ANSI C63.6-1996
(Revision of ANSI C63.6-1988)

American National Standard Guide for the Computation of Errors in Open-Area Test Site Measurements

Accredited Standards Committee on Electromagnetic Compatibility, C63
accredited by the
American National Standards Institute

Secretariat
Institute of Electrical and Electronics Engineers, Inc.

Approved 27 September 1996
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Abstract: The basis for the acceptability criterion of ±4 dB for the site attenuation measurements required in ANSI C63.4-1992 is provided.
Keywords: acceptability criterion, antenna factor, attenuator uncertainty, electromagnetic noise, error analysis, error budget

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Introduction

(This introduction is not part of ANSI C63.6-1996, American National Standard Guide for the Computation of Errors in Open-Area Test Site Measurements.)

ANSI C63.4, 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, has undergone several revisions since the original document, covering methods of measurement, was produced in 1940. While 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 1 of American National Standards Committee C63 to determine how the technique could be improved. Evidence showed that the variability was due, in part, to inadequate (1) control of site ground plane conductivity, flatness, site enclosures, effects of surrounding objects, and certain other site construction features; (2) accounting for antenna factors, associated cabling, and balun and device under test characteristics; and (3) consideration of mutual coupling effects between the device under test and the receiving antenna and their images in the ground plane. Accordingly, ANSI C63.4 was revised, and C63.5, C63.6, and C63.7 were prepared to provide additional information. This standard provides guidance information on the calculation of the errors incurred in making tests on an open-area site.

Participants

At the time that the Accredited Standards Committee on Electromagnetic Compatibility, C63, approved this guide, Subcommittee 1 had the following membership:

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At the time this guide was developed, the Working Group on Open-Area Test Sites had the following membership:

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American National Standard Guide for the Computation of Errors in Open-Area Test Site Measurements

1. Scope

This guide shows the basis for the acceptability criterion of ±4 dB for the site attenuation measurements required in ANSI C63.4-1992.

2. References

This guide shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

ANSI C63.2-1996, American National Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz—Specifications.[1]

ANSI C63.4-1992, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronics Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.14-1992, American National Standard Dictionary for Technologies of Electromagnetic Compatibility (EMC), Electromagnetic Pulse (EMP), and Electrostatic Discharge (ESD).

IEEE Std 100-1996, The IEEE Standard Dictionary of Electrical and Electronics Terms.[2]

3. Definitions

The definitions found in the four references in Clause 2 are by reference incorporated herein, and the definitions found in ANSI C63.14-1992 take precedence in the event of conflicts.

[1]The ANSI standards listed in this clause are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

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4. Error analysis

The error analysis in Table 1 applies to the normalized site attenuation measurement method given in 5.4.6 of ANSI C63.4-1992. The total estimated errors are the basis for the ±4 dB site acceptability criterion in 5.4.6.1 of ANSI C63.4-1992 (i.e., approximately 3 dB measurement uncertainty and an allowable 1 dB for site imperfections, added linearly in decibels).

Table 1—Error budget

Error item	Measurement method (5.4.6.1 of ANSI C63.4-1992)	
	Discrete	Swept
Antenna factor (Tx)[a]	±1 dB	±1 dB
Antenna factor (Rx)[a]	±1 dB	±1 dB
Electromagnetic noise and field strength instrument as a two-terminal voltmeter	0 dB	±1.6 dB
Attenuator	±1 dB	0 dB
Site imperfections for a well-built site	±1 dB	±1 dB
TOTALS[b]	±4 dB	±4.6 dB

[a]Above 800 MHz, errors can be ±1.5 dB (NIST).
[b]Assumed worst-case linear addition (in decibels) of each item.

The error budget in Table 1 does not include uncertainties in the amplitude stability of the signal generator or tracking generator, and any amplifiers that may be used, nor does it include the potential errors in the tracking generator leveling or measurement technique. The output level of most signal and tracking generators will drift with time and temperature, and the gain of many amplifiers will drift as temperature changes. It is imperative that these sources of error be held to an insignificant amount or corrected in making the measurements; otherwise, the measurements may indicate that the site fails to meet the acceptability criterion.

From the operating instructions for a typical automatic spectrum analyzer, for example, if everything is done to remove or compensate every potential error as much as possible, the remaining amplitude errors are as follows:

a) ±0.2 dB calibrator uncertainty
b) ±1.0 dB frequency response flatness
c) ±1.0 dB input attenuator switching
d) ±0.4 dB radio frequency (RF) and intermediate frequency (IF) gain uncertainty

This gives a total potential error of ±2.6 dB. This does not include ±0.05 dB/°C temperature drift. In practice, when performing substitution type measurements, the errors associated with the frequency response flatness and input attenuator switching are usually 1 dB less, so that the total error band for the spectrum analyzer as a two-terminal voltmeter is ±1.6 dB or less, which is used in Table 1.

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Many attenuators have absolute accuracy far poorer than ±1 dB, but some are better. The total error budget could thus be increased or decreased in discrete measurements. If an external attenuator is used with the automatic spectrum analyzer in swept measurements, this error budget is also increased.

These error budgets do not contain errors by time- and temperature-induced drifts of the gains, output levels, or amplitude responses of the test equipment. Such errors may exist, and steps must be taken to avoid them. Furthermore, in practice, the errors seldom are in the same direction. Meeting the ±4 dB criterion for well-constructed and well-located sites may allow more than ±1 dB site anomaly variation from ideal.

NOTE—If any of the error items has less uncertainty than shown in Table 1, the other items can have more uncertainty than shown and still meet the ±4 dB criteria. For example, if the attenuator uncertainty is less, then the site or antenna factors can have a larger uncertainty than that shown.

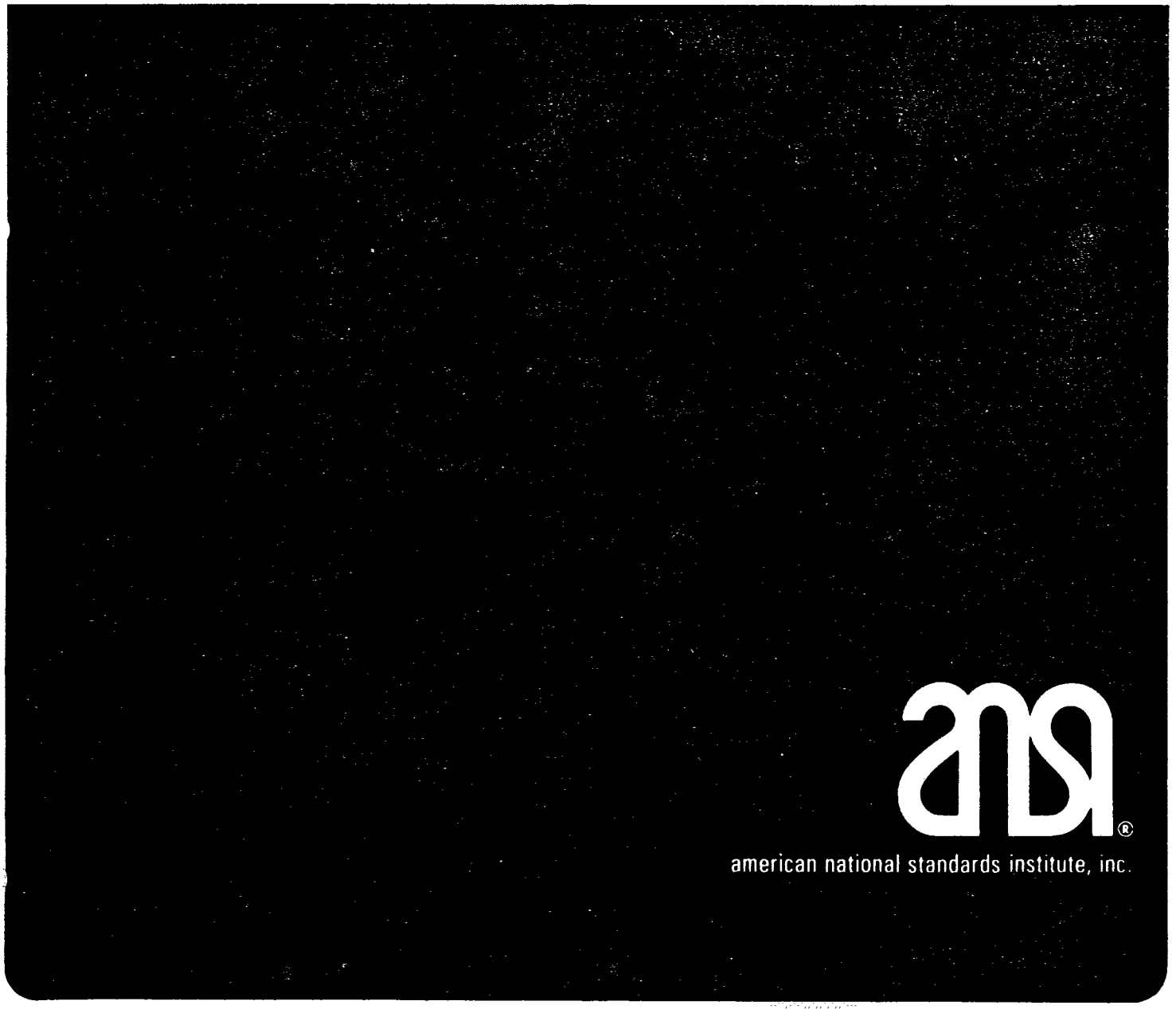
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Foreword

(This Foreword is not a part of ANSI C63.6-1988, American National Standard Guide for the Computation of Errors in Open-Area Test Site Measurements.)

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American National Standard Guide for the Computation of Errors in Open-Area Test Site Measurements

1. Scope

This guide shows the basis for the acceptability criterion of ±4 dB for the site attenuation measurements required in ANSI C63.4-1988 [2].[1]

2. References

References shall form a part of this standard to the extent referenced or necessary and when American National Standards referred to in this standard are superceded by a revision approved by the American National Standards Institute the revision shall apply.

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

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

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

3. Definitions

The definitions found in [1], [2], and [3] are by reference incorporated herein.

[1]The numbers in brackets correspond to those of the references listed in Section 2.

[2]ANSI publications can be obtained from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

[3]ANSI/IEEE publications can be obtained from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10017, or from the Service Center, Institute of Electrical and Electronics Engineers, 345 Hoes Lane, Piscataway, NJ 08894-1331.

4. Error Analysis

The error analysis in Table 1 applies to the normalized site attenuation measurement methods given in 4.1.3 of ANSI C63.4-1988 [2]. The total estimated errors are the basis for the ±4 dB site acceptability criterion in 4.1.3.1 of ANSI C63.4-1988 [2], that is, approximately 3 dB measurement uncertainty and an additional allowable 1 dB for site imperfections.

The error budget in Table 1 does not include uncertainties in the amplitude stability of the signal generator or tracking generator, and any amplifiers that may be used, nor does it include the potential errors in the tracking generator leveling or measurement technique error. The output level of most signal and tracking generators will drift with time and temperature, and the gain of many amplifiers will drift as temperature changes. It is imperative that these sources of error be held to an insignificant amount or corrected in making the measurements, otherwise the measurements may indicate that the site fails to meet the acceptability criterion.

From the operating instructions for a typical automatic spectrum analyzer, for example, if everything is done to remove or compensate every potential error as much as possible, the remaining amplitude errors are

(1) ±0.2 dB calibrator uncertainty
(2) ±1.0 dB frequency response flatness
(3) ±1.0 dB input attenuator switching
(4) ±0.4 dB RF and IF gain uncertainty

This gives a total potential error of ±2.6 dB. This does not include ±0.05 dB/C temperature drift. In practice, when performing substitution type measurements, the errors associated with the frequency response flatness and input attenuator switching are usually 1 dB less, so that the total error band for the spectrum analyzer as a two-terminal voltmeter is ±1.6 dB or less, which is used in Table 1.

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Many attenuators have absolute accuracy far poorer than ±1 dB, but some are better. The total error budget could thus be increased or decreased in discrete measurements. If an external attenuator is used with the automatic spectrum analyzer in swept measurements, this error budget is also increased.

These error budgets do not contain errors by time- and temperature-induced drifts of the gains, output levels, or amplitude responses of the test equipment. Such errors may exist and steps must be taken to avoid them. Furthermore, in practice, the errors seldom are in the same direction. Meeting the ±4 dB criterion for well constructed and located sites may allow more than ±1 dB site anomaly variation from ideal.

Table 1
Error Budget

Error Item	Measurement Method Section 4.1.3.3 of C63.4 [2]	
	Discrete	Swept
Antenna Factor (T_x)*	± 1 dB	± 1 dB
Antenna Factor (R_x)*	± 1	± 1
Electromagnetic Noise and Field Strength Instrument as a 2-Terminal Voltmeter	0	± 1.6
Attenuator	± 1	0
Site Imperfections	± 1	± 1
TOTALS	± 4 dB	± 4.6 dB

*Above 800 MHz, errors can be ± 1.5 (National Institute of Standards and Technology [NIST], formerly National Bureau of Standards).

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