CISPR 16-2-2

Edition 2.0 2010-07

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 2-2: Methods of measurement of disturbances and immunity – Measurement of disturbance power

Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 2-2: Méthodes de mesure des perturbations et de l'immunité – Mesure de la puissance perturbatrice

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: 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.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

CISPR 16-2-2

Edition 2.0 2010-07

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 2-2: Methods of measurement of disturbances and immunity – Measurement of disturbance power

Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 2-2: Méthodes de mesure des perturbations et de l'immunité – Mesure de la puissance perturbatrice

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX X

ICS 33.100.10; 33.100.20

ISBN 978-2-88912-097-0

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 2-2: Methods of measurement of disturbances and immunity – Measurement of disturbance power

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 16-2-2 has been prepared by CISPR subcommittee A: Radio-interference measurements and statistical methods, in cooperation with CISPR subcommittee D: Electromagnetic disturbances related to electric/electronic equipment on vehicles and internal combustion engine powered devices.

This second edition cancels and replaces the first edition (2003), its Amendment 1 (2004) and Amendment 2 (2005). It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition: provisions for the use of spectrum analyzers for compliance measurements (Annex D) and the use of FFT-based test instrumentation (Clauses 3, 6 and 8) are now included.

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.*

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

CDV	Report on voting
CISPR/A/877/CDV	CISPR/A/896/RVC

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

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

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

The committee has decided that the contents of this 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 publication using a colour printer.

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 2-2: Methods of measurement of disturbances and immunity – Measurement of disturbance power

1 Scope

This part of CISPR 16 specifies the methods of measurement of disturbance power using the absorbing clamp in the frequency range 30 MHz to 1 000 MHz.

NOTE In accordance with IEC Guide 107, CISPR 16-2-2 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 sub-committees are prepared to co-operate with product committees in the determination of the value of particular EMC tests for specific products.

2 Normative references

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

CISPR 16-1-1:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-3:2004, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-3: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Disturbance power*

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

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

3 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
absorbing clamp measurement method
ACMM
method for measurement of disturbance power of an equipment under test (EUT) by using an absorbing clamp device that is clamped around the lead(s) of the EUT

3.2
absorbing clamp test site
ACTS
test site that is validated to perform disturbance power measurements by using the absorbing clamp measurement method (ACMM)

3.3
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

3.4
clamp factor
CF
F_C
ratio of the disturbance power of an EUT to the received voltage at the output of the absorbing clamp

NOTE The clamp factor is a transducer factor of the absorbing clamp.

3.5
clamp reference point
CRP
indication on the outside of the absorbing clamp that is related to the longitudinal position of the front edge of the current transformer within the clamp and is used to define the horizontal position of the clamp during the measurement

3.6
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

3.7
common mode (asymmetrical) disturbance voltage
RF voltage between the artificial midpoint of a two-conductor line and reference ground, or in case of a bundle of lines, the effective RF disturbance voltage of the whole bundle (vector sum of the unsymmetrical voltages) against the reference ground measured with a clamp (current transformer) at a defined terminating impedance

NOTE See also IEC 60050-161, 161-04-09.

3.8
common mode current
the vector sum of the currents flowing through two or more conductors at a specified cross-section of a "mathematical" plane intersected by these conductors

3.9
continuous disturbance
RF disturbance with a duration of more than 200 ms at the IF-output of a measuring receiver, which causes a deflection on the meter of a measuring receiver in quasi-peak detection mode which does not decrease immediately

[IEC 60050-161, 161-02-11, modified]

3.10
discontinuous disturbance
for counted clicks, disturbance with a duration of less than 200 ms at the IF-output of a measuring receiver, which causes a transient deflection on the meter of a measuring receiver in quasi-peak detection mode

NOTE For impulsive disturbance, see IEC 60050-161, 161-02-08.

3.11
(electromagnetic) emission
the phenomenon by which electromagnetic energy emanates from a source

[IEC 60050-161, 161-01-08]

3.12
emission limit (from a disturbing source)
the specified maximum emission level of a source of electromagnetic disturbance

[IEC 60050-161, 161-03-12]

3.13
EUT
equipment (devices, appliances and systems) subjected to EMC (emission) compliance tests

3.14
lead under test
LUT
lead, associated with an EUT, that is the subject of an emission or an immunity test

NOTE In general, an EUT may have one or more leads that are used for interconnections to the mains supply, or other networks, or for interconnection to auxiliary equipment. These leads are generally electrical cables such as mains cables, coaxial cables, data bus cables, etc.

3.15
measurement
process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity

[2.1 of ISO/IEC Guide 99] [6][1]

3.16
measurement, scan and sweep times

3.16.1
measurement time
T_m
effective, coherent time for a measurement result at a single frequency (in some areas also called dwell time)

– 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 r.m.s. detector, the effective time to determine the r.m.s. of the signal envelope

1 Numbers in square brackets refer to the Bibliography.

3.16.2
observation time
T_o
sum of measurement times T_m on a certain frequency in case of multiple sweeps; if n is the number of sweeps or scans, then $T_o = n \times T_m$

3.16.3
scan
continuous or stepped frequency variation over a given frequency span

3.16.4
span
Δf
difference between stop and start frequencies of a sweep or scan

3.16.5
sweep
continuous frequency variation over a given frequency span

3.16.6
sweep rate
scan rate
frequency span divided by the sweep or scan time

3.16.7
sweep time
scan time
T_s
time between start and stop frequencies of a sweep or scan

3.16.8
total observation time
T_{tot}
effective time for an overview of the spectrum (either single or multiple sweeps). If c is the number of channels within a scan or sweep, then $T_{tot} = c \times n \times T_m$

3.17
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 meets the relevant clauses of CISPR 16-1-1

NOTE See Annex I of CISPR 16-1-1 for further information.

3.18
number of sweeps per time unit (e.g. per second)
n_s
1/(sweep time + retrace time)

3.19
product publication
publication specifying EMC requirements for a product or product family, taking into account specific aspects of such a product or product family

3.20
slide reference point
SRP
end of the clamp slide where the EUT is located and which is used to define the horizontal distance to the clamp reference point (CRP) of the absorbing clamp during the measurement procedure

3.21
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 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.

[IEC 60050-151, 151-16-13] [5]

3.22
test configuration
combination that gives the specified measurement arrangement of the EUT in which an emission level is measured

3.23
weighting (of e.g. impulsive disturbance)
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 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 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 which perfect error correction can still occur or by another, objective and reproducible parameter.

3.23.1
weighted disturbance measurement
measurement of disturbance using a weighting detector

3.23.2
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

3.23.3
weighting detector
detector that provides an agreed weighting function

3.23.4
weighting factor
value of the weighting function relative to a reference PRF or relative to the peak value

NOTE Weighting factor is expressed in dB.

3.23.5
weighting function
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

4 Types of disturbance to be measured

4.1 General

This clause describes the classification of different types of disturbance and the detectors appropriate for their measurement.

4.2 Types of disturbance

For physical and psychophysical reasons, dependent on the spectral distribution, measuring receiver bandwidth, the duration, rate of occurrence, and degree of annoyance during the assessment and measurement of radio disturbance, distinction is made between the following types of disturbance:

a) *narrowband continuous disturbance*, i.e. disturbance on discrete frequencies as, for example, the fundamentals and harmonics generated with the intentional application of RF energy with ISM equipment, constituting a frequency spectrum consisting only of individual spectral lines whose separation is greater than the bandwidth of the measuring receiver so that during the measurement only one line falls into the bandwidth in contrast to b);

b) *broadband continuous disturbance* that normally is unintentionally produced by the repeated impulses of, for example, commutator motors, and that has a repetition frequency that is lower than the bandwidth of the measuring receiver so that during the measurement more than one spectral line falls into the bandwidth; and

c) *broadband discontinuous disturbance* is also generated unintentionally by mechanical or electronic switching procedures, for example by thermostats or programme controls with a repetition rate lower than 1 Hz (click-rate less than 30/min).

The frequency spectra of b) and c) are characterized by having a continuous spectrum in the case of individual (single) impulses and a discontinuous spectrum in case of repeated impulses, both spectra being characterized by having a frequency range that is wider than the bandwidth of the measuring receiver specified in CISPR 16-1-1.

4.3 Detector functions

Depending on the types of disturbance, measurements may be carried out using a measuring receiver with:

a) an average detector generally used in the measurement of narrowband disturbance and signals, and particularly to discriminate between narrowband and broadband disturbance;

b) a quasi-peak detector provided for the weighted measurement of broadband disturbance for the assessment of audio annoyance to a radio listener, but also usable for narrowband disturbance;

c) an rms-average detector provided for the weighted measurement of broadband disturbance for the assessment of the effect of impulsive disturbance to digital radio communication services but also useable for narrowband disturbance;

d) a peak detector that may be used for either broadband or narrowband disturbance measurement.

Measuring receivers incorporating these detectors are specified in CISPR 16-1-1.

5 Connection of measuring equipment

5.1 General

This subclause describes the connection of measuring equipment, measuring receivers and ancillary equipment.

5.2 Connection of ancillary equipment

The connecting cable between the measuring receiver and the ancillary equipment (absorbing clamp) shall be shielded and its characteristic impedance shall be matched to the input impedance of the measuring receiver.

6 General measurement requirements and conditions

6.1 General

Radio disturbance measurements shall be:

a) reproducible, i.e. independent of the measurement location and environmental conditions, especially ambient noise;

b) free from interactions, i.e. the connection of the EUT to the measuring equipment shall neither influence the function of the EUT nor the accuracy of the measurement equipment.

These requirements may be met by observing the following conditions:

– existence of a sufficient signal-to-noise ratio at the desired measurement level, e.g. the level of the relevant disturbance limit;

– having a defined measuring set-up, termination and operating conditions of the EUT.

6.2 Disturbance not produced by the equipment under test

6.2.1 General

The measurement signal-to-noise ratio with respect to ambient noise shall meet the following requirements. Should the ambient noise level exceed the required level, it shall be recorded in the test report.

6.2.2 Compliance testing

A test site shall permit emissions from the EUT to be distinguished from ambient noise. The ambient noise level should preferably be 20 dB, but at least be 6 dB below the desired measurement level. For the 6 dB condition, the apparent disturbance level from the EUT is increased by up to 3,5 dB. The suitability of the site for required ambient level may be determined by measuring the ambient noise level with the test unit in place but not operating.

In the case of compliance measurement according to a limit, the ambient noise level is permitted to exceed the preferred –6 dB level provided that the level of both ambient noise and source emanation combined does not exceed the specified limit. The EUT is then considered to meet the limit. Other actions can also be taken; for example, reducing the bandwidth for narrowband signals.

6.3 Measurement of continuous disturbance

6.3.1 Narrowband continuous disturbance

The measuring set shall be kept tuned to the discrete frequency under investigation and returned if the frequency fluctuates.