Dual Circularly-Polarized Slot-Array Antenna in Ka-Band fed by Groove Gap Waveguide

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***Abstract*—A dual circularly-polarized slot-array antenna fed by a Groove Gap Waveguide (GGW) and operating in the Ka-Band is presented in this paper. A simple mechanism is proposed to switch the polarization, from RHCP to LHCP, and viceversa. The lid of the antenna has two pieces: one fixed and one sliding. The fixed piece hosts T-shaped slots, and the sliding block is in charge of adjusting the offset of the perpendicular grooves with respect to the longitudinal slots. Preliminary results show an axial ratio below 1.5 dB for both, RHCP and LHCP, within a bandwidth of 1 GHz centered at 30 GHz.**

***Index Terms*—Circular polarization, Gap waveguide technology, Groove Gap Waveguide, Ka-Band, slotted-waveguide antenna**

I. Introduction

Circular polarization is widely used in many communications systems to minimize losses associated with polarization mismatch between transmitters and receivers. The way to obtain a circularly-polarized (CP) pattern with a slotted waveguide array may be tough, but for many years remarkable designs have been achieved.

In 1957, Simmons [1] showed that a simple slot radiator formed by a pair of narrow slots crossed at proper angles, and located at the proper positions, produces a CP pattern. Since many wireless communication applications such as satellite communications use circularly polarized (CP) signals, easy switching of the polarization sense is a need.

There are few examples in the literature of two-dimensional array designs capable of switching between both circular polarization [2]-[4]. In this paper, we present a slotted waveguide array antenna with a novel switching mechanism. The antenna is formed by 12 radiating elements in an all-metallic structure. The switching between RHCP and LHCP is done by means of a sliding metallic piece.

II. Switchable RHCP/LHCP Slot Array antenna Design

Basically, the array consists of 12 shunt slots, which are transformed into T-shaped slots to provide a CP pattern [5]. Fig. 1 shows a general view of the array antenna. As we can see, there is a sliding piece that can be placed in position 1 or 2. The piece is a kind of comb that adjusts the offset of the perpendicular arm of the T-shaped slot. Thereby, depending on the position of the sliding piece, an RCHP or LHCP pattern is obtained.

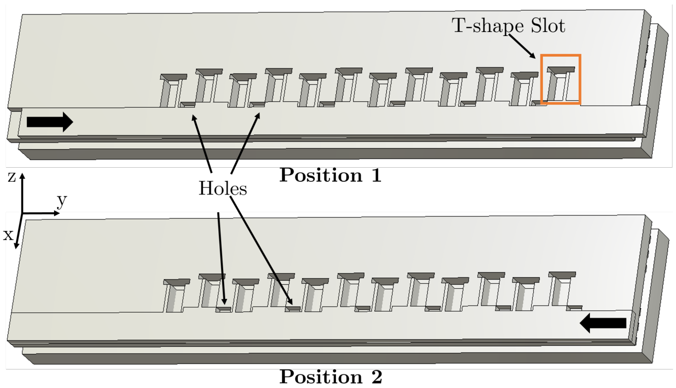


Fig. 1: 3D view of the dualCP slot array antenna.

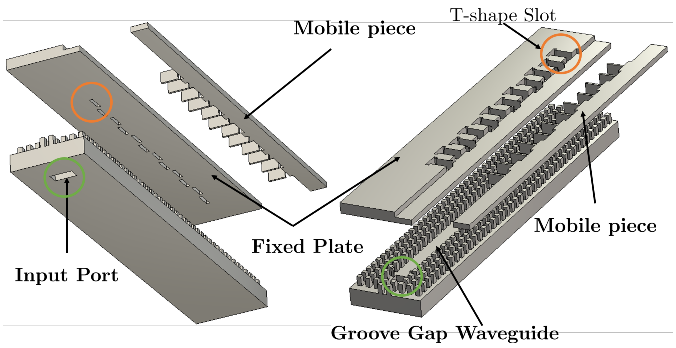


Fig. 2: Parts of the dual CP slot array antenna

Fig. 2 shows the three metal pieces that make up the antenna. Slots are fed by a Groove Gap Waveguide (GGW). It should be noted that the same concept could have been designed with a conventional rectangular waveguide (RW) but a GGW performance is quasi-identical to a RW. The advantage of using a GGW over the RW is its ability to confine the field even though the metal parts are not perfectly assembled [6]-[7]. Above the GGW, there is a cover that consists of two parts. One is the fixed part, where the slots are placed, and the other is the sliding piece, which controls the CP sign.

III. Simulated Results

The radiation pattern on the main planes of the antenna are shown in Fig. 3 at the central, upper and lower frequencies of the operation band (29.5, 30 and 30.5 GHz). Figs. 3a and 3b show the patterns if the sliding piece is in position 1, and Figs. 3c and 3d show the patterns if the sliding piece is in

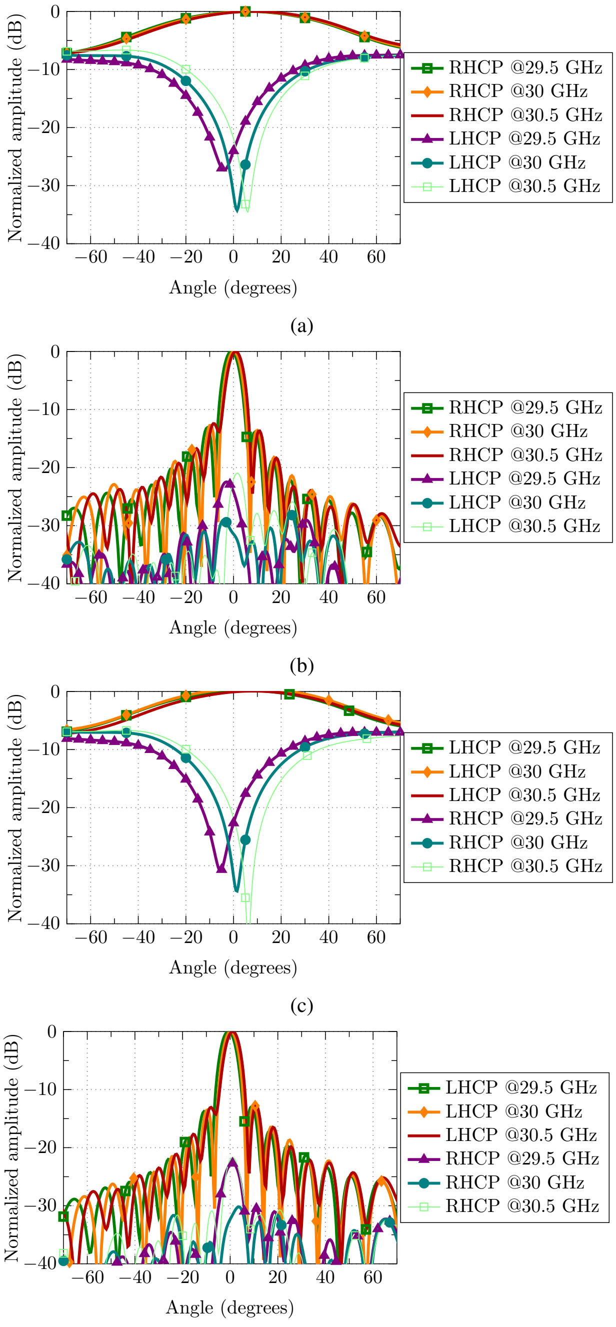
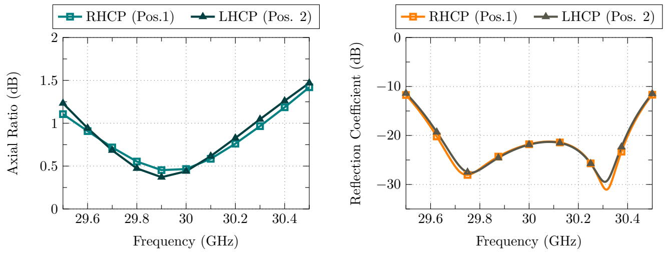


Fig. 3: Normalized simulated radiation patterns for several frequencies for both circular polarization: (a) XZ-plane (Pos. 1), (b) YZ-plane (Pos. 1), (c) XZ-plane (Pos. 2) and (d) YZ-plane (Pos. 2).

position 2. The sliding piece provides an RHCP in the first position, and an LHCP in the second position. As shown in the figures, the YZ-plane corresponds to the pattern of a 12 elements array, and the XZ-plane to the radiation pattern of a single slot.

The simulated axial ratio remains below 1.5 dB (see Fig. 4a) from 29.5 GHz to 30.5 GHz. Also, it is worth noting that the



(a) (b)

Fig. 4: (a) Simulated axial ratio. (b) Simulated reflection coefficient.

shifting of the metallic piece from position 1 to position 2 hardly affects the reflection coefficient (see Fig. 4b) of the antenna, and neither the polarization purity.

IV. Conclusion

This work is based on a slot waveguide array design with circular polarization to propose a simple mechanism capable of switching between two orthogonal circular polarization. This contribution opens the appealing possibility to explore low-profile highly-efficient and low-cost arrays with a dual circular polarization performance. An experimental validation will be carried out in the coming months.

Acknowledgment

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