

Novel 1256-Element Circularly-Polarized Metal-Only Reflectarray Using Spiral Slots

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There has been significant interest in reflectarrays since the introduction of microstrip technology. The features of reflectarrays allow them to be planar or conformal to a surface for a low-profile design. This leads reflectarray to be implemented on multiple different platforms and applications such as satellites for digital broadcasting services (DBS) and communications. Reflectarrays use different size elements in its unit cell, instead of a shaped metal surface like a parabolic reflector, to change the phase of the reflected beam from its illumination source. This characteristic allows the beam to be contoured from a planar lightweight surface. One drawback is the use of a dielectric substrate, which can be expensive for a large surface, contribute to high losses, and undergoes thermal stresses in a space environment. Because of these issues, metal-only reflectarrays remove the dielectric substrate and use an air gap between the two metal layers instead. The second challenge is circular polarization for satellite applications. As a result, recent metal-only reflectarray designs are either linearly polarized or have phase coverage of less than 360°.

The authors have designed a $20\lambda_0$ metal-only aluminum reflectarray using a novel spiral slot for circular polarization (CP) at 20 GHz. The unit cell consists of a square slot in the center with four L-slots extending from the corners of the square slot. By changing the length of the L-slots, the unit cell is able to obtain 360° of phase coverage with a maximum loss of 0.35 dB. When excited by a CP wave during simulation, the peak gain of the reflectarray was 32.3 dB for an aperture efficiency of 44%. The 1-dB bandwidth was 6.25% and the 3-dB bandwidth was 10%. The axial ratio was less than 3 dB for both bandwidths. The fabricated design and measurement results will be presented at the conference.