Ultra-Wide Band Corrugated Gaussian Profiled Horn Antenna Design

Jorge Teniente, Ramón Gonzalo, and Carlos del-Río

***Abstract*—Nowadays, an increasing number of applications need stable radiation patterns with low sidelobes and low crosspolar levels in a very wide bandwidth. Gaussian profiled horn antennas (GPHAs) have demonstrated their feasibility as one of the best solutions. A corrugated Gaussian horn antenna design with more than 40% bandwidth is proposed in this letter. The measured radiated far field patterns are in good agreement with the simulated ones. The measured results show a Gaussian antenna with extremely wide bandwidth, low sidelobes, and low crosspolar levels.**

***Index Terms*—Corrugated horns, Gaussian beam, low cross-polar level, low side-lobe level, microwave antennas, profiled horns, wide bandwidth.**

I. INTRODUCTION

THE CONICAL corrugated horn antennas are known since the 1960s [1]. These antennas have been applied in many applications due to their excellent radiating properties such as symmetry patterns, low crosspolar and sidelobes levels. Lately, a new kind of profile, the so-called Gaussian profiled horn antenna (GPHA), has spurred the features of the corrugated antennas. Very low sidelobes and cross-polar levels together with high Gaussian-like patterns have been reported in [2] making these antennas good enough to overcome the most stringent requirements.

In this letter, the bandwidth properties of this kind of profiles are studied. Ultra wide bandwidths have been obtained by designing, fabricating, and measuring a GPHA operating at satellite communication frequencies. These results prove the suitability of this profile to satellite applications for covering at the same time several channels and also in measurement facilities as feedhorn.

II. ANTENNA DESIGN

The design was performed to accomplish an ultra-wide bandwidth (more than 40%), with low side-lobe and cross-polar levels. The selected frequency bands were X and Ku. A WR-75 waveguide was selected in order to cover the frequency range from 9 to 16 GHz. To ensure the high axial symmetry, circular corrugated waveguide technology should be used in the horn.

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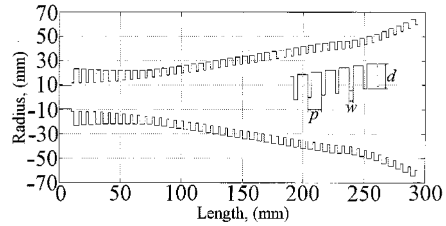

Fig. 1. Corrugated horn antenna profile.

Therefore, a rectangular-to-circular transformer was included at the beginning of the antenna.

A very compact (14 mm) cross-polar free rectangular-to-circular transition was used to feed the antenna from a standard WR-75 waveguide. The output radius of this transition was 9.5 mm being directly connected to the antenna input.

The proposed corrugated horn antenna profile is formed by two GPHAs stacked together (see Fig. 1) [3]. The corrugation period ($p = 6$ mm) and the tooth width ($w = 2$ mm) were fixed along the antenna. The total length was 284 mm with an output radius of 59.6 mm. Notice that at the throat, a waveguide transformer from $\lambda/2$ to $\lambda/4$ was introduced.

III. MEASUREMENTS

To verify the behavior of the antenna in all the operational bandwidth, two different feeds were used: a standard WR-90 input waveguide (in order to cover the band from 8.2 to 12.4 GHz) and a standard WR-62 input waveguide (from 12.4 to 18 GHz).

The measurement of the proposed antenna was performed from 9 to 16 GHz in steps of 5 MHz with an azimuthal step of 1°, covering from -70 to 70°. The E, H, 45°, and 135° planes were measured in co-polar polarization. Besides, the cross-polar 45° and 135° planes were also obtained in the whole band.

Postprocessing time gating techniques were applied to clean the antenna response from the multiple reflections of the chamber. Time gating techniques consist on filtering the antenna time domain response obtained by means of a FFT transform from a certain bandwidth frequency domain measurement [4].

It also should be noted that the cross-polar levels below -40 dB were difficult to measure due to the inherent cross-polar level of the reference feedhorns (see Fig. 3).

IV. COMPARISONS BETWEEN MEASUREMENT AND SIMULATION

Measured input return loss values below 18 dB were obtained from 11 to 14 GHz. These results are in good agreement with

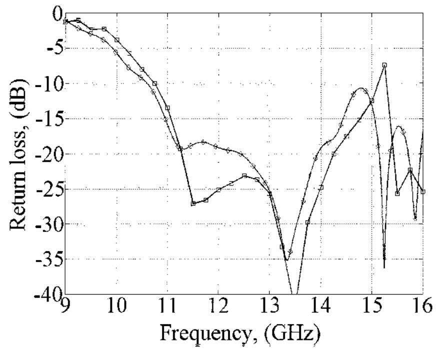

Fig. 2. ⊟ Simulated return loss (Ansoft HFSS finite element code). ⟡ Measured return loss.

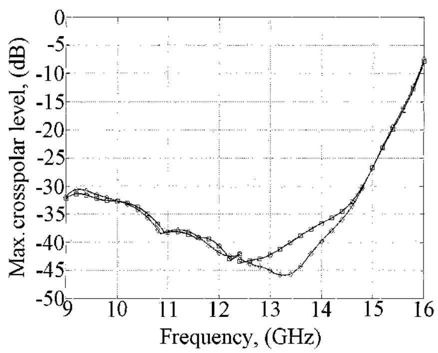

Fig. 3. Measured crosspolar maximum: ⊟ 45 deg plane, ⟡ 135 deg plane.

the simulated ones obtained by using ANSOFT-HFSS finite element code (see Fig. 2). These results could be improved by designing a better rectangular-to-circular transition.

The antenna shows a measured maximum cross-polar level below −30 dB from 9 to 14.8 GHz, (49% bandwidth), and below −35 dB from 10.6 to 14.4 GHz, (more than 30% bandwidth) (see Fig. 3). Fig. 4 depicts the radiation pattern in 1 GHz steps for the whole band. High symmetry patterns with directivity values from 19 to 22 dB along the band have been obtained. Also it should be noted that the sidelobes levels are below −28 dB from 9 to 15 GHz.

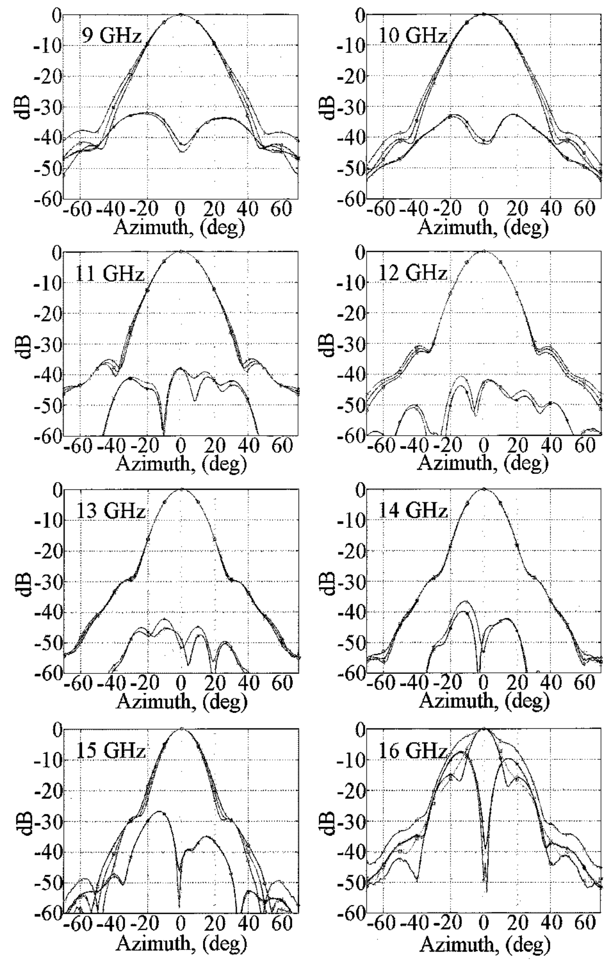

Fig. 4. Measured far field radiation patterns. ⊖ H plane copolar, ⊟ 45 deg plane copolar, ⟡ E plane copolar, ▽ 135 deg plane copolar, ⋆ 45 deg plane crosspolar, ⋆ 135 deg plane crosspolar.

V. Conclusion

An ultra-wide band corrugated GPHA with low side-lobes (−30 dB in 40% bandwidth) and cross-polar levels (−30 dB in 49% bandwidth and −35 dB in 30% bandwidth) has been designed, manufactured, and measured. A very good agreement between simulations and measurements has been reported.

These results make this type of antenna suitable for a wide variety of applications, i.e., as a feed for antenna measurement facilities or wide bandwidth satellite communications. Return loss features are limited by the rectangular–circular transition restricting the real bandwidth of this design. New transitions to overcome this problem are under development.

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