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COMITÉ INTERNATIONAL SPÉCIAL DES PERTURBATIONS RADIOÉLECTRIQUES

BASIC EMC PUBLICATION
PUBLICATION FONDAMENTALE EN CEM

Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements

Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 2-3: Méthodes de mesure des perturbations et de l'immunité – Mesurages des perturbations rayonnées



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements

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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.

International Standard CISPR 16-2-3 has been prepared by CISPR subcommittee A: Radio-interference measurements and statistical methods.

This fourth edition constitutes a technical revision.

This edition includes the following significant technical change with respect to the previous edition: addition of content on correction of the electric field strength to account for phase centre of log-periodic dipole array antennas.

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

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

The committee has decided that the contents of this document and its amendments will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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INTRODUCTION to Amendment 1

Amendment of CISPR 16-2-3 regarding EUT volume specifications for radiated disturbance measurements depending on test method and on measurement distance

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements

1 Scope

This part of CISPR 16 specifies the methods of measurement of radiated disturbance phenomena in the frequency range of 9 kHz to 18 GHz. The aspects of measurement uncertainty are specified in CISPR 16-4-1 and CISPR 16-4-2.

NOTE In accordance with IEC Guide 107 [13][1], CISPR 16-2-3 is a basic EMC publication for use by product committees of the IEC. As stated in Guide 107, product committees are responsible for determining the applicability of the EMC standard. CISPR and its subcommittees are prepared to co-operate with product committees in the evaluation of the value of particular EMC tests for specific products.

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 14-1:2016, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

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

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-1-4:~~2010~~2019, *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 16-1-4:2019/AMD1:2020
CISPR 16-1-4:2019/AMD2:2023

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

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

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[1] Numbers in square brackets refer to the Bibliography.

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

CISPR TR 16-4-5, *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*

IEC 60050-161, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

IEC 61000-4-20, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1
absorber-lined OATS/SAC
OATS or SAC with ground plane partially covered by RF-energy absorbing material

Note 1 to entry: CISPR 16-1-4 uses the analogous term free-space open-area test site (FSOATS).

3.1.2
ancillary equipment
transducers (e.g. current and voltage probes and artificial networks) connected to a measuring receiver or (test) signal generator and used in the disturbance signal transfer between the EUT and the measuring or test equipment

3.1.3
antenna beam
main lobe of the antenna pattern (gain pattern) of the receive antenna (usually the direction with maximum sensitivity or lowest antenna factor) that is directed towards the EUT

3.1.4
antenna beamwidth
angle between the half-power (3 dB) points of the main lobe of the antenna beam, when referenced to the maximum power of the main lobe

Note 1 to entry: It may be expressed for the H plane or for the E plane of the antenna.

Note 2 to entry: Antenna beamwidth is expressed in degrees.

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2 A consolidated version of this publication exists, comprising CISPR 16-4-2:2011, CISPR 16-4-2:2011/AMD1:2014 and CISPR 16-4-2:2011/AMD2:2018.

3.1.5
associated equipment
AE
apparatus, that is not part of the system under test, but needed to help exercise the EUT

Note 1 to entry: This note applies to the French language only.

3.1.6
auxiliary equipment
AuxEq
peripheral equipment that is part of the system under test

Note 1 to entry: This note applies to the French language only.

3.1.7
basic standard
standard that has a wide-ranging coverage or contains general provisions for one particular field

Note 1 to entry: A basic standard may function as a standard for direct application or as a basis for other standards.

[SOURCE: ISO/IEC Guide 2:1991, definition 5.1 [6]]

3.1.8
coaxial cable
cable containing one or more coaxial lines, typically used for a matched connection of ancillary equipment to the measuring equipment or (test-) signal generator providing a specified characteristic impedance and a specified maximum allowable cable transfer impedance

3.1.9
common-mode absorption device
CMAD
device that may be applied on cables leaving the test volume in radiated emission measurements to reduce the compliance uncertainty

Note 1 to entry: This note applies to the French language only.

[SOURCE: CISPR 16-1-4:~~2010~~2019, ~~3.1.4~~ 3.1.7]

3.1.10
conformity assessment
demonstration that specified requirements relating to a product, process, system, person or body are fulfilled

Note 1 to entry: The subject field of conformity assessment includes activities defined elsewhere in ISO/IEC 17000:2004 [7], such as testing, inspection and certification, as well as the accreditation of conformity assessment bodies.

[SOURCE: ISO/IEC 17000:2004, 2.1, modified – Note 2 has been deleted.]

3.1.11
continuous disturbance
RF disturbance with duration of more than 200 ms at the IF-output of a measuring receiver that causes a deflection on the meter of a measuring receiver in quasi-peak detection mode, and that does not decrease immediately

[SOURCE: IEC 60050-161:1990, 161-02-11, modified – The definition has been changed.]

3.1.12
emission
<electromagnetic> phenomenon by which electromagnetic energy emanates from a source

[SOURCE: IEC 60050-161:1990, 161-01-08]

3.1.13
emission limit
<from a disturbing source> specified maximum emission level of a source of electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-03-12]

3.1.14
equipment under test
EUT
equipment (devices, appliances and systems) subjected to EMC (emission) compliance (conformity assessment) tests

Note 1 to entry: This note applies to the French language only.

3.1.15
fully-anechoic room
FAR
enclosure, whose six internal surfaces 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: This note applies to the French language only.

3.1.16
large loop-antenna system
LLAS
antenna system consisting of three orthogonally-oriented loop antennas that are used to measure the three orthogonal magnetic dipole moments of an EUT located in the centre of the three loops

Note 1 to entry: This note applies to the French language only.

3.1.17
measurement, scan and sweep times

3.1.17.1
measurement time
T_m
effective, coherent time for a measurement result at a single frequency

– for the peak detector, the effective time to detect the maximum of the signal envelope,
– for the quasi-peak detector, the effective time to measure the maximum of the weighted envelope,
– for the average detector, the effective time to average the signal envelope,
– for the rms detector, the effective time to determine the rms of the signal envelope

Note 1 to entry: In some areas "measurement time" is also called dwell time.

3.1.17.2
scan
continuous or stepped frequency variation over a given frequency span

3.1.17.3
span
Δf
difference between stop and start frequencies of a sweep or scan

3.1.17.4
sweep
continuous frequency variation over a given frequency span

3.1.17.5
sweep or scan rate
frequency span divided by the sweep or scan time

3.1.17.6
sweep or scan time
T_s
time between start and stop frequencies of a sweep or scan

3.1.17.7
observation time
T_o
sum of measurement times T_m on a certain frequency in case of multiple sweeps

Note 1 to entry: If n is the number of sweeps or scans, then $T_o = n \times T_m$.

3.1.17.8
total observation time
T_{tot}
effective time for an overview of the spectrum (either single or multiple sweeps)

Note 1 to entry: If c is the number of channels within a scan or sweep, then $T_{tot} = c \times n \times T_m$.

3.1.18
measuring receiver
instrument such as a tunable voltmeter, an EMI receiver, a spectrum analyzer or an FFT-based measuring instrument, with or without preselection, that complies with CISPR 16-1-1

3.1.19
number of sweeps per time unit
n_S
reciprocal of the sum of sweep time and retrace time, i.e. 1/(sweep time + retrace time)

Note 1 to entry: Sweeps per second, for example.

3.1.20
open-area test site
OATS
facility for measurements and calibrations in which the ground reflection is made reproducible by a large flat electrically conducting ground plane

Note 1 to entry: An OATS can be used for radiated disturbance measurements, where it is also designated as a COMTS. An OATS can also be used for antenna calibrations, where it is designated as a CALTS.

Note 2 to entry: An OATS is an uncovered outdoor site, and is far enough away from buildings, electric lines, fences, trees, underground cables, pipelines, and other potentially reflective objects, so that the effects due to such objects are negligible. See CISPR 16-1-4 for guidance on the construction of an OATS.

Note 3 to entry: This note applies to the French language only.

3.1.21
product standard
standard that specifies requirements to be fulfilled by a product or group of products, to establish its fitness for purpose

Note 1 to entry: A product standard may include, in addition to the fitness for purpose requirements, directly or by reference, aspects such as terminology, sampling, testing, packaging and labelling and, sometimes, processing requirements.

Note 2 to entry: A product standard can either be complete or not, according to whether it specifies all or only a part of the necessary requirements. In this respect, one may differentiate between standards such as dimensional, material and technical delivery standards.

[SOURCE: ISO/IEC Guide 2:2004, definition 5.4 [6]]

3.1.22
semi-anechoic chamber
SAC
shielded enclosure in which five of the six internal surfaces are lined with radio-frequency absorbing material (i.e. RF absorber) that attenuates electromagnetic energy in the frequency range of interest, and the bottom horizontal surface is a conducting ground plane for use with OATS test set-ups

Note 1 to entry: This note applies to the French language only.

3.1.23
test configuration
combination that gives the specified measurement arrangement of the EUT in which an emission level is measured

3.1.24
weighting
pulse-repetition-frequency (PRF) dependent conversion (mostly reduction) of a peak-detected impulse voltage level to an indication that corresponds to the interference effect on radio reception

Note 1 to entry: For the analogue receiver, the psychophysical annoyance of the interference is a subjective quantity (audible or visual) usually not a certain number of misunderstandings of a spoken text.

Note 2 to entry: For the digital receiver, the interference effect is an objective quantity that may be defined by the critical bit error ratio (BER) or bit error probability (BEP) for that perfect error correction can still occur or by another, objective and reproducible parameter.

Note 3 to entry: Weighting of impulsive disturbance, for example.

3.1.24.1
weighted disturbance measurement
measurement of disturbance using a weighting detector

3.1.24.2
weighting characteristic
peak voltage level as a function of PRF for a constant effect on a specific radiocommunication system, i.e. the disturbance is weighted by the radiocommunication system itself

3.1.24.3
weighting detector
detector that provides an agreed weighting function

3.1.24.4
weighting factor
value of the weighting function relative to a reference PRF or relative to the peak value

Note 1 to entry: Weighting factor is expressed in dB.

3.1.24.5
weighting function or weighting curve
relationship between input peak voltage level and PRF for constant level indication of a measuring receiver with a weighting detector, i.e. the curve of response of a measuring receiver to repeated pulses

3.1.25
measurement
process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity

[SOURCE: 2.1 of ISO/IEC Guide 99:2007 [9][3], modified – Notes 1 to 3 have been deleted.]

3.1.26
test
technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure

Note 1 to entry: A test is carried out to measure or classify a characteristic or a property of an item by applying to the item a set of environmental and operating conditions and/or requirements.

[SOURCE: IEC 60050-151:2001, 151-16-13 [10]]

3.1.27
highest internal frequency
highest frequency generated or used within the EUT or the highest frequency at which the EUT operates or tunes

3.1.28
module
part of an EUT that provides a function and may contain radio-frequency sources

3.1.29
compliance test site
COMTS
environment that assures valid, reproducible measurement results of the disturbance field strength from equipment under test for comparison to a compliance limit

3.1.30
far-field region
region of the electromagnetic field of a radiating EUT or antenna where the predominant components of the field represent a propagation of energy and where the radiation pattern is essentially independent of the distance from the radiating EUT or antenna

Note 1 to entry: In the far-field region, all the components of the electromagnetic field change with an inverse proportion to the distance from the radiating EUT or antenna.

[SOURCE: IEC 60050-712:1992 [14], 712-02-02, modified – Replacement of "far field region" by "far-field region" in the term itself, replacement of "antenna" by "radiating EUT or antenna", replacement of "angular field distribution" by "radiation pattern" and deletion of Note 2 to entry.]

3.1.31
near-field effect
deviation of the field propagation from far-field propagation

[3] Figures in square brackets refer to the Bibliography.

Note 1 to entry: The near-field effect occurs in the zone close to the EUT where reactive (non-radiating) field-strength components exist. Although not contributing to far-field radiation, they are real measurable field strengths.

Note 2 to entry: A criterion can be set to limit the deviation from far-field propagation, e.g. 1 dB. If E_1 and E_2 are field-strength levels in dB(µV/m) at distances d_1 and d_2 from an EUT, then e.g. the following inequality describes the criterion: $(20\lg(d_2/d_1) - 1\ \text{dB}) \leq (E_1 - E_2) \leq (20\lg(d_2/d_1) + 1\ \text{dB})$, which can be reduced to $-1\ \text{dB} \leq [(E_1 - E_2) - 20\lg(d_2/d_1)] \leq 1\ \text{dB}$, where $(E_1 - E_2) \geq 6\ \text{dB}$.

3.1.32
test volume
validated volume within a test facility in which an EUT may be positioned

Note 1 to entry: Validation procedures in CISPR 16-1-4 are used to determine the test volume.

Note 2 to entry: The test volume as defined in this document is cylindrical in shape. Different test volume shapes have been defined in other documents, e.g. in a cubic form in IEC 61000-4-20 (TEM waveguides).

3.1.33
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 to entry: The test volume is one of several criteria limiting the EUT volume.

Note 2 to entry: The EUT volume has a diameter D (boundary diameter) and a height h.

3.1.34
protection distance
distance between the source of a radiated disturbance and the victim receiver at the edge-of-service area used for the derivation of a specific CISPR radiated disturbance limit

Note 1 to entry: The edge-of-service area is defined by the minimum value of the wanted field strength of a radio service or application derived from ITU-R specifications.

Note 2 to entry: This definition can vary in other publications, when conducted disturbances are concerned.

Note 3 to entry: Every limit has an associated protection distance; the protection distance can vary with frequency.

3.1.35
small EUT
equipment under test, including its cables, either positioned on a tabletop or standing on the floor, that fits in a cylindrical volume of 1,5 m (2,0 m) in diameter and 1,5 m (2,0 m) in height measured from the floor with a measurement distance of 3 m (5 m) at an OATS/SAC

3.1.36
feed point of a shielded loop antenna
location of the slit in the shielding of a loop antenna

Note 1 to entry: The feed point of a shielded loop antenna is important for a correct set-up. The location of the feed point has an influence on the site insertion loss between two magnetic field antennas [24], [25].

3.2 Abbreviated terms

The following abbreviations, not already provided in 3.1 are used in this standard.

AF	Antenna factor
AM	Amplitude modulation
APD	Amplitude probability distribution
AV	Average
BB	Broadband