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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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CISPR TR 16-4-5 edition 1.1 contains the first edition (2006-10) [documents CISPR/A/665/DTR and CISPR/A/685/RVC] and its amendment 1 (2014-07) [documents CISPR/A/1050/DTR and CISPR/A/1069/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. 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 amendment 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- withdrawn,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.

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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), 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 16-4-1~~: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, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements*

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~~, definition 3.6~~]

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]

4 Symbols and abbreviated terms

The following abbreviations are used in this technical report:

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
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
L	limit
M	measurement (or calculation) result
N	number of EUTs
OATS	open-area test site
RRT	round robin test
s	standard deviation
SAC	semi-anechoic chamber
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 and test set-ups for radiated emissions testing have been described in basic standards. One particular combination of test method and test set-up also having defined emissions limits is the open area test site (OATS) method, which has proven to be successful for the protection of radio services. In general limits have not been defined for the other, alternative test methods, e.g., fully anechoic room, TEM waveguide, reverberation chamber.

Each alternative method can be used to get measurement results related to emission of the EUT. Although each method gives an emission level from the EUT, the different methods may capture the EUT emission differently. For example, considering radiated emission

measurements, different methods may capture different EUT radiation pattern lobes, differing numbers of lobes, or the test facility may alter the EUT radiation pattern producing a different apparent emission level. Therefore the limits defined for the established test method cannot be applied directly to the alternative test methods. Consequently, a procedure is needed for how to derive limits to use for the results of alternative test methods.

The specification for such a procedure should consider the general goal of disturbance measurements. The aim of the disturbance measurement is to verify whether the EUT satisfies or violates certain compliance criteria. Past experience has shown that using the present system of the established test method and the associated limits yields a situation without many cases of interference due to conducted or radiated emissions. Applying the established test method with the 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.

– 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 limits for the alternative test method from the existing limits of the established test method. Such a procedure shall relate the results of the alternative test method to those of the established test method. Using this relation the limits of the 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 procedure will provide a similar amount of protection, even though an alternative test method is used.

The limits conversion procedure should consider the goal of emissions measurements as described above. The results of standard emissions tests can be considered as an approximation of the interference potential of an EUT. Depending on the characteristics of the EUT (e.g., radiation pattern characteristics for radiated disturbance test methods), and on the measurement set-up, the measured value differs from the actual interference potential of the EUT. This deviation can be divided into two parts: a systematic deviation, which can be interpreted as a bias of the test method, and a random deviation depending on the characteristics of different EUTs, which can be interpreted as an uncertainty of the test method. Each emissions test method contains both quantities, and consequently the established test method does too. In the following clauses, a procedure based on these two quantities for comparing an alternative test method with the established test method is described. To determine these quantities, the abstract term “interference potential” needs to be expressed in terms of a physical quantity. For the purposes of this report, this quantity is called the “reference quantity,” *X*. More details about correlation of test methods using a reference quantity can be found in [1][1)].

6 Procedure to derive limits for an alternative test method

6.1 Overview

A procedure to derive limits for an alternative test method based on the limits of an established test method is described in the following paragraphs. Figure 1 shows a summary of the estimated quantities needed for the correlation process. Figure 2 shows a flowchart for the correlation process using these quantities. The nine-step conversion process below can be accomplished using numerical simulations, measurements, or a combination of simulations and measurements. Calculable or reference EUTs are invaluable for this conversion procedure. In the following subclauses, as part of the conversion process the quantities shown in Figure 1 and Figure 2 are combined into several equations. A summary of the equations is given in Table 2. A summary of the steps in the conversion procedure is shown in Table 1.

1) Figures in square brackets refer to the Bibliography.

Table 1 – Summary of steps in conversion procedure

1	Select the reference quantity
2	Describe the test methods and measurands
3	Determine the deviations of the measured quantities from the reference quantity
4	Determine the average values of the deviations
5	Determine the standard uncertainties of the test methods
6	Verify the calculated values
7	Apply the conversion

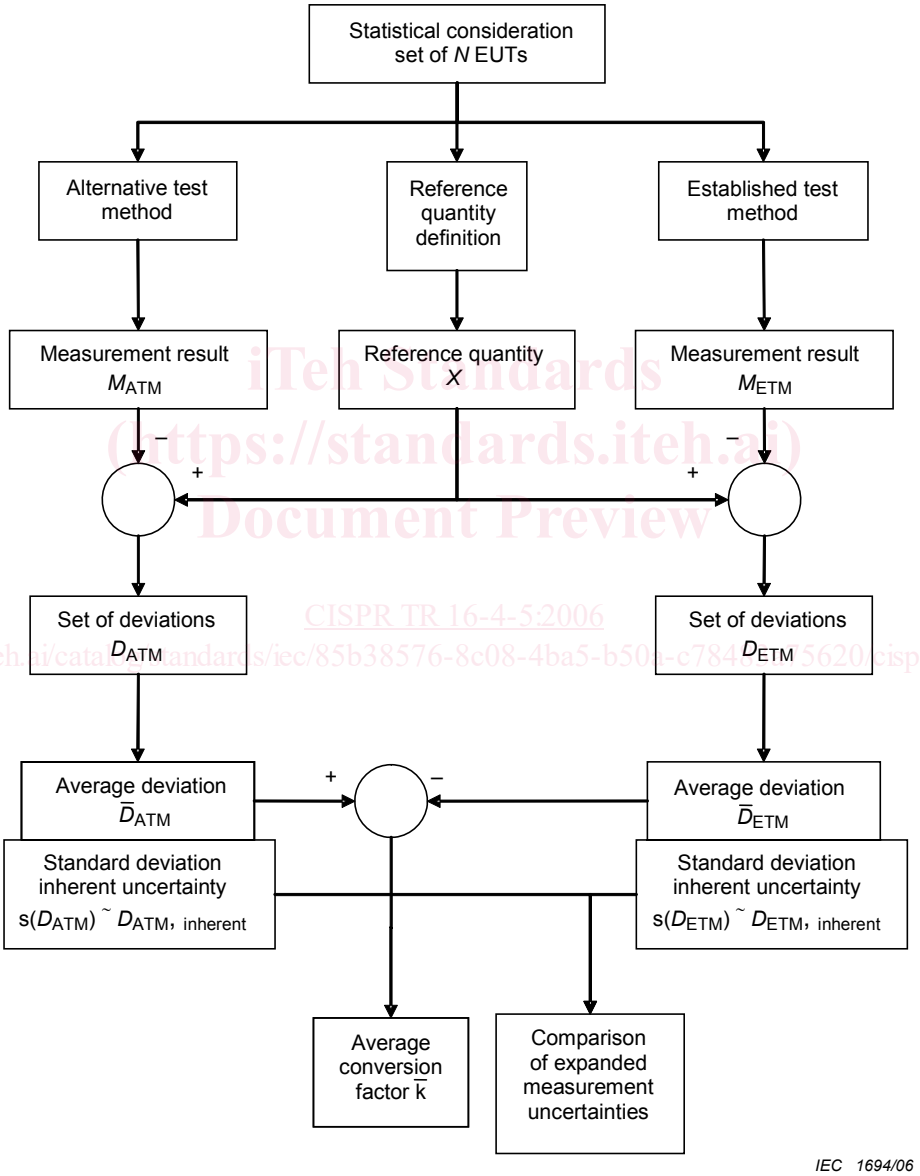

Figure 1 – Overview of quantities to estimate for use in conversion procedure