**Designation: ~~F3057 – 16~~ F3057 – 21**

# Standard Test Method for Electromagnetic Shielding Effectiveness of Glazings[1]

This standard is issued under the fixed designation F3057; 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 This test method covers the determination of the electromagnetic shielding effectiveness of glazings or glazing configurations.

1.1.1 The intended application of this test method is for glazings or glazing configurations to be evaluated for their transmittance or shielding capability to electromagnetic frequencies.

1.1.2 This is a component test. It is not applicable to full systems such as walls, floors, ceilings, shielded racks, or window systems.

1.1.3 The intention of this test method is to standardize a measurement procedure for glazings or glazing configurations, with and without coatings, films, interlayers, or other enhancements, as single or insulating units at a standard size and when mounted in a standardized frame.

1.1.4 This test method is to provide a means of generating data for the glazing or glazing configuration infills that can be used by the consumer, designer, and system manufacturer to understand the capability and contribution of glazings or glazing configurations to a system used for Electromagnetic Interference (EMI) security.

1.2 This test method is for use in the assessment of EMI transmittance for frequency ranges 100 kHz to 20 GHz. Specific test frequencies within these ranges are required.

1.3 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use. Some specific hazards statements are given in Section 8 on Hazards.*

1.5 *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 Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

~~2.1 *ASTM Standards:*~~[2]

[1] This test method is under the jurisdiction of ASTM Committee F12 on Security Systems and Equipment and is the direct responsibility of Subcommittee F12.10 on Systems Products and Services.

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[2] ~~Available from American National~~ 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* ~~Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.~~volume information, refer to the standard's Document Summary page on the ASTM website.

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2.1 *ANSI Standard:*[2]

ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment

2.2 *IEEE Standards:*[3]

IEEE Standard 299–1977 IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures

IEEE STD C95.1–1991 IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

2.3 *OSHA Standard:*[4]

OSHA Regulation, 29 CFR 1910 Department of Labor, July 1992

2.4 *ANSI Standard:*[5]

ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment

2.3 *ISO Standard:*[4]

ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories

2.4 *OSHA Standard:*[5]

OSHA Regulation, 29 CFR 1910 Department of Labor, July 1992

## 3. Terminology

3.1 *Definitions:*

3.1.1 *accredited independent testing laboratory*—testing laboratory accredited to perform the referenced testing procedures by a nationally recognized accrediting agency in accordance with ISO/IEC 17025 and led by a test director.

3.1.2 *electric field measurements*—the attenuation provided by a glazing or glazing configuration is assessed by using a local source to generate the electric field. Thefield; the electric field measurement will be from 1 to 100 MHz.

3.1.3 *magnetic field measurements*—the attenuation provided by a glazing or glazing configuration is assessed by using a local source to generate the near field. Thefield; the magnetic field measurements will be conducted from 100 kHz to 20 MHz.

3.1.4 *obscuration glazing*—glass that may transmit light but only allows a limited amount of visual information to pass through.

3.1.5 *plane wave measurements*—the attenuation provided by a glazing or glazing configuration is assessed by using a locally generated distant source or plane wave field. Thefield; the plane wave measurements will be from 100 MHz to 20 GHz.

3.2 *Acronyms:*

3.2.1 *ANSI*—American National Standards Institute.

3.2.2 *cw*—continuous wave.

3.2.3 *EMI*—Electromagnetic Interference.

3.2.4 *h*—hours.

3.2.5 *IEC*—International Electrotechnical Commission.

3.2.6 *ISO*—International Organization for Standardization.

3.2.7 *NCSL*—National Conference of Standards Laboratories.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Available from American National Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[3] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854, http://www.ieee.org.

[5] Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., Washington, DC 20210, http://www.osha.gov.

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

3.2.8 *OSHA*—Occupational Safety and Health Administration.

3.2.9 *pw*—plane wave.

3.2.10 *SE*—shielding effectiveness.

3.2.11 *SI*—système International d'unités (International System of ~~Units)~~Units).

## 4. Summary of Test Method

4.1 This section is a summary of Section 13. Specific details are included in that section.

4.2 The test method applies to the magnetic field, electric field, and plane wave, and is comprised of a reference run and a specimen run.

4.3 Measurements shall be taken at a minimum of 461 frequencies equally spaced across the tested logarithmic scale.

4.4 Reference runs are performed through the test aperture with the antenna in position but without the test specimen installed.

4.5 Specimen runs are performed in the same manner as the reference run, but with the specimen installed.

4.6 All test points are evaluated with the maximum received signal strength results stored under the specimen indicator number.

4.7 The attenuation level provided by the glazing or glazing configuration specimen is determined by subtracting the specimen run data from the reference data.



4.8 Three identical specimens are tested with the results at each test point frequency averaged.

## 5. Significance and Use



5.1 This test method provides measurement procedures for determining the electromagnetic shielding effectiveness of glazings and glazing configurations as a material. This test method specifies a method for comparing the glazings and glazing configurations as an infill component to allow comparison of between different infills. In addition, this test method is written to minimize variations in measured shielding effectiveness at a given frequency and test point regardless of test personnel, equipment, and test site. Therefore, the shielding effectiveness of a glazing or glazing configuration from any supplier can be determined. This test method specifies a minimum set of measurements over a frequency range to determine shielding effectiveness.

5.2 *Source Fields*—Performance of a shielded enclosure and glazing or glazing configurations are to be assessed for three source fields: magnetic, electric, and plane wave.

## 6. Interferences

6.1 *Interference with Electronic Equipment*—Care shall be taken to avoid interference with other electronic equipment operating in the vicinity

6.2 *Operational Impact Analysis and Risk*—The electromagnetic barrier must remain intact during the shielding effectiveness measurement sequence, and use of electrically noisy equipment must be restricted. Radiated signal levels should present no hazard to equipment, but frequency adjustments may be required to avoid self interference or interference with nearby facilities. Record the actual test frequencies. Normal electrical safety precautions apply.

6.3 The test director shall ensure that testing is conducted with inboard and outboard surfaces of the test specimen identified, and the test specimen shall be at the prescribed temperature in Section 12.

## 7. Apparatus

7.1 *Test Chamber*—An RF shielded enclosure that meets IEEE STD 299-1997.

7.2 *Mounting Frame*—The mounting frame must be capable of securely holding the glazing or glazing configuration in a fixed location where the glazing or glazing configuration surface is parallel to the frame. The geometrical center of the glazing or glazing configuration shall be 1 m from the floor. The edge capture of the glazing or glazing configuration shall be 26 ± 2 mm, leaving an aperture opening of 0.86 by 0.86 m ± 2 mm. For systems 0.91 by 0.91 m specimen and an aperture opening of 1.17 by 2.39 m for the 1.22 by 2.44 m specimen with the ability to test glazing configurations from 6 to 130 mm ± 2 mm thick.

7.2.1 The specimen must be mounted in a metal frame using the manufacturer's installation procedures.

7.2.2 Shielding material may be grounded or not grounded. Special consideration given to the grounding of the specimen, it shall be noted in the report.

7.3 The mounting plates should be constructed to not exert unnecessary pressure on the glazing or glazing configuration so as to cause breakage, distortion, or compression of the glazing or glazing components.

7.4 Test equipment should be selected to provide a dynamic range that exceeds the shielding effectiveness of the glazing or glazing configuration specimen.

## 8. Hazards

8.1 For human exposure to electromagnetic energy in controlled environments, the maximum permissible exposure to electric and magnetic field strengths shall be minimized to the maximum extent possible. Acceptable levels can be found in IEEE STD C95.1-1991 and OSHA Regulation, 29, CFR.



## 9. Sampling, Test Specimens, and Test Units

9.1 *Sample*—A sample shall consist of one glazing or glazing configuration unit.



9.2 *Specimen:*

9.2.1 *Specimen Size*—The specimen size to be tested shall correlate with the intended size of the system as follows:

9.2.1.1 For systems incorporating glazing infill less than or equal to 1 m in the short dimension, the specimen size shall be 0.91 by 0.91 m ± 3 mm.

9.2.1.2 For systems incorporating glazing infill greater than 1 m in the short dimension, the specimen size shall be 1.22 by 2.44 m ± 6 mm.

9.2.1.3 For systems requiring a test with glazing larger than those indicated in 9.2.1.2, may be specified by the authority having jurisdiction and must be designated in the report per 15.2*(3)*.

9.2.2 *Specimen Configuration*—The specimen shall be constructed with the same materials as will be made commercially available. The materials used in the construction shall be documented. Substitution of materials or components without testing is not permitted.

## 10. Preparation of Apparatus

10.1 *Glazing Testing*—Testing of glazing or glazing configuration can be conducted wherever the equipment and environment are appropriate.

10.2 *Movable Equipment*—Movable equipment containing metal shall be removed from the test enclosure prior to making measurements.

10.3 *Preliminary Procedures*—Perform the following preliminary test on all accessible shielding faces to detect weak points and to permit remedy of shielding defects caused by faulty assembly and poor workmanship prior to actual measurement.

10.3.1 With the transmitting antenna turned off, perform a continuous wave (cw) measurement at each frequency to be used for testing to ensure that no emitters are nearby that may cause interference. Frequency adjustments may be necessary to avoid interferences.

10.3.2 Additionally, perform a receiving equipment coupling measurement. The setup for this measurement is the reference measurement with the following exceptions. Disconnect the receiving antenna from the nearest cable and replace the receiving antenna with a dummy load (resistive load matched to the characteristic impedance of the receiving system). Measured levels shall be negligible so the required dynamic ranges are maintained. If the measured levels are larger than expected, determine the penetration points and correct the identified leakage points. Repeat the receiving equipment coupling measurements until negligible levels are maintained.

10.3.3 Perform a noise measurement with the following equipment setup. Place the receiving antenna and equipment on the inboard side of the glazing or glazing configuration and turn off the transmitting antenna placed outboard side of the glazing or glazing configuration. The receiving antenna or the specimen can be reversed as appropriate if the specimen is asymmetrical and the orientation may cause a shielding difference side to side. The prescribed background tests are to be completed whenever the specimen or equipment is moved. Measure the noise level at each frequency to be used for testing.

10.4 After noise levels have been found negligible (or the test equipment has been modified to make the penetration negligible), position the transmitting and receiving antennas so that they align with the geometric center of the glazing or glazing configuration specimen ±6 mm.

## 11. Test Equipment Calibration

11.1 All test equipment shall be calibrated according to ANSI/NCSL Z540.3.

## 12. Conditioning

12.1 Glazing or glazing configuration shall be conditioned to 21 ± ~~3°C~~3 °C with free flowing air between the lites for a minimum of 4 h prior to test. This temperature is to be held throughout the test.

## 13. Procedure

13.1 *General Test Procedures for Each Glazing or Glazing Configuration Specimen:*

13.1.1 The test procedure applies to magnetic field, electric field, and plane wave and is comprised of two basic setups: a reference run and a specimen run.

13.1.2 Transmit and receive antennae must be positioned at the distances discussed above and centered (horizontally and vertically) in the aperture.

13.1.3 The reference run is performed through the test aperture with the antenna in position but without the test specimen installed. It is important that all mounting frame or bracing be installed, without the glazing or glazing configuration specimen. All test points are evaluated with the maximum received signal strength results stored as reference.

13.1.4 The specimen run is performed in the same manner as the reference run, but with the glazing or glazing configuration specimen installed. All test points are evaluated with the maximum received signal strength results stored under the specimen indicator number.

13.1.5 The attenuation level provided by the glazing or glazing configuration specimen is determined by subtracting the specimen run data from the reference data.

13.1.6 One specimen is to be tested.

NOTE 1—For specific applications, the frequency range may be extended to 40 GHz. Appendix X1 provides guidance on measurement frequencies.

13.2 *Magnetic Field Testing Procedures:*

13.2.1 The magnetic field testing shall be run with the transmitting and receiving antenna located directly opposite each other and separated from the material under test by a distance of 30.48 cm from the surface of the glazing or glazing configuration system being evaluated to the center of the antenna loop.

13.2.2 Measurements shall be made with the loop antenna oriented in three orthogonal planes with respect to the test specimen as shown in Fig. 1 below.

13.2.3 Results shall be provided at each test frequency resulting in the maximum signal strength recovered (lowest attenuation) from the three orthogonal planes test data.

13.2.4 Measurements shall be taken at a minimum of 461 frequencies equally spaced across logarithmic scale from ~~100 KHz~~ 100 KHz to 20 MHz.

13.3 *Electric Field Testing Procedures:*

13.3.1 The electric field testing shall be run with the transmitting and receiving antenna located directly opposite each other and separated from the material under test by a distance of 183 cm from the surface of the glazing or glazing configuration system being evaluated to the center of the antenna (for dipoles and monopoles) or to the closest extremity for log-periodic and similar directional antennas.

13.3.2 Measurements shall be made with the antenna oriented (that is, rotated and directed) for optimum polarization and direction to achieve maximum signal strength with respect to the test specimen as shown in Figs. 2 and 3 below.

13.3.3 Results shall be provided at each test frequency resulting in the maximum signal strength recovered (lowest attenuation) from the two polarization planes test data.

13.3.4 Measurements shall be taken at a minimum of 461 frequencies equally spaced across the logarithmic scale from ~~1 to~~ 1 to 100 MHz.

13.4 *Plane Wave Testing Procedures:*

13.4.1 The plane wave testing shall be run with the transmitting and receiving antenna located directly opposite each other and

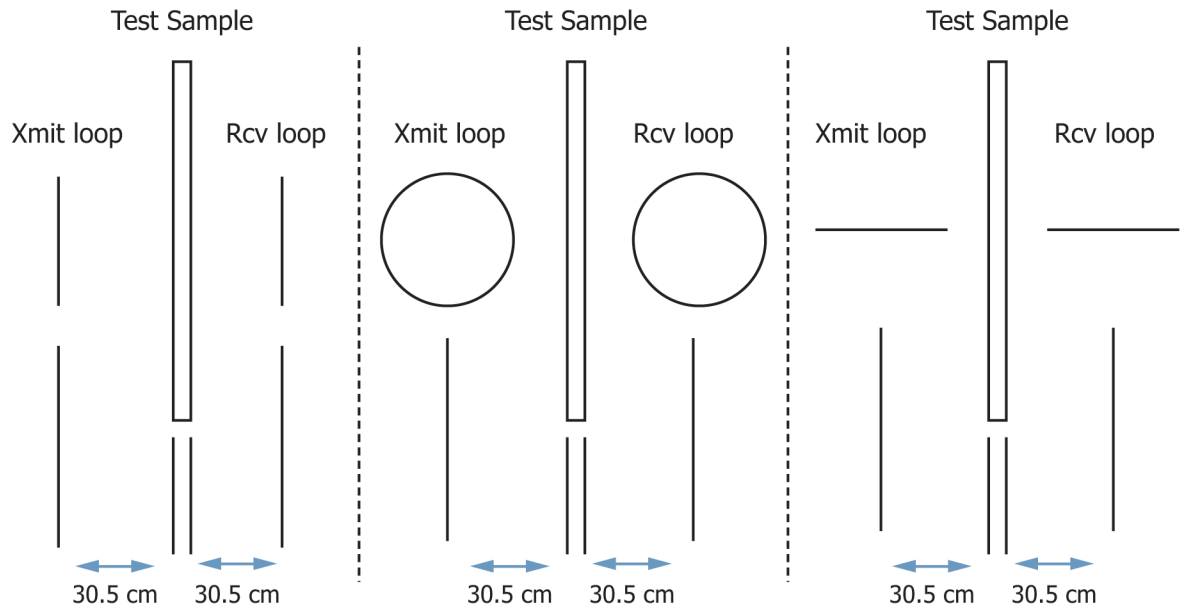


**FIG. 1 Magnetic Field Antenna Positions**

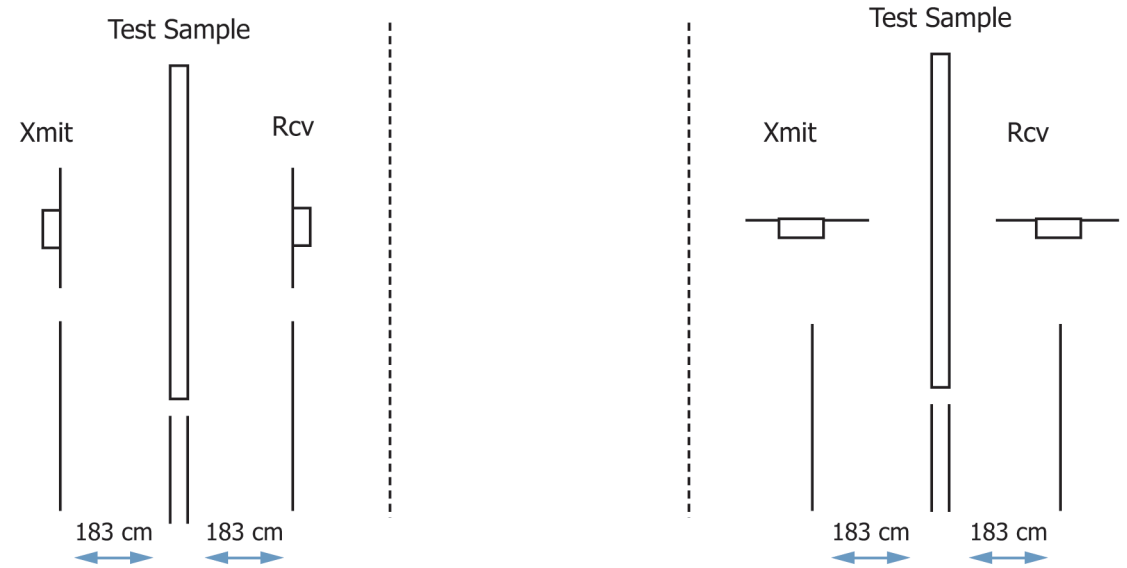


**FIG. 2 Electric Field Antenna Positions (Dipoles and Monopoles)**

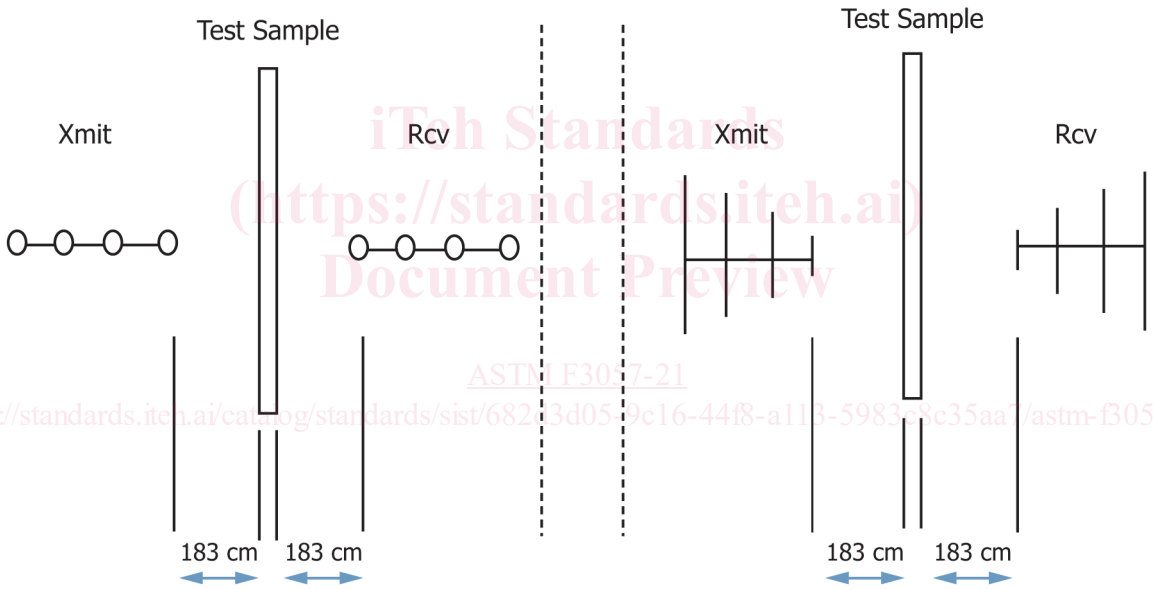




**FIG. 3 Electric Field Antenna Positions (Log Periodic et al)**

separated from the material under test by a distance of 183 cm from the surface of the glazing or glazing configuration system being evaluated to the center of the antenna (for dipoles and monopoles) or to the closest extremity for log-periodic and similar direction antennas.

13.4.2 Measurements shall be made with the antenna oriented (that is, rotated and directed) for optimum polarization and direction to achieve maximum signal strength with respect to the test specimen as shown in Figs. 4 and 5 below.

13.4.3 Results shall be provided at each test frequency resulting in the maximum signal strength recovered (lowest attenuation) from the two polarization planes test data.

13.4.4 Measurements shall be taken at a minimum of 461 frequencies equally spaced across the logarithmic scale from 100 to 20 000 MHz.