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Design and Implementation of Horn Antenna

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ABSTRACT
This project is about the design and implementation of a standard gain horn antenna using High Frequency Structure Simulator (HFSS) Software. The horn was designed by implementing a procedure. Simulation & optimization of the horn was carried out in HFSS based on Finite Element Method (FEM). The reason to simulate the horn in HFSS is the fact to achieve optimum gain and equal radiation patterns in both E-plane & H-plane (pencil beam). It's also easy in HFSS to optimize the various dimensions of the horn for optimum results. After the simulation & optimization, the horn was manufactured and tested. The results of the finalized simulation and actually manufactured horn are very close to each other. Simulation and measurement results of 0.7-7 GHz double-ridged guide horn (DRGH) antenna with coaxial input feed section is presented. This antenna, due to the large frequency band required by standards, is appropriate to be used in electromagnetic compatibility (EMC) testing and antenna measurement as a transmitter. A step-by-step method for designing DRGH antenna is given. A suitable taper for the ridges in the horn is designed and its impedance variations along the horn are shown. In addition, a new structure for the electrical field probe in the feed section is introduced by which a shift down of lower frequency to 0.7 GHz is achieved. A sensitivity analysis is done on the parameters of the proposed structure. Other parameters of the feed section are also investigated and optimized values are obtained. Finally, the proposed antenna has been fabricated and measurement results show good agreement with the simulation. Index Terms-Standard gain horn antenna, Pyramidal horn antenna, Radiation pattern, High Frequency Structure Simulator (HFSS) Software, Characteristic impedance; double ridged guide horn (DRGH); electromagnetic compatibility (EMC); impedance taper.

Keywords- HFSS Software, Finite Element Method, E-plane & H-plane,

I. INTRODUCTION

Antennas are one of the most important parts of a communication chain. A comprehensive design procedure of C-Band Standard Gain Horn is presented. A pyramidal horn is chosen for this purpose. The reason to use this horn antenna is the fact that equal radiation patterns in both Eplane and H-plane can be obtained. Another reason to use this antenna is its high gain and directivity.

First of all, the design procedure used to implement the horn is presented here. Formulas are presented that are used to calculate the aperture fields and radiated fields. Then this design procedure and formulas were implemented to obtain the required radiation pattern. After the implementation, the finalized horn was simulated in HFSS to measure its radiation patterns, gain and VSWR. The length and aperture dimensions of the horn were optimized to obtain the optimum values of gain, radiation patterns and VSWR. The results of each step are presented.

After the finalization of design using and HFSS, the horn was manufactured. An antenna test procedure was carried out to measure the gain and radiation patterns of the horn. The measured results are plotted. The optimized and practically measured results are very close to each other.

Mainly include E-plane, H-plane, pyramidal and conical. It is nothing more than a

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hollow pipe of different cross sections which has been flared to a larger opening. The type, direction and amount of flare can have a profound effect on the overall performance of the element. Pyramidal horn, the main subject area in this exercise, is used as Standard Gain Horn Antenna. Pyramidal horn is one which is flared in both directions. This horn is most widely used and its radiation characteristics are essentially a combination of E-plane and H-plane sectoral horns. Since this horn is flared in both directions, equal radiation patterns in both Eplane and H-plane can be obtained by properly adjusting its dimensions. Such a beam which has equal radiation patterns in both E-plane and H-plane is called pencil beam.

Horn antennas are very popular at UHF (300 MHz-3 GHz) and higher frequencies (I've heard of horn antennas operating as high as 140 GHz). Horn antennas often have a directional radiation pattern with a high antenna gain, which can range up to 25 dB in some cases, with 1020 dB being typical. Horn antennas have a wide impedance bandwidth, implying that the input impedance is slowly varying over a wide frequency range (which also implies low values for S11or VSWR). The bandwidth for practical horn antennas can be on the order of 20:1 (for instance, operating from 1 GHz-20 GHz), with a 10:1 bandwidth not being uncommon.

II. LITERATURE SURVEY

[1] C. Brunsetal has presented the electromagnetic simulation for 1 to 18GHz broadband DRH antenna including a coaxial excitation. In this frequency domain MOMsimulation have been used for measurements. In this paper, first time such a complete antenna system was simulated in one step over the entire frequency range.It was observed that to get satisfactory antenna performance, small geometric tolerances of the ridged waveguide horn needs to be maintained and that theintroduction of mechanical imperfections into the simulation model significantly enhances the agreement between measurements and simulations. Disadvantage of this approach is that designed broadband ridged horns exhibit same performance that is degradation in upper frequency range, because propagation of higher ordermodes were fail to suppress effectively.

[2] A. R. Mallahzadehet et al has explained Dual polarized antenna which is widely used in different communication systems like ECM and DF system. In this paper, for 8 18 GHz dual polarized double ridged horn antenna was introduced. In this, five layer polarizer was used to provide dual polarizations of the DRH antenna. In order toachieve dual polarizations the strips width, strips spacing and layers distances were optimized. CST software was used for analysis of designed antenna. The Eθ and Eϕ pattern of designed antenna for x-y plane and y- z plane for various frequencies show that, the antenna proposed yields good performance for dual polarizations application. Moreover, the antenna VSWR is < 2 over the operating frequency band which is require in UWB application

Proposed System

It is designed in HFSS software. The waveguide section of the quad ridged horn antenna consists of two pairs.

Dual Ridged Horn supports single linear polarization. Over the years the ridges were increased from two to four so that horn antenna supports circular polarization.

Quad Ridge horn antenna supports the linear polarization in the direction H-plane and E-plane.

It works in the frequncy range from 700MHz-2GHZ.

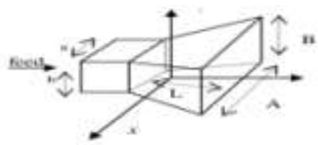


Fig 3.1 3D Horn Antenna

Working Principle:

A horn antenna serves the same function for electromagnetic waves that an acoustical horn does for sound waves in a musical instrument.

It provides gradual transition structure to match the impedance of a tube to the impedance of free space, enabling the waves from the tube to radiate efficiently into space.

This acts like an impedance matching transformer, allowing most of the wave energy to radiate out the end of the horn into space, with minimal reflection.

The wide aperture of the horn projects the waves in a narrow beam.

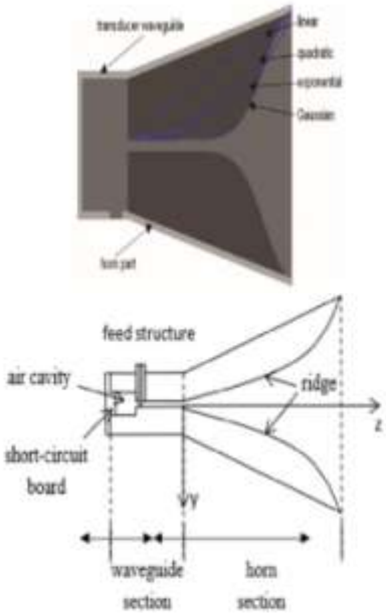


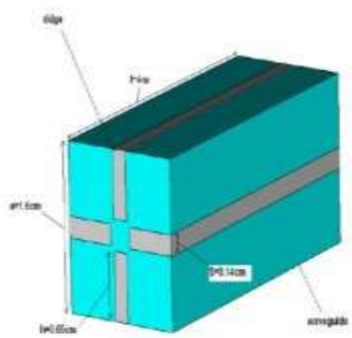
Fig 3.2: Horn Antenna

Distinguishes a quadruple-ridged waveguide significantly from a single-or dual-ridged waveguide. However, if the TE11 mode is sufficiently suppressed or not excited the bandwidth between the TE10 and theTE20L can be very large. we observe that higher order mode, i.e., TE20L, can not propagate in the waveguide because theS12 parameter is much lower than 0 dB

In next step, it is necessary to use the transition between two coaxial probes to the quadruple-ridged waveguide.

One coaxial prob for vertical polarization and the other for horizontal polarization.

Entrance of the coaxial probes is critical for the return loss performance of the horn antenna. A lot of simulations have been made to optimize the transitional performance using Ansoft's HFSS.



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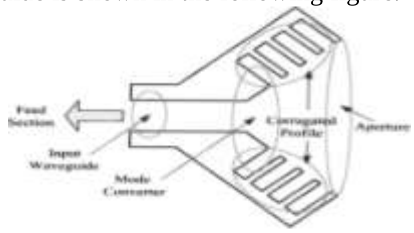
Two port quad ridged waveguide

III. HARDWARE

Waveguides are basically a device ("a guide") for transporting electromagnetic energy from one region to another. Typically, waveguides are hollow metal tubes (often rectangular or circular in cross section). They are capable of directing power precisely to where it is needed, can handle large amounts of power and function as a high-pass filter.

The waveguide acts as a high pass filter in that most of the energy above a certain frequency (the cutoff frequency) will pass through the waveguide, whereas most of the energy that is below the cutoff frequency will be attenuated by the waveguide. Waveguides are often used at microwave frequencies (greater than 300 MHz, with 8 GHz and above being more common).

Waveguides are wideband devices, and can carry (or transmit) either power or communication signals. An example of a hollow metal rectangular waveguide is shown in the following figure.



Sectional View Of Horn Antenna

IV. SOFTWARE DISCRIPTION

HFSS

- Ansys HFSS is a 3D electromagnetic (EM) simulation software for designing and simulating high-frequency electronic products such as antennas, antenna arrays.
- RF or microwave components, high-speed interconnects, filters, connectors, IC packages and printed circuit boards.
- Engineers worldwide use Ansys HFSS software to design high-frequency, high-speed electronics found in communications systems.

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- Advanced driver assistance systems (ADAS), satellites, and internet-ofthings(IoT)products.

V. RESULTS

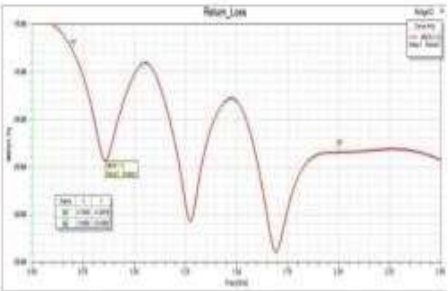


Fig 7.1: Plot of Reflection Loss

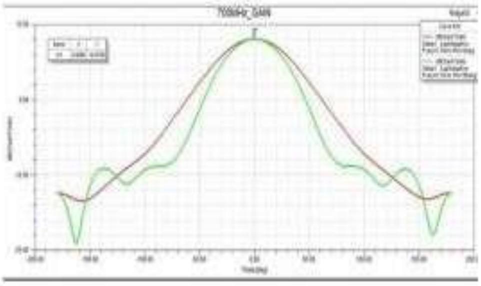


Fig 7.2: Gain Plot at 0.7GHz

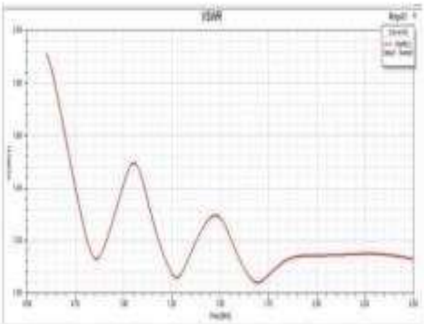


Fig 7.3: Gain Plot at 0.7GHz

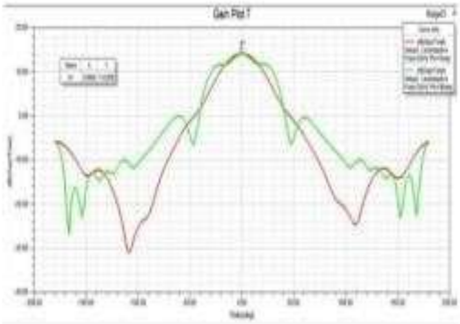


Fig 7.4: VSWR

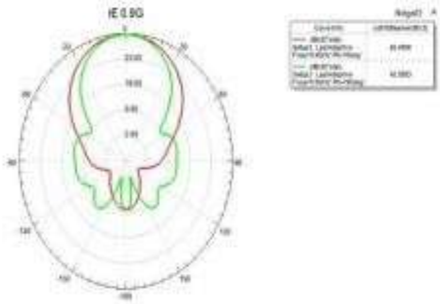


Fig 7.5: Radiation pattern at 0.9GHz

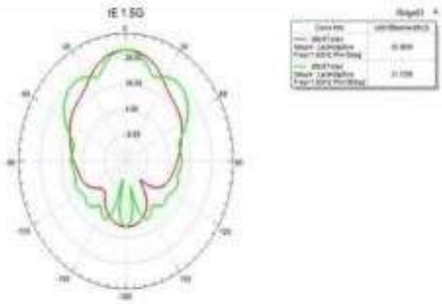


Fig 7.6: Radiation pattern at 1GHz

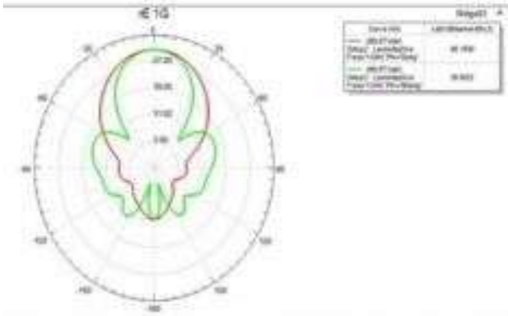


Fig 7.7: Radiation pattern at 1.5GHz

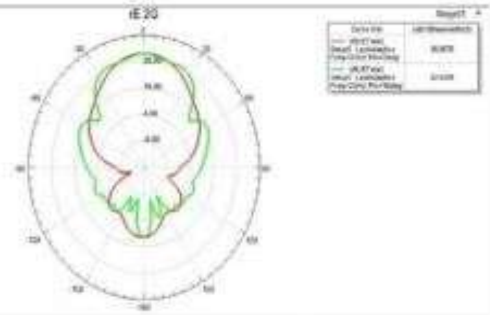
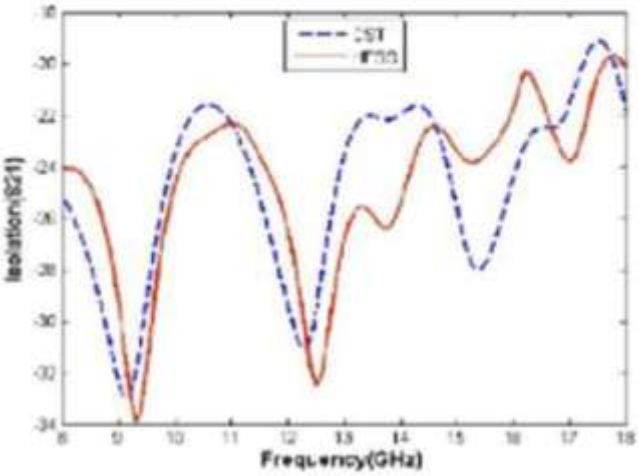


Fig 7.8: Radiation pattern at 2GHz

The voltage standing wave ratio (VSWR) results of the designed horn antenna are presented. It can be seen that both of the coaxial ports have VSWR ≤ 2.6 over the frequency range of 8–18 GHz. From these figures it is obvious that the VSWR initially(around 8 GHz) starts from 2.6 and around 8.3 GHz it reaches below2.4, i.e., the required band of 8–18 GHz is effectively below VSWR of2.4.

The isolation between the two coaxial ports is shown in Fig. 12which is better than 19.92 dB over the entire frequency.



REFERENCES

[1]. W L Barrow, L J Chu, and W K Chen, 1993 "Theory of the Electromagnetic Horn", Linear Networks and Systems (Book style), Belmont, CA: Wadsworth, pp 123–135.

[2]. W L Barrow, F M Greene (Massachusetts Institute of Technology, Cambridge, Massachusetts) and B Smith, Dec 1938 "Rectangular Hollow-Pipe Radiators", Proceeding of The Institute of Radio Engineers, vol. 26, pp -1498-1519.

[3]. William M Truman And Constantine ABalanis, "Optimum Design of Horn Feeds for Reflector Antennas", 1974, IEEE transaction on Antenna and Propagation, vol. AP-22, 585-586.

[4]. Mohamed Lashab, Samir Ladaci, F Abdelliche and F Benabdelaziz "Fractal Surface Effect on Horn Antennas Radiation Pattern", May 08 1945, 3rd National Conference on Fractional order System and Their Applications,SOFA 2012, vol. 3, Guelma, Algeria.