

Broad Band Half Width Leaky Wave Microstrip Antenna Fabricated with Additive Manufacturing

Malachi Keener¹ and William Harokopus¹

(1) Department of Electrical and Computer Engineering, Michigan State University,
East Lansing, MI, 48824-1226, Keenerm3@msu.edu

Leaky wave antennas have been the subject of research for nearly 40 years, first by Menzel who used slots to suppress the fundamental microstrip mode. Later Oliner and Lee (A. A. Oliner and K. S. Lee, "Leakage from Higher Order Modes on Microstrip Line With Application to Antennas," *Radio Science*, vol. 22, no. 6, pp. 907-912, 1987.) provided an explicit formulation that was suitable for antenna design based on the transverse resonance method (TRM). The geometry used is referred to herein as a full-width leaky-wave (FWLW) antenna.

Half-width microstrip leaky wave antennas (G. M. Zelinski, G. A. Thiele, M. L. Hastriter, M. J. Havrilla and A. J. Terzouli, "Half Width Leaky Wave Antennas," *IET Micro, Antennas Propagation*, pp. 341-348, April 2007) have been a focus of research for over a decade primarily due to a simplified feeding method, thin profile, and suitability and conformal emplacement. Leaky wave antennas on printed circuit board material are limited to about 20% bandwidth. However, with an air dielectric, the bandwidth can be increased to near 50%. Coupled with a topology amenable to additive manufacturing will facilitate installation on complex curved surfaces which is challenging when using planar circuit board construction. Furthermore, this fabrication technique with an air dielectric, allows more flexibility in the dielectric material choice as it does not require a solid substrate underlying the top conductor. The dielectric material serves as a support structure for the antenna but has little impact on the propagation properties. In this work, a wideband microstrip air dielectric leaky wave aperture operates between 7-11 GHz. A method to fabricate using 3D printing and a secondary metal deposition step is presented, and an extension to a curved antenna using the same additive process is discussed.

The traveling wave coefficients are determined using the FE-BI model in a planar canonical surface, utilizing the electric fields along the longitudinal free edge of the HWLW (C.A. Jaramillo-Henao, L.C. Kempel, and S.W. Schneider, "Simulation of microstrip leaky-wave antennas on inhomogeneous substrates using the transverse resonance and finite element methods," *Electromagnetics*, 28, pp. 27-41, Jan-Mar 2008) antenna and compared to the TRM method. These coefficients will include the effects of the materials and termination loads used in the construction of the antenna. We will demonstrate that as the intervening dielectric approaches air, the usable bandwidth increases. The modeled antenna is fabricated using additive manufacturing, and test data is compared to the model. Bandwidth and radiation patterns of the antenna with air dielectric are compared to those of a microstrip HWLW antenna on Duroid.

