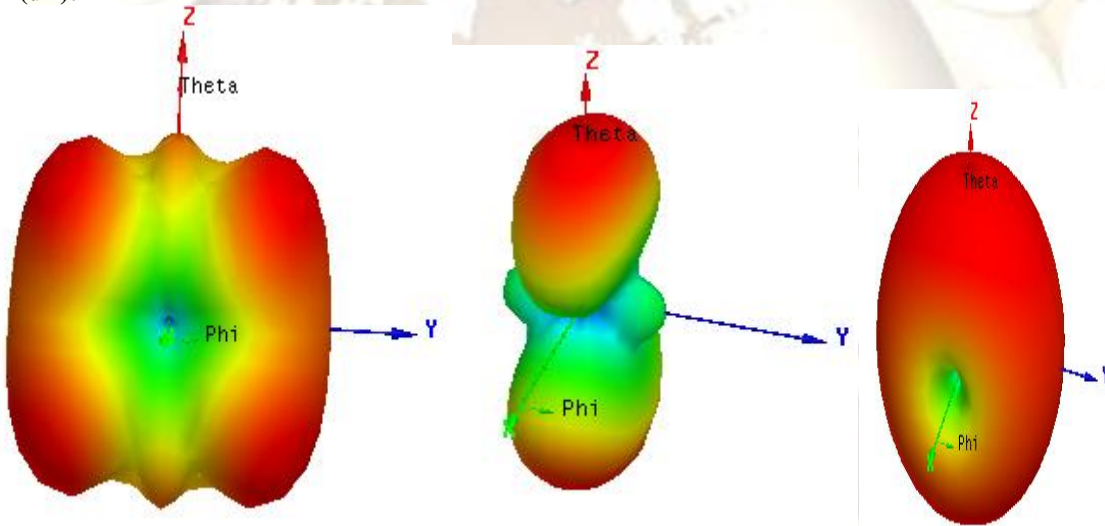


Fig8a: Gain at 8.20-12.20GHz

Fig8b: Gain at 4.90-8.20GHz

Fig8c: Gain at 2.20- 3.95GHz

VSWR:

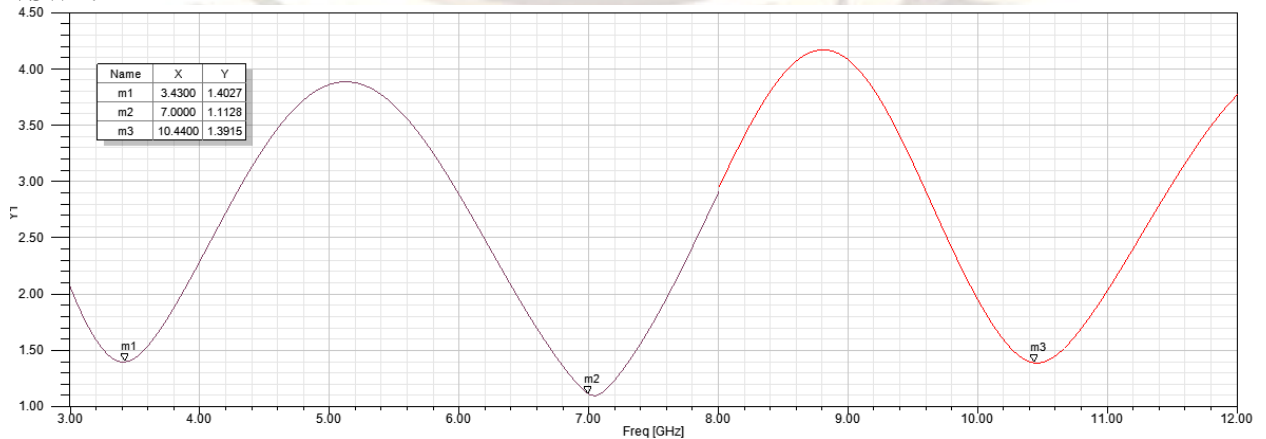


Fig9: VSWR of all three frequency bands considered

Conclusion

From the simulated results we can observe that input impedance of three frequency bands are $34.85+i3.29$, $46.13-i3.37$, $69.14+i3.79$ from the fig: 6a, 6b&6c. VSWR ranges differently at three frequency bands 1.4:1, 1.11:1, and 1.38:1. Directivity at their center frequencies and ϕ values 0deg and 90deg has been improved but more area is being covered at 10.44GHz. Finally, gain in 2.90-3.95GHz is -2.83dB, in 4.90-8.20GHz is 6.03dB and in 8.20-12.40 GHz we have 4.36dB. We can observe more uniformity in 3-5GHz but we get negative gain. From all the results we observed that it gives better performance in 5.5-7.5 and 8-12GHz frequency bands but bandwidth has been more in 2.90-3.95GHz and next to it was 4.9-8.20 GHz. Therefore, this model performs well in 4.9-8.20 GHz.

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