



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 D 2520; 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.

This standard has been approved for use by agencies of the Department of Defense.

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 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 *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 Insulating Materials²

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing²

D 1711 Terminology Relating to Electrical Insulation²

F 131 Test Method for Complex Dielectric Constant of

Nonmetallic Magnetic Materials at Microwave Frequencies³

3. Terminology

3.1 Definitions:

3.1.1 *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.

3.1.2 For other definitions used in these test methods, refer to Terminology D 1711.

4. Significance and Use

4.1 Design calculations for such components as transmission lines, antennas, radomes, resonators, phase shifters, etc., require knowledge of values of complex permittivity at operating frequencies. The related microwave measurements substitute distributed field techniques for low-frequency lumped-circuit impedance techniques.

4.2 Further information on the significance of permittivity may be found in Test Methods D 150.

4.3 These test methods are useful for specification acceptance, service evaluation, manufacturing control, and research and development of ceramics, glasses, and organic dielectric materials.

TEST METHOD A—SHORTED TRANSMISSION LINE METHOD

5. Scope

5.1 This test method covers the determination of microwave dielectric properties of nonmagnetic isotropic solid dielectric materials in a shorted transmission line method. This test

¹ These test methods are under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee D09.12 on Electrical Tests.

Current edition approved July 15, 1995. Published March 1996. Originally published as D 2520 – 66 T. Last previous edition D 2520 – 86 (1990) ^{ε1}.

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

³ *Annual Book of ASTM Standards*, Vol 03.04.