Advancement in Designing of Wideband Horn Antenna

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Abstract— A Dual Ridge Horn Antenna operating in frequency range of 4-17 GHz is designed using equation based exponential tapered part varies the impedance of the guide from 50 © at the feeding point (double-ridged rectangular waveguide) to 377 © at the aperture of thenantenna. Designed Horn Antenna has a total length of 43.375 mm which means it is very small in size and weight. An N- type coaxial line to rectangular double-ridged waveguide transition is introduced for coaxial feeding of the designed antenna. Major modifications are imposed on Back Cavity, exponential taper and to design antenna as small as possible. The proposed antenna is simulated with commercially available packages such as Ansoft HFSS. Microwave Studio for the given operating frequency range. The antenna gives decent gain of about 4 dB to 25 dB over operating range while delivering 13 GHz bandwidth.
*Keywords-**HFSS , VSWR , EMC***

I. INTRODUCTION

Antennas are one of the most important parts of a communication chain. In Modern times need for wideband applications has increased. The Horn Antenna is widely used in the EMC measurement, radar and communication system. Pyramidal Horn is the best horn as it has equal radiation patterns in both E-plane and H-plane along with its high gain and directivity.So,the need to develop a Wideband horn antenna for communication and calibration purposes.With the development of measurement, communication system, radar techniques and electromagnetic, the horn antenna has been widely used which made it one of the most practical antennas. By adding ridge, horn antenna can effectively extend the working bandwidth of the antenna and improve the impedance matching between waveguide and free space. Generally, when VSWR of the wide-band ridge horn antenna is below 2.5, engineering applications can be satisfied. The main type of ultra-wideband has log-periodical antenna, helical antenna and ridged antenna .The double ridged horn antenna is widely device for transmission and reception of the electromagnetic waves [7]. It has very wide frequency band, relative small capacity, stable phase center and high bore efficiency. To extend the operating frequency bandwidth of the horn antenna ridges are commonly introduced in waveguide to lower the cut off frequency of the fundamental mode.

In this paper, based on the double-ridged rectangular waveguide, a double-ridged antenna including a 50 © coaxial feed input is proposed. Accordingly, a waveguide transition structure for the single-mode, the TE10 mode, with low return loss performance and a new technique for synthesizing the exponential taper is presented. The proposed antenna is simulated with commercially available nite element method and CST microwave studio which is based on the nite integral technique. Simulation results for the VSWR, gain, and radiation patterns of the designed antenna at various frequencies are presented.

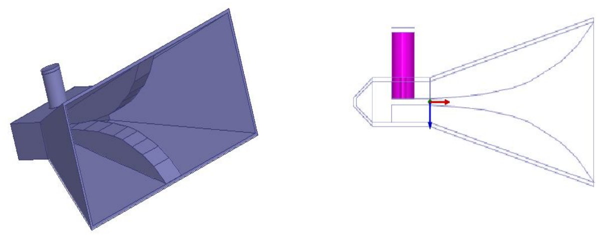

FIGURE 1. Designed Horn Antenna Perspective View and (b) Wireframe View in HFSS

An electromagnetic horn can take many different forms, four of which are shown in Figure 1. The horn is nothing more than a hollow pipe of different cross sections, which has been tapered (flared) to a larger opening. The type, direction, and amount of taper (flare) can have a profound effect on the overall performance of the element as a radiator. In this chapter, the fundamental theory of horn antennas will be examined.

II. OPERATING PRINCIPLE OF ANTENNA

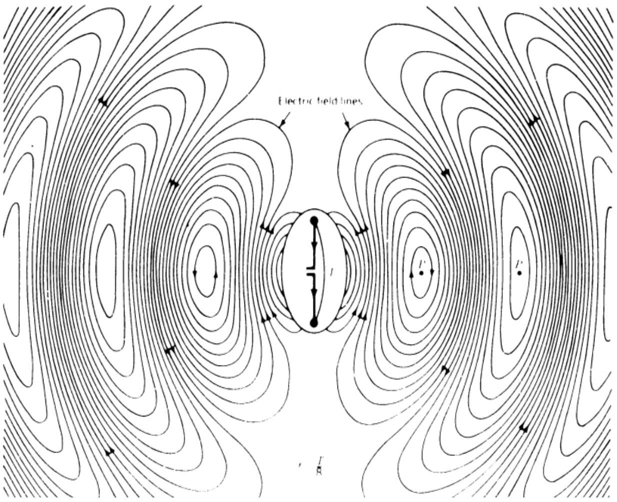

FIGURE2- A typical standing wave pattern of a transmission line

The reflected waves from the interface create, along with the traveling waves from the source toward the antenna, constructive and destructive interference patterns, referred to as standing waves, inside the transmission line which represent pockets of energy concentrations and storage, typical of resonant devices. A typical standing wave pattern is shown in Figure 2. If the antenna system is not properly designed, the transmission line could act to a large degree as an energy storage element instead of as a wave guiding and energy trans-porting device. If the maximum field intensities of the standing wave are sufficiently large, they can cause arching inside the transmission lines.

III FAR FIELD/ RADIATION PATTERN

An antenna radiation pattern or antenna pattern is defined as "a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates. In most cases, the radiation pattern is determined in the far-field region and is represented as a function of the directional coordinates.

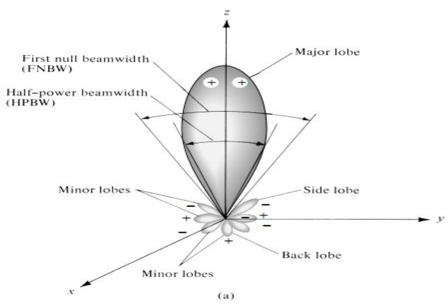

FIGURE 3- 3D View of Radiation Pattern

. IV E AND H PLANE SECTORAL HORN

In E-plane sectoral horn opening is flared in the direction of the E-field, and it is shown in Figure 4. One of the simplest and probably the most widely used microwave antenna is the horn. Its existence and early use dates back to the late 1800s, and is widely used as a feed element for large radio astronomy, satellite tracking, and communication dishes found installed throughout the world. In addition to its utility as a feed for reflectors and lenses, it is a common element of phased arrays and serves as a universal standard for calibration and gain measurements of other high-gain antenna, Balanis, C.A[1]. As such, it is often referred to as the standard gain horn.

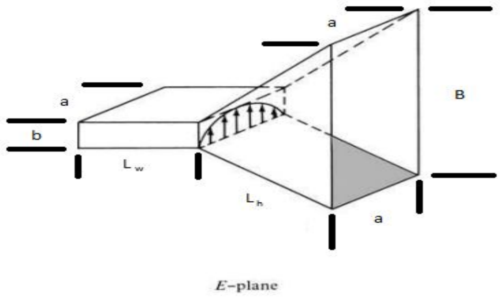

FIGURE 4 E- plane horn and coordinate system

Flaring the dimensions of a rectangular waveguide in the direction of the H-field, while keeping the other constant, forms an H-plane sectoral horn shown in Figure 5. Its physical structure is same as that of E-plane only the difference is that in place of E-plane flaring we do H-plane flaring

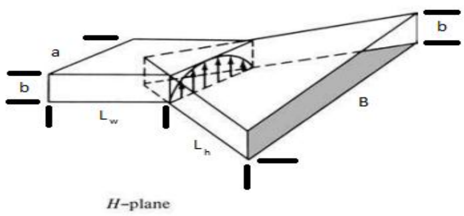

FIGURE5- H-plane horn and coordinate system

V RESULT AND DISCUSSIONS

Structuresare simulated using ANSOFT HFSS.The designed antenna exhibits low cross polarization. The gain of the proposed antenna versus frequency is shown in Fig 6. Regardless of its size horn antenna gives decent gain of about 4 dB to 22 dB over operating range while delivering 13 GHz bandwidth. The maximum value of gain occurs at the end of the operating frequency band. To conclude, this antenna is capable of providing high gain and less distorted transmitted pulses for EMC application.

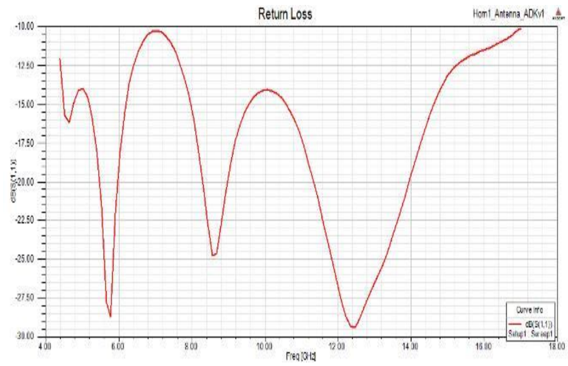

FIGURE -6 RETURN LOSS |S| DB OVER FREQUENCY RANGE

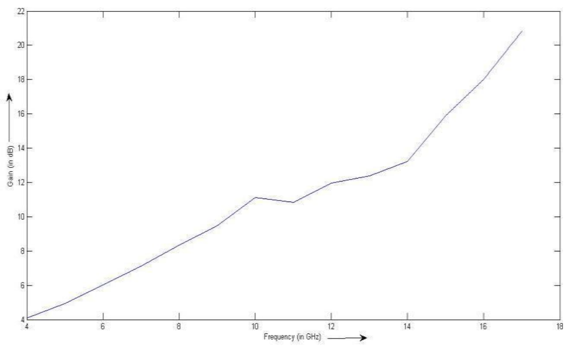

FIGURE7- GAIN VS. FREQUENCY PLOT

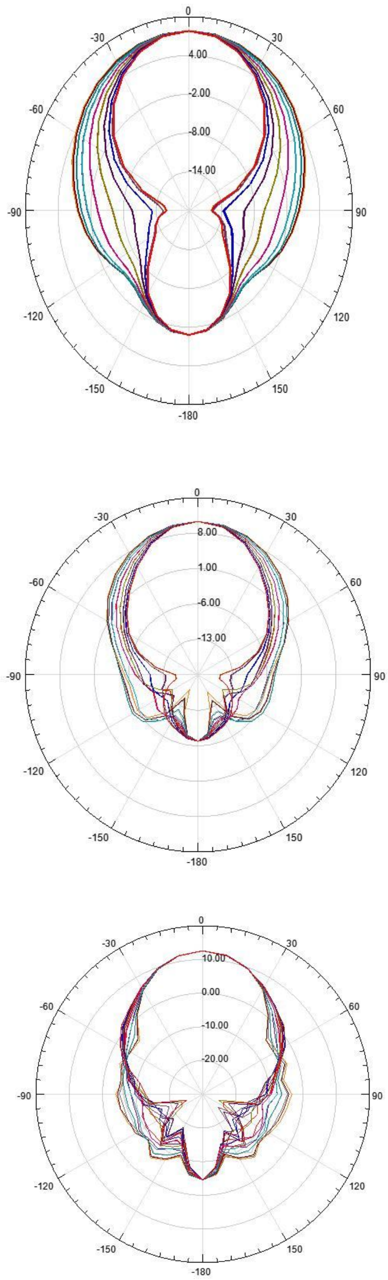

FIGURE 8- Simulated Farfield patterns of the antenna for various at:
(a) 6GHz, (b) 10 GHz, (c) 16 GHz.

Radiation Pattern of the designed antenna is shown in Fig 8. We have shown the patterns for C-Band, X-band and Ku-Band. From the figure we can clearly see that for low frequency band like C-Band, designed horn antenna has moderately low gain of 6.25dB and high directivity while its side lobe level is very low. For medium frequency band like X-Band, designed horn antenna has moderately gain of about 8.5 dB and high directivity while its side lobe level is low. Also for high frequency band like Ku-Band, designed horn antenna has high gain of 18dB with acceptable side lobe level. Hence it is clear from the figure that the antenna shows feasible pattern over the entire range of operation.

VI CONCLUTION

An Ultra Wideband Dual Ridge Horn Antenna operating in frequency range of 4-17 GHz is designed and optimized using HFSS. This linearly polarized antenna regardless of its size gives decent gain of about 4 dB to 25 dB over operating range while delivering 13 GHz bandwidth. Compared to conventional double-ridged horn antennas with rectangular apertures, the designed antenna (with lower size of aperture) has lower weight and low cross polarization. Incidentally, the fabrication of proposed antenna is much easier than double-ridged horn antennas. Desired results are achieved and the simulated structures are suitable for our applications. Structures are yet to be fabricated and measurement results will be presented accordingly. Efforts are going on to further improve bandwidth so as to accumulate even wider frequency range especially K Band and lower bands (L and S).

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