

Design of Corrugated Conical Horn Antenna for KU band satellite Application

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Abstract— In this paper, basic review and design of the corrugated conical horn antenna is presented. The dependence of radiation pattern of corrugated horn depends on many parameters, so design parameter are discussed and based on discussion the mode converter with variable depth slot is designed which shows good characteristics like return loss and pattern symmetry on given frequency range. The designed antenna achieves a measured peak gain of 13 dB, Directivity 13.2 dB and return loss -53.30 dB at 16 GHz frequency .The electromagnetic accuracy of the antenna is measured with the help of High Frequency structure simulator (HFSS) Software.

Index Terms— HFSS systems, corrugated horn Antennas,direct-broadcast satellite (DBS), feeds

I. INTRODUCTION

One of the simplest and probably the most widely used microwave antenna is the horn antenna. The horn antenna is nothing more than a hollow pipe of different cross sections, which has been tapered (flared) to a larger opening. Horn antennas consist of a flaring metal waveguide shaped like a horn to direct radio waves in a beam. They are used as feeders (feed horns) for larger antenna structures such as parabolic antennas and as directive antennas for such devices. They are used as a feed element for large radio astronomy, satellite tracking and communication dishes. Its widespread applicability stems from its simplicity in construction, ease of excitation, versatility, large gain, and preferred overall performance. Horn antennas are popular in the KU band (above 16 GHz) for satellite communication.

In the 1960s, the idea of corrugated horns was first considered by Kay [2], Simons and Kay [1] and Minnett and Thomas [4], [5]. This was due to the specific interest in achieving symmetric radiation patterns so that low-side lobe and high efficiency reflector antennas could be produced. It was also realised in the 1970s by Parini, Clarricoats, and Olver [5] that corrugated horns radiate very low levels of cross polarisation, which is essential for dual-polarisation operation

or frequency re-use. This is the situation where two signal channels are transmitted on orthogonal polarisations at the same frequency, and no interaction takes place between the two channels. Therefore the channel capacity is doubled for a single antenna. Corrugated horns supporting so-called hybrid modes have become well established as feeds for reflector antennas, and even as direct radiators. It is not difficult to trace the popularity of the corrugated horn, given the ability of certain hybrid modes to produce radiation patterns having extremely good beam symmetry with low cross-polarization levels, a high beam efficiency with very low side lobes, and the potential for wide-bandwidth performance [6,7]. Why they are called “corrugated” is clear from the typical example of a horn shown in Figure1, where the inside wall is manufactured in a succession of slots and “teeth.” The purpose of the corrugated surface is to provide the means to support the propagation of hybrid modes within the horn [3].

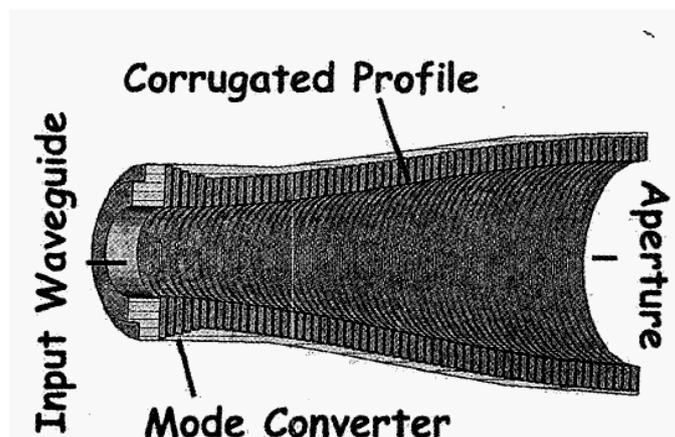


Fig. 1. A cut-away view of a typical corrugated horn [3].

Hybrid modes are basically a combination of TE and TM modes. For this combination to propagate as a single entity with a common propagating velocity, the horn or waveguide must have anisotropic surface-reactance properties: properties

that are satisfied by the corrugated surface. It is worth pointing out that hybrid modes can also be supported by other means, such as waveguides or horns partially filled with dielectric. However, these alternative possibilities are outside the scope of this design note [3]. We begin with some practical considerations. The band-width of a horn is usually defined by the frequency range over which the horn is required to have a suitable beam width and beam symmetry for a return loss with a cross polarization. These values are typical, but many high-performance applications have much tighter specifications [3]. As illustrated in Figure 1, it is usual for the corrugated horn to be connected to a circular, smooth-walled, input waveguide. The fundamental mode of this guide is the TE₁₁ mode, and there is the need for a so-called “mode converter” at the transition between the smooth-walled input waveguide and the body of the corrugated horn. This mode converter is designed to provide a smooth transition from the TE₁₁ to the HE₁₁ mode supported by the corrugated horn [3].

II. CALCULATION

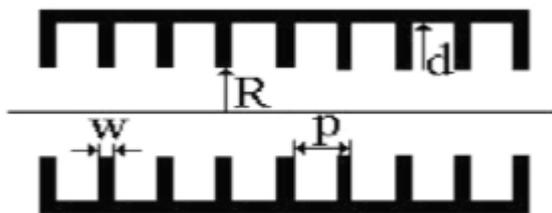


Fig. 2. Phasing section with corrugations

Fig.2 show that phasing section with corrugation Because of compactness of corrugated horn antenna in first section, directivity is low and phase centers on E and H planes are not coincident. So we use a phasing section to place phase centers together in the desired frequency band. Also it improves the mixture of TE₁₁ and TM₁₁ modes. Actually when this section is attached to the normal corrugated horn, they result in a potter like horn with new characteristics in bandwidth and radiation pattern (We named it potter corrugated horn). The phasing section is shown in Fig. 2 and design parameters is $w=3.12\text{mm}$, $p=6.25\text{mm}$, $r=7.3\text{mm}$, $l=150\text{mm}$.

- (1) period (p)
- (2) corrugation depth (d)
- (3) corrugation width (w)
- (4) input radius (r)

All these parameters are depends upon the wavelength (λ), and wavelength is calculated by the mid frequency of the frequency band for optimum performance.

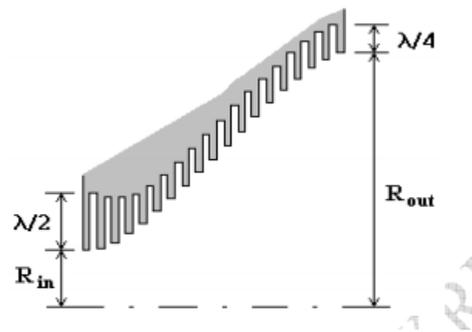


Fig. 3. Corrugation depth $\lambda/2$ to $\lambda/4$

Important parameters for the design of the corrugated wave guide mode converter are

As per theory period of the corrugation is $\lambda/3$

Width of the ridge is $p/2$

Corrugation depth starts from $\lambda/2$ and decrease to $\lambda/4$.

Input radius is $0.39*\lambda$ and profile angle α is 5 degree

TABLE I. Parameters & Result

No	Parameter	Value
1	Frequency band	Ku band (12GHz to 18GHz)
2	Operated frequency	16GHz
3	Wavelength λ	18.75mm
4	period p	6.25 mm
5	width w	3.125 mm
6	input radius r	7.3125 mm
7	Length L	150 mm

III. SIMULATION RESULTS

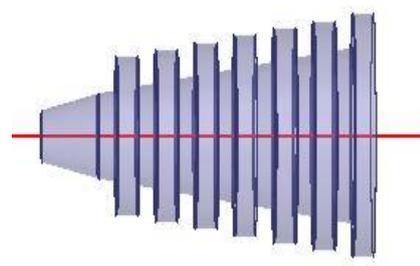


Fig. 4. Side view of corrugated conical horn antenna

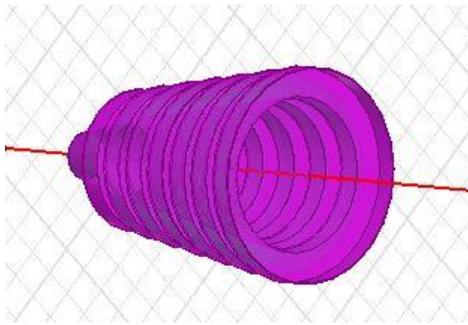


Fig. 5 front view of corrugated conical horn antenna

Fig. 4 and Fig.5 show that the design of corrugated conical horn antenna in different views. Fig. 6 shows the Directivity is 13.2db of the designed corrugated horn antenna, Fig. 7 shows the gain is 13.2db of the designed corrugated horn antenna, Fig. 8 shows the Return loss is -53.13db of the designed corrugated horn antenna and Fig. 9 Show the radiation pattern of corrugated conical horn antenna.

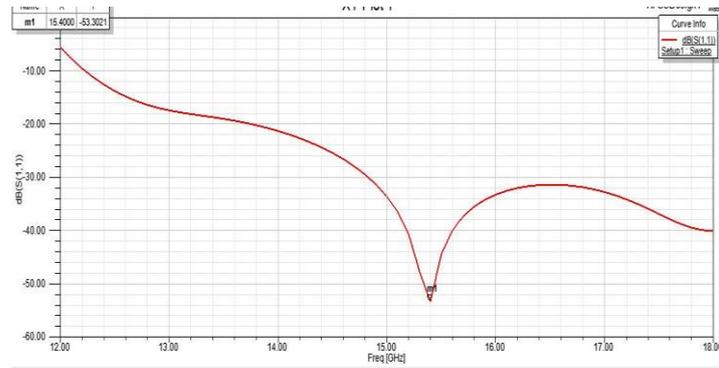


Fig. 8. Return loss of corrugated conical horn antenna

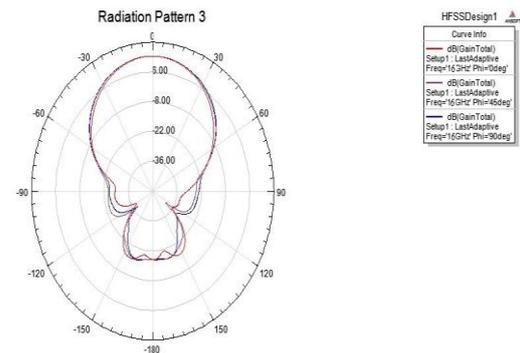


Fig. 9. Radiation pattern of corrugated conical horn antenna

IV. CONCLUSION

Review and design parameter of corrugated horn is presented in this paper. design which shows good pattern symmetry with gain of around 13 dB and Directivity of around 13.2dB down to the main beam with the return loss of -53.3 dB at the design frequency at 16 GHz. corrugated conical horn antennas in the Ku-band. Multiple horn antennas used for different polarization levels but it increases interference. To reduce the interference between polarization levels a corrugated horn antenna can be used.

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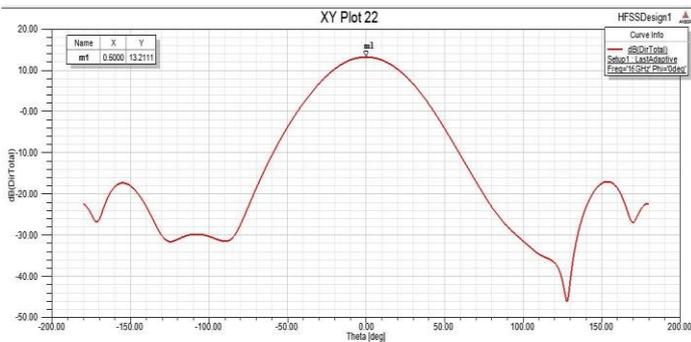


Fig. 6. Directivity of corrugated conical horn antenna

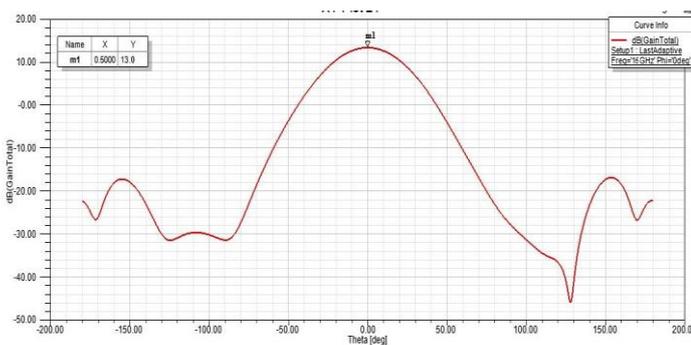


Fig. 7. Gain of corrugated conical horn antenna

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