CISPR TR 16-4-5

Edition 1.2 2021-10
CONSOLIDATED VERSION

TECHNICAL REPORT

colour inside

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

Specification for radio disturbance and immunity measuring apparatus and methods –
Part 4-5: Uncertainties, statistics and limit modelling – Conditions for the use of alternative test methods

CISPR TR 16-4-5:2006-10+AMD1:2014-07+AMD2:2021-10 CSV(en)

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

Tel.: +41 22 919 02 11
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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: sales@iec.ch.

IEC online collection - oc.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

CISPR TR 16-4-5

Edition 1.2 2021-10
CONSOLIDATED VERSION

TECHNICAL REPORT

colour inside

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-5: Uncertainties, statistics and limit modelling – Conditions for the use of alternative test methods

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 33.100.10; 33.100.20

ISBN 978-2-8322-4232-2

CISPR TR 16-4-5

Edition 1.2 2021-10
CONSOLIDATED VERSION

REDLINE VERSION

colour inside

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

Specification for radio disturbance and immunity measuring apparatus and methods –
Part 4-5: Uncertainties, statistics and limit modelling – Conditions for the use of alternative test methods

CISPR TR 16-4-5:2006-10+AMD1:2014-07+AMD2:2021-10 CSV(en)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 4-5: Uncertainties, statistics and limit modelling – Conditions for the use of alternative test methods

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.

This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

CISPR TR 16-4-5 edition 1.2 contains the first edition (2006-10) [documents CISPR/A/665/DTR and CISPR/A/685/RVC], its amendment 1 (2014-07) [documents CISPR/A/1050/DTR and CISPR/A/1069/RVC] and its amendment 2 (2021-10) [documents CIS/A/1321/DTR and CIS/A/1324/RVDTR].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

CISPR 16-4-5, which is a technical report, has been prepared by CISPR subcommittee A: Radio-interference measurements and statistical methods.

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

A list of all parts of the CISPR 16-4 series, published under the general title *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainties, statistics and limit modelling*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments 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 publication using a colour printer.

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 4-5: Uncertainties, statistics and limit modelling – Conditions for the use of alternative test methods

1 Scope

This part of CISPR 16-4 specifies a method to enable product committees to develop limits for alternative test methods, using conversions from established limits. This method is generally applicable for all kinds of disturbance measurements, but focuses on radiated disturbance measurements (i.e. field strength and total radiated power), for which several alternative methods are presently specified. These limits development methods are intended for use by product committees and other groups responsible for defining emissions limits in situations where it is decided to use alternative test methods and the associated limits in product standards.

2 Normative references

IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

CISPR 16-1-1:2019, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

~~CISPR 16-4-1:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-1: Uncertainties, statistics and limit modelling – Uncertainty in standardized EMC tests*~~

CISPR 16-4-2:~~2003~~2011, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling –~~ *Uncertainty in EMC measurements* ~~* Measurement instrumentation uncertainty*
CISPR 16-4-2:2011/AMD1:2014
CISPR 16-4-2:2011/AMD2:2018

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the following apply.

3.1
established test method
test method described in a basic standard with established emissions limits defined in corresponding product or generic standards. An established test method consists of a specific test procedure, a specific test set-up, a specific test facility or site, and an established emissions limit

NOTE The following test methods have been considered to be established test methods in CISPR:

– conducted disturbance measurements at mains ports using an AMN in the frequency range 9 kHz to 30 MHz; ~~test~~ this method is defined in CISPR 16-2-1~~:2003, Clause 7~~;

– radiated disturbance measurements ~~up~~ in the frequency range 30 MHz to 1 GHz at 10 m distance on an OATS or in a SAC; ~~the test~~ this method is defined in CISPR 16-2-3~~, 7.2.1~~;

– radiated disturbance measurements ~~up~~ in the frequency range 1 GHz to 18 GHz at 3 m distance on an FSOATS; ~~the test~~ this method is defined in CISPR 16-2-3~~, 7.3~~.

3.2
alternative test method
test method described in a basic standard without established emissions limits. The alternative test method is designed for the same purpose as the established test method. An alternative test method consists of a specific test procedure, a specific test set-up, a specific test facility or site, and a derived emissions limit that was determined by the application of the proposed method stated in this document

3.3
established limit
limit having “many years” of good protection of radio services.

NOTE An example is radiated field strength measured on OATS, developed to protect radio services as described in CISPR 16-3.

3.4
derived limit
limit applicable for the alternative test method, derived by appropriate conversion from the established limit and expressed in terms of the misbrands

3.5
conversion factor *K*
for a given EUT or type of EUT, the relation of the measured value of the established test method to the measured value of the alternative test method

NOTE The terms measured and calculated are used interchangeably at various places in this document to describe actual laboratory tests and computer simulations.

3.6
reference quantity *X*
the basic parameter which determines the interference potential to radio reception. It may be independent of the parameters presently used in established standards

NOTE The goal for both the established and alternative test methods is to determine the reference quantity (X) for all frequencies of interest. For both established and alternative test methods, the test results may deviate from the reference quantity values. The specification of the reference quantity when applying methods of this document should include applicable procedures and conditions to calculate (or measure) this quantity

3.7
inherent uncertainty
u_{inherent}
uncertainty caused solely by the difference in EUT characteristics and the ability of the measurement procedure to cope with them. It is specific to each test method and remains, even if the measurement is performed perfectly, i.e., the standards compliance uncertainty is zero and the measurement instrumentations uncertainty is zero

3.8
intrinsic uncertainty of the measurand
$u_{\text{intrinsic}}$
minimum uncertainty that can be assigned in the description of a measured quantity. In theory, the intrinsic uncertainty of the measurand would be obtained if the measurand was measured using a measurement system having negligible measurement instrumentation uncertainty.

[CISPR 16-4-1:2009, ~~definition 3.6~~ 3.1.6, modified – Deletion of notes]

3.9
EUT type
grouping of products with sufficient similarity in electromagnetic characteristics to allow testing with the same test installation and the same test protocol.

3.10
standards compliance uncertainty
SCU
parameter, associated with the result of a compliance measurement as described in a standard, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

[IEC 60050-161:1990, 311-01-02, modified, deletion of the notes]

3.11
EUT volume
cylinder defined by EUT boundary diameter and height that fully encompasses all portions of the actual EUT, including cable racks and 1,6 m of cable length (for 30 MHz to 1 GHz), or 0,3 m of cable length (for 1 GHz and above)

NOTE 1 The test volume is one of several criteria limiting the EUT volume.

NOTE 2 The EUT volume has a diameter D (boundary diameter) and a height h.

4 Symbols and abbreviated terms

The following abbreviations are used in this technical report. Note that the symbol k is used for four different quantities.

ATM	alternative test method (e.g. subscript in D_{ATM})
D	deviation
ETM	established test method (e.g. subscript in D_{ETM})
f	index number of an individual measured frequency
F	number of measured frequencies in the considered frequency range
FAR	fully anechoic room
i	index number of ~~one~~ an individual EUT ~~(e.g., of a number of EUTs)~~
j	index number of an individual test lab
~~K~~	~~conversion factor~~
~~k~~	~~coverage factor~~
k	$= 2\pi/\lambda$, wave number (in this document, k is used in the electrical size ka, where a is the EUT radius)
$k(f)$	linear conversion factor
$K(f)$	logarithmic conversion factor
k	coverage factor
k	Boltzmann's constant
L	limit
M	measurement (or calculation) result
N	number of EUTs
OATS	open-area test site
RC	reverberation chamber
RRT	round robin test
s	standard deviation
SAC	semi-anechoic chamber
SCU	standards compliance uncertainty
T	number of test labs

U	expanded uncertainty
u	standard uncertainty
v	volume
X	reference quantity
Δ	difference of two values or quantities
$\bar{x}$	mean value of a set of values x (e.g., $\bar{D}$)

5 Introduction

Over the years, several test ~~procedures~~ methods and test set-ups for radiated ~~emissions testing~~ disturbance measurement have been described in basic standards. One particular combination of test method and test set-up also having defined ~~emissions~~ disturbance limits is the open area test site (OATS) method, which has proven to be successful for the protection of radio services. ~~In general~~ Since the first edition of this document, limits have ~~not~~ been defined for ~~the~~ other~~,~~ – alternative – test methods, e.g., fully anechoic rooms~~,~~ and TEM waveguides, but not for reverberation chambers.

Each alternative method can be used to get measurement results related to ~~emission of the~~ disturbance from an EUT. Although each method gives ~~an emission~~ a disturbance level from ~~the~~ an EUT, the different methods ~~may~~ might capture the EUT ~~emission~~ disturbance differently. For example, considering radiated ~~emission~~ disturbance measurements, different methods may capture different EUT radiation pattern lobes, ~~differing numbers~~ a different number of lobes, or the test facility ~~may~~ might alter the EUT radiation pattern producing a different apparent ~~emission~~ disturbance level. Therefore the limits defined for the established test method cannot be applied directly to the alternative test methods. Consequently, ~~a~~ procedures ~~is~~ are needed ~~for how~~ to derive limits to be used for the results of alternative test methods.

The specification ~~for~~ of such ~~a~~ procedures ~~should~~ considers the general goal of disturbance measurements. ~~The aim of the disturbance measurement~~, which is to verify whether ~~the~~ an EUT satisfies or violates certain compliance criteria. Past experience has shown that using the present system of ~~the~~ established test methods and ~~the~~ associated limits yields a situation without many cases of interference due to conducted disturbance or radiated ~~emissions~~ disturbance. Applying ~~the~~ an established test method with ~~the~~ its associated limits will fulfill the protection requirement with a high probability. To preserve this situation, the most important requirement for the use of alternative test methods is ~~as follows~~ the following:

– Use of an alternative test method in a normative standard shall provide the same protection of radio services as the established test method.

This requirement can be met by developing ~~a procedure for deriving emission~~ procedures to derive disturbance limits for ~~the~~ alternative test methods from the existing limits of the established test methods. Such ~~a~~ procedures shall relate the results ~~of the~~ from an alternative test method to those ~~of the~~ from an established test method. Using the relations derived in this ~~relation~~ document, the limits of the relevant established test method can be converted into limits for the alternative test method. The measured values of the alternative test method can then easily be evaluated against the converted limits. Such ~~a~~ procedures will provide a similar amount of protection, even though an alternative test method is used.

The limit~~s~~ conversion procedures ~~should~~ consider the preceding goal of ~~emissions~~ disturbance measurements ~~as described above~~. The results of standard ~~emissions tests~~ disturbance measurements can be considered as an approximation of the interference potential of an EUT. Depending on the characteristics of ~~the~~ an EUT (e.g., radiation pattern characteristics for radiated disturbance test methods), and ~~on~~ the ~~measurement~~ test set-up, the measured value ~~differs~~ deviates from the actual interference potential of the EUT. This deviation can be divided into two parts: 1) a systematic deviation, which can be interpreted as a bias of the test method~~,~~; and 2) a random deviation depending on the characteristics of different EUTs, which can be interpreted as an uncertainty of the test method. Each ~~emissions~~