IEC®

CISPR 16-1-5

Edition 2.0 2014-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE
COMITÉ INTERNATIONAL SPÉCIAL DES PERTURBATIONS RADIOÉLECTRIQUES

BASIC EMC PUBLICATION
PUBLICATION FONDAMENTALE EN CEM

Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-5: Radio disturbance and immunity measuring apparatus – Antenna calibration sites and reference test sites for 5 MHz to 18 GHz

Spécification des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 1-5: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Emplacements d'étalonnage d'antenne et emplacements d'essai de référence pour la plage comprise entre 5 MHz et 18 GHz

CISPR 16-1-5:2014-12(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 14 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 55 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Catalogue IEC - webstore.iec.ch/catalogue
Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,…). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org
Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 14 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary
Plus de 55 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

IEC®

CISPR 16-1-5

Edition 2.0 2014-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE
COMITÉ INTERNATIONAL SPÉCIAL DES PERTURBATIONS RADIOÉLECTRIQUES

BASIC EMC PUBLICATION
PUBLICATION FONDAMENTALE EN CEM

Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-5: Radio disturbance and immunity measuring apparatus – Antenna calibration sites and reference test sites for 5 MHz to 18 GHz

Spécification des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 1-5: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Emplacements d'étalonnage d'antenne et emplacements d'essai de référence pour la plage comprise entre 5 MHz et 18 GHz

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX XD

ICS 33.100.10; 33.100.20

ISBN 978-2-8322-1932-4

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

____

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 1-5: Radio disturbance and immunity measuring apparatus – Antenna calibration sites and reference test sites for 5 MHz to 18 GHz

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard CISPR 16-1-5 has been prepared by CISPR subcommittee A: Radio-interference measurements and statistical methods.

This second edition cancels and replaces the first edition published in 2003, and its Amendment 1 (2012). It constitutes a technical revision.

It has the status of a basic EMC publication in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications.*

This edition includes the following significant technical changes with respect to the previous edition:

– site validation methods for other sites covered in CISPR 16-1-6 are added;
– smaller step sizes are specified for swept-frequency measurements;
– the minimum ground plane size is increased;
– other miscellaneous technical and editorial refinements are included.

The text of this standard is based on the following documents:

FDIS	Report on voting
CISPR/A/1086A/FDIS	CISPR/A/1097/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

A list of all parts of the CISPR 16 series can be found, under the general title *Specification for radio disturbance and immunity measuring apparatus and methods*, on the IEC website.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This standard describes validation procedures for Calibration Test Sites (CALTS) that are used to calibrate antennas in the frequency range 5 MHz to 18 GHz. The associated antenna calibration procedures are described in CISPR 16-1-6.

Due to problems with suppressing ground reflections in the frequency range 30 MHz to 200 MHz, the main function of a reflecting ground plane is for the calibration of dipole, biconical, and hybrid antennas over the frequency range for which their H-plane patterns are uniform. The free-space antenna factor, F_a, for dipole antennas may be measured in a free-space environment above 200 MHz. Because of the difficulty of reducing reflections from objects that surround an antenna, and in particular the ground surface, a flat metal ground plane is used to ensure reproducibility of results and to enable the ground reflected signal to be precisely removed mathematically.

Requirements for the construction of a CALTS are given in Annex A. The specifications and validation procedures for a CALTS are given in Clause 4. The most precise way of validating a CALTS is to use calculable dipole antennas, which are the basis of the validation procedure in this standard. The design principles of calculable antennas are given in Annex B, and the theory and methods for calculating site insertion loss (SIL) are given in Annex C and Annex D.

Validation procedures for other antenna calibration sites are given in Clause 5 through Clause 7. Where an antenna calibration method utilizes the ground reflection, a CALTS is required. The validation methods are summarized in Table 1 with reference to the associated antenna calibration methods in CISPR 16-1-6.

All site validation methods involve the measurement of SIL between two antennas. It is critical that the validation of the site itself not be unduly compromised by reflections from antenna supports; see A.3 for associated guidance.

Table 1 – Summary of site validation methods by subclause number

	Calibration site(s)	CISPR 16-1-5 validation method(s) Subclause	CISPR 16-1-6:2014 calibration method(s) Subclause	Frequency range MHz	Antenna type(s)	Polarization	Notes
1	CALTS for monopoles	4.10	G.1	5 to 30	Monopole	VP	With tolerance of ± 1 dB
2	CALTS or SAC[a]	4, 7.2	8.4	30 to 1 000	Biconical, LPDA, hybrid	HP	SSM
3	CALTS or SAC	4	9.2.2	30 to 300	Biconical, hybrid, dipole	HP or VP	At large height or with absorber on ground
4	FAR	5.3.2	9.2.2	30 to 300 60 to 1 000	Biconical, hybrid, dipole Biconical, dipole	HP	
5	REFTS CALTS	4.7 4.9	9.3	30 to 300	Biconical, hybrid	VP	
6	Free space	6.1	9.4.2 9.4.3	200 to 18 000	LPDA, hybrid, horn	VP	HP with greater height
7	Free space	6.2	9.4.4	200 to 18 000	LPDA, hybrid, horn	VP (or HP)	With absorber on ground
8	FAR	5.3.3	9.5	1 000 to 18 000	Horn, LPDA	HP or VP	
9	FAR	5.3.2	9.2 and 9.4	140 to 1 000	LPDA, hybrid	HP or VP	
10	CALTS	4.6	B.4, B.5	30 to 300	Biconical, dipole	HP	
11	Transfer of properties of a validated site to a site not validated by methods in other clauses	7.1 (excluding 5.3 FAR)	A.9.4	30 and above	Any, but not monopole or loop	HP or VP	Use primarily for SAM and FAR, for particular antenna types and frequencies, except 5.3

[a] A CALTS is well specified as being free of reflecting obstacles, and if the antenna supports have negligible reflections the ground plane itself is likely to provide results that agree with the theoretical performance to better than 0,5 dB. However for a Semi Anechoic Chamber (SAC), it is important that the entire allowed acceptance criterion of 1 dB is not taken up by wall reflections, leaving no latitude for other uncertainty components such as reducing reflections from masts and cables.

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 1-5: Radio disturbance and immunity measuring apparatus – Antenna calibration sites and reference test sites for 5 MHz to 18 GHz

1 Scope

This part of CISPR 16 specifies the requirements for calibration sites in the frequency range 5 MHz to 18 GHz used to perform antenna calibrations according to CISPR 16-1-6. It also specifies the requirements for reference test sites (REFTS) that are used for the validation of compliance test sites (COMTS) in the frequency range 30 MHz to 1 000 MHz according to CISPR 16-1-4.

It has the status of a basic EMC standard in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications.*

Measurement instrumentation specifications are given in CISPR 16-1-1 [1][1] and CISPR 16-1-4. Further information and background on uncertainties in general is given in CISPR 16-4 [3], which can also be helpful in establishing uncertainty estimates for the calibration processes of antennas and site validation measurements.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*
CISPR 16-1-4:2010/AMD 1:2012

CISPR 16-1-6:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-6: Radio disturbance and immunity measuring apparatus – EMC antenna calibration*

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050, as well as the following apply.

NOTE Full terms for abbreviations not already given in 3.1 are listed in 3.2.

---

1 Numbers in square brackets refer to the bibliography.

3.1.1 Antenna terms

3.1.1.1
antenna
transducer that converts the guided electromagnetic energy of the feed line into a radiated wave in space and vice versa

Note 1 to entry: In the context of this standard, for antennas for which a balun is intrinsic to the functioning of the antenna, the term "antenna" includes the balun.

3.1.1.2
biconical antenna
symmetric antenna formed by two conical radiating elements having a common axis, and adjacent vertices at which they are fed

Note 1 to entry: For use in the VHF band, biconical antennas are usually made of two conical-shaped wire cages. Often each cage has a cross-bar connecting the centre conductor and one of the peripheral wires to remove a narrowband resonance. Such shorting cross-bars can affect the characteristics of the antenna above 215 MHz. For more details, see also A.4.3 of CISPR 16-1-6:2014.

3.1.1.3
broadband antenna
antenna having acceptable characteristics over a wide range of radio frequencies

3.1.1.4
calculable antenna
dipole-like antenna of which the antenna factor of a single antenna, and the site insertion loss between a pair of antennas, may be calculated using either analytical or numerical (method of moments) techniques based on the dimensions, load impedance and geometrical parameters, and that can be verified by measurement

Note 1 to entry: An example of a calculable antenna is that specified in Annex B. Another example is a simple loop antenna.

Note 2 to entry: Effects of the balun are typically accounted for by S-parameters measurements of the balun network, or the balun structure can be modelled.

3.1.1.5
horn antenna
antenna consisting of a waveguide section in which the cross-sectional area increases towards an open end, which is known as the aperture

Note 1 to entry: Rectangular-waveguide pyramidal horn antennas are popular in the microwave frequency range above about 1 GHz. Double-ridged-waveguide horn antennas (DRH; sometimes also referred to as DRG horn, for double-ridged-guide) cover a very wide frequency range. The mainlobe of some DRH antennas splits into several beams at higher frequencies.

3.1.1.6
hybrid antenna
antenna consisting of a wire-element log-periodic dipole array section and a broadband dipole section

Note 1 to entry: The longest element of the LPDA section (see 3.1.1.7) is typically resonant at approximately 200 MHz, and the boom is lengthened at the open-circuit end to feed the connected broadband dipole (e.g. biconical or bowtie) section. Over the range 30 MHz to 200 MHz, the broadband dipole exhibits a performance similar to a biconical antenna, notably in the variation of height-dependent antenna factor.

Note 2 to entry: A common-mode choke is typically used at the open-circuit end (i.e. rear) of the boom to minimize parasitic (unintended) RF currents on the outer conductor of the coaxial cable flowing into the measuring receiver.

3.1.1.7
log-periodic dipole array antenna
LPDA antenna
antenna comprising an array of linear dipole elements whose dimensions and spacings increase logarithmically with frequency from the tip to the rear end of the antenna

3.1.1.8
resonant dipole antenna
tuned dipole antenna
antenna consisting of two straight collinear conductors of equal length, placed end to end, separated by a small gap constituting a balanced feed, with each conductor approximately a quarter-wavelength long such that at the specified frequency the input impedance of the antenna measured across the gap has zero reactance when the dipole is located in free space

Note 1 to entry: A resonant dipole antenna is also a calculable antenna (see 3.1.1.4). In this standard the term "linear dipole" implies "two straight collinear conductors," in contrast to the biconical dipole, or array of dipoles as in the LPDA antenna.

3.1.1.9
standard antenna
STA
antenna for which the AF is calculated or measured precisely

Note 1 to entry: Precision is attainable by a calculable antenna such as specified in 4.3. Alternatively an STA may be an antenna of a type similar to the AUC that has been calibrated to lower uncertainties than required for the AUC, e.g. by the three antenna method.

Note 2 to entry: An STA is used for measurements by the standard antenna method (see 4.3.5, etc. of CISPR 16-1-6:2014). An STA is mechanically robust such that reproducibility of AF to better than ± 0,2 dB is maintained with continuous use of the STA. Balance and cross-polar criteria applicable to the STA are found in 6.3.2 and 6.3.3 of CISPR 16-1-6:2014.

3.1.1.10
balun
device for transforming an unbalanced transmission line to a balanced transmission line and vice versa

Note 1 to entry: A balun is used, for example, to couple balanced antenna elements to an unbalanced feed line, such as a coaxial cable. A balun may exhibit inherent impedance transformation differing from unity.

3.1.1.11
test antenna
combination of the resonant dipole antenna and the specified balun

Note 1 to entry: The definition is for the purposes of this standard only (see also 3.1.1.8 resonant dipole antenna, and 3.1.1.12 wire antenna). The test antenna is described in 4.3.

3.1.1.12
wire antenna
a specified structure consisting of one or more metallic wires or rods for radiating or receiving electromagnetic waves

Note 1 to entry: A wire antenna does not contain a balun.

Note 2 to entry: In the context of this standard, a wire antenna connected to a balun is called a "test antenna" (see 3.1.1.11).

3.1.1.13
antenna factor
F_{a}
ratio of the electric field strength of a plane wave incident from the direction corresponding to the mechanical boresight (i.e. the main axis of the antenna) to the voltage induced across a specified load connected to the antenna, measured in a free-space environment

Note 1 to entry: The abbreviation AF is used as a general term to denote antenna factor, whereas F_a denotes the boresight AF in free-space. AF is affected by the load impedance (typically 50 Ω) connected to the antenna, and is frequency dependent. AF can be affected by mutual coupling of the antenna to the ground plane, and is directivity dependent. For more details see the definitions and 4.2 in CISPR 16-1-6:2014.

Note 2 to entry: The AF has the physical dimension in dB relative to 1/m [dB(m^{-1})]. In radiated emission measurements, if F_a is known, the strength of an incident field, E, can be calculated from a reading, V, of a measuring receiver connected to the antenna as follows:

$$E = V + F_a$$

where E is in dB(μV/m), V is in dB(μV) and F_a is in dB(m^{-1}).

3.1.2 Measurement site terms

3.1.2.1
calibration site
any site at which an antenna is calibrated

Note 1 to entry: Calibration sites include a CALTS (see 3.1.2.2) on which the ground reflection is intentionally used, a FAR (see 3.1.2.5), and an open-area calibration site (see Clause 6) at which the antennas are high enough above the ground to reduce the ground reflection. For each of these, any reflections from all directions meet the appropriate site acceptance criteria for antenna calibration.

3.1.2.2
calibration test site
CALTS
calibration site with a metallic ground plane and tightly specified site insertion loss in horizontal electric field polarization

Note 1 to entry: A CALTS is used for the measurement of height dependent AF, and to measure free-space AF by the standard site method.

Note 2 to entry: A CALTS can also be validated for: a) vertical polarization using the method of 4.7 (see also 3.1.2.7 definition of REFTS); and b) use for other specific CISPR 16-1-6 calibration methods using the methods of 4.9 and 4.10 (see also Table 1).

3.1.2.3
compliance test site
COMTS
environment that assures valid, reproducible measurement results of disturbance field strength from equipment under test for comparison to a compliance limit

Note 1 to entry: Requirements for a COMTS, including those for site validation, are specified in CISPR 16-1-4.

3.1.2.4
free space
environment where it has been shown that the effect of any obstacle, including the ground, on the radiated signals passing directly between two antennas is below a specified uncertainty contribution for the measurement of F_a

3.1.2.5
fully-anechoic room
FAR
an enclosure, the six internal surfaces of which are lined with radio-frequency absorbing material (i.e. RF absorber) that attenuates electromagnetic energy in the frequency range of interest

Note 1 to entry: A FAR suitable for antenna calibration has a tighter field uniformity specification compared with that for EMC radiated disturbance measurement specified in CISPR 16-1-4. If ambient RF interference prevents the required signal to noise ratio, the FAR should be built inside a shielded enclosure. The site acceptance criteria are given in the FAR validation methods in this standard.