A Novel Logarithmic-Spiral-Shaped 3D-Printed Dielectric Polarizer for Dual-Circularly Polarized Conical-Beam Radiation Patterns in the Ka-Band

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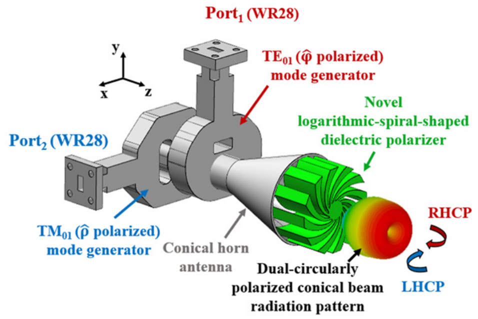
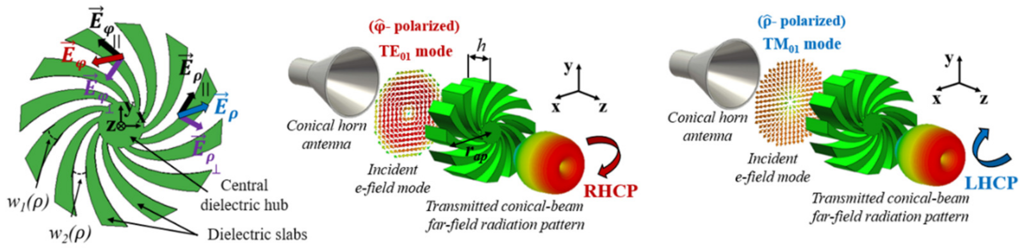
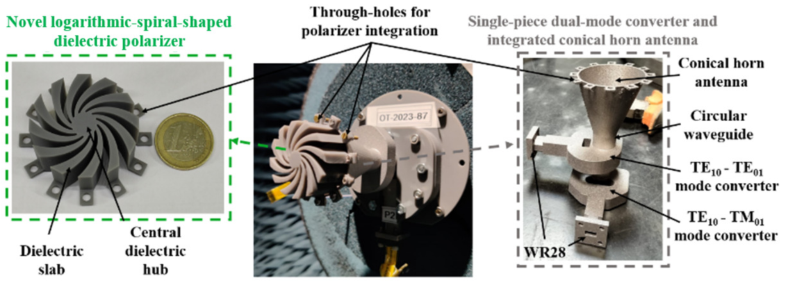
In this contribution, a novel cylindrical dielectric polarizer capable of generating dual-circularly polarized (CP) conical-beam (CB) radiation patterns from a dual-linearly polarized (LP) antenna feeder is presented for millimeter-wave applications in the Ka-band (28-30 GHz).

The antenna system comprises a dual-mode converter, feeding a conical horn antenna that integrates the newly designed dielectric polarizer in its aperture. The dual-mode converter enables the excitation of the TE_{01} mode, featuring azimuthal ($\hat{\varphi}$-) polarization, and the TM_{01} mode, featuring radial ($\hat{\rho}$-) polarization, in the conical horn. Conversely, the novel integrated dielectric polarizer ensures the LP-CP conversion of the electric field for both modes, thereby generating two CB far-field radiation patterns featuring right-handed CP (RHCP) and left-handed CP (LHCP), respectively.



Regarding the operation of the polarizer, it can convert incident $\hat{\varphi}$- and $\hat{\rho}$- LP waves, achieved by the excitation of the $\hat{\varphi}$- polarized TE_{01} mode and the $\hat{\rho}$- polarized TM_{01} mode in the conical horn antenna, into RHCP and LHCP waves, respectively. The proposed polarizer is composed of novel dielectric slabs, which consistently form a local angle of 45º with $\hat{\varphi}$ and $\hat{\rho}$ directions, thus ensuring local anisotropy for incident $\hat{\varphi}$- and $\hat{\rho}$- polarized e-field modes. As linearly $\hat{\varphi}$- ($\vec{E}_{\varphi}$) and $\hat{\rho}$- ($\vec{E}_{\rho}$) polarized waves impinge on the anisotropic polarizer, if they are decomposed in their respective orthogonal electric field components, $\vec{E}_{\varphi_{||}}/\vec{E}_{\varphi_{\perp}}$ and $\vec{E}_{\rho_{||}}/\vec{E}_{\rho_{\perp}}$, each component will exhibit a different propagation constant, which will lead to different transmission phases along the polarizer. Thus, by tuning the polarizer dimensions, it is possible to generate a 90º phase shift between both electric field components, achieving linear $\hat{\varphi}$- and $\hat{\rho}$- polarization to CP conversion, RHCP and LHCP, respectively.





The DMC and the conical horn antenna are produced as a single piece using AlSi10Mg alloy through Selective Laser Melting (SLM) technology, whereas the novel dielectric polarizer is printed with the Form 3 3D printer using Gray Resin material, both supplied by Formlabs.

The normalized radiation pattern and the axial ratio are shown for different φ cuts at f=30 GHz, demonstrating a great correspondence between simulated and measured results: