

American National Standard

for electromagnetic compatibility —
radio-noise emissions from low-voltage electrical
and electronic equipment in the range of
10 kHz to 1 GHz — methods of measurement



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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

Secretariat

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

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American National Standard

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Foreword

(This Foreword is not a part of 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.)

Almost from the beginning of radio broadcasting, the electric utility companies were faced with problems of radio noise. In 1924 the National Electric Light Association appointed a committee to study the subject. The manufacturers of electric power equipment had encountered similar problems, and in 1930, a subcommittee of the NEMA Codes and Standards Committee was set up. The following year the EEI-NEMA-RMA Joint Coordination Committee on Radio Reception was organized.

The Joint Coordination Committee issued a number of reports, among which was *Methods of Measuring Radio Noise*, 1940. This report included specifications for a radio-noise and field-strength meter for the frequency band 0.15 MHz–18 MHz. The report recommended procedures for measuring radio-noise voltage (conducted noise) from low- and high-voltage apparatus, making noise field-strength measurements near overhead power lines, determining broadcast field strengths, and collecting data upon which to base tolerable limits for radio noise.

During World War II, the needs of the armed services for instruments and methods for radio-noise measurement, particularly at frequencies higher than the broadcast band, became pressing and, in 1944, work on developing suitable specifications was begun by a special subcommittee of ASA Sectional Committee C63, Radio-Electrical Coordination. This special subcommittee developed a war-time specification which became Army-Navy Specification JAN-I-225 issued in 1945 and later approved as American War Standard—Method of Measuring Radio Interference of Electrical Components and Completed Assemblies of Electrical Equipment for the Armed Forces from 150 kHz to 20 MHz, C63.1-1946.

In 1951, ASA Sectional Committee C63, through its subcommittee No 1 on Techniques and Developments, started work on improving and extending measurement methods, taking into account methods mentioned in the 1940 report and those in current military specifications. In the course of this work, subcommittee No 1 developed the standard Radio-Noise Voltage and Radio-Noise Field Strength, 0.015 to 25 MHz/s, Low-Voltage Electric Equipment and Nonelectric Equipment C63.4-1963. Work continued within the subcommittee on developing methods of measurement above 25 MHz/s and the subsequent inclusion of these measurement methods in future revisions of C63.4-1963.

The standard C63.4-1963 was reaffirmed in 1969, and work within the subcommittee was accelerated to produce a draft standard which would make use of the experience gained by several years use of the standard, and extend its coverage to embrace a broader frequency range and incorporate newer measurement techniques that had been developed within the USA and by the International Special Committee on Radio Interference (CISPR) as set forth in IEC-CISPR Publications 14 and 16. The revised standard was published in 1981.

Although many improvements had been made in standard C63.4 in the several revisions, the reproducibility of measurements of radiated interference from one test site to another had 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 further revised, and Standards C63.5, C63.6, and C63.7 were prepared to provide the additional information.

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

Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 10 kHz to 1 GHz

1. Scope

This standard sets forth uniform methods of measurement of radio noise emitted from low-voltage electrical and electronic equipment in the frequency range of 10 kHz to 1 GHz. Methods for the measurement of radiated and power-line conducted radio noise are covered and may be applied to any such equipment unless otherwise specified by individual equipment requirements. These methods apply to the measurement of individual components, units, or systems comprising components and units. Additional methods may be added to this standard to fulfill future requirements as needed. Unless specifically called out, this standard is not intended for certification or approval of avionic equipment. The method for validation of test sites such as open area sites and absorber-lined chambers for frequencies in the range of 30 MHz–1000 MHz is contained in this standard.

2. References

The following references shall form a part of this standard, and 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.¹
- [2] ANSI C63.5-1989, American National Standard Calibration of Antennas Used for Radiated Emissions Measurements in Electromagnetic Interference (EMI) Control.
- [3] ANSI C63.6-1988, American National Standard Guide for the Computation of Errors in Open-Area Test Site Measurements.

¹ANSI 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 213-1987, Radio Interference; Methods of Measurement of Conducted Interference Output to the Power Line from FM and Television Broadcast Receivers in the range of 300 kHz–25 MHz.²

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

- [7] IEC, CISPR Publication 16-1987, Specification for Radio Interference Measuring Apparatus and Measurement Methods.³

- [8] IEEE Std 139-1988, Recommended Practice for the Measurement of Radio Frequency Emission from Industrial, Scientific, and Medical (ISM) Equipment Installed on User's Premises.

- [9] HEIRMAN, D. N. Vertical Site Attenuation—A Necessity, *1986 IEEE International Symposium on EMC*, 86CH2294-7, San Diego, CA, Sept 16–18, 1986, pp 342–346.

- [10] HEIRMAN, D. N. Definitive Open-Area Test Site Qualifications, *1987 IEEE International Symposium on EMC*, 87CH2487-7 Atlanta, GA, Aug 25–27, 1987.

- [11] SMITH, Jr., A. A., et al. Calculation of Site Attenuation from Antenna Factors. *IEEE Trans. on Electromagnetic Compatibility*, vol EMC-25, no 3, Aug 1982, pp 301–316.

²ANSI/IEEE publications can be obtained 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, Piscataway, NJ 08854-1331.

³IEC publications are available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

3. Definitions

The following definitions apply specifically to the subject treated in this standard. For additional definitions, see ANSI/IEEE Std 100-1988 [6].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.

broadband radio noise. Radio noise having a spectrum broad in width as compared to the nominal bandwidth of the measuring instrument, and whose spectral components are sufficiently close together and uniform so that the measuring instrument cannot resolve them.

common-mode radio noise. Conducted radio noise that appears between a common reference plane (ground) and all wires of a transmission line, causing their potentials to be changed simultaneously, and by the same amount relative to the common reference plane (ground).

conducted radio noise. Radio noise produced by equipment operation, which exists on the power line of the equipment and is measurable under specified conditions as a voltage or current.

differential-mode radio noise. Conducted radio noise that causes the potential of one side of the signal transmission path to be changed relative to another side.

emission. An act of throwing out or giving off, generally used here in reference to electromagnetic energy.

equipment under test (EUT). A representative component unit or system to be used for evaluation purposes.

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.

individual-equipment test requirements. The set of explicit requirements specifying the test conditions, instrumentation, equipment under test (EUT) operation, etc, to be used in testing a spe-

cific EUT for conducted and radiated radio noise. Such requirements should take precedence over the requirements of this standard.

line-impedance stabilization network (LISN). A network inserted in the supply-mains lead of the equipment under test (EUT) that provides a specified measuring impedance for radio-noise voltage/current measurements and isolates the EUT from the supply mains at radio frequencies.

low-voltage electrical and electronic equipment. Electrical and electronic equipment with operating input voltages of up to 600 V dc or rms ac.

narrowband radio noise. Radio noise having a spectrum exhibiting one or more sharp peaks, narrow in width compared to the nominal bandwidth of, and far enough apart to be resolvable by, the measuring instrument (or the communication receiver to be protected).

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

occupied bandwidth. The frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5% of the total mean power radiated by a given emission. In some cases, for example multichannel frequency division systems, the percentage of 0.5% may lead to certain difficulties in the practical application of the definition of occupied bandwidth; in such cases a different percentage may be useful.

radiated radio noise. Radio-noise energy in the form of an electromagnetic field including both the radiation and induction components of the field.

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

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

⁴The numbers in brackets correspond to the references listed in Section 2 of this standard.