Broadband, Nondestructive Characterization of PEC-Backed Materials Using a Dual-Ridged-Waveguide Probe

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A new single waveguide probe is introduced which utilizes a dual-ridged waveguide (DRWG) to provide nondestructive, broadband material characterization measurements of PEC-backed materials (much like existing coaxial probes, yet more broadly applicable) while maintaining the structural robustness of rectangular/circular waveguide probes. A schematic of the measurement geometry is shown in Figure 1—a DRWG attached to an infinite PEC flange plate is placed in contact with a PEC-backed magnetic material of unknown ε_r and μ_r. The theoretical expression for the reflection coefficient S_{11}^{thy}, necessary to characterize the material under test (MUT), is derived. This is achieved by replacing the DRWG aperture with an equivalent magnetic current which maintains the fields in the parallel-plate/MUT region in accordance with Love's equivalence theorem. Enforcing the continuity of the transverse magnetic fields at the DRWG aperture results in a magnetic field integral equation, which when solved using the Method of Moments, yields S_{11}^{thy}. The ε_r and μ_r of the MUT are then found by minimizing the root-mean-square difference between the theoretical and measured reflection coefficients using nonlinear least squares. At a minimum, two independent reflection measurements are required to unambiguously characterize the MUT. In this research, two-thickness method is used for this purpose. To experimentally verify the new probe, broadband material characterization results of a magnetic absorbing material are presented and compared to those obtained using the traditional, destructive Nicolson-Ross-Weir technique. The new probe's sensitivity to sample thickness, flange-plate thickness, and measured S_{11} uncertainties is also presented.

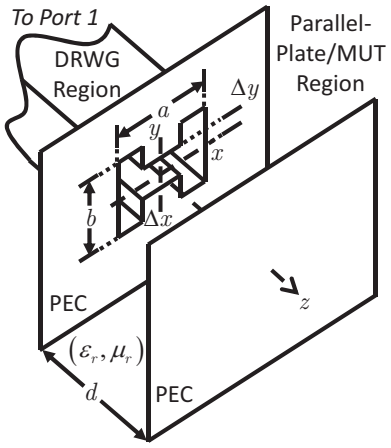

Figure 1: Single DRWG probe measurement geometry.