Design of Conical Horn Antenna for UWB Applications

A.Swetha [1], Dr.P.Nageswara Rao [2]

[1] *Assistant professor G.Pullaiah college of Engineering & Technology*

[2] *Professor& Principal of G.Pullaiah college of Engineering & Technology*

Abstract— The horn is widely used as a feed for reflectors and lenses, it is a common element of phased arrays and gain measurements of other high gain antennas. This paper deals with design aspects of a conical horn antenna and to study its properties, the feed of a conical horn is often a circular waveguide. Horn antennas have very little loss, so the directivity of a horn is roughly equal to its gain. Horn antennas are used for receiving and transmitting RF signals. Here the conical horn antenna operates between 1-5 GHz and designed by using HFSS 13. Based on the study, simulations are carried out on a conical horn antenna.

Keywords— *Conical horn, HFSS software*

I. INTRODUCTION

Horn antennas are characterized using several parameters like gain, voltage standing wave ratio (VSWR), geometry, half-power beam width, frequency of operation, and polarization. There are several constraints that apply to our design. This antenna is required to operate within a frequency range of 1 to 5 GHz, attain a gain of 8 dB and maintain a half-power beam width of less than 60 degrees.

A. Conical Horn Antenna

Horn antennas are used for receiving and transmitting RF signals. The waveguide structure is open out or flared, launching the signal towards the receiving antenna. Since horn antennas are used in VHF (very high frequency) their application is in microwave and radar communication. There are three types of rectangular/conical horn antennas, H-plane sectoral horn, E-plane sectoral horn.

B. Design parameters of Conical Horn Antenna Waveguide

Waveguides are rectangular/circular shaped tubes. They are used for energy and information transfer in electromagnetic systems. Electromagnetic waves travel along waveguides by means of multiple reflections from the metallic walls, through the dielectric tube so the waves are guided by the tube conductor. Generally metallic waveguides have one conductor and operate at frequencies above 1 GHz. Metallic waveguides and cavity resonators are important components of many technologies with practical applications such as radar antenna feeds, circuitry, waveguide slot antenna arrays, horn antennas, microwave filters and other various other circuit component. The size of waveguide depends on the frequency you want to pass through it. Large frequencies have smaller wave guide. Because our design covers the frequency range of 1 - 5 GHZ.

C. Dimensions of a Conical Horn Antenna

Antenna Aperture & Body: The antenna body is an extension of the waveguide. The length of an antenna is proportional to its gain. As length increases the gain of antenna increases. Another physical parameter is the antennas effective aperture. It is defined as the ratio of the power received by the load at the antenna terminals and the surface power density of the incoming electromagnetic wave. The aperture of horn antenna is directly related to the gain of the antenna, which is given by the formula,

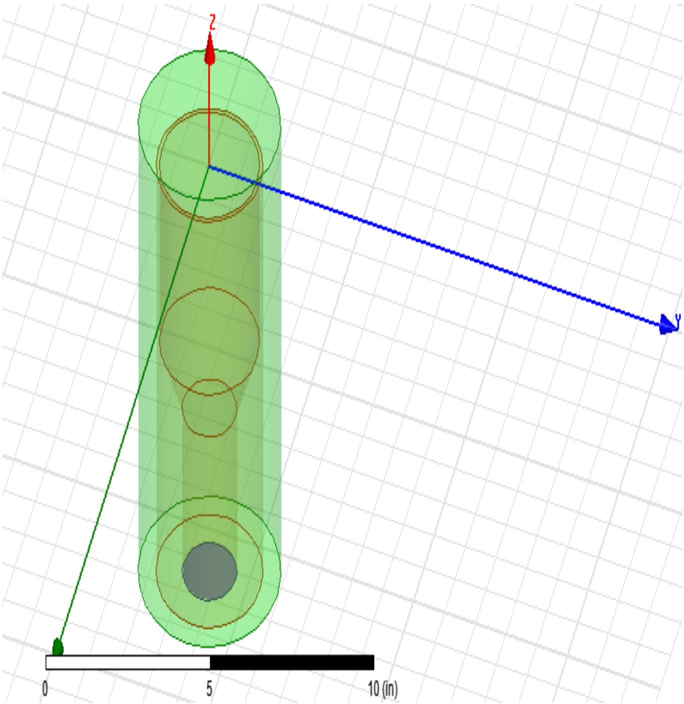

Fig.1: Geometry of Conical horn antenna

The following formulas are based on the transmission line model:

The width and length of a rectangular micro strip patch are given by,

$$A_{eff} = \lambda^2 / 4\Pi * G \qquad (1)$$

Where,

G is the gain of an antenna and λ is the wavelength.

Antenna Feed: The waveguide of a horn antenna is fed with a monopole to transmit electromagnetic radiation. The most frequently used monopole antenna is quarter-wave vertical wire monopole i.e. h =_/4. In our design the monopole is fed with the outer connecter connected to the waveguide.

II. SIMULATION SETUP AND RESULTS

The software used to model and simulate the Conical horn antenna is HFSS (High Frequency Simulator Software) based on the method of moments. It analysis3D and multi layer structure of general shapes.

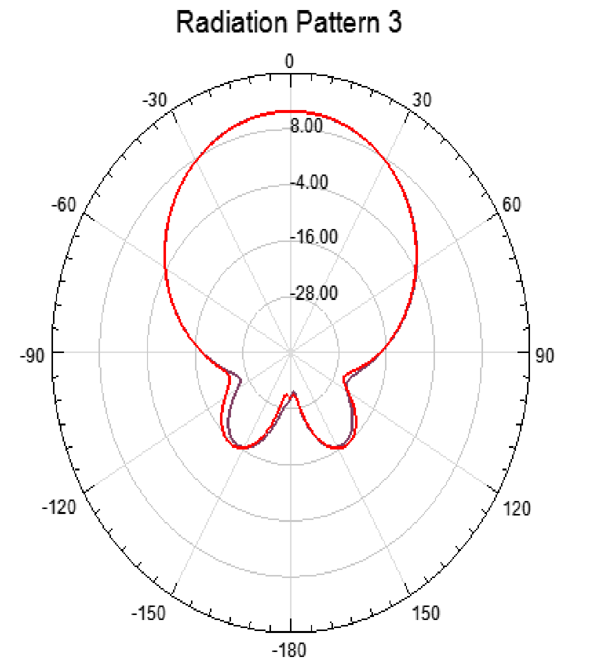

Fig.2: Directivity of a Conical horn antenna of RHCP

The far-field radiation patterns are calculated using the following equations

$$E_\theta = -j(\cos(\phi)\, Ja_{02})\, F \quad (2)$$

$$E_\phi = +j(\cos(\theta)\sin(\phi)\, Jb_{02})\, F \quad (3)$$

Where

$$Ja_{02} = J_0(ko.a_e.\sin(\theta)) - J_2(ko.a_e.\sin(\theta)) \quad (4)$$

$$Jb_{02} = J_0(ko.a_e.\sin(\theta)) + J_2(ko.a_e.\sin(\theta)) \quad (5)$$

$$F = \frac{\sin(ko.h.\cos\theta)}{ko.h.\cos\theta} \quad (6)$$

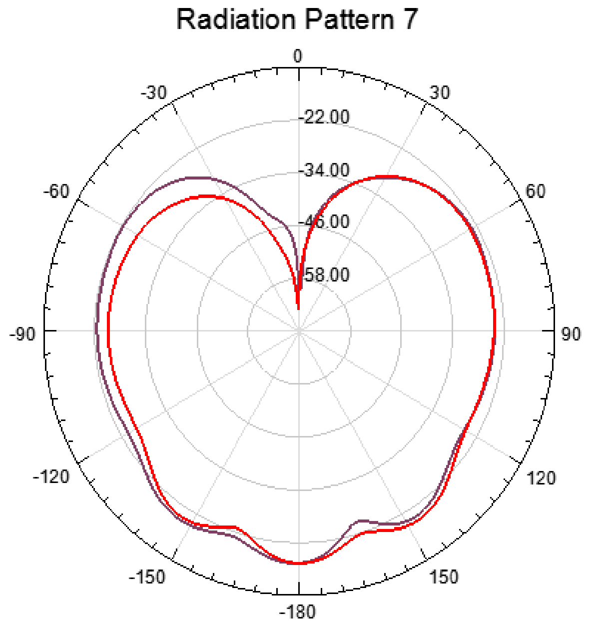

Fig.3: Directivity of a Conical horn antenna of LHCP

$$ko = 2\pi / \lambda_o$$

$$a_e = a\left\{1 + \frac{2h}{\pi.a.E_r}\left[\ln\left(\frac{\pi a}{2h}\right)\right] + 1.7726\right\}^{1/2} \quad (7)$$

J_0 denotes zero order Bessel function of the first kind. J_2 denotes second order Bessel function of the first kind.The total far-field forthe circular patch is given by the following equation:

$$Epatchc = \left(|E_\theta|^2 + |E_\phi|^2\right)^{1/2} .PatternSF$$

where

$$PatternSF = \frac{1}{\frac{1}{(RollOff\ (\theta - 90))^2 + K} + 1} \quad (8)$$

RollOff is the roll-off factor between 0 and 1 (0=soft , 1=sharp), typical value is 0.15. K is a small offset to avoid infinities at theta=90, typical value is 0.001

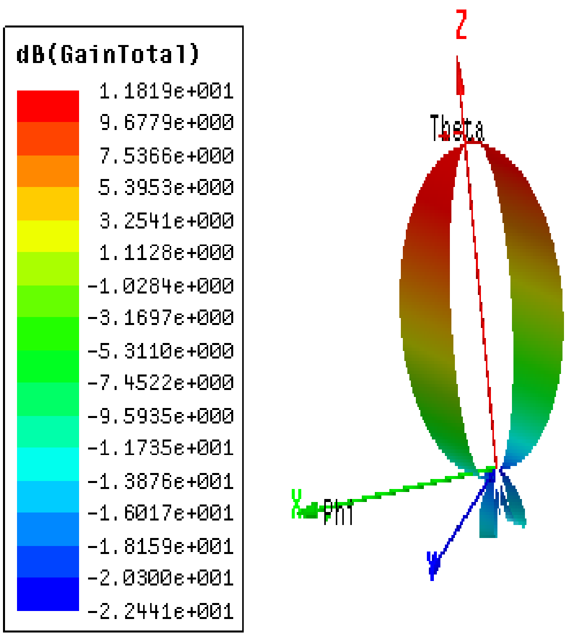

Fig.4: 3 – D Polar plot of Conical Horn Antenna

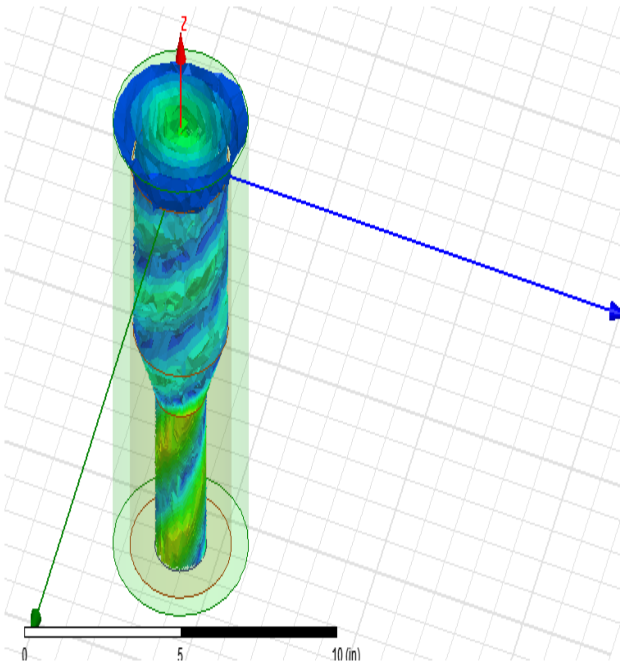

Fig.5: Radiation Pattern of Conical Horn Antenna

III. CONCLUSION

The microwave horn antenna is relatively straightforward in its appearance and as a result, its advantages may be Wide bandwidth, Simple construction and Easy interface to waveguide. One particular use of horn antennas is for Short range radar systems which can be used in speed enforcement cameras.

The horn antenna is a particularly useful form of antenna for use with RF microwave applications and waveguide feeder. Although it is not used below RF microwave frequencies because waveguides are not used at low frequencies as a result of the sizes needed, the horn antenna is nevertheless a very useful form of RF antenna design for use at high frequencies.

This designed conical horn antenna operates between the frequency of 1-5 GHz and having the gain of more than 10 db and simulations have been carried out by using HFSS 13.

IV. REFERENCES

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Mrs. A. SWETHA received the B.Tech degree in Electronics and Communication Engineering from Dr. K.V. Subba Reddy College of Engineering & Tech, JNTU Anantapur, A.P in 2012 and received her M.Tech in G. Pullaiah College of Engg & Tech Kurnool, JNTU Anantapur, A.P. Her current research interests includes study and designing properties of antennas and its applications and she is working as an Assistant Professor of GPCET.

Dr. P. Nageswara Rao received his B.Tech degree from Nagarjuna University, Guntur, India, in Electronics and Communications Engineering and Master's degree from Coimbatore Institute of Technology, Coimbatore, India, in 1990 and 1995, respectively. He received his Doctoral degree from NIT Warangal. He worked as faculty in ECE department at NBKRIST, Nellore and Sree Vidyanikethan Engineering College, Tirupati for 10 years. Currently he is working as Principal at G. Pullaiah College of Engineering &Technology, Kurnool, A.P, India. His areas of interest are Numerical Electromagnetic and micro strip antennas.