

American National Standard For Calibration of Antennas Used for Radiated Emission Measurements in Electromagnetic Interference (EMI) Control

Secretariat

**American National Standards Committee for C63
Institute of Electrical and Electronics Engineers, Inc**

Approved June 16, 1988

American National Standards Institute

Published by

The Institute of Electrical and Electronics Engineers, Inc
345 East 47th Street, New York, NY 10017-2394, USA

American National Standard

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Foreword

(This Foreword is not a part of ANSI C63.5-1988, American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electromagnetic Interference (EMI) Control.)

American National Standard C63.4, Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 10 kHz to 1 GHz, has undergone several revisions since the original document covering methods of measurement was produced in 1940. Although many improvements were made in the standard from time to time, the reproducibility of measurements of radiated interference from one test site to another has not been completely satisfactory.

In 1982 a concerted effort was organized in Subcommittee One of the American National Standards Committee C63 to determine how the technique could be improved. Evidence showed that the variability was due, in part, to inadequate (a) control of site ground plane conductivity, flatness, site enclosures, effects of surrounding objects, and certain other site construction features, (b) accounting for antenna factors, associated cabling, and balun and device under test characteristics, and (c) consideration of mutual coupling effects between the device under test and the receiving antenna and their images in the ground plane. Accordingly, Standard C63.4 has been revised, and Standards C63.5, C63.6, and C63.7 were prepared to provide additional information. Standard C63.5 provides methods of calibration of antennas for use on the test site.

At the time that the Accredited Standards Committee on Electromagnetic Compatibility, C63 approved this standard, it had the following membership:

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American National Standard For Calibration of Antennas Used for Radiated Emission Measurements in Electromagnetic Interference (EMI) Control

1. Scope

This standard provides methods for determining antenna factors of antennas used for radiated emission measurements of electromagnetic interference (EMI) from 30 MHz to 1000 MHz. Antennas included are linearly polarized antennas such as tuned dipoles, biconical dipoles, log-periodic arrays, etc, which are used in measurements governed by ANSI C63.4-1988 [2].¹ The methods include standard site, reference antennas, standard antenna, and standard field methods. The latter two methods are incorporated by reference.

2. References

The following references shall form a part of this standard to the extent referenced. When American National Standards referred to in this standard are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

[1] ANSI C63.2-1987, American National Standard Specifications for Electromagnetic Noise and Field-Strength Instrumentation, 10 kHz-40 GHz.²

[2] ANSI C63.4-1988, American National Standard Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 10 kHz to 1 GHz.

[3] ANSI C63.6-1988, American National Standard Guide for the Computation of Errors in Open-Area Test Site Measurements.

¹The numbers in brackets correspond to the references listed in Section 2 of this standard.

²ANSI publications are available from the Sales Department of the American National Standards Institute, 1430 Broadway, New York, NY 10018.

[4] ANSI C63.7-1988, American National Standard Guide for Construction of Open-Area Test Sites for Performing Radiated Emission Measurements.

[5] ANSI/IEEE Std 100-1988, IEEE Standard Dictionary of Electrical and Electronics Terms.³

[6] FCC Project 3235-16, 1957, *A New Wideband Balun*, Federal Communications Commission, Washington, DC.

[7] FCC Project 3235-33, 1980, *Construction of General Purpose Receiving Antenna Dipole Sets and Balun Assemblies*, Federal Communications Commission, Washington, DC.

[8] FITZGERRELL, R. G. Linear Gain—Standard Antennas Below 1000 MHz. US Dept of Commerce, NBS Tech. Note 1098.

[9] MIL-STD-45662, June 1980, Military Standard Calibration Systems Requirements. Dept of Defense, Washington, DC.⁴

[10] ROBERTS, W. K. A New Wide-Band Balun. *Proceedings of the Institute of Radio Engineers*, Dec 1957, pp 1628–1631.

[11] ROBERTS, W. K. *A Guide to FCC Equipment Authorizations*. Willmar K. Roberts, New Smyrna Beach, FL, 1980.

[12] SMITH, A. A. Jr Standard Site Method for Determining Antenna Factors. *IEEE Transactions on Electromagnetic Compatibility*, EMC-25, no 3, Aug 1982, pp 316–322.

[13] TAGGART, H. E. and WORKMAN, J. L. Calibration Principles and Procedures for Field Strength Meters (30 Hz to 1 GHz). US Dept of Commerce, NBS Tech. Note 370.

3. Definitions

The following definitions apply specifically to the subject treated in this standard. For additional definitions, see ANSI/IEEE Std 100-1988 [4].

ambient level: The values of radiated and conducted signal and noise existing at a specific test location and time when the test sample is not activated.

antenna factor: Quantity relating the strength of the field in which the antenna is immersed to the output voltage across the load connected to the antenna.

ground plane: A conducting surface or plate used as a common reference point for circuit returns and electric or signal potentials.

ideal site: A test site on which the reflective surface is flat and has infinite conductivity and size.

normalized site attenuation (NSA): Site attenuation divided by the antenna factors of the radiating and receiving antennas (all in linear units).

radio noise: An electromagnetic noise that may be superimposed upon a wanted signal and is within the radio-frequency range. For the purposes of this standard, an electromagnetic disturbance of a sinusoidal character is also considered radio noise.

³ANSI/IEEE publications are available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018, or from the Institute of Electrical and Electronics Engineers Service Center, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331.

⁴MIL publications are available from the Director, US Navy Publications and Printing Service, Eastern Division, 700 Robbins Avenue, Philadelphia, PA 19111.

random noise: Noise that comprises transient disturbances occurring at random.

NOTE — The part of the noise that is unpredictable except in a statistical sense. The term is most frequently applied to the limiting case where the number of transient disturbances per unit time is large, so that the spectral characteristics are the same as those of thermal noise (thermal noise and shot noise are special cases of random noise).

site attenuation: The ratio of the power input to a matched balanced lossless tuned dipole radiator to that at the output of a similarly balanced matched lossless tuned dipole receiving antenna for specified polarization, separation, and heights above a flat reflecting surface.

standard antenna calibration site: A flat, open area site, devoid of nearby scatterers such as trees, power lines, and fences, which has a large metallic groundplane.

radiated emissions test site: A site meeting specified requirements suitable for measuring radio interference fields radiated by a device, equipment, or system under test.

4. General Test Conditions

The following paragraphs describe the general test conditions for antenna calibration.

4.1 Measurement Geometry

Accurate antenna calibration requires some restrictions on measurement geometry. The antenna separation distance R must be great enough to ensure that near-field effects and antenna-to-antenna mutual coupling effects are negligible. Antenna heights (h_1 , h_2) must be great enough to minimize antenna-to-ground plane mutual impedance and to ensure negligible contribution from the surface wave component of the groundwave.

When tuned dipoles are calibrated using the methods in this standard, they must be calibrated at separation distances R equal to or greater than 10 m and at heights equal to or greater than 2 m. The spacing R between log-periodic array antennas is measured from the projection onto the ground plane of the midpoint of the longitudinal axis of each antenna.

NOTE — If measurements are needed in special geometries such as 3 m separation or vertical polarization, refer to Appendix A.

4.2 Test Instrumentation

Signal generators and power amplifiers shall have a 50- Ω output impedance; and radio noise meters, spectrum analyzers, other tuned voltmeters, and preamplifiers shall have a 50- Ω input impedance. Refer to ANSI C63.2-1987 [1] for radio noise meter specifications.

An impedance mismatch at the output of signal sources or at the input of voltmeters may result in reflections which could cause antenna factor measurement errors. This should be avoided by the use of padding attenuators of 10 dB: one at the output end of the transmitting cable and one at the voltmeter input. The signal sources should provide sufficient power to produce a signal at least 10 dB above the ambient and equivalent receiver noise at the receiver input. Preamplifiers may be used at the voltmeter input to meet this requirement. The source power and preamplifier gain requirements shall depend upon voltmeter/preamplifier sensitivity, antenna factors, cable losses, and measurement distance. It is preferable to use preamplifiers at the voltmeter input rather than power amplifiers at the source output. This will improve signal-plus-noise-to-noise ratio, while minimizing the potential for interference with susceptible equipment or licensed radio services in the vicinity of the test area.

Signal generators, antennas, and receiving equipment (voltmeters and preamplifiers) must be calibrated at regular intervals. Calibration should include amplitude accuracy, frequency accuracy, drift, and sensitivity, where applicable. Effects of drift, especially during the measurement time, should be compensated or corrected. These calibration