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Design and Performance Evaluation of Pyramidal Horn Antenna for Microwave Applications

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Abstract
The broadband characteristics possessed by horn antenna is attracting the interest of many researchers in the development of communication devices. This research presents the design of pyramidal horn antenna for 10 GHz frequency. Performance parameters of the antenna are extracted by using High Frequency Structure Simulator.
Index Terms— Horn antenna, Gain, Voltage standing wave ratio, Efficiency, High frequency structure simulator.

Introduction

Horn antenna is among the most widely used antennas which in addition to radiation and reception of electromagnetic signal can be used as feed element for radio telescopes and for satellite tracking. It is also very common in phased antenna arrays. Horn antenna also serves as a universal standard antenna for calibration and gain measurement of other high gain antennas. Simple and easy to design, high gain broad band characteristics are among the few features of horn antenna for its popularity. An electromagnetic horn can take many different forms, such as basic pyramidal, conical, corrugated, double-ridged, and dual polarized horns as shown in Fig (1).

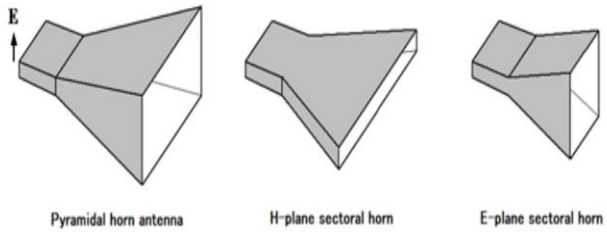

Figure 1 Horn Antennas

Horn antennas are generally fed by waveguides. The Radiation pattern of horn antenna depends upon the Length and Width of the opening, Height of Horn and also on the dimensions of waveguide as shown in Fig (2). Horn antennas provide a gradual transition structure to match the antenna impedance with the impedance of free space. This provides complete impedance matching to couple maximum power from antenna to free space.

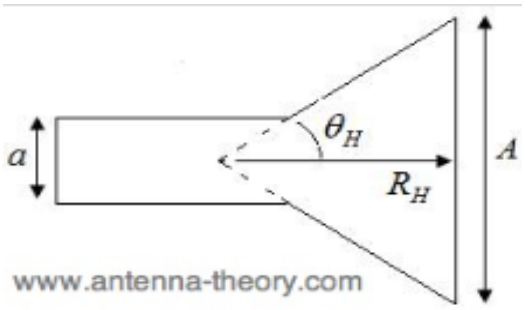

Figure 2 Cross section of Horn Antenna along E

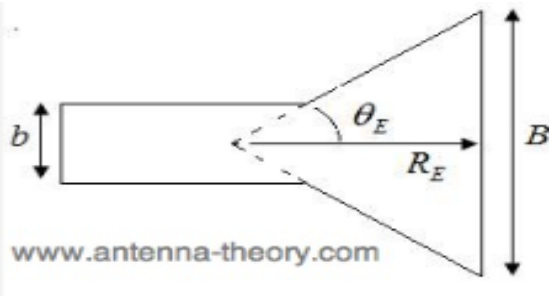

Figure 3 Cross section of Horn Antenna along H

As per the references [1-5] Design parameters of horn antenna are shown in Fig (4).

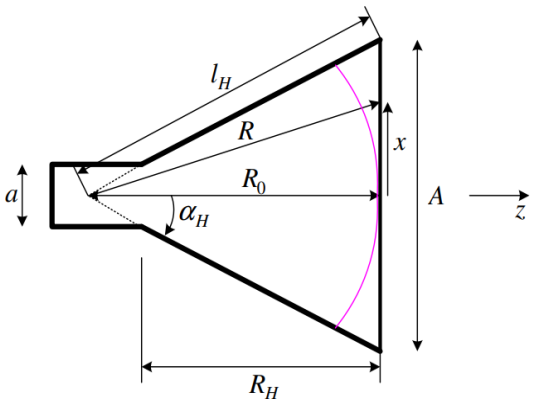

Figure 4 Design parameters of Horn Antenna

Two required dimensions to construct Horn are A and R_H.

Here $l_H^2 = R_o^2 + \left(\frac{A}{2}\right)^2$

$$\alpha_H = \arctan\frac{A}{2R_o}$$

$$R_H = (A-a)\sqrt{\left(\frac{l_H}{A}\right) - \frac{1}{4}}$$

Gain of Horn antenna can be expressed as

$$G = \frac{4\pi A}{\lambda^2} e_A$$

Here A is cross sectional aperture area of horn antenna.
e_A is Aperture efficiency of horn antenna which range from 0 to 1.
Based on above equations design parameters of E plane Horn antenna are presented below

Table 1

S.No.	Name of Parameter	Value
1	Horn width (A)	3.556 cm
2	Horn flare length	7.62 cm
3	Wave guide Length	2.5 cm
4	Wave guide Width	1.25 cm

Results and Discussion

The structure of E plane pyramidal horn antenna designed in HFSS is shown in Fig (5).

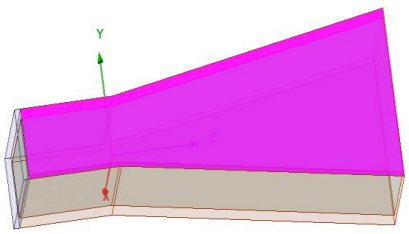

Figure 5 Structure of Horn Antenna

The Scattering parameters S_{11} of designed antenna are shown in Fig (5). At operative frequency of
10 GHz return loss is measured as

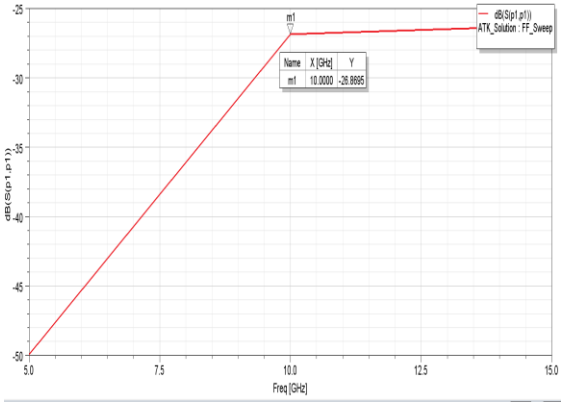

Figure 6 S_{11} parameter of Horn Antenna

The radiation patten of Horn antenna is plotted in Fig (6). The maximum achieved directive gain of antenna is 13.8 dB.

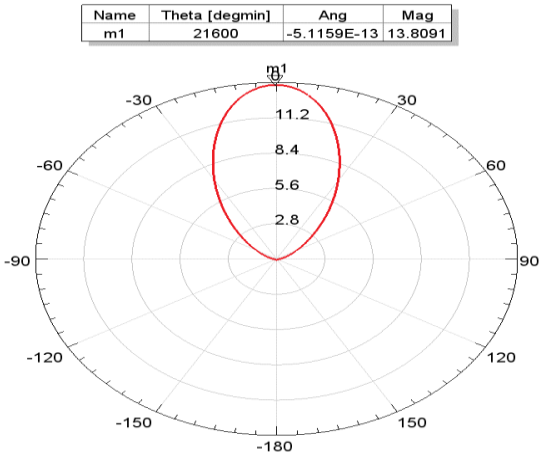

Figure 7 Radiation Pattern of Horn Antenna

Conclusion

An E plane Horn antenna is designed and simulated in this research. High frequency structure simulator is used to simulate the design of horn antenna. A high value of directive gain equal to 13.8 dB is achievable from this antenna.

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