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Analysing a Stepped Conical Antenna

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ABSTRACT: Cone-shaped antennas are helpful for several applications as a result of their broadband characteristics and relative simplicity. This instance includes an analysis of the antenna electric resistance and also the graphical record as functions of the frequency for a monoconical antenna with a finite ground plane and a fifty Ω concentrically feed. A double stepped conical is designed and analysed, The electric field of the proposed antenna is nearly same that is 22 and 25 respectively Reflection losses and S parameter of the proposed antenna is also less, which is 28 w.r.t 34. The bandwidth of the proposed antenna much more (5GHZ) than the basic conical antenna (0.2GHZ-6GHZ). The reflection parameter of the proposed antenna is better than the basic antenna. The gain is almost double than the proposed antenna. Far field amplitude is nearly comparative at the last point

KEYWORDS: Conical, Antenna, S-parameter, Gain.

I. INTRODUCTION

Conical antennas are useful for many applications due to their broadband characteristics and relative simplicity. This example includes an analysis of the antenna impedance and the radiation pattern as functions of the frequency for a monoconical antenna with a finite ground plane and a 50 Ω coaxial feed. The rotational symmetry makes it possible to model this in axially symmetric 2D. When modeling in 2D, you can use a dense mesh, giving an excellent accuracy for a wide range of frequencies.

II. MODEL DEFINITION

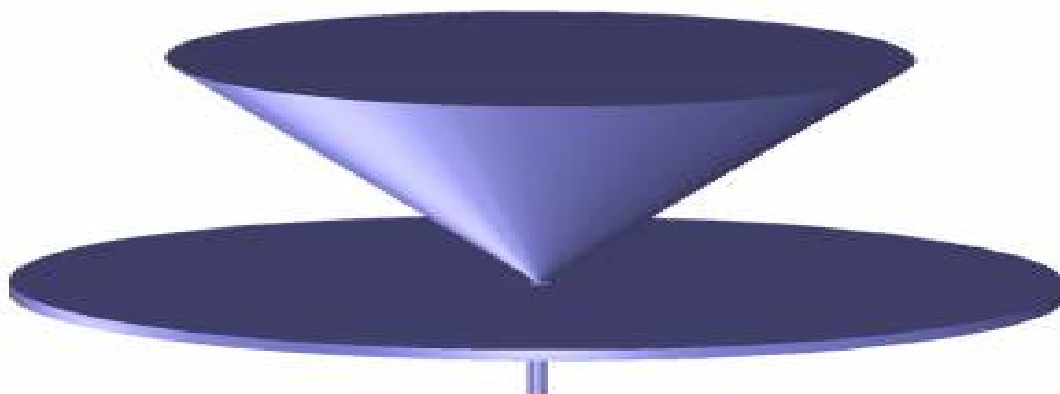


Figure 1: The pure mathematics of the antenna.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 7, Issue 6, June 2018

The antenna geometry consists of a 0.2 m tall metallic cone with a top angle of 90 degrees on a finite ground plane of a 0.282 m radius. The coaxial feed has a central conductor of 1.5 mm radius and an outer conductor (screen) of 4.916 mm radius separated by a Teflon dielectric of relative permittivity of 2.07. The central conductor of the coaxial cable is connected to the cone, and the screen is connected to the ground plane.

III. GEOMETRY DESIGN

Designing a conical antenna using comsol tool, to generate the above conical antenna geometry we needed the following steps.

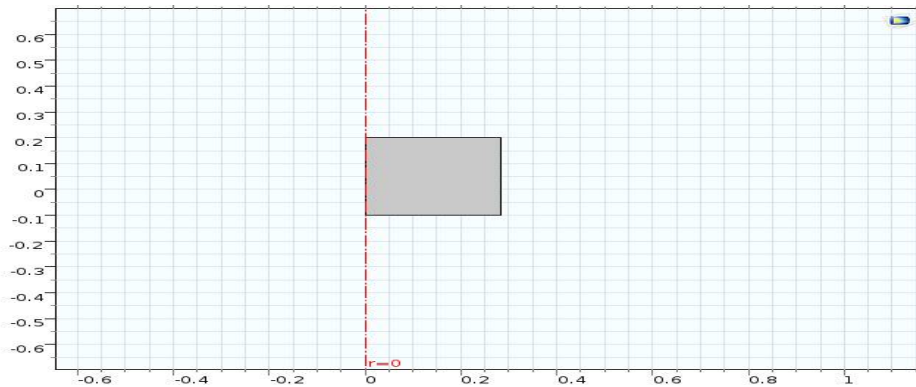


Figure 2: Rectangle with dimension length of 28.2 cm.

First we draw a rectangle 1 with width 28.2 and height dw i.e. 30.1 cm as shown in above figure.

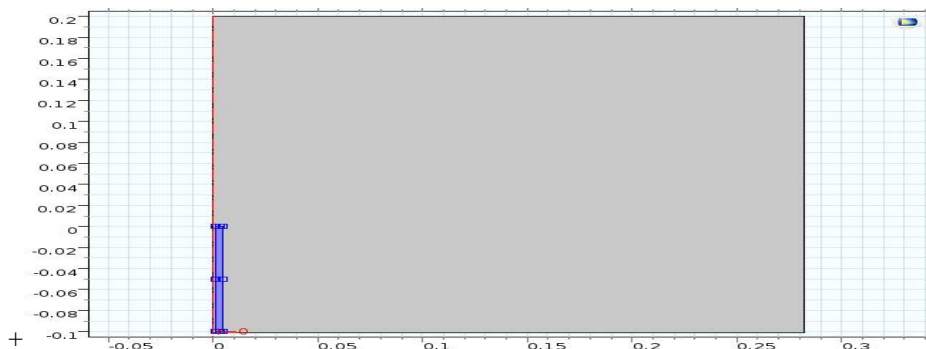


Figure 3: Rectangle 2 with dimension length of 0.342 cm.

Then we draw a rectangle 2 with width 0.342 and height 10 cm, adjacent to the rectangle 1 as shown in above figure in blue color.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 7, Issue 6, June 2018

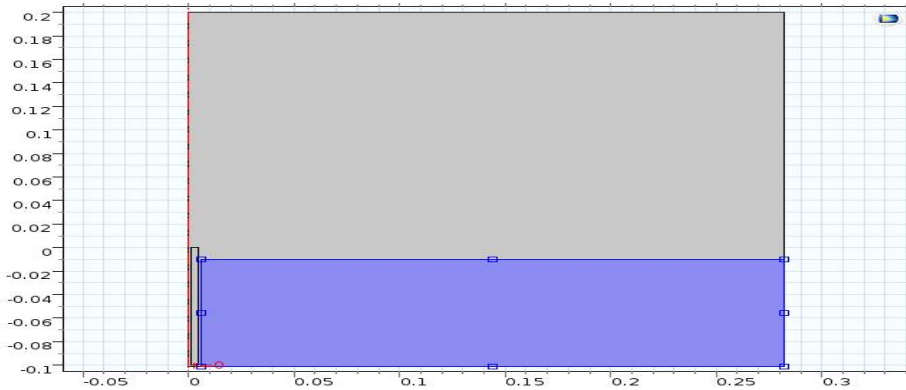


Figure 4: Rectangle 3 with dimension length of 27.6 cm.

Then we draw a rectangle 3 with width 27.6 and height 9.1 cm, adjacent to the rectangle 2 as shown in above figure.

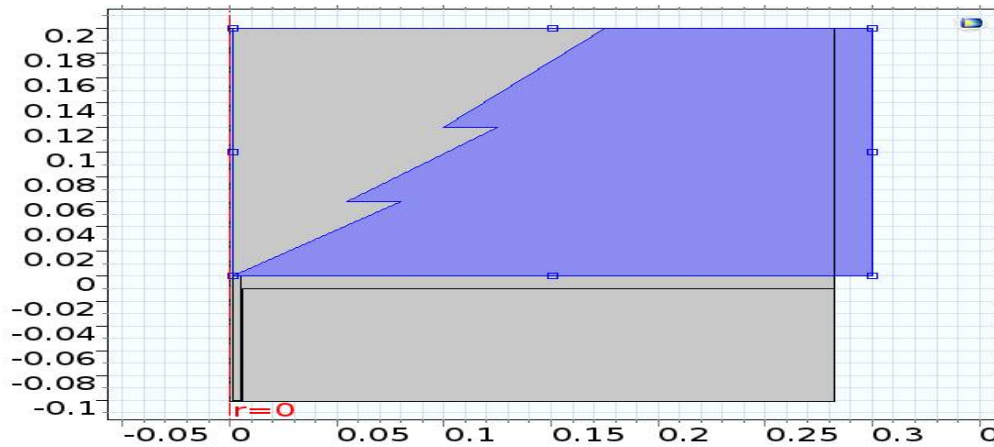


Figure 5: Polygon Design

By using $r = 0.3, 0.3, 0.175, 0.1, 0.125, 0.055, 0.08, 0.0015$ and $z = 0, 0.2, 0.2, 0.12, 0.12, 0.06, 0.06, 0$ we design a polygon as shown in blue.

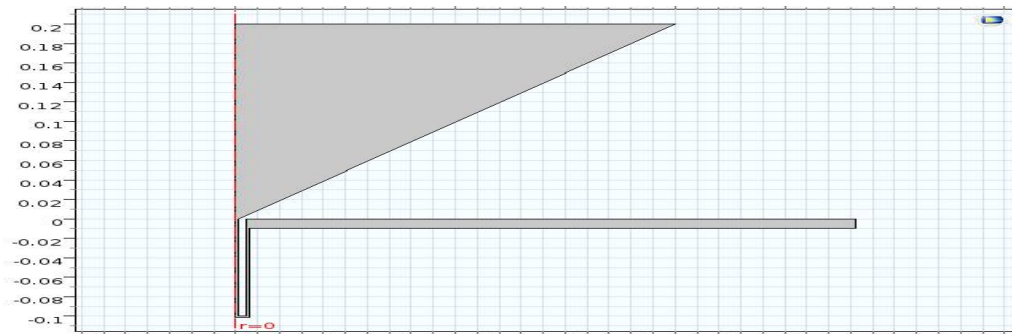


Figure 6: Symmetrical Half of Biconical Antenna.

Symmetrical half of typical biconical antenna is shown in figure 6. The central conductor of the cable is connected to the

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Vol. 7, Issue 6, June 2018

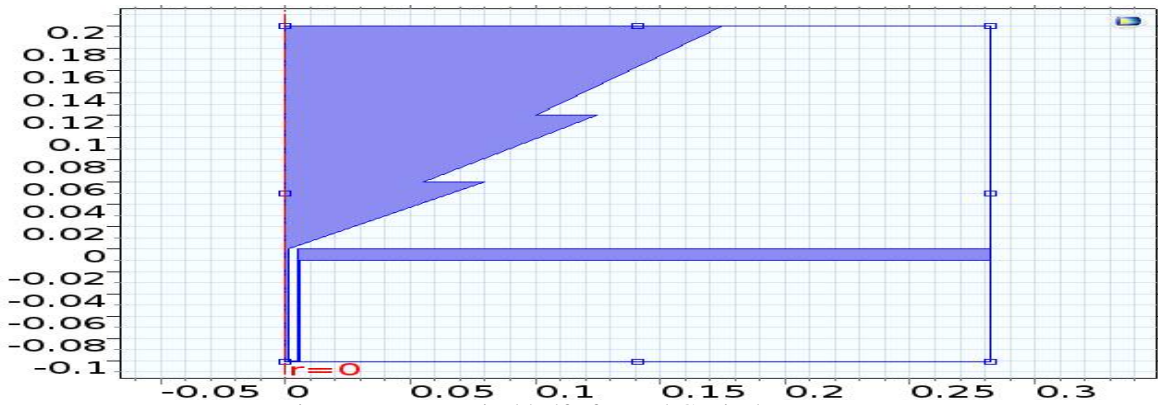


Figure 7: symmetrical half of Novel Conical antenna.

Symmetrical half of novel conical antenna is shown in figure 7. The central conductor of the cable is connected to the bronze stepped cone, and also the cable screen is connected to the finite ground plane.

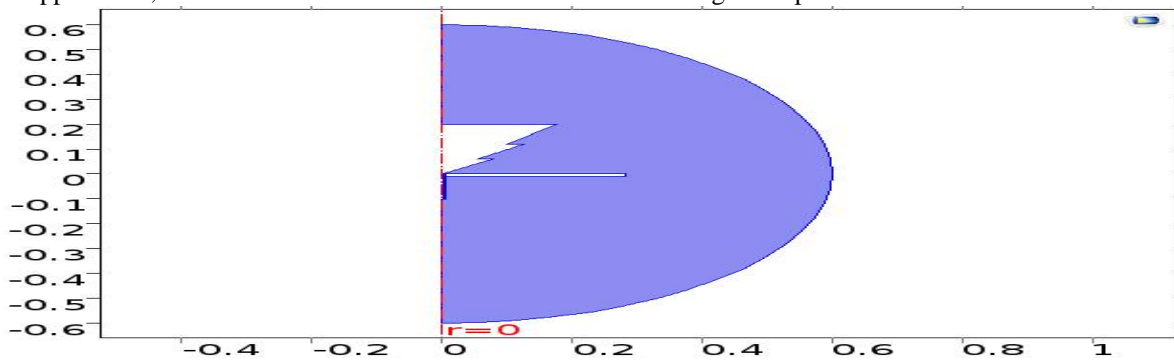


Figure 8: symmetrical half eith air domain.

Then a semi-circle of radius of 60 cm is drawn as an air domain for radiation pattern which is shown in figure 8.

IV. APPLING MATERIAL

The central conductor of the cable is connected to the stepped cone is made up of bronze, and also the cable screen is connected to the finite ground plane.

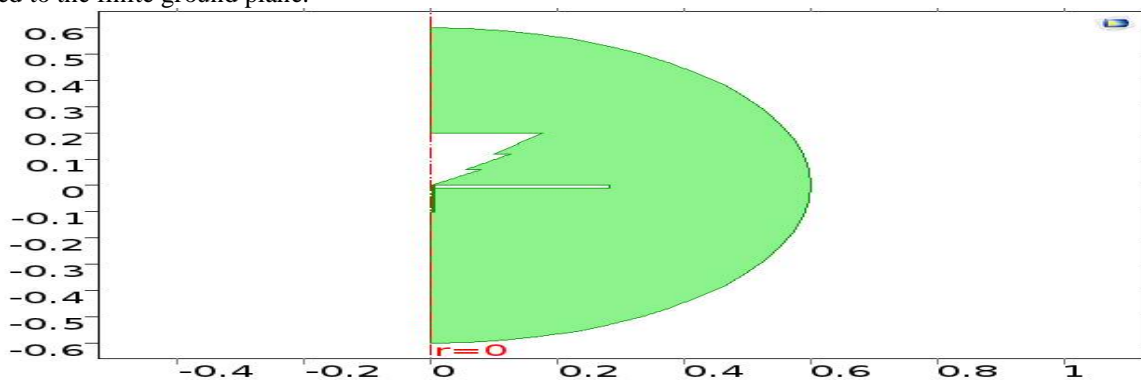


Figure 9: Appling Material

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 6, June 2018

The concentric feed incorporates a central conductor of 1.5 millimetre radius Associate in nursing an outer conductor (screen) of 4.916 millimetre radius separated by a teflonnonconductor of relative permittivity of 2.07. The central conductor of the cable is connected to the cone, and also the screen is connected to the bottom plane.

Table 1: Teflon Properties

»	Property	Name	Value	Unit
✓	Relative permittivity	epsilon _r	2.07	1
✓	Relative permeability	mu _r	1	1
✓	Electrical conductivity	sigma	0	S/m

V. BOUNDARY CONDITIONS

By using Electromagnetic Waves, Frequency Domain physics we can analyze the novel stepped conical antenna. The boundary conditions for the bronze surfaces are:

$$\mathbf{n} \times \mathbf{E} = 0$$

At the feed purpose, a matched concentric port stipulation is employed to form the boundary clear to the wave.

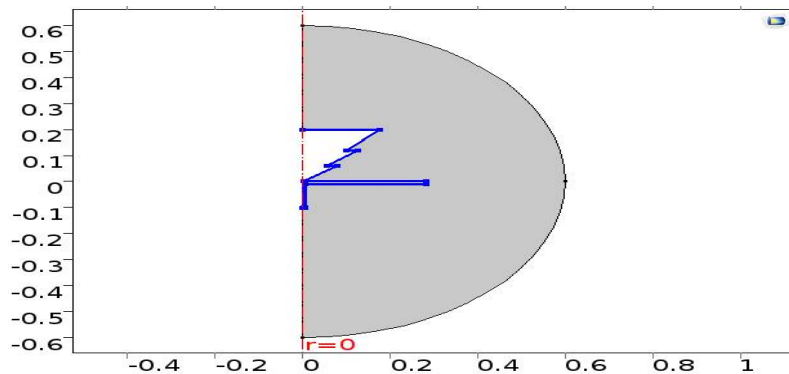


Figure 10: boundary conditions for the bronze surfaces

The antenna is divergent into free area, however you'll be able to solely discretize a finite region. Therefore, truncate the pure mathematics a long way from the antenna employing a scattering stipulation providing outgoing spherical waves to pass with little reflections. A symmetry stipulation is mechanically applied on boundaries at $r = 0$.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 7, Issue 6, June 2018

VI. MESHING

By meshing we can interruption of the geometry into small parts to make the solution more accurate, as shown in figure

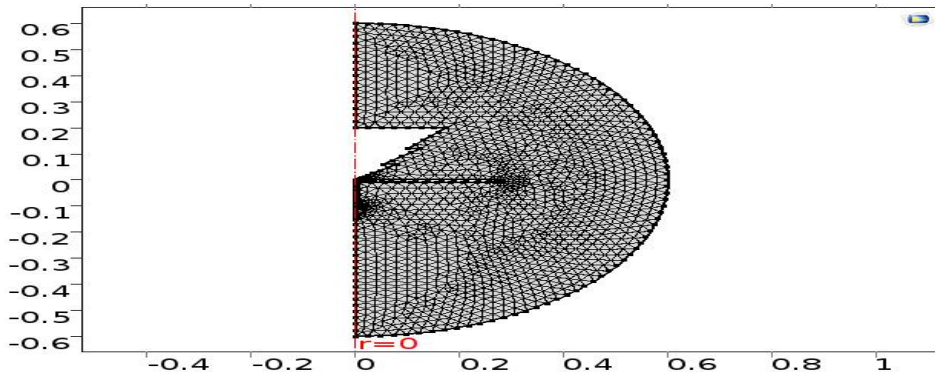


Figure 11: Meshing

VII. STUDY

In study we provide the study parameters for a geometry, in this model we apply the frequency at terminal ranging from 200 MHz to 1.5 GHz with a step size of 25 MHz as shown in figure below

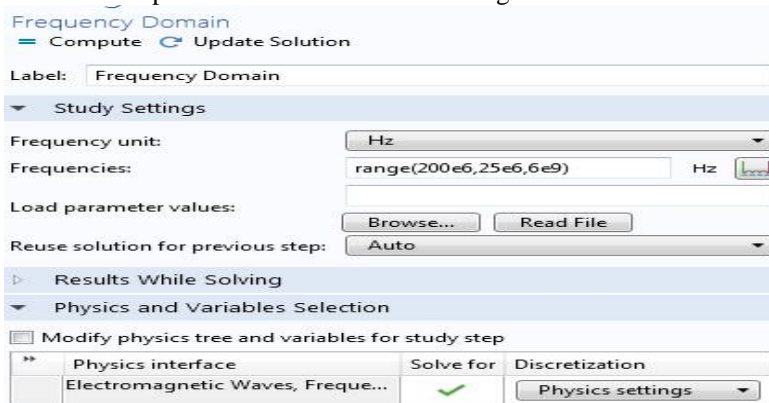


Figure 12: Applying Frequency Range

VIII. RESULTS

In post processing we analyse the various results of the basic design and new proposed stepped conical antenna design with various parameters of them.

a. ELECTRIC FIELD

The electric field of basic conical antenna are shown in figure 13, the blue and red circles around the cone in air domain are shown, with maximum value of 22.4 A/m.

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Vol. 7, Issue 6, June 2018

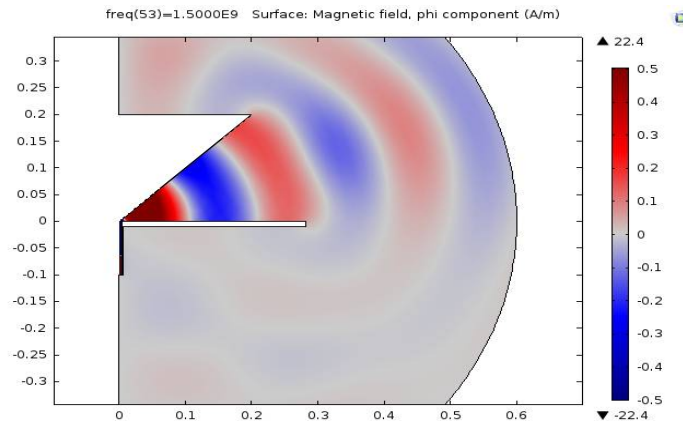


Figure 13: Electric Field basic

The electric field of proposed stepped conical antenna are shown in figure 14, the blue and red circles around the cone in air domain are shown, with maximum value of 19.7 A/m.

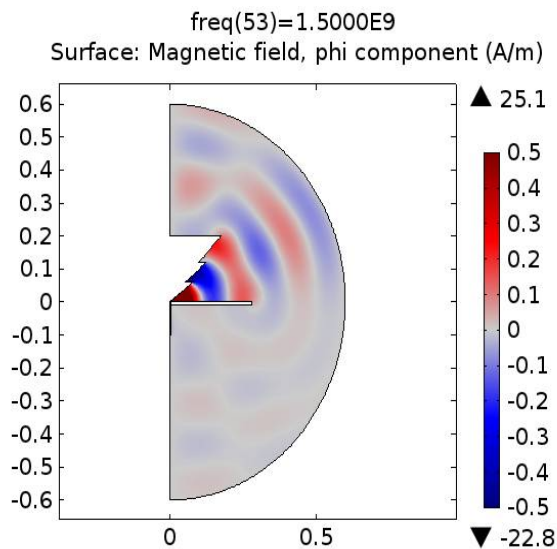


Figure 14: Electric Field of stepped

b. S - PARAMETER

The S - parameter of basic conical antenna are shown in figure 15, the losses in dB are shown for range of frequency is shown below with maximum loss of -38 dB.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 7, Issue 6, June 2018

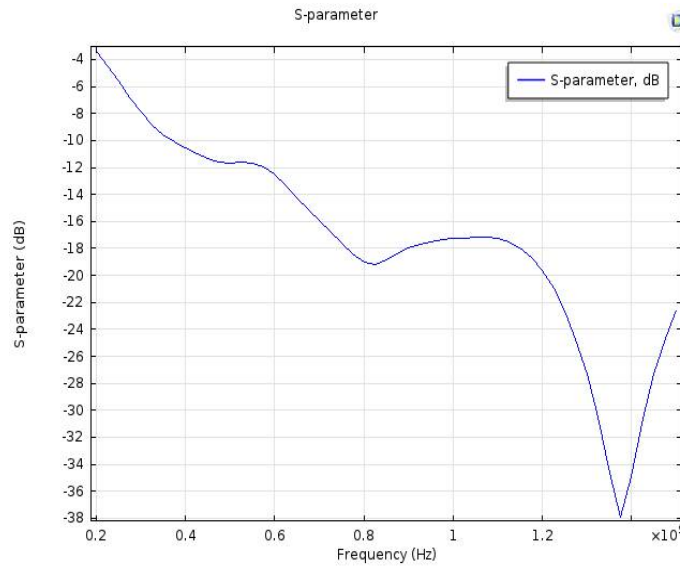


Figure 15: S – parameter basic

The S - parameter of proposed stepped conical antenna are shown in figure 16, the losses in dB are shown for range of frequency is shown below with maximum loss of -34 dB. Which is nearly half of the basic conical antenna.

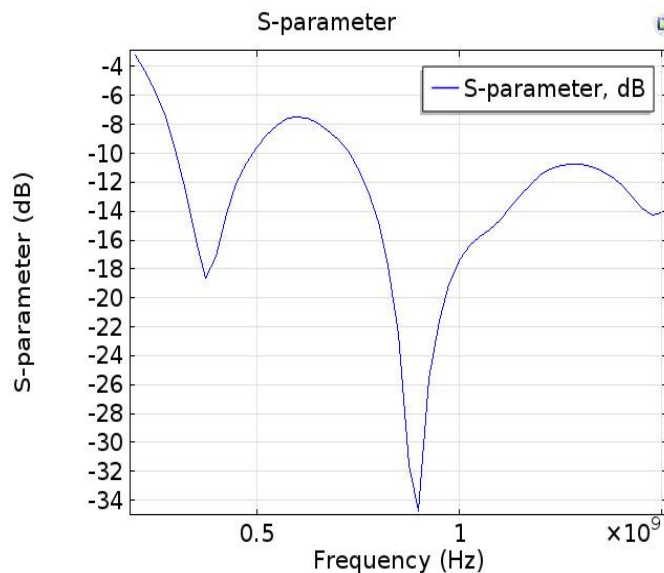


Figure 16: S-parameter of stepped

c. FAR-FIELD NORM (V/M) 3D

The polar far field pattern of basic conical antenna are shown in figure 4.17, with band of frequency starting from 200 MHz to 1.5 GHz with step size of 25 MHz.

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Vol. 7, Issue 6, June 2018

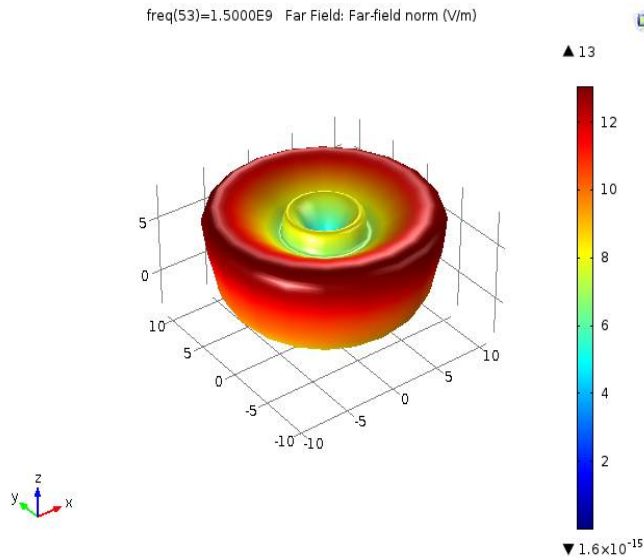


Figure 17: far field basic

The polar far field pattern of stepped conical antenna are shown in figure 4.18, with band of frequency starting from 200 MHz to 1.5 GHz with step size of 25 MHz. a unique pattern of field is shown below.

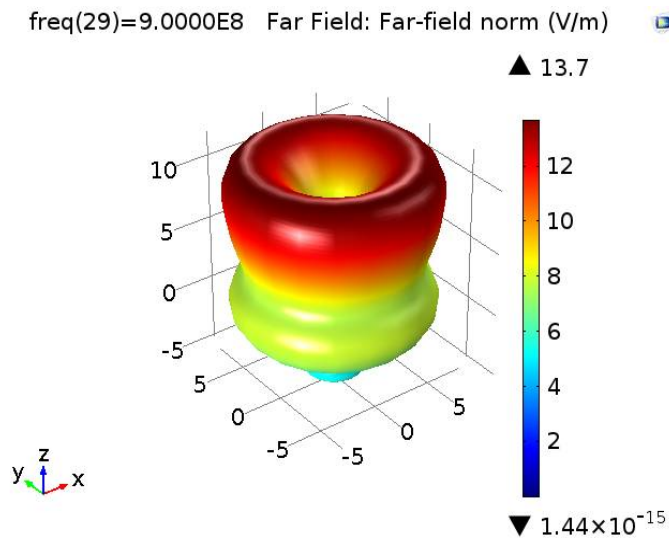


Figure 18: Far field of stepped

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 6, June 2018

IX. RESULT COMPARISION

Parameters	Basic Antenna	Conical Antenna	Stepped conical Antenna
Electric Field	21.9A/m		25.1A/m
S parameter	-38 db		-34db
Frequency Band	0.2 GHZ-1.4 GHZ		0.2 GHZ-6 GHZ
Reflection Parameter	-20db		-28.1db
Resonating Frequency	1.3 GHZ		0.9 GHZ
Gain	10db		20db
Far field	12.9		13.7

The table shows the comparison of various parameters of proposed stepped antenna v/s conical antenna.

1. The electric field of the proposed antenna is nearly same that is 22 and 25 respectively
2. Reflection losses and S parameter of the proposed antenna is also less, which is 28 w.r.t 34.
3. The bandwidth of the proposed antenna is much more (5GHZ) than the basic conical antenna (0.2GHZ-6GHZ).
4. The reflection parameter of the proposed antenna is better than the basic antenna .
5. The gain is almost double than the proposed antenna.
6. Far field amplitude is nearly comparative at the last point.

The distance covered by far field is almost double than the basic conical antenna due to which the problem of the signal losses at long distance can be minimized.

X. CONCLUSION

In practice, the stepped conical antenna is difficult to fabricate but the 10 dB return loss results in the low frequencies is small compared to the normal conical design. Thus the stepped conical antenna may be useful in some applications which demand specific radiation patterns. The input impedance of the conical antenna varies according to the step, as expected. It is observed that an optimum step exists for 50Ω matched impedance. From the above results, the influence of geometric parameters on impedance matching is noted. It is observed that the improvement in bandwidth can be obtained with the height of the conical antenna is approximately equal to the base radius of the cone. By using the proposed stepped antenna we are able to generate much better directivity i.e. it can transmit the radiation twice as far as compared to the basic conical antenna and without affecting its efficiency.

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Vol. 7, Issue 6, June 2018

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