



Designation: D2520 – 21

Standard Test Methods for Complex Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials at Microwave Frequencies and Temperatures to 1650 °C¹

This standard is issued under the fixed designation D2520; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover the determination of relative (Note 1) complex permittivity (dielectric constant and dissipation factor) of nonmagnetic solid dielectric materials.

NOTE 1—The word “relative” is often omitted.

1.1.1 *Test Method A* is for specimens precisely formed to the inside dimension of a waveguide.

1.1.2 *Test Method B* is for specimens of specified geometry that occupy a very small portion of the space inside a resonant cavity.

1.1.3 *Test Method C* uses a resonant cavity with fewer restrictions on specimen size, geometry, and placement than Test Methods A and B.

1.2 Although these test methods are used over the microwave frequency spectrum from around 0.5 to 50.0 GHz, each octave increase usually requires a different generator and a smaller test waveguide or resonant cavity.

1.3 Tests at elevated temperatures are made using special high-temperature waveguide and resonant cavities.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are inch-pound units that are provided for information only and are not considered standard.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 *ASTM Standards:*²

A893/A893M Test Method for Complex Dielectric Constant of Nonmetallic Magnetic Materials at Microwave Frequencies

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D1711 Terminology Relating to Electrical Insulation

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology **D1711**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *neper, n*—a division of the logarithmic scale wherein the number of nepers is equal to the natural logarithm of the scalar ratio of either two voltages or two currents.

NOTE 2—The neper is a dimensionless unit. 1 neper equals 0.8686 bel. With I_x and I_y denoting the scalar values of two currents and n being the number of nepers denoted by their scalar ratio, then:

$$n = \ln_e(I_x / I_y)$$

where:

$\ln_e$ = logarithm to base e.

3.3 *Definitions of Terms Specific to Test Methods B and C:*

3.3.1 *electrical skin depth, n*—the effective depth of field penetration at high frequencies where electric currents are confined to a thin layer at the surface of conductors due to basic electromagnetic phenomena.

3.3.1.1 *Discussion*—The skin depth for copper and silver is approximately 0.002 mm at 1 GHz and decreases by a factor of 10 at 100 GHz.

¹ These test methods are under the jurisdiction of ASTM Committee **D09** on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee **D09.12** on Electrical Tests.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.