

# INTERNATIONAL STANDARD



INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

BASIC EMC PUBLICATION

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

CISPR 16-1-1:2010

<https://standards.iteh.ai/standards/iec/42b16839-60b6-480d-acc3-e45e8ac9f4a6/cispr-16-1-1-2010>



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2010 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

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

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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 It also gives information on projects, replaced and withdrawn publications.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](http://webstore.iec.ch/justpublished)

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

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://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: [csc@iec.ch](mailto:csc@iec.ch).

CISPR 16-1-1:2010

<https://standards.iteh.ai/catalog/standards-iec/42b16839-60b6-480d-acc3-e45e8ac9f4a6/cispr-16-1-1-2010>

# INTERNATIONAL STANDARD



INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

BASIC EMC PUBLICATION

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

CISPR 16-1-1:2010

<https://standards.iteh.ai/standards/iec/42b16839-60b6-480d-acc3-e45e8ac9f4a6/cispr-16-1-1-2010>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 33.100.10

ISBN 978-2-8891-0010-1

**Warning! Make sure that you obtained this publication from an authorized distributor.**

Withdrawn

iTech Standards  
(<https://standards.iteh.ai>)  
Document Preview

CISPR 16-1-1:2010

<https://standards.iteh.ai/catalog/standards/sic/42b16839-60b6-480d-ae33-e45e8ac9f4a6/cispr-16-1-1-2010>

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



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 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus**

**Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques –  
Partie 1-1: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Appareils de mesure**

## CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references.....	9
3 Terms and definitions.....	10
4 Quasi-peak measuring receivers for the frequency range 9 kHz to 1 000 MHz.....	13
4.1 General.....	13
4.2 Input impedance.....	13
4.3 Sine-wave voltage accuracy.....	13
4.4 Response to pulses.....	13
4.4.1 Amplitude relationship (absolute calibration).....	13
4.4.2 Variation with repetition frequency (relative calibration).....	14
4.5 Selectivity.....	18
4.5.1 Overall selectivity (passband).....	18
4.5.2 Intermediate frequency rejection ratio.....	19
4.5.3 Image frequency rejection ratio.....	19
4.5.4 Other spurious responses.....	20
4.6 Limitation of intermodulation effects.....	21
4.7 Limitation of receiver noise and internally generated spurious signals.....	22
4.7.1 Random noise.....	22
4.7.2 Continuous wave.....	22
4.8 Screening effectiveness.....	22
4.8.1 General.....	22
4.8.2 Limitation of radio-frequency emissions from the measuring receiver.....	23
4.9 Facilities for connection to a discontinuous disturbance analyzer.....	23
5 Measuring receivers with peak detector for the frequency range 9 kHz to 18 GHz.....	23
5.1 General.....	23
5.2 Input impedance.....	23
5.3 Fundamental characteristics.....	24
5.3.1 Bandwidth.....	24
5.3.2 Charge and discharge time constants ratio.....	24
5.3.3 Overload factor.....	25
5.4 Sine-wave voltage accuracy.....	25
5.5 Response to pulses.....	25
5.6 Selectivity.....	25
5.7 Intermodulation effects, receiver noise, and screening.....	26
6 Measuring receivers with average detector for the frequency range 9 kHz to 18 GHz.....	27
6.1 General.....	27
6.2 Input impedance.....	27
6.3 Fundamental characteristics.....	27
6.3.1 Bandwidth.....	27
6.3.2 Overload factor.....	27
6.4 Sine-wave voltage accuracy.....	28
6.5 Response to pulses.....	28
6.5.1 General.....	28

6.5.2	Amplitude relationship .....	28
6.5.3	Variation with repetition frequency.....	29
6.5.4	Response to intermittent, unsteady and drifting narrowband disturbances.....	29
6.6	Selectivity .....	31
6.7	Intermodulation effects, receiver noise, and screening .....	31
7	Measuring receivers with rms-average detector for the frequency range 9 kHz to 18 GHz.....	31
7.1	General.....	31
7.2	Input impedance.....	31
7.3	Fundamental characteristics.....	32
7.3.1	Bandwidth .....	32
7.3.2	Overload factor.....	32
7.4	Sine-wave voltage accuracy .....	33
7.5	Response to pulses.....	33
7.5.1	Construction details.....	33
7.5.2	Amplitude relationship .....	33
7.5.3	Variation with repetition frequency.....	34
7.5.4	Response to intermittent, unsteady and drifting narrowband disturbances.....	34
7.6	Selectivity .....	35
7.7	Intermodulation effects, receiver noise, and screening.....	35
8	Measuring receivers for the frequency range 1 GHz to 18 GHz with amplitude probability distribution (APD) measuring function.....	35
9	Disturbance analyzers.....	36
9.1	General.....	36
9.2	Fundamental characteristics.....	37
9.3	Test method for the validation of the performance check for the click analyzer.....	43
9.3.1	Basic requirements.....	43
9.3.2	Additional requirements.....	44
Annex A (normative)	Determination of response to repeated pulses of quasi-peak and rms-average measuring receivers (See 3.6, 4.4.2, 7.3.2 and 7.5.1) .....	45
Annex B (normative)	Determination of pulse generator spectrum (See 4.4, 5.5, 6.5, 7.5).....	51
Annex C (normative)	Accurate measurements of the output of nanosecond pulse generators (See 4.4, 5.5, 6.5, 7.5) .....	53
Annex D (normative)	Influence of the quasi-peak measuring receiver characteristics on its pulse response (See 4.4.2).....	55
Annex E (normative)	Response of average and peak measuring receivers (See 6.3.1) .....	56
Annex F (normative)	Performance check of the exceptions from the definitions of a click according to 4.2.3 of CISPR 14-1 .....	65
Annex G (informative)	Rationale for the specifications of the APD measuring function.....	72
Annex H (informative)	Characteristics of a quasi-peak measuring receiver.....	75
Annex I (informative)	Example of EMI receiver and swept spectrum analyzer architecture.....	76
	Bibliography.....	78
	Figure 1 – Pulse response curves .....	17

Figure 2 – Limits of overall selectivity .....	20
Figure 3 – Arrangement for testing intermodulation effects .....	21
Figure 4 – Limits for the overall selectivity – pass band (Band E).....	26
Figure 5 – Block diagram of an average detector. ....	30
Figure 6 – Screenshot showing response of the meter-simulating network to an intermittent narrowband signal.....	30
Figure 7 – Example of a disturbance analyzer.....	38
Figure 8 – A graphical presentation of test signals used in the test of the analyzer for the performance check against the definition of a click according to Table 14 .....	39
Figure E.1 – Correction factor for estimating the ratio $B_{imp}/B_6$ for other tuned circuits .....	57
Figure E.2 – Pulse rectification coefficient $P$ .....	59
Figure E.3 – Example (spectrum screenshot) of a pulse-modulated signal with a pulse width of 200 ns .....	60
Figure E.4 – Pulse-modulated RF signal applied to a measuring receiver .....	61
Figure E.5 – Filtering with a $B_{imp}$ much smaller than the prf.....	61
Figure E.6 – Filtering with a $B_{imp}$ much wider than the prf.....	62
Figure E.7 – Calculation of the impulse bandwidth .....	62
Figure E.8 – Example of a normalized linear selectivity function .....	64
Figure F.1 – A graphical presentation of the test signals used for the performance check of the analyzer with the additional requirements according to Table F.1.....	71
Figure G.1 – Block diagram of APD measurement circuit without A/D converter.....	73
Figure G.2 – Block diagram of APD measurement circuit with A/D converter.....	73
Figure G.3 – Example of display of APD measurement.....	74
Figure I.1 – Example block diagram of EMI receiver consisting of swept spectrum analyzer with added preselector, preamplifier and quasi-peak/average detector .....	76
Table 1 – Test pulse characteristics for quasi-peak measuring receivers (see 4.4.1) .....	13
Table 2 – Pulse response of quasi-peak measuring receivers .....	18
Table 3 – Combined selectivity of CISPR measuring receiver and high-pass filter.....	19
Table 4 – Bandwidth characteristics for intermodulation test of quasi-peak measuring receivers (see 4.6).....	22
Table 5 – VSWR requirements for receiver input impedance.....	24
Table 6 – Bandwidth requirements for measuring receivers with peak detector .....	24
Table 7 – Relative pulse response of peak and quasi-peak measuring receivers for the same bandwidth (frequency range 9 kHz to 1 000 MHz).....	25
Table 8 – Bandwidth requirements for measuring receivers with average detector .....	27
Table 9 – Relative pulse response of average and quasi-peak measuring receivers for the same bandwidth (frequency range 9 kHz to 1 GHz).....	28
Table 10 – Maximum reading of average measuring receivers for a pulse-modulated sine-wave input in comparison with the response to a continuous sine wave having the same amplitude .....	30
Table 11 – VSWR requirements of input impedance.....	32
Table 12 – Bandwidth requirements for measuring receivers with rms-average detector .....	32
Table 13 – Minimum pulse repetition rate without overload .....	32
Table 14 – Relative pulse response of rms-average and quasi-peak measuring receivers.....	33



Table 15 – Pulse response of rms-average measuring receiver .....	34
Table 16 – Maximum reading of rms-average measuring receivers for a pulse-modulated sine-wave input in comparison with the response to a continuous sine wave having the same amplitude .....	35
Table 17 – Disturbance analyzer performance test – Test signals used for the check against the definition of a click.....	40
Table B.1 – Pulse generator characteristics .....	51
Table E.1 – $B_{imp}$ and $A_{imp}$ values for a peak measuring receiver .....	58
Table E.2 – Carrier level for pulse-modulated signal of 1,4 nVs .....	60
Table F.1 – Disturbance analyzer test signals <sup>a</sup> .....	66
Table H.1 – Characteristics of quasi-peak measuring receivers .....	75

Withstand

iTech Standards  
(<https://standards.iteh.ai>)  
Document Preview

CISPR 16-1-1:2010  
<https://standards.iteh.ai/catalog/standards/iec/47b16839-60b6-480d-acc3-e45e8ac9f4a6/cispr-16-1-1-2010>

INTERNATIONAL ELECTROTECHNICAL COMMISSION  
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

---

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

**Part 1-1: Radio disturbance and immunity measuring apparatus –  
Measuring apparatus**

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.

International Standard CISPR 16-1-1 has been prepared by CISPR subcommittee A: Radio-interference measurements and statistical methods.

This third edition cancels and replaces the second edition published in 2006, and its Amendments 1 (2006) and 2 (2007). It is a technical revision.

This main technical change with respect to the previous edition consists of the addition of new provisions for the use of spectrum analyzers for compliance measurements.

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:

FDIS	Report on voting
CISPR/A/867/FDIS	CISPR/A/881/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.

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

The contents of the corrigenda 1 (October 2010) and 2 (October 2011) have been included in this copy.

**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.**

## INTRODUCTION

The CISPR 16 series, published under the general title *Specification for radio disturbance and immunity measuring apparatus and methods*, is comprised of the following sets of standards and reports:

- CISPR 16-1 – five parts covering measurement instrumentation specifications;
- CISPR 16-2 – five parts covering methods of measurement;
- CISPR 16-3 – a single publication containing various technical reports (TRs) with further information and background on CISPR and radio disturbances in general;
- CISPR 16-4 – five parts covering uncertainties, statistics and limit modelling.

CISPR 16-1 consists of the following parts, under the general title *Specification for radio disturbance and immunity measuring apparatus and methods – Radio disturbance and immunity measuring apparatus*:

- Part 1-1: Measuring apparatus
- Part 1-2: Ancillary equipment – Conducted disturbances
- Part 1-3: Ancillary equipment – Disturbance power
- Part 1-4: Ancillary equipment – Radiated disturbances
- Part 1-5: Antenna calibration test sites for 30 MHz to 1 000 MHz

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the measuring receiver with rms-average detector (patent no DE 10126830) given in Clause 7.

IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

Rohde & Schwarz GmbH & Co. KG  
Muehldorfstrasse 15  
81671 Muenchen  
Germany

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

ISO ([www.iso.org/patents](http://www.iso.org/patents)) and IEC ([http://www.iec.ch/tctools/patent\\_decl.htm](http://www.iec.ch/tctools/patent_decl.htm)) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

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

## Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus

### 1 Scope

This part of CISPR 16 specifies the characteristics and performance of equipment for the measurement of radio disturbance in the frequency range 9 kHz to 18 GHz. In addition, requirements are provided for specialized equipment for discontinuous disturbance measurements.

NOTE In accordance with IEC Guide 107, CISPR 16-1-1 is a basic EMC standard 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 evaluation of the value of particular EMC tests for specific products.

The specifications in this standard apply to EMI receivers and spectrum analyzers. The term “measuring receiver” used in this standard refers to both EMI receivers and spectrum analyzers.

Further guidance on the use of use of spectrum analyzers and scanning receivers can be found in Annex B of any one of the following standards: CISPR 16-2-1, CISPR 16-2-2 or CISPR 16-2-3.

### 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 11:2009, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

CISPR 14-1:2005, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*  
Amendment 1 (2008)

CISPR 16-2-1:2008, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-2: Methods of measurement of disturbances and immunity – Measurement of disturbance power*  
Amendment 1 (2004)  
Amendment 2 (2005)

CISPR 16-2-3:2006, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR/TR 16-3:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 3: CISPR technical reports*  
 Amendment 1 (2005)  
 Amendment 2 (2006)

IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*  
 Amendment 1 (1997)  
 Amendment 2 (1998)

### 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 bandwidth

$B_n$   
 width of the overall selectivity curve of the receiver between two points at a stated attenuation, below the midband response

NOTE  $n$  is the stated attenuation in dB.

#### 3.2 CISPR indication range

range specified by the manufacturer which gives the maximum and the minimum meter indications within which the measuring receiver meets the requirements of this part of CISPR 16

#### 3.3 electrical charge time constant

$T_C$   
 time needed after the instantaneous application of a constant sine-wave voltage to the stage immediately preceding the input of the detector for the output voltage of the detector to reach 63 % of its final value

NOTE This time constant is determined as follows: a sine-wave signal of constant amplitude and having a frequency equal to the mid-band frequency of the IF amplifier is applied to the input of the stage immediately preceding the detector. The indication,  $D$ , of an instrument having no inertia (e.g. an oscilloscope) connected to a terminal in the d.c. amplifier circuit so as not to affect the behaviour of the detector, is noted. The level of the signal is chosen such that the response of the stages concerned remains within the linear operating range. A sine-wave signal of this level, applied for a limited time only and having a wave train of rectangular envelope is gated such that the deflection registered is 0,63  $D$ . The duration of this signal is equal to the charge time of the detector.

#### 3.4 electrical discharge time constant

$T_D$   
 time needed after the instantaneous removal of a constant sine-wave voltage applied to the stage immediately preceding the input of the detector for the output of the detector to fall to 37 % of its initial value

NOTE The method of measurement is analogous to that for the charge time constant, but instead of a signal being applied for a limited time, the signal is interrupted for a definite time. The time taken for the deflection to fall to 0,37  $D$  is the discharge time constant of the detector.

#### 3.5 impulse area

$A_{imp}$   
 voltage-time area of a pulse defined by the integral: