A dual band complementary circular polarization selective structure

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Circular polarization is of interest in multiple beam antennas for the emerging broadband satellite market (N. J. G Fonseca and C. Mangenot, EuCAP 2014, 570–574, 2014). In order to reduce out-of-band signal rejection it is desirable to employ orthogonal transmit and receive modes, which also operate at different frequencies. The desired functionality of a dual band circular polarization selective structure (CPSS) operating in complementary polarizations is that it should reflect right hand circular polarization (RHCP) and transmit left hand circular polarization (LHCP) in band 1, and reflect LHCP and transmit RHCP in band 2. The bands would typically be separated by a factor of 1.5–2.

In (D. Sjöberg and A. Ericsson, EuCAP 2014, 464–468, 2014), a wideband (about 40% bandwidth) CPSS concept was presented based on a multilayer structure, with metal meander line sheets interspaced by distance materials. Each sheet consists of printed parallel meander lines, where the axes of the meander lines are rotated in proportion to the distance between the sheets. At a nominal wavelength λ_0, this means the angle between two consecutive sheet axes is $\varphi = 2\pi/x$, and the distance is $d = \lambda_0/x$ for some number x. This provides a strong selectivity for the polarization with the same handedness as the geometrical structure.

This kind of structure features an interesting harmonic. If it has a clockwise rotation with angle φ between the sheets, it also has a counter-clockwise rotation with angle $\pi - \varphi = 2\pi/y$ between the sheets, where $y = 2\pi/(\pi - 2\pi/x) = x/(x/2 - 1)$. At wavelength $\lambda = \lambda_0 y/x$ the distance between the sheets is $d = \lambda/y$ corresponding to the complementary CP selectivity condition. This means the ratio between the high and low frequency band is $f_2/f_1 = x/y = x/2 - 1$. Choosing $x = 6$ implies $x/y = 2$, which can be implemented in a small hexagonal unit cell.

In my presentation I will give examples of such designs, and how the number of layers, and the other geometrical parameters, can be chosen to provide return loss, insertion loss, and axial ratios, in each band of operation of around 1 dB. This corresponds to the design requirements used by (Fonseca and Mangenot, 2014) and (Sjöberg and Ericsson, 2014).