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Circular Open Slot Array for Beam Steering

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Extended Abstract

In this paper we propose a methodology for designing circular arrays with unidirectional radiation capacity and with the possibility of synthesizing arbitrary radiation patterns. The methodology is based on the use of the Characteristic Modes theory for slots in planar structures and on the design of resonant unit cells that can be combined with other adjacent cells with high isolation. The analysis of slots in metallic planes using the theory of characteristic modes has been studied previously [1]. Modal analysis in three-dimensional cylindrical structures with sectorial cells has also been studied [2].

A hexagonal array of 6 antennas formed from triangular unit cells is proposed as a design example, operating within the 5 GHz frequency band, specially used for Wi-Fi applications.The antennas are open slots 25.38 mm long and 1 mm thick, fed with ILA antennas inside. The ILA antennas are fed in differential mode, through a slot line and a microstrip line transition. The material is copper with a 1.5 mm thick FR4 substrate. The antenna feed has been optimized to achieve the optimum matching impedance at the center frequency of the design (5.225 MHz), with a -10 dB bandwidth of 400 MHz with an extremely low profile.

The array has been analyzed with the CST simulator, obtaining the radiation patterns, directivity, beamwidths and isolation between the 6 antennas. The array can be pointed in different directions feeding only one antenna. Figure 1 shows the configuration and three patterns obtained by switching between antennas, with the maximum in the direction perpendicular to the hexagon edge. Maximums in the direction of the vertices can be achieved by combining adjacent antennas. Combining the 6 antennas with sequential phasing results in a radiation pattern with circular polarization in the broadside direction, perpendicular to the ground plane.

In summary, the proposed methodology allows for the design of circular arrays with unidirectional radiation capacity and the ability to synthesize arbitrary radiation patterns. The methodology is based on the use of the Characteristic Modes theory for slots in planar structures.

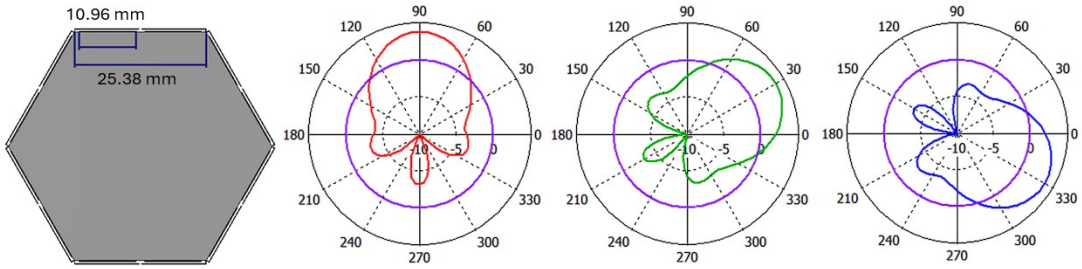

Figure 1. Array dimensions and radiation patterns

References

[1] E. Antonino-Daviu, M. Cabedo-Fabrés, M. Sonkki, N. Mohamed Mohamed-Hicho, and M. Ferrando-Bataller, "Design guidelines for the excitation of characteristic modes in slotted planar structures," *IEEE Transactions on Antennas and Propagation*, vol. 64, no. 12, pp. 5020–5029, 2016.

[2] J. Molins-Benlliure, M. Cabedo-Fabrés, E. Antonino-Daviu, and M. Ferrando-Bataller, "Sector unit-cell methodology for the design of sub-6 ghz 5g mimo antennas," *IEEE Access*, vol. 10, pp. 100 824–100 836, 2022.

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