On Novel Approach for High Precision Characterization of Complex Permittivity with Low Loss Dielectrics

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The complex permittivity of dielectrics plays important roles in the modeling, design, fabrication and testing of antennas, microwave circuits and high speed digital systems. Accordingly, extensive research has been conducted in the past decades. To date, the popular measurement techniques in the RF and microwave region are cavity resonator, transmission line, free space and open-ended coaxial probe, among others. Each method has its unique pros and cons.

In this paper, we extend the investigation of multi-mode method (R. Voelker, G. Lei, G. Pan, and B. Gilbert, IEEE Trans. MTT., **45**(10), 1995-1960, 1997), and replace the rectangular geometry with circular. As a result, a high fidelity broadband nondestructive method has been developed for measuring the permittivity and loss tangent of dielectrics. This nondestructive method is simple, accurate, robust and repeatable in high precision and broadband (500 MHz - 12 GHz). We utilize multiple resonances, take the advantage of highly symmetrical configuration and nearly closed-form analytical solutions, and take into account of disk rim fringing fields and radiation loss. A copper-FR4-copper sandwich disk is used as the device under test (DUT) for laboratory measurements using the HP-8510C network analyzer, and the resulting data of frequency dependent permittivity and loss tangent are verified to satisfy the Kramer-Kronig self-consistent property.