



Standard Test Method for Relative Permittivity (Dielectric Constant) and Dissipation Factor of Polymer-Based Microwave Circuit Substrates¹

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1. Scope

1.1 This test method permits the rapid measurement of apparent relative permittivity and loss tangent (dissipation factor) of metal-clad polymer-based circuit substrates in the X-band (8 to 12.4 GHz).

1.2 This test method is suitable for testing PTFE (polytetrafluorethylene) impregnated glass cloth or random-oriented fiber mats, glass fiber-reinforced polystyrene, polyphenyleneoxide, irradiated polyethylene, and similar materials having a nominal specimen thickness of 1.6 mm. The materials are applicable to service at nominal frequency of 9.6 GHz.

NOTE 1—See Appendix X1 for additional information about range of permittivity, thickness other than 1.6 mm, and tests at frequencies other than 9.6 GHz.

1.3 The values stated in inch-pound units are to be regarded as the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation²

D 618 Practice for Conditioning Plastics for Testing³

D 1711 Terminology Relating to Electrical Insulation²

D 2520 Test Methods for Complex Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials at Microwave Frequencies and Temperatures to 1650°C⁴

2.2 IPC Standards:⁵

IPC-TM-650 Test Methods Manual Method 2.5.5.5.

IPC-CF-150E Copper Foil for Printed Wiring Applications.

2.3 *IEEE Standards:*⁶

Standard No. 488.1 Standard Digital Interface for Programmable Instrumentation.

Standard No. 488.2 Standards, Codes, Formats, Protocols and Common Commands for use with ANSI and IEEE Standard 488.1.

3. Terminology

3.1 *Definitions*—See Terminology D 1711 for the definitions of terms used in this test method. See also Test Methods D 2520, D 150, and IPC TM-650 for additional information regarding the terminology.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *D*—a symbol used in this test method for the dissipation factor.

3.2.2 ΔL —a correction factor associated with length which corrects for the fringing capacitance at the ends of the resonator element.

3.2.3 κ' —symbol used in this test method to denote relative permittivity.

NOTE 2—The preferred symbol for permittivity is Greek kappa prime but some persons use other symbols to denote this property such as *DK*, *SIC*, or ϵ'_R .

3.2.4 *microstrip line*—a microwave transmission line employing a flat strip conductor bonded to one surface of a dielectric board or sheet, the other surface of which is clad with, or bonded to, a continuous conductive foil or plate which is substantially wider than the strip. Microstrip provides easier accessibility than stripline for attaching components and devices to the strip circuitry.

3.2.5 *microwave substrate*—a board or sheet of low-loss dielectric material which may be clad with metal foil on one, or both, surfaces. In this test method all metal is removed by etching prior to testing.

3.2.6 *stripline*—microwave transmission line using a flat strip conductor clamped, or bonded, between two substantially wider dielectric boards. The outer surfaces of both boards are

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² *Annual Book of ASTM Standards*, Vol 10.01.

³ *Annual Book of ASTM Standards*, Vols 08.01 and 10.01.

⁴ *Annual Book of ASTM Standards*, Vol 10.02.

⁵ Available from IPC, 2215 Sanders Rd., Northbrook, IL 60062.

⁶ Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331