3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

1×4 Antenna Array corporately fed by a Novel Half-Mode Groove Gap Waveguide network

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Abstract

This paper presents a Ka-band linearly-polarized 4-antenna array fed with a novel corporate distribution network that uses a half-mode groove gap waveguide (HM-GGW). The antenna feed has no contact with the top cover where the array antenna is located, thanks to the features inherent in gap waveguide technology (GW). This technology, with many advantages, sometimes suffers from a complex mechanization, which in this case is reversed by the novel network proposed in this paper.

1 Introduction

Flat panel antennas (FPAs) are gaining relevance as the trend in demand for communications on-the-move keeps growing. While the satellite industry is in the midst of a transformation, the downward trend in capacity prices signals a significant technological game-changer. FPAs with lower profiles and higher bandwidth efficiency are driving technological changes in the satellite industry, helping to enable new applications. In this context, companies in the sector are eager for solutions that are as light, compact and easy to manufacture as possible. Of course, in addition to all the technical and challenging characteristics of radiant devices such as excellent S-parameters performance (reflection coefficient, insertion loss, isolation), high efficiency or even steerability of the beam, among others. Here, in search of new horizons to solve these challenges, we propose this antenna fed by a Half-Mode Groove Gap Waveguide (HM-GGW) whose greatest strength is to facilitate the machining of the feeding network.

In the past, Gap Waveguide technology (GW) has already been extensively described and detailed [1]-[5]. Among its advantages it includes the ability of the surface created by the pins to confine the field even when the parts are not in contact. Among the disadvantages, the machining of these pins must often be dedicated and requires more time than conventional fabrication techniques. This is mostly due to pins coexisting with cavities, corners, bends and transitions on the same bed of nails [6]-[9]. As first demonstrated experimentally in [10], the use of an HM-GGW can radically alleviate these problems, evidenced there by the construction of a power divider and a curved waveguide. Here, we go a step further and make use of the HM-GGW to feed corporatively a 1×4 antenna array. While this is only a first approach, the design could be scalable in the future to build higher gain antennas with new features. In the following, this Ka-band antenna design as well as some simulated results are presented.

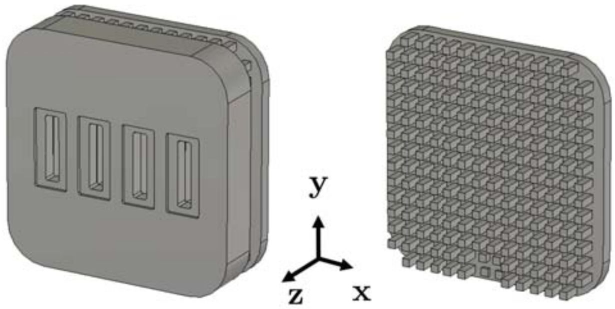


Figure 1. Perspective view of the 1×4 HM-GGW antenna with and without the lid.

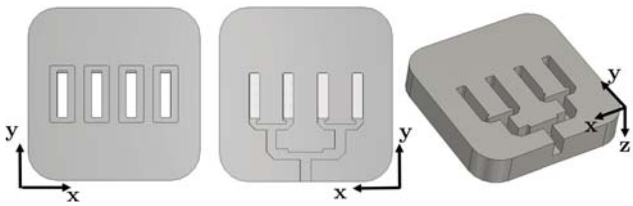
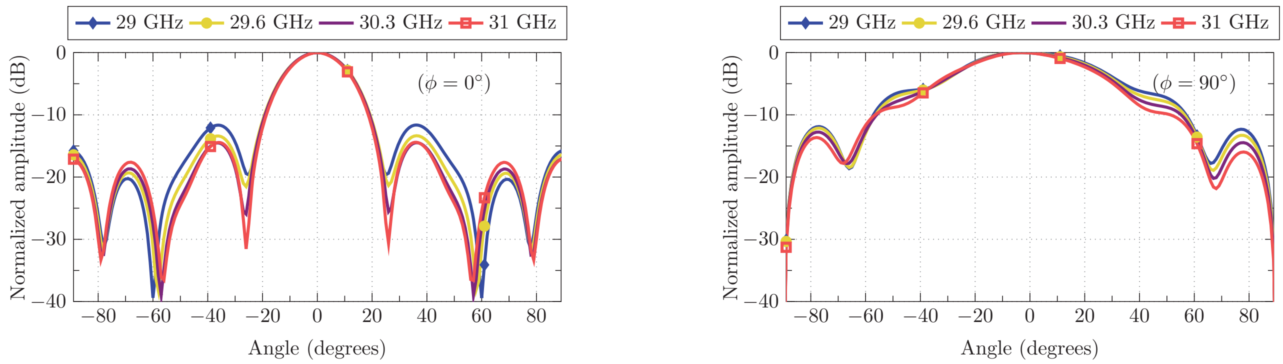


Figure 2. Top and back view of the upper piece.

2 Antenna design

The complete antenna is shown in Figures 1 and 2. In Fig. 1 the left subfigure shows the complete assembled antenna, which is composed of two full metallic pieces. The right subfigure shows only the bottom piece, which is a uniform bed of equispaced pins. In Fig. 2, solely the top metallic piece is now shown. This part houses on one side the four slots that make up the array. The other side of the same piece houses the corporate distribution network, whose input port is located at at one side of the lid.

The dimensions of this array antenna are 30 mm×30 mm×10 mm. The top piece has a thickness of 5.8 mm and the bottom piece of 4 mm. Between both pieces there is an air gap of 200 μm. There are several



(a) (b)

Figure 3. Simulated radiation patterns for several frequencies: (a) XZ-plane; (b) YZ-plane.

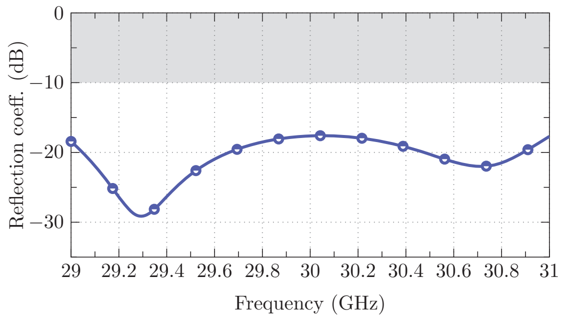


Figure 4. Simulated reflection coefficient of the antenna of Fig. 1

considerations in this design that are not trivial. As just indicated, the lid has a maximum thickness of 5.8 mm and corporate-feed network of its lower face has a depth of 3.3 mm. A waveguide of width a=3.3 mm has a cut-off frequency of 45 GHz and would not propagate any wave below that frequency, but the operating frequency range of this antenna is from 29 GHz to 31 GHz. That is why the bed of nails of the lower layer is key. As described in more detail in [10], this uniform bed of nails acts as a magnetic wall so the waveguide is virtually twice as high and the propagation of the waves in this frequency range is possible. The fact of separating the network from the pins is very appealing for GW antennas as it avoids having to make ad-hoc bed of nails depending on the design. In this way the bed is completely uniform and the network is simply milled in a metallic sheet without further complexity .

3 Simulated results

Some preliminary simulation results of this 1×4 linearly-polarized Ka-band antenna are now presented. First, the two main cuts of the 3D-pattern (XZ and YZ planes) are shown in Fig. 3. Stable patterns for different frequencies, and with expected secondary lobes for this uniformly fed array, have been obtained. Fig. 4 illustrates the antenna matching. Note that the reflection coefficient is below -17 dB in the defined frequency bandwidth. This working band has been chosen because it is the typical one used in transmitting antennas for SATCOM on the move applications.

4 Conclusions

This paper presents an antenna fed by an HM-GGW distribution network. To the authors' knowledge, it is the first antenna in the literature using an HM-GGW feeding network. Although the antenna has reduced dimensions, this work is intended as a first step to validate the idea. Simulated results from 29 GHz to 31 GHz are presented to confirm the array suitability. In the future, the concept should be experimentally tested, ideally in a higher gain antenna.

Acknowledgment

This work is part of the projects PID2019-107688RB-C22 and PID2019-103982RB-C43 funded by the Spanish Ministry of Science and Innovation MCIN/AEI/10.13039/501100011033.

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