

# Multi-Mode Analysis of Dual Ridged Waveguide Systems for Material Characterization

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In this paper, two nondestructive dual ridged waveguide (DRWG) material characterization systems are investigated. Shown in Fig. 1, the single and clamped DRWG probe geometries were analyzed in previous work; however, that research only incorporated the dominant DRWG mode. Here, that restriction is removed and the existence of evanescent higher-order modes is considered.

Theoretical analysis of the single and clamped DRWG probes is presented and discussed. The approach taken here is similar to that presented in previous research: Love's equivalence theorem is used to remove the DRWG apertures which are replaced with equivalent magnetic currents radiating in the presence of the background parallel-plate waveguide structure. Enforcing the continuity of the tangential magnetic fields in the DRWG and parallel-plate regions yields a system of coupled magnetic field integral equations (MFIEs). This coupled MFIE system is solved using the Method of Moments (MoM) where the tangential electric and magnetic fields in the DRWG are used as expansion and testing functions, respectively. Inversion of the resulting MoM impedance matrix produces theoretical expressions for the reflection and transmission coefficients which are numerically inverted (via nonlinear least squares) to yield estimates of the permittivity and permeability of the material under test. While the steps taken in the theoretical development are similar to previous work, the addition of higher-order modes into the analysis substantially complicates the derivation and is a significant extension of the existing dominant-mode-only literature.

Lastly, simulation results of the two structures in Fig. 1 are presented. A comparison of the dominant-mode only reflection and transmission coefficients with the higher-order mode coefficients is provided. The higher-order modes which contribute most to the improved theoretical reflection and transmission coefficients are physically discussed.

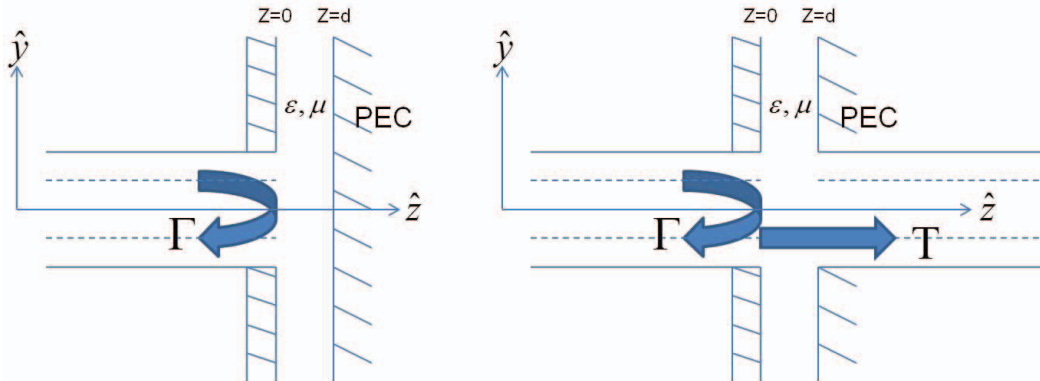


Figure 1: Single probe and clamped probe DRWG systems