TEST CASE : K/KA Dual Band Polarizer

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Abstract:

This test concerns the simulation of a dual band polarizer in K/Ka-band. This design has the particularity of converting a given lineraly polarized (PL) wave, to orthogonal circularly polarized (CP) waves at the two frequency bands. The polarizer is tested with two LP rectangular horns, one for each band. This problem can be challenging due to the rather small thickness and intricacies of the unit cell that contains curved patterns.

1. Definition of the Geometry

The polarizer is composed by a 8x8 periodic arrangement of the unit cell described in Figure 1 and Table 1. The cell is constituted by three metallic layers parallel to the x´y´-plane, separated by thin 0.508mm dielectric Rogers DuroidTM 5880 slabs. The first and the third layers of the UC are identical and composed of a patch and a split ring. The middle layer is composed of a circular slot plus a rectangular patch. Two 14.5 dBi standard-gain rectangular horn antennas (see inset of Figure 1) are used to illuminate the polarizer at each band. The model of the two horns are given in the files “horn_FM20240-15_20GHz.step” and “horn_FM22240-15_30GHz.step”

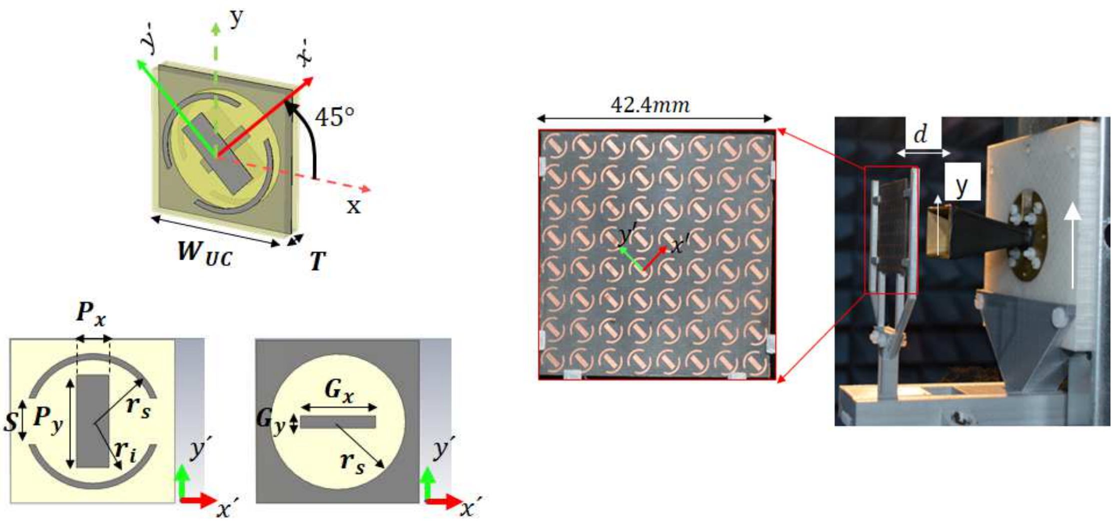


Figure 1 – Unit cell for the polarizer

Table 1 – Description of the problem materials and dimensions

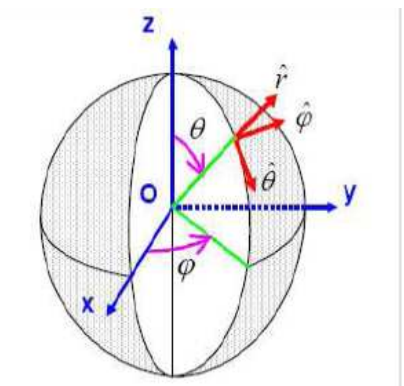
Materials	
Dielectric permittivity, ε_r	2.2
Dielectric loss tangent, tan δ	0.0009
Metal	PEC with thickness 0.035 mm
Unit cell dimensions (mm)	
G_x	2.35
G_y	0.50
P_x	0.90
P_y	2.90
r_s	2.20
r_i	1.85
S	1.50
T	1.121
W_{UC}	5.3
Polarizer	
Dimensions (mm^2)	42.4×42.4
Distance to horns, d (mm)	~~21.5~~ 23.7

2. Attached files

- “Unit cell.stp”: geometry of the unit cell
- “Polarizer.stp”: 8x8 array geometry
- “horn_FM20240-15_20GHz.stp”: geometry of the 20 GHz horn;
- “horn_FM22240-15_30GHz.stp”: geometry of the 30 GHz horn;

3. Simulation Parameters

- 2 Frequencies: 20.2 and 30.0 GHz with the 20 and 30) GHz horn respectively.
- Angular sweep: -180°<θ<+180°, δθ=1° for E planes.
- The horns should have y-polarization, as shown in Figure 1
- Gain for RHCP for LHCP x 2 frequencies [20.2, 30.0] x 1 planes (4 curves)



4. Data formats

The RHCP and LHCP polarization are defined by (exp(+jωt) convention):

- RHCP $\frac{1}{\sqrt{2}}(E_\theta + jE_\varphi)$
- LHCP = $\frac{1}{\sqrt{2}}(E_\theta - jE_\varphi)$

The results for each frequency will be stored in 4 separated ASCII file containing on each row the data: Theta (degree), Gain (dBi)

1. Gain_RHCP_20.2_E-plane: RHCP gain at 20.2 GHz in the yz plane (φ=90º)
2. Gain_LHCP_20.2_E-plane: LHCP gain at 20.2 GHz in the yz plane (φ=90º)
3. Gain_RHCP_30.0_E-plane: RHCP gain at 30.0 GHz in the yz plane (φ=90º)
4. Gain_LHCP_30.0_E-plane: LHCP gain at 30.0 GHz in the yz plane (φ=90º)

5. Reporting

The numerical method will be presented briefly, including the meshing properties. Furthermore, the characteristics of the computer used for the simulation (type of processors, number of cores, memory) and elapse simulation time should also be given.