A Method of Phase-less Measurements for the Circularly Polarized Gain in the Sub-Millimeter Band

S. Bhardwaj*, N. K. Nahar, J. L. Volakis
Electroscience Laboratory, The Ohio State University,
1330 Kinnear Road, Columbus, OH-43212, USA

Increasing interest in W-band communication systems and sub-millimeter wave imaging systems has stimulated research in sub-millimeter wave antennas. Circularly polarized (CP) antennas are important for point-to-point communication for airborne transceivers and for satellite communication. Conventional methods for CP gain characterizations require measurement of the radiated field (magnitude and phase) using an LP antenna in the two orthogonal planes. In this method, the antenna under test (AUT) or LP antenna must be rotated by 90°. Such rotations normally cause phase errors due to cable bending and possible position inaccuracies. For sub-millimeter waves, these errors can be significant in the phase of the vertical field with respect to horizontal. Furthermore, for WR-8 band (90-140 GHz), coaxial cables are not available. Frequency multiplier boxes with WR-8 output waveguides needs to be also used for antenna measurements in this band. Rotation and alignment of these boxes adds more phase errors, since rotation of the box can change the distance between the AUT and LP antenna. For example, at 100 GHz, a variation of distance as small as 0.25 mm can cause a phase error of 30°. These complications make antenna CP measurements a daunting task for frequencies beyond 100GHz.

In this presentation, a new method for CP gain measurements is provided that does not involve phase recording. Specifically, we instead directly obtain the right hand CP (RHCP) and left hand CP (LHCP) gains in co-pol and cross-pol configurations. The process involves two measurement steps: (1) Power transmitted by the AUT is reflected from a corner reflector prior to being received by the AUT, (2) Step 1 is repeated by replacing the reflector with a metallic plate. These measurements are calibrated using a standard gain antenna to normalize losses due to free-space propagation. The resulting measurements lead to two equations with two variables namely: RHCP and LHCP gains, subsequently used to obtain the desired antenna gain values. The application of this new measurement method to a CP radial line slot array aperture is demonstrated at 106 GHz.