Coaxially-fed Solid Probe in a Parallel Plate Waveguide

J. Roelvink*, A. G. Williamson
Department of Electrical and Computer Engineering, The University of Auckland,
Private Bag 92019, Auckland, New Zealand

A commonly encountered problem in antenna feed and microwave systems is the situation of a coaxially excited probe feeding a rectangular or parallel plate waveguide. An important requirement in the analysis of such problems is the accurate determination of the current distribution on the probe as from this all other field quantities can be readily obtained. Despite this, many previous analyses assume a sinusoidal probe current. An accurate and numerically efficient theoretical analysis was developed for the case of a hollow-ended probe (A. G. Williamson, *IEE Proc. H.*, 132, 273-285, 1985) in which no assumption was made about the form of the probe current. In that analysis the electric field in the coaxial aperture was approximated as the TEM mode in the coaxial line. The gap electric field (off the end of the probe between the probe and the top plate) was represented as an infinite series of Chebyshev polynomials multiplied by a term containing a singularity of the same form as the Meixner edge condition for a hollow probe.

In most practical applications, of course, the probe would be solid-ended. In this paper the case of a coaxially-fed solid probe in a parallel plate waveguide is solved by representing the gap electric field as an infinite series of Gegenbauer polynomials (T. Do-Nhat and R. H. Macphie, *IEEE Trans. Antennas & Propagat*., AP-35, 1273-1280, 1987), multiplied by a term which satisfies the Meixner edge condition for a solid-ended probe. The TEM approximation is used for the electric field excitation in the coaxial aperture. The Gegenbauer coefficients are computed from an integral-equation representation using a Chebyshev polynomial approximation process as in (A. G. Williamson, *IEE Proc. H.*, 132, 273-285, 1985). The resulting equations are rigorous and numerically efficient, requiring only a few terms of the Gegenbauer polynomial series to produce accurate results. This can be demonstrated by the rapid convergence of the field in the gap as the number of terms is increased. Moreover for an electrically small gap the computed gap electric field is in very close agreement with the static gap field obtained by conformal mapping.

Results are given for the gap electric field and the current distribution on the probe (including the top surface). A comparison of the current distribution on hollow-ended and solid-ended probes is also given. From this, theoretically derived length adjustment factors relating the currents on hollow and solid ended probes are deduced. Finally, results for the input admittance are reported that are shown to be very accurate compared to simulation results (CST Microwave Studio, http://www.cst.com).