INTERNATIONAL ELECTROTECHNICAL COMMISSION

# CISPR 16-2

Second edition
2003-07

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

## Specification for radio disturbance and immunity measuring apparatus and methods –

## Part 2: Methods of measurement of disturbances and immunity

*Spécification pour les appareils et méthodes de mesure des perturbations radioélectriques et de l'immunité –*

*Partie 2: Méthodes de mesure des perturbations et de l'immunité*



Reference number
CISPR 16-2:2003

## Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

## Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

## Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site (www.iec.ch)**

- **Catalogue of IEC publications**

  The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

  This summary of recently issued publications (www.iec.ch/online_news/ justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

  If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

  Email: custserv@iec.ch
  Tel: +41 22 919 02 11
  Fax: +41 22 919 03 00

INTERNATIONAL ELECTROTECHNICAL COMMISSION

# CISPR 16-2

Second edition
2003-07

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE



## Specification for radio disturbance and immunity measuring apparatus and methods –

## Part 2: Methods of measurement of disturbances and immunity



*Spécification pour les appareils et méthodes de mesure des perturbations radioélectriques et de l'immunité –*

*Partie 2:*
*Méthodes de mesure des perturbations et de l'immunité*





International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE XE

*For price, see current catalogue*

# CONTENTS

SECTION 4: AUTOMATED MEASUREMENTS



SECTION 5: FACTORS INFLUENCING MEASUREMENT ACCURACY

INTERNATIONAL ELECTROTECHNICAL COMMISSION
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

# SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

## Part 2: Methods of measurement of disturbances and immunity

## 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, 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
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 has been prepared by CISPR, subcommittee A: Radio interference measurements and statistical methods.

This second edition cancels and replaces the first edition published in 1996, Amendment 1 (1999) and Amendment 2 (2002).

The document CISPR/A/443/FDIS, circulated to the National Committees as Amendment 3, led to the publication of the new edition.

The text of this standard is based on the first edition, its Amendment 1 and Amendment 2 and on the following documents:

| FDIS | Report on voting |
|---|---|
| CISPR/A/443/FDIS | CISPR/A/463/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.

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

This standard should be read in conjunction with CISPR 16-1.

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

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

# SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

## Part 2: Methods of measurement of disturbances and immunity

## Section 1: General

### 1.1 Scope

This part of CISPR 16 specifies the methods of measurement of EMC phenomena in the frequency range 9 kHz to 18 GHz.

### 1.2 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.

IEC 60083:1997, *Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC – Standards*

IEC 60364-4: *Electrical installations of buildings – Part 4: Protection for safety*

CISPR 11:1997, *Industrial, scientific and medical (ISM)radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*

CISPR 13:2001, *Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement*

CISPR 14-1:2000, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

CISPR 16-1:1999, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*

CISPR 22:1997, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

ITU-R Recommendation BS.468-4: *Measurement of audio-frequency noise voltage level in sound broadcasting*

### 1.3 Definitions

For the purpose of this part of CISPR 16, the definitions of IEC 60050(161) apply, as well as the following:

**1.3.1**
**associated equipment**

1) Transducers (e.g. probes, networks and antennas) connected to a measuring receiver or test generator
2) Transducers (e.g. probes, networks, antennas) which are used in the signal or disturbance transfer between an EUT and measuring equipment or a (test-) signal generator

**1.3.2**
**EUT**

the equipment (devices, appliances and systems) subjected to EMC (emission and immunity) compliance tests

**1.3.3**
**product publication**
publication specifying EMC requirements for a product or product family, taking into account specific aspects of such a product or product family

**1.3.4**
**emission limit (from a disturbing source)**
the specified maximum emission level of a source of electromagnetic disturbance

[IEV 161-03-12]

**1.3.5**
**immunity limit**
the specified minimum immunity level

[IEV 161-03-15]

**1.3.6**
**ground reference**
a connection that constitutes a defined parasitic capacitance to the surrounding of an EUT and serves as reference potential

NOTE See also IEV 161-04-36.

**1.3.7**
**(electromagnetic) emission**
the phenomenon by which electromagnetic energy emanates from a source

[IEV 161-01-08]

**1.3.8**
**Immunity (to a disturbance)**
the ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20]

**1.3.9**
**coaxial cable**
a cable containing one or more coaxial lines, typically used for a matched connection of associated equipment to the measuring equipment or (test-)signal generator providing a specified characteristic impedance and a specified maximum allowable cable transfer impedance

**1.3.10**
**common mode (asymmetrical disturbance voltage)**
the 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 IEV 161-04-09.

**1.3.11**
**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

**1.3.12**
**differential mode voltage; symmetrical voltage**
the RF disturbance voltage between the wires of a two conductor line

[IEV 161-04-08, modified]

**1.3.13**
**differential mode current**
half the vector difference of the currents flowing in any two of a specified set of active conductors at a specified cross-section of a “mathematical” plane intersected by these conductors

**1.3.14**
**unsymmetrical mode (V-terminal voltage)**
the voltage between a conductor or terminal of a device, equipment or system and a specified ground reference. For the case of a two-port network, the two unsymmetrical voltages are given by:

a) the vector sum of the asymmetrical voltage and half of the symmetrical voltage; and

b) the vector difference between the asymmetrical voltage and half of the symmetrical voltage.

NOTE See also IEV 161-04-13.

**1.3.15**
**measuring receiver**
a receiver for the measurement of disturbances with different detectors

NOTE The receiver is specified according to CISPR 16-1.

**1.3.16**
**test configuration**
gives the specified measurement arrangement of the EUT in which an emission or immunity level is measured

NOTE The emission level or immunity level is measured as required by IEV 161-03-11, IEV 161-03-12, IEV 161-03-14 and IEV 161-03-15, definitions of emission level and immunity level.

**1.3.17**
**artificial network (AN)**
an agreed reference load (simulation) impedance presented to the EUT by actual networks (e.g., extended power or communication lines) across which the RF disturbance voltage is measured

**1.3.18**
**artificial mains network (AMN)**
a network inserted in the supply mains lead of apparatus to be tested which provides, in a given frequency range, a specified load impedance for the measurement of disturbance voltages and which may isolate the apparatus from the supply mains in that frequency range

[IEV 161-04-05]

**1.3.19**
**weighting (quasi-peak detection)**
the repetition-rate dependent conversion of the peak-detected pulse voltages to an indication corresponding to the psychophysical annoyance of pulsive disturbances (acoustically or visually) according to the weighting characteristics, or alternatively gives the specified manner in which an emission level or an immunity level is evaluated

NOTE 1 The weighting characteristics are specified in CISPR 16-1.

NOTE 2 The emission level or immunity level is evaluated as required by IEC 60050(161) definitions of level (see IEV 161-03-01, IEV 161-03-11 and IEV 161-03-14).

**1.3.20**
**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

[IEV 161-02-11, modified]

NOTE The measuring receiver is specified in CISPR 16-1.

**1.3.21**
**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 1 For impulsive disturbance, see IEV 161-02-08.

NOTE 2 The measuring receiver is specified in CISPR 16-1.

**1.3.22**
**fully anechoic chamber (FAC) or fully anechoic room (FAR)**
shielded enclosure, the internal surfaces of which are lined with radio frequency absorbing material (i.e. RF absorber), that absorbs electromagnetic energy in the frequency range of interest. The Fully Absorber-Lined Room is intended to simulate a free space environment where only the direct ray from the transmitting antenna reaches the receiving antenna. All indirect and reflected waves are minimised with the use of proper absorbing material on all walls, the ceiling and the floor of the FAR

**1.3.23**
**measurement time**
$T_m$
the effective, coherent time for a measurement result at a single frequency (sometimes 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

**1.3.24**
**sweep**
a continuous frequency variation over a given frequency span

**1.3.25**
**scan**
a continuous or stepped frequency variation over a given frequency span

**1.3.26**
**sweep or scan time**
$T_s$
the time between start and stop frequencies of a sweep or scan

**1.3.27**
**span**
$\Delta f$
difference between stop and start frequencies of a sweep or scan

**1.3.28**
**sweep or scan rate**
the frequency span divided by the sweep or scan time

**1.3.29**
**number of sweeps per time unit (e.g. per second)**
$n_s$
1/(sweep time + retrace time)

**1.3.30**
**observation time**
$T_o$
the 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 $T_o = n \times T_m$

**1.3.31**
**total observation time**
$T_{tot}$
the 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 $T_{tot} = c \times n \times T_m$

## Section 2: Disturbance measurements

### 2.1 Types of disturbance to be measured

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

#### 2.1.1 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,* which normally is unintentionally produced by the repeated impulses of, for example, commutator motors, and which have a repetition frequency which 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 which is wider than the bandwidth of the measuring receiver specified in CISPR 16-1.