American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

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C63.4

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ANSI C63.4-2009
(Revision of
ANSI C63.4-2003)

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Accredited Standards Committee C63®—Electromagnetic Compatibility
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American National Standards Institute

Secretariat

Institute of Electrical and Electronic Engineers, Inc.

Approved 7 July 2009

American National Standards Institute

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Abstract: U.S. consensus standard methods, instrumentation, and facilities for measurement of radio-frequency (RF) signals and noise emitted from electrical and electronic devices in the frequency range 9 kHz to 40 GHz are specified. This standard does not include generic nor product-specific emission limits. Where possible, the specifications herein are harmonized with other national and international standards used for similar purposes.

Keywords: conducted emission testing, conducting ground plane, digital equipment, electric-field measurement, intentional radiators, line impedance stabilization network, low-voltage electrical equipment, low-voltage electronic equipment, magnetic field measurement, normalized site attenuation, radiated emission testing, radio-noise emissions, radio-noise power, site attenuation, unintentional radiators

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Introduction

This introduction is not a part of ANSI C63.4-2009, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

Almost from the beginning of radio broadcasting, the electric utility companies were faced with the problem 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 established.[a] 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 to 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 on 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, called the ASA Sectional Committee C63, Radio-Electrical Coordination. This special subcommittee developed a wartime specification that became Army-Navy Specification JAN-I-225 issued in 1945 and later approved as C63.1-1946, 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.

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 C63.4-1963, Radio-Noise Voltage and Radio-Noise Field Strength, 0.015 to 25 MHz, Low-Voltage Electric Equipment and Non-Electric Equipment. Work continued within the subcommittee on developing methods of measurement above 25 MHz and the subsequent inclusion of these measurement methods in future revisions of C63.4-1963.

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

Although many improvements had been made in ANSI 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 No. 1 of the American National Standards Committee C63 to determine how the technique could be improved. Evidence showed that the variability was caused, in part, by the following inadequate processes:

— Control of site reference ground plane conductivity, flatness, site enclosures, effects of surrounding objects, and certain other site construction features

— Accounting for antenna factors, associated cabling, and balun and device under test characteristics

[a] Acronyms: ASA, American Standards Association; EEI, Edison Electric Institute; JAN, joint Army-Navy; NEMA, National Electrical Manufacturers Association; RMA, Radio Manufacturers Association.

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— Consideration of mutual coupling effects between the device under test and the receiving antenna and their images in the reference ground plane

Accordingly, ANSI C63.4 was further revised in 1988, and the standards ANSI C63.5, ANSI C63.6, and ANSI C63.7 were prepared to provide additional information.

In late 1988 and in 1989, the importance of including additional details on test procedures to provide proper evaluation of complex systems, such as information technology equipment and systems, was recognized. Measurements on such systems can be sensitive to the exact arrangement of equipment units and interconnecting cables. The 1991 edition of ANSI C63.4 was the result of a major effort on the part of the members of the Committee and various other participating individuals.

Work on another revision began during 1991 to provide for the testing of intentional as well as unintentional radiators. The 1992 ANSI C63.4 document included these changes. In 1994, work began on harmonizing the document with emerging international standards, clarifying several issues with respect to ac power-line conducted emission measurements and turntable usage, and standardizing terminology. Also added were provisions for the use of transverse electromagnetic (TEM) wave devices for measuring emissions, extension of the lowest frequency from 10 kHz down to 9 kHz, and revisions to the clause on the artificial hand. Minor changes were made to the normalized site attenuation tables to correct rounding errors. That work culminated in the 2001 issue of ANSI C63.4.

When the 2001 issue of ANSI C63.4 was approved, several subject areas were identified that needed to be considered for the next edition. Those subjects included clarification of what is mandatory and that figures are examples while text takes precedence; allowing emission measurement instrumentation, such as a spectrum analyzer, which does not fully meet either CISPR 16 or ANSI C63.2, to be used, but in case of dispute allowing only instrumentation meeting either of these two standards to take precedence; clarification of instrumentation calibration interval requirements; identifying new test setups when power accessories (power packs) are either the equipment under test (EUT) or not; allowing use of “loop back” cable connections for large floor-standing equipment to accommodate the arrangement of cables connected to output ports to be connected to input ports under certain conditions; warning that test facilities not allowing full antenna height search may not yield sufficient data to predict radiated emissions at a site that meets normalized site attenuation; clarifying EUT setups and minimum ports that need to be populated during personal computer testing; clarifying test frequencies for intentional radiator measurements; and correcting errors on certain figures, tables, and appendices. The resolution of these subject areas as well as other clarifications appeared in the 2003 edition of ANSI C63.4.

As was the case for the 2003 edition of this standard, several topics continued to be identified for future editions of the standard. There were several areas of interest to be considered for this edition. Based on the maturity of the work on these areas, significant progress was achieved on the following items:

a) Adding tables of LISN impedances (in addition to the plots in the 2003 edition) with and without the use of extension cords between the EUT power connection of the LISN and the end of the extension cord where the EUT connects its power plug

b) Clarifying and expanding the information and criteria to be used for selecting what must appear on video displays during emission testing

c) Updating of the signal levels used in receiver testing in Clause 12

d) Clarifying in Annex B the LISN calibration process

e) Accommodating the concern for the variation in antenna cable loss as a function of significant temperature variation at the test site

These areas are addressed in this edition as well as further edits in the text resulting from the process of review and entering the above changes. A significant addition was precautions that are needed in using spectrum analyzers, which appear in 4.2.2 and Annex H. The informative annexes for step-by-step testing procedures have been omitted, because those were mostly duplicative of the normative procedures in the

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main text. Basic specifications for current probes have been omitted, because LISN and voltage probe measurements remain preferred. In several clauses, figures were placed at the end of the respective clause to avoid breaking the flow of the text itself.

Additionally, based on comments received during the initial ballot of this revision, other areas deserved due attention, which led to the following changes:

- Ensured that the standards not under the control of Accredited Standards Committee (ASC) C63® were dated to guarantee the acceptance of the versions that are referenced, whereas the ASC C63® standards were undated because ASC C63® would be voting their acceptance.
- Added information on the effects of materials used to construct EUT support tables and antenna masts.
- Condensed the information about absorbing clamp calibration and use, as well as the artificial hand, as these continue to be in limited use.
- Retained the Clause 13 requirements for emission measurements of intentional radiators.
- Introduced site validation specifications above 1 GHz from CISPR 16-1-4:2007, while still allowing use of absorber material on the ground plane for an open-area test site (OATS) and semi-anechoic chambers without any further site validation measurements.
- For measurement methods above 1 GHz, there remains international standards activity as to the final outcome about how such measurements are to be made; meanwhile, this edition of ANSI C63.4 retains provisions of ANSI C63.4-2003 with no change.

Other topics remain under consideration for the next edition of the standard to be prepared after this version. ASC C63® has started this further work to include, but is not limited to, site validation above 1 GHz, measurement methods above 1 GHz, and measurement uncertainty as well as the possibility of moving the information on antenna calibration into one document and in particular ANSI C63.5. These other areas will constitute the ASC C63® maintenance process.

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1. Overview

1.1 Scope

This standard specifies U.S. consensus standard methods, instrumentation, and facilities for measurement of radio-frequency (RF) signals and noise emitted from electrical and electronic devices in the frequency range 9 kHz to 40 GHz. It does not include generic nor product-specific emission limits. Where possible, the specifications herein are harmonized with other national and international standards used for similar purposes.

Uses of the word *shall* in this standard indicate a mandatory requirement that must be met to satisfy this standard. The word *should* is used to indicate that a requirement is recommended but not mandatory. Tolerances on dimensions and distances are based on good engineering practice where not specified. The word *may* is used to indicate a recommendation that is at the discretion of the user. In addition, notes in this document are informative and are not part of the requirements. In this standard, the text takes precedence over the figures because the text is complete and the figures are illustrative of a typical application of the text. Notes are used in the text for emphasis or to offer informative suggestions about the technical content of the standard, and these notes provide additional information to assist the reader with a particular passage but do not include mandatory requirements. Footnotes in text are included only for information,

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Measurement methods are included for radiated and line-conducted emissions that can be generated by a variety of devices, as described in 1.2. Definitions are provided for terms and phrases contained in the text, in which the words do not represent obvious or common usage. Measurement instrumentation, facilities, and test sites are specified and characterized, including open-area test sites (OATS) and RF absorber-lined, metal chambers used for radiated emission measurement. Transverse electromagnetic (TEM) wave devices used for radiated emission measurement are treated in normative Annex F. The requirements of Annex F, when such tests are performed, shall take precedence in this standard. In most cases, measurement instrumentation and calibration requirements are only generally characterized in deference to standards dedicated to these subjects, which should be used in conjunction with this standard. The requirements for operation of test samples during measurements are presented for devices in general, as well as for specific types of devices that are frequently measured. Specific requirements for emission test data recording and reporting are presented with reference to general requirements contained in documents dedicated to standard laboratory practices, which should be used in conjunction with this standard. The main text is augmented by a series of annexes that provide details for certain measurement methods and facilities. Annex A provides an index of main text clauses to be used when testing particular equipment under test (EUT) types.

1.2 Purpose and applications

This document is intended to standardize methods, instrumentation, and facilities used to characterize device emissions with respect to voluntary or regulatory compliance requirements designed to protect authorized communication services. The specified procedures are intended to be applied primarily in controlled laboratory environments, but they may be used for emission measurement of in situ devices where indicated.

This standard may be applied to emission measurement of a variety of electrical and electronic devices, regardless of size and characteristics. The devices may be single, stand-alone units, or multiple, interconnected units.

These methods may be applied to the measurement of certain devices that purposefully radiate energy, such as intentional emitters, but they might not be applicable to licensed transmitters in the United States and other countries. Similarly, these methods may not be adequate for measurement of emissions from avionics or industrial, scientific, and medical (ISM) equipment.[1]

All limit specifications, relevant to a given emitting device, should be applied in their entirety to the characterization of the device over the specified frequency range in all propagation modes. Piecewise application is discouraged and runs the risk of incomplete characterization, which could fail to protect the authorized radio communications services in the manner intended. Emission limit requirements shall be obtained from other voluntary and regulatory sources, and certain other procedural documents shall be applied concurrently where specified herein. Still other procedural documents may be used as alternatives to this standard where equivalent results can be demonstrated. For regulatory applications invoking the methods in this standard, results obtained as prescribed herein shall take precedence over results obtained with alternative methods.

Not all clauses in this standard are applicable to all devices that can be measured with these methods. The nature of this standard is to specify general methods that may be applied to all devices within its scope and to supplement these methods with particular requirements for some types of devices. Device-particular

[1]Various standards used in the United States require emission measurements below 9 kHz (e.g., MIL-STD-461F [B19], MDS-201-0004 [B18], and SAE ARP 1972:1986 [B21]). These have their own measurement procedures and thus require no reference to ANSI C63.4 emission measurement procedures. However, they may require reference to ANSI C63.2 and ANSI C63.4 for instrumentation specifications. Individual procurement requirements shall take precedence.

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