Planar Antennas for Circular Polarization in a Constrained Space

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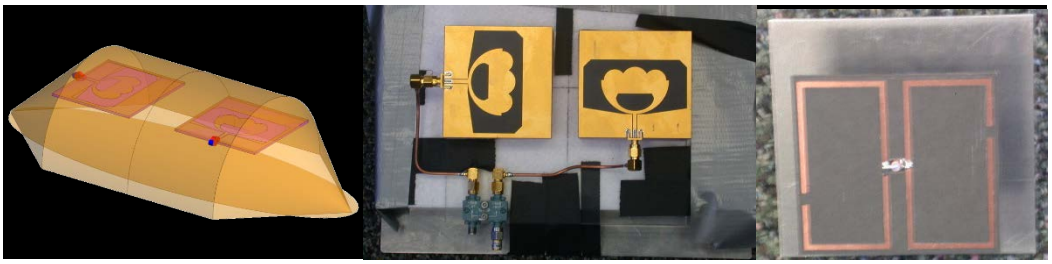
Planar antenna designs have many advantages such as low-profile, light-weight, and ease of fabrication. Here, linearly polarized slot-type antennas on a thin substrate with coplanar waveguide feed are cross-polarized and combined with a 90-degree hybrid coupler to produce circular polarization (CP). This paper summarizes the CP antenna design by simulation using FEKO (www.feko.info), based on the Method of Moments. The frequency range is 1.3 – 2.6 GHz with high gain and axial ratio (AR) <3 dB desired. The results serve to guide the future analysis of broadband antennas for CP requirements in space constrained applications.

The antennas are coplanar waveguide (CPW) fed on RT/Duroid 5870 having $\varepsilon_r = 2.33$ and $\tan\delta = 10^{-3}$ with thickness 1.575 mm (62-mils). A patch radiator exciting a rectangular slot is combined with a cross polarized antenna to produce right-handed CP (RCP)). This slot-type antenna is more compact with a larger impedance bandwidth (IBW) than conventional CP antennas and fits within an existing radome on an airborne platform. A metal ground plane is used to increase directivity, but causes some variations in the gain vs. frequency. For communication applications a flat gain vs. frequency is desired with good AR over the IBW. The antennas considered here are restricted in size to less than 64 mm (2.5-inch) square to fit in the width of the radome footprint as shown in Fig. 1 (a). The separation from the ground plane is limited by the radome height, so it is kept at 50 mm (2 inches). For demonstration purposes 3-inch antennas were fabricated (Fig. 1 (b)) to evaluate the RCP performance on boresight (i.e., at zenith) vs. frequency. A prototype bi-quad antenna shown in Fig.1 (c) also meets the space requirement but does not quite have the desired IBW. A comparison of several different CP antennas (e.g., helical, conical spiral, CP patch and crossed dipoles) was done by simulation, and it was found that they would have poor performance when scaled to fit in the existing radome. The planar slot (P-slot) and bi-quad radiator could meet the space requirement while maintaining good performance. However, the AR suffers at low frequencies for all CP antenna designs in this constrained space. The spacing between the P-slots was increased to an overall length of 158 mm (6.2 inch) to improve the gain and AR by ~1 dB yet still fit within the existing radome. Comparison of simulation results for CP antennas and prototype measurements for model validation will be included in the presentation.



(a) (b) (c)

Figure 1. Compact CP antenna prototypes in an existing radome (a) 2.45-inch P-slot, (b) 3-inch prototype and (c) prototype bi-quad antenna.