Effects of Cavity Backing on the Phase Center of Spiral Antennas

Matthew J. Radway*[(1)], Thomas P. Cencich[(2)], and Dejan S. Filipović[(1)]
(1) University of Colorado, Boulder, CO, 80309
(2) Lockheed Martin Space Systems Company, Littleton, CO, 80125

Not long after its invention, the planar spiral antenna was recognized as having several important traits that make it an especially attractive choice for use as the feed antenna for reflector and lens antenna systems. Included among these characteristics are frequency-stable impedance, beamwidth, phase center, and low axial ratio. These qualities have enabled reflector-based systems using spiral feeds with decade bandwidths to be successfully fielded in the past, including automatic tracking telemetry antennas and space data acquisition systems. The possession of a stable phase center also makes the spiral antenna attractive for use in interferometer-based angle-of-arrival systems.

However, despite these recognized and well-established applications there is little published data available on the interaction of the spiral with its substrate and cavity backing regarding the phase center behavior of planar spiral antennas. In this work, phase center is studied in terms of the spiral mode theory through the application of modal decomposition of the far field. Also, since the concept of a phase center is only approximately applicable for physically realizable antennas, bounding the errors associated with the assignment of the phase center will be discussed. Data on substrate effects, as well as the cavity backing parameter effects on the phase center of the spiral antenna are examined. It is shown that the design of the cavity can cause significant degradation in the phase center stability. Studies are validated through numerical modeling with commercial moment and finite-element method codes. Finally, approaches for mitigating the negative effect of the cavity backing are proposed.