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Citation for the original published paper (version of record):
Ren, Q., Uz Zaman, A., Yang, J. (2021). A Dual Circularly Polarized Array Antenna for Ka-Band Satellite Communications. 2021 International Symposium on Antennas and Propagation, ISAP 2021.
http://dx.doi.org/10.23919/ISAP47258.2021.9614491

A Dual Circularly Polarized Array Antenna for Ka-Band Satellite Communications

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***Abstract*—This work presents a dual circularly polarized 8-by-8 array antenna using inbuilt polarizers for satellite communications. The design consists of five metal layers, including two feeding layers for the dual circular polarization and a polarizer layer that utilizes a pair of circular cavities as phase delay elements for each sub-array. Two corporate feeding networks using folded E-plane and H-plane T-junctions have been proposed to excite the radiating elements. Simulated results of the array antenna have shown that the axial ratios are less than 1 dB from 29 to 31 GHz for both polarizations. The realized gains for both polarizations are larger than 25 dBi at center frequency.**

***Keywords*—Dual circular polarization, Polarizer, Antenna array, Ka-band.**

I. Introduction

With the advent of next generation high throughput satellite communication systems, dual circularly polarized antenna systems operating at Ka band have been widely investigated in recent years [1]-[3]. On the one hand, Ka band features higher throughput comparing with lower frequency bands, such as C band and Ku band. On the other hand, dual circular polarization will provide enhanced isolation between the transmitting and receiving channels. Moreover, circular polarization is more favorable than linear polarization considering the suppression of multi-path interference of satellite communication.

Normally, circularly polarized waves are realized by combining two orthogonal linearly-polarized waves with 90° phase difference. In [4], a dual-circularly polarized horn antenna operating at V-band has been proposed based on an inbuilt mono-groove polarizer. A left-hand circularly polarized horn antenna featuring internal polarizer that consists of nine pairs of circular cavities, has been designed in [5]. It has been shown that circular waveguide based polarizers have advantages of better radiation performance comparing with conventional septum polarizer [6]-[8].

The antenna proposed in this work utilizes a pair of circular cavities as phase delay elements. The simulated results show good performance regarding axial ratios over the frequency band of interest.

II. Dual-circularly Polarized Sub-array

Fig.1 shows the geometry of the dual-circularly polarized sub-array. The design consists of two feeding layers with respect to two orthogonal polarization. The polarizer has been realized by two sector cavities that are placed 45° and 135° offset from both feeding ports respectively. The operating principle can be demonstrated using Fig.2. When port 1 is excited, the TE11 wave inside the circular waveguide $\overrightarrow{E_1}$ can be decomposed into two components: $\overrightarrow{E_{1x}}$ and $\overrightarrow{E_{1y}}$. $\overrightarrow{E_{1y}}$ will experience a larger propagating radius than $\overrightarrow{E_{1x}}$. When the waves go through the polarizer with specific length, $\overrightarrow{E_{1x}}$ will be 90° phase ahead of $\overrightarrow{E_{1y}}$, thus generate RHCP waves. Similarly, when port 2 is excited, it will generate LHCP waves.

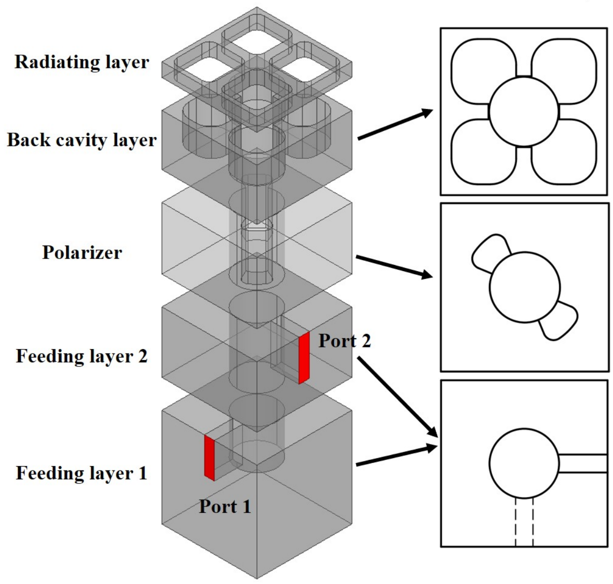

Fig. 1. Overview of the sub-array consisting of 5 layers.

III. Simulation Results of the Array Antenna

A 8-by-8 antenna array has been proposed in this work utilizing the sub-array discussed in the previous section, as shown in Fig.3. Compact feeding networks have been realized by combination of folded E-plane and H-plane T-junctions. The reflection coefficient of the inputs, as well as the isolation between the two input ports are shown in Fig.4. The radiation patterns of the array at the center frequency for both polarization are shown in Fig.5. Fig.6 shows the simulated axial ratio of both configurations. Thanks to the

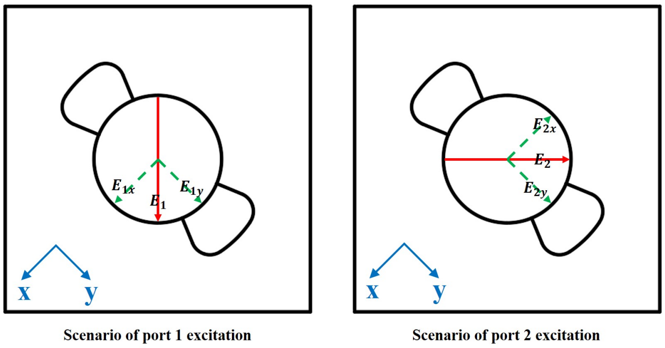

Fig. 2. polarizer using a pair of circular cavities.

circular waveguide based polarizer, the array antenna shows good radiation performance.

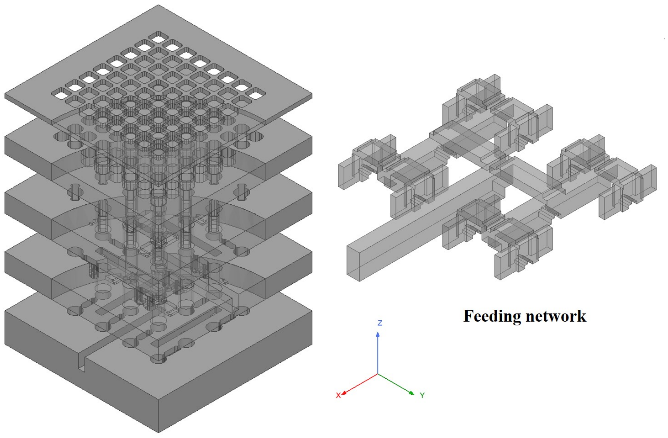

Fig. 3. Overview of the 8-by-8 antenna array.

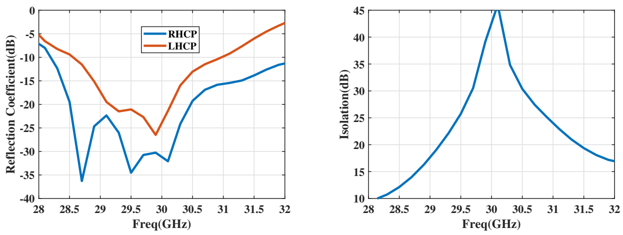

Fig. 4. Reflection coefficient and isolation of the inputs.

IV. Conclusion

A dual circularly polarized 8-by-8 array antenna for satellite communications has been proposed in this work. The design consists of five metal layers, including two feeding layers and a polarizer layer that utilize two sector cavities as phase delay elements for each sub-array. Simulated results of the array antenna have shown that the axial ratios are less than 1 dB from 29 to 31 GHz for both polarizations. It also shows good performance in terms reflection coefficients and isolation.

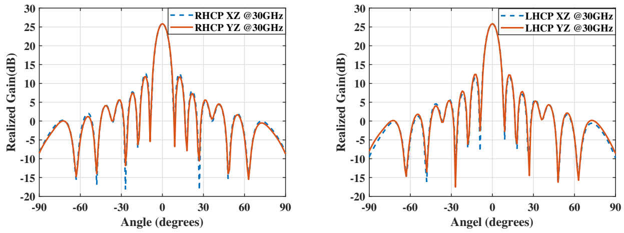

Fig. 5. Simulated XZ and YZ pattern.

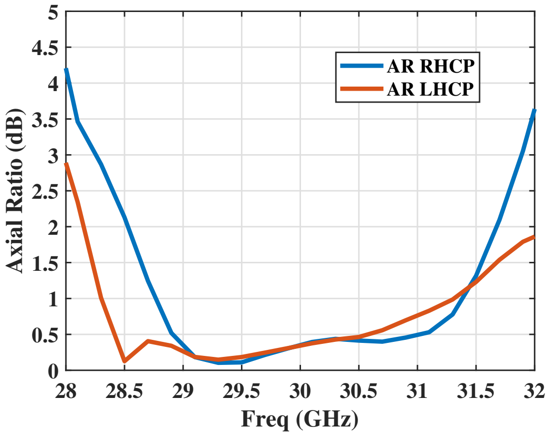

Fig. 6. Simulated axial ratio of both configurations.

Acknowledgment

This work is supported by Swedish Strategic Vehicle Research and Innovation FFI grant 2018-02707.

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