



BSI Standards Publication

Specification for radio disturbance and immunity measuring apparatus and methods

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

National foreword

This British Standard is the UK implementation of EN IEC 55016-1-1:2019. It is identical to CISPR 16-1-1:2019. It supersedes BS EN 55016-1-1:2010+A2:2014, which will be withdrawn on 26 June 2022.

The UK participation in its preparation was entrusted to Technical Committee GEL/210/11, EMC - Standards Committee.

A list of organizations represented on this committee can be obtained on request to its secretary.

BSI, as a member of CENELEC, is obliged to publish EN IEC 55016-1-1:2019 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval.

The UK committee draws users' attention to Annex K, which it considers requires clarification on whether the verification of receivers should be traceable to the requirements of this standard or to a manufacturer's proprietary method. Guidance on this matter is currently under consideration.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Amendments/corrigenda issued since publication

Date	Text affected
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English Version

Specification for radio disturbance and immunity measuring
apparatus and methods - Part 1-1: Radio disturbance and
immunity measuring apparatus - Measuring apparatus
(CISPR 16-1-1:2019)

Spécification 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
(CISPR 16-1-1:2019)

Anforderungen an Geräte und Einrichtungen sowie
Festlegung der Verfahren zur Messung der hochfrequenten
Störaussendung (Funkstörungen) und Störfestigkeit - Teil 1-
1: Geräte und Einrichtungen zur Messung der
hochfrequenten Störaussendung (Funkstörungen) und
Störfestigkeit - Messgeräte
(CISPR 16-1-1:2019)

This European Standard was approved by CENELEC on 2019-06-26. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document CIS/A/1290/FDIS, future edition 5 of CISPR 16-1-1, prepared by CISPR SC A "Radio-interference measurements and statistical methods" of CISPR "International special committee on radio interference" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 55016-1-1:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-03-26
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-06-26

This document supersedes EN 55016-1-1:2010 and all of its amendments and corrigenda (if any).

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

This document supports essential requirements of EU Directive(s).

Endorsement notice

The text of the International Standard CISPR 16-1-1:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

CISPR 15:2018	NOTE	Harmonized as EN 55015:2018 ¹ (not modified)
CISPR 25:2016	NOTE	Harmonized as EN 55025:2017 (not modified)
CISPR 32:2015	NOTE	Harmonized as EN 55032:2015 (not modified)
CISPR 16-2 (series)	NOTE	Harmonized as EN 55016-2-4 (series)

¹ Under preparation. Stage at the time of publication: FprEN 55015:2018

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
CISPR 11 (mod)	2015	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement	EN 55011	2016
+ A1	2016		+ A1	2017
+ A2	2019		-	-
CISPR 14-1	2016	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission	EN 55014-1	2017
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	EN 55016-2-1	2014
CISPR 16-2-2	2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-2: Methods of measurement of disturbances and immunity - Measurement of disturbance power	EN 55016-2-2	2011
CISPR 16-2-3	-	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements	EN 55016-2-3	-
CISPR/TR 16-3:2010	2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 3: CISPR technical reports	-	-
+ A1	2012		-	-
+ A2	2015		-	-
IEC 60050-161	1990	International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility	-	-

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

This fifth edition cancels and replaces the fourth edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Reorganization of the document structure to remove common elements of receiver performance from Clauses 4, 5, 6, and 7 and create a new clause that applies across all of these clauses. Key common parameters include:

- 1) Input impedance
 - 2) CW amplitude accuracy
 - 3) Limitations of intermodulation effects
 - 4) Limitation of receiver noise and internally generated spurious signals
- b) Rewording of Subclause B.1.1 for the purpose of correcting existing errors
 - c) Amendments to Subclause 7.5.2 to modify the definition of the test signal to be used for calibrating and verifying the required RMS-average detector response to pulses of the receiver. This section will include a note requiring that the amplitude of the pulsed signal be verified prior to the calibration, and will include several verification methods.
 - d) Amendments to Subclause 6.5.2 to modify the definition of the test signal to be used for calibrating and verifying the required average detector response to pulses. The purpose of this proposed change is the alignment of the test signal type with that of the newly proposed signal used to verify the RMS-average detector, allowing the use of a pulsed RF signal. This section will include a note requiring that the amplitude of the pulsed signal be verified prior to the calibration and will include several verification methods.
 - e) Implementation and use of Gaussian filters
 - f) Amendments to Clause 9 on discontinuous disturbance analyzers (DDAs) to allow the use of measuring receivers with built-in DDAs, to clarify which signal is used for click time parameter determination and to allow the use of FFT-based measuring instruments with internal DDAs.
 - g) Amendments to Subclauses 4.2, 5.2, 6.2 and 7.2 to remove the mention of a symmetric input for measuring receivers.
 - h) Deletion of Subclause 4.8.1 "Screening Effectiveness".
 - i) add a frequency accuracy specification to the proposed reorganized clause mentioned in a) above.
 - j) Amend Subclause 6.5.3 to adjust the allowable tolerance for the variation with repetition frequency for the linear average detector.
 - k) Add interpretation information to Clause K.4 based on CISPR-A-1188-INF.
 - l) Indicate that the 31,6 Hz pulse repetition frequency for the RMS-Average test requirement for Bands C and D in Table 15 is optional. For the RMS-Average overload requirement in Table 13, change the minimum pulse repetition frequency to 100 Hz and the associated Peak to RMS-Average ratio to 30,6 dB.
 - m) Improve the phrasing used for the tolerance statements in Subclauses 4.4.1, 5.5, 6.5.2, 6.5.3, 6.5.4 and 7.5.2.
 - n) Remove a note from Clause E1.
 - o) Add a reference for FFT-based discontinuous disturbance analyzers

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 International Standard is based on the following documents:

FDIS	Report on voting
CIS/A/1290/FDIS	CIS/A/1295/RVD

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

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

A list of all parts in 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 will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document 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 document 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 documents:

- CISPR 16-1 – six parts covering measurement instrumentation specifications;
- CISPR 16-2 – five parts covering methods of measurement;
- CISPR TR 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: Coupling devices for conducted disturbance measurements
- Part 1-3: Ancillary equipment – Disturbance power
- Part 1-4: Antennas and test sites for radiated disturbance measurements
- Part 1-5: Antenna calibration sites and reference test sites for 5 MHz to 18 GHz
- Part 1-6: EMC antenna calibration

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) and IEC (<http://patents.iec.ch>) 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 electromagnetic compatibility (EMC) standard for use by product committees of the IEC. As stated in Guide 107, product committees are responsible for determining the applicability of a basic EMC standard. CISPR and its subcommittee 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 document apply to electromagnetic interference (EMI) receivers and spectrum analyzers. The term “measuring receiver” used in this document refers to both EMI receivers and spectrum analyzers (see also 3.7). The calibration requirements for measuring receivers are detailed in Annex J.

Further guidance on the use of spectrum analyzers can be found in Annex B of any one of the following documents: CISPR 16-2-1:2014, CISPR 16-2-2:2010, or CISPR 16-2-3:2016.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 11:2015, *Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement*

CISPR 11:2015/AMD1:2016

CISPR 11:2015/AMD2:2019

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

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 16-2-1:2014/AMD1:2017

CISPR 16-2-2:2010, *Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-2: Methods of measurement of disturbances and immunity - Measurement of disturbance power*

CISPR 16-2-3:2016, *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 16-3:2010, *Specification for radio disturbance and immunity measuring apparatus and methods - Part 3: CISPR technical reports*
 CISPR TR 16-3:2010/AMD1:2012
 CISPR TR 16-3:2010/AMD2:2015

IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Part 161: Electromagnetic compatibility* (available at www.electropedia.org)

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 bandwidth

B_x
width of the overall selectivity curve of the receiver between two points at a stated attenuation, below the mid-band response

Note 1 to entry: x 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 1 to entry: 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, K_D , of an instrument having no inertia (e.g. an oscilloscope) connected to a terminal in the DC amplifier circuit so as not to affect the behavior of the detector, is noted. The level of the signal is chosen so 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 so that the deflection registered is $0,63 K_D$. 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 1 to entry: 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 $0,37 K_D$ is the discharge time constant of the detector (K_D is the indication of an instrument having no inertia (e.g. an oscilloscope) connected to a terminal in the DC amplifier circuit so as not to affect the behavior of the detector).

3.5 impulse area

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

$$A_{\text{imp}} = \int_{-\infty}^{+\infty} V(t) dt \quad (1)$$

Note 1 to entry: The impulse area, sometimes referred to as impulse strength, is typically expressed in μVs or $\text{dB}(\mu\text{Vs})$.

Note 2 to entry: Spectral density (D) is related to the impulse area and expressed in $\mu\text{V}/\text{MHz}$ or $\text{dB}(\mu\text{V}/\text{MHz})$. For rectangular impulses of pulse duration T at frequencies $f \ll 1/T$, the relationship $D (\mu\text{V}/\text{MHz}) = \sqrt{2} \times 10^6 A_{\text{imp}} (\mu\text{Vs})$ applies.

3.6 impulse bandwidth

B_{imp}

$$B_{\text{imp}} = \frac{A(t)_{\text{max}}}{2G_0 \times A_{\text{imp}}} \quad (2)$$

where

$A(t)_{\text{max}}$ is the peak of the envelope at the IF output of the receiver with an impulse area A_{imp} applied at the receiver input;

G_0 is the gain of the circuit at the centre frequency;

A_{imp} is the impulse area.

Note 1 to entry: Specifically, for two critically-coupled tuned transformers,

$$B_{\text{imp}} = 1,05 \times B_6 = 1,31 \times B_3 \quad (3)$$

where B_6 and B_3 are the bandwidths at the -6 dB and -3 dB points, respectively.

For the Gaussian filter type, the relationship is [12],¹

$$B_{\text{imp}} = 1,065 \times B_6 = 1,506 \times B_3 \quad (4)$$

Note 2 to entry: See Clause A.2 for further information.

3.7 measuring receiver

instrument such as a tunable voltmeter, an EMI receiver, a spectrum analyzer or a Fast Fourier Transform (FFT)-based measuring instrument, with or without preselection, which meets the relevant parts of this standard

¹ Numbers in square brackets refer to the Bibliography.

Note 1 to entry: See Annex I for further information.

3.8 mechanical time constant

T_M
<critically damped indicating instrument>

$$T_M = \frac{T_L}{2\pi} \quad (5)$$

where T_L is the period of free oscillation of the instrument with all damping removed.

Note 1 to entry: For a critically damped instrument, the formula of motion of the system can be written as:

$$T_M^2 \left(\frac{d^2 \alpha}{dt^2} \right) + 2T_M \frac{d\alpha}{dt} + \alpha = ki \quad (6)$$

where

α is the deflection;

i is the current through the instrument; and

k is a constant.

It can be deduced from this relation that this time constant is also equal to the duration of a rectangular pulse (of constant amplitude) that produces a deflection equal to 35 % of the steady deflection produced by a continuous current having the same amplitude as that of the rectangular pulse.

Note 2 to entry: The methods of measurement and adjustment are deduced from one of the following:

- the period of free oscillation having been adjusted to $2\pi T_M$, damping is added so that $\alpha T = 0,35\alpha_{\max}$;
- when the period of oscillation cannot be measured, the damping is adjusted to be just below critical such that the overswing is not greater than 5 % and the moment of inertia of the movement is such that $\alpha T = 0,35\alpha_{\max}$.

3.9 overload factor

ratio of the level that corresponds to the range of practical linear function of a circuit (or a group of circuits) to the level that corresponds to full-scale deflection of the indicating instrument

Note 1 to entry: The maximum level at which the steady-state response of a circuit (or group of circuits) does not depart by more than 1 dB from ideal linearity defines the range of practical linear function of the circuit (or group of circuits).

3.10 weighting

<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 to entry: For an 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 a 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.

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

3.10.1**weighted disturbance measurement**

measurement of disturbance using a weighting detector

3.10.2**weighting characteristic**

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

3.10.3**weighting detector**

detector which provides an agreed weighting function

3.10.4**weighting factor**

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

Note 1 to entry: The weighting factor is expressed in dB.

3.10.5**weighting function****weighting curve**

relationship between the input peak voltage level and the 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

3.11**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 RMS-average detector, the effective time to determine the maximum of the weighted signal envelope

3.12**calibration**

operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

Note 1 to entry: A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Note 2 to entry: Calibration should not be confused with adjustment of a measuring system, often mistakenly called "self-calibration," nor with verification of calibration.

Note 3 to entry: Often, the first step alone in the preceding definition is perceived as being calibration.

[SOURCE: ISO/IEC Guide 99:2007, 2.39] [5]

3.13

verification

provision of objective evidence that a given item fulfils specified requirements

EXAMPLE Checking whether the functions of a measuring instrument or auxiliary equipment, such as a common mode absorption device (CMAD; see CISPR 16-1-4), meet stated specifications, such as those given in a data sheet.

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

[SOURCE: ISO/IEC Guide 99:2007, 2.44, modified – addition of an example and of Note 1] [5]

3.14

adjustment of a measuring system

set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured

Note 1 to entry: Types of adjustment of a measuring system include zero adjustment of a measuring system, offset adjustment, and span adjustment (sometimes called gain adjustment).

Note 2 to entry: Adjustment of a measuring system should not be confused with calibration, which is a prerequisite for adjustment.

Note 3 to entry: After an adjustment of a measuring system, the measuring system shall usually be recalibrated.

[SOURCE: ISO/IEC Guide 99:2007, 3.11] [5]

3.15

correction

compensation for an estimated systematic effect

Note 1 to entry: See ISO/IEC Guide 98-3:2008, 3.2.3 [4] for an explanation of 'systematic effect'.

Note 2 to entry: The compensation can take different forms, such as an addend or a factor, or can be deduced from a table.

[SOURCE: ISO/IEC Guide 99:2007, 2.53] [5]

3.16

metrological traceability

property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty

[SOURCE: ISO/IEC Guide 99:2007, 2.41] [5]

4 Fundamental characteristics of a measuring receiver

4.1 General

Spectrum analyzers and FFT-based measuring instruments that meet the requirements of Clause 4 and Clauses 5, 6, 7, 8 and 10 for the relevant detector or discontinuous disturbance analyzer (DDA) may be used for compliance measurements. For emission measurements, FFT-based measuring instruments shall sample and evaluate the signal continuously during the measurement time.

This standard utilizes a "black-box" approach to determining equipment compliance to the standard. Equipment shall be determined to be compliant with CISPR 16-1-1 based only on meeting the stated performance requirements of this document. Equipment compliance to CISPR 16-1-1 shall not be based on circuit topology or design (e.g. analog or digital), unless specifically stated in this document.

4.2 Input impedance

The input port of a measuring receiver shall be unbalanced. For receiver control settings within the CISPR indication range, the nominal input impedance shall be 50 Ω with a voltage standing wave ratio (VSWR) not to exceed the values in Table 1.

Table 1 – VSWR requirements for receiver input impedance

Frequency range	Attenuation dB	VSWR
9 kHz to 1 GHz	0	2,0 to 1
9 kHz to 1 GHz	≥ 10	1,2 to 1
1 GHz to 18 GHz	0	3,0 to 1
1 GHz to 18 GHz	≥ 10	2,0 to 1

4.3 Sine-wave voltage-tolerance

The tolerance of sine-wave voltage measurement shall be better than ± 2 dB ($\pm 2,5$ dB above 1 GHz) when the instrument measures a sine-wave signal using a 50 Ω resistive source impedance.

4.4 Overall pass-band selectivity

The curve representing the overall selectivity of the measuring receiver shall lie within the limits shown in Figures 1, 2, 3, and 4.

Selectivity shall be described by the variation with frequency of the amplitude of the input sine-wave voltage that produces a constant indication on the measuring receiver.

For the measurement of equipment that requires higher selectivity at the transition between 130 kHz and 150 kHz (e.g. mains signaling equipment as defined in EN 50065-1 [10]), a high-pass filter may be added in front of the measuring receiver to achieve the combined selectivity of the CISPR measuring receiver and high-pass filter as shown in Table 2. The measuring receiver in conjunction with the high-pass filter shall meet the requirements of this document.

Table 2 – Combined selectivity of CISPR measuring receiver and high-pass filter

Frequency kHz	Relative attenuation dB
150	≤ 1
146	≤ 6
145	≥ 6
140	≥ 34
130	≥ 81

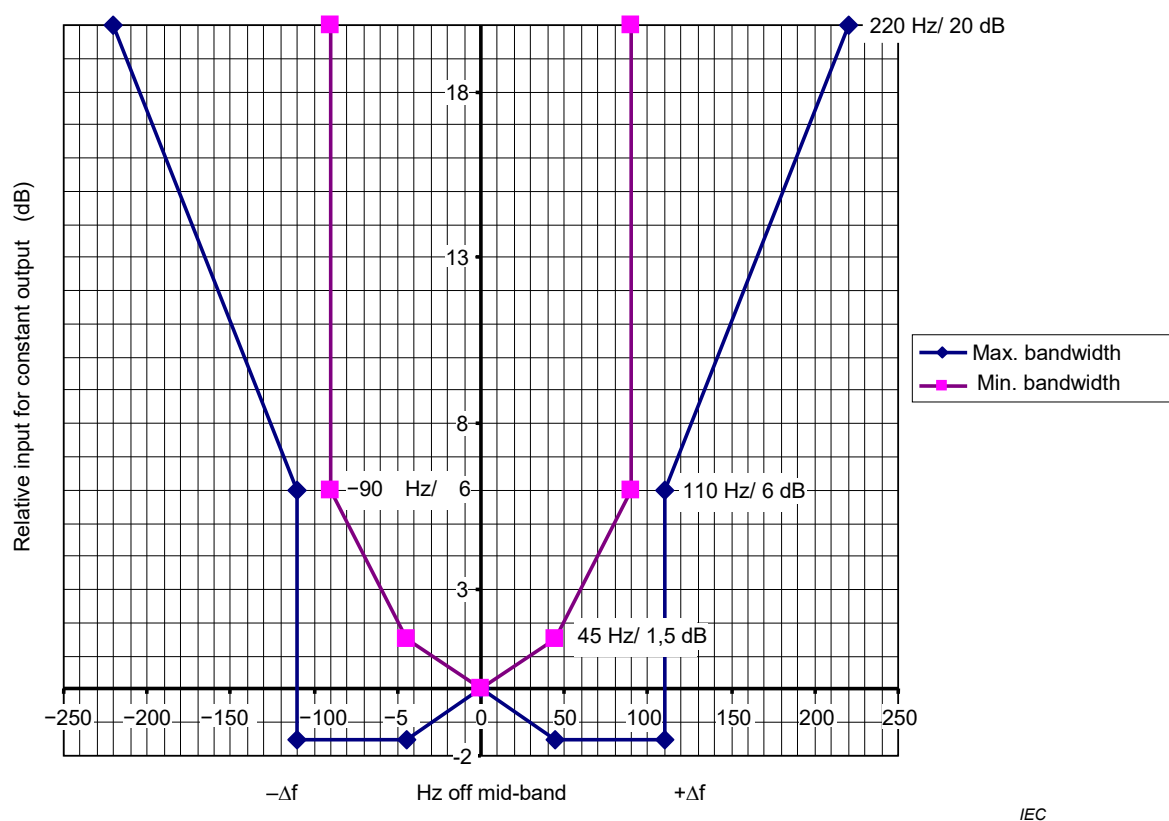


Figure 1 – Limits of overall selectivity – Pass-band (Band A)

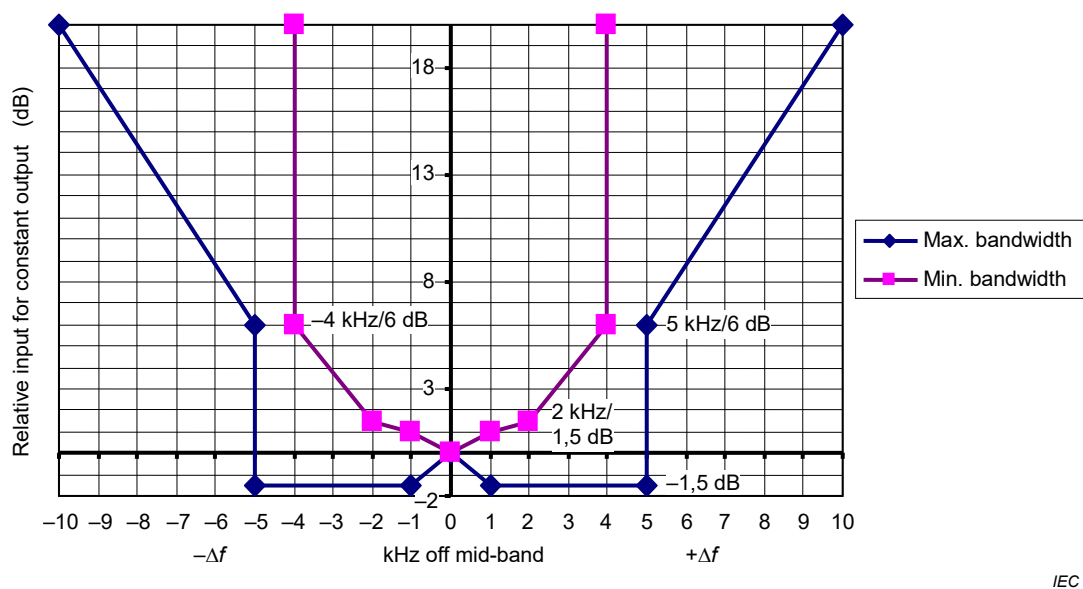


Figure 2 – Limits of overall selectivity – Pass-band (Band B)

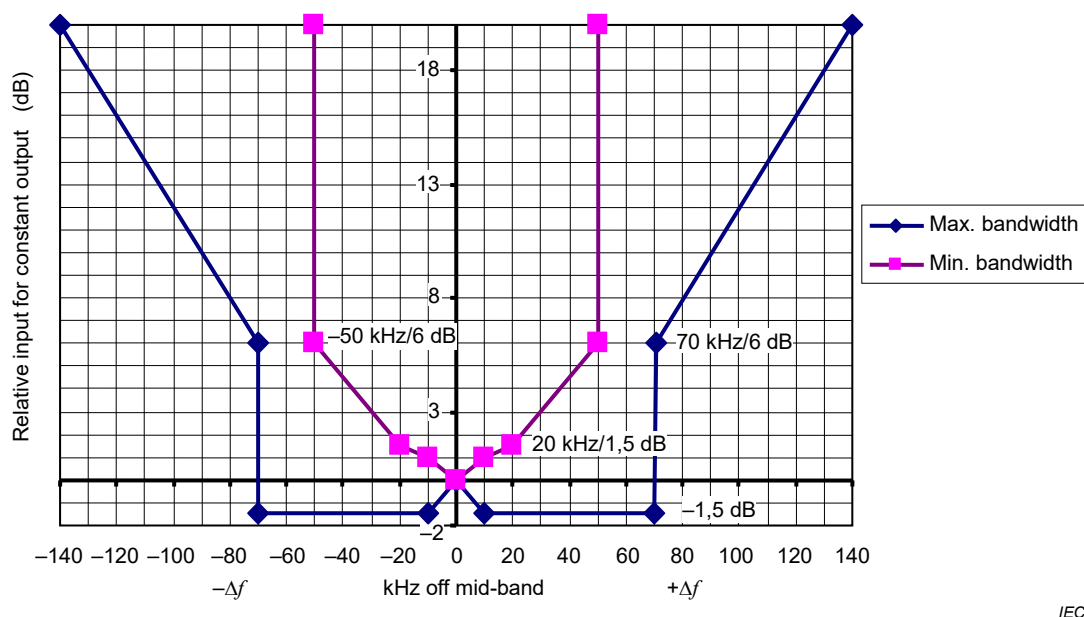
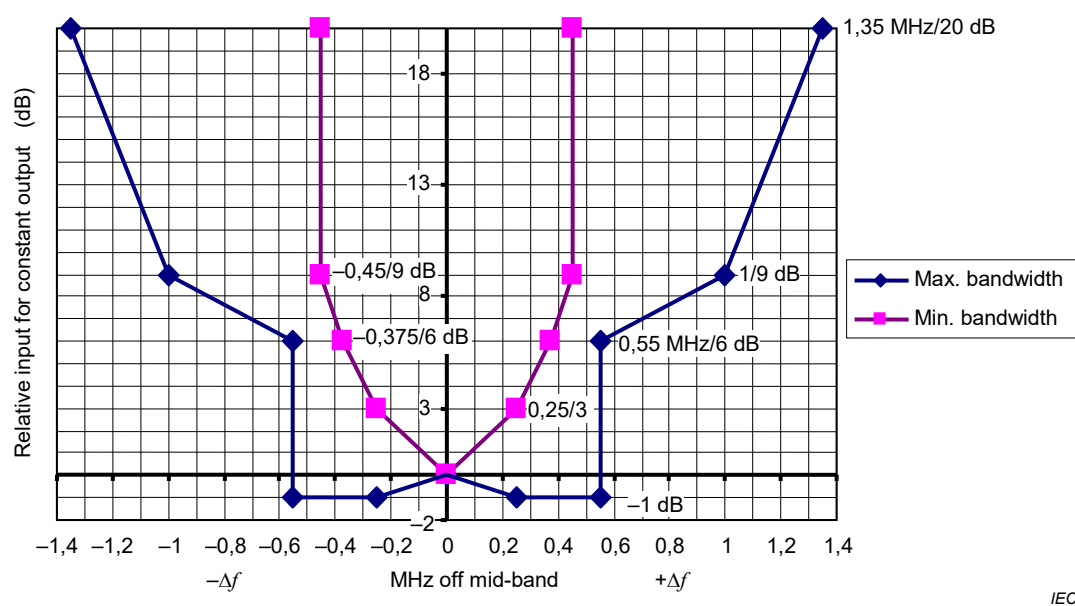


Figure 3 – Limits of overall selectivity – Pass-band (Bands C and D)



NOTE 1 The limits for the impulse bandwidth cannot be shown in the diagram, as the related filter attenuation depends on the type of the filter. Bounds for the 6 dB and the 9 dB bandwidths have been given for orientation.

NOTE 2 The limits for the overall selectivity have been derived from equipment being in use at the time of introduction of the selectivity requirement.

Figure 4 – Limits for the overall selectivity – Pass-band (Band E)

4.5 Bandwidth

For measuring receivers with peak and average detectors for all types of broadband disturbance, the actual value of the bandwidth shall be stated when the disturbance level is quoted and the bandwidth is within the values in Table 3. For measuring receivers with RMS-average detector the bandwidth shall be equal to the reference bandwidth in Table 3.

Table 3 – Bandwidth requirements for measuring receivers

Frequency range	Bandwidth B_6	Reference-bandwidth
9 kHz to 150 kHz (Band A)	100 Hz to 300 Hz ^{a, c}	200 Hz (B_6)
0,15 MHz to 30 MHz (Band B)	8 kHz to 10 kHz ^{a, c}	9 kHz (B_6)
30 MHz to 1 000 MHz (Bands C and D)	100 kHz to 500 kHz ^{a, c}	120 kHz (B_6)
1 GHz to 18 GHz (Band E)	300 kHz to 2 MHz ^{a, c}	1 MHz ^b (B_{imp})
<p>^a Since the response of a peak measuring receiver to non-overlapping pulses is proportional to its impulse bandwidth, either the actual bandwidth is quoted in the result or the level may be quoted as "in a 1 MHz bandwidth", calculated by dividing the measured value by the impulse bandwidth in MHz (see 3.6). For other types of broadband disturbance, this procedure can introduce an error. Therefore, data measured with the reference bandwidth shall take precedence.</p> <p>^b The bandwidth selected shall be defined as the impulse bandwidth of the measuring receiver with a tolerance of ± 10 %.</p> <p>^c The subject of bandwidth is discussed in Clause E.1. If a bandwidth other than the reference bandwidth is used, this bandwidth shall be stated when the disturbance level is reported.</p>		

4.6 Frequency tuning tolerance

The frequency tuning tolerance requirement for the measuring receiver is ± 2 %.

4.7 Intermediate frequency rejection ratio

The ratio of the input sine-wave voltage at the intermediate frequency to that at the tuned frequency that produces the same indication of the measuring receiver shall be not less than 40 dB. Where more than one intermediate frequency is used, this requirement shall be met at each intermediate frequency.

NOTE For Band E receivers, requirements are under consideration.

4.8 Image frequency rejection ratio

The ratio of the input sine-wave voltage at the image frequency to that at the tuned frequency that produces the same indication on the measuring receiver shall be not less than 40 dB. Where more than one intermediate frequency is used, this requirement shall be met at the image frequencies corresponding to each intermediate frequency.

4.9 Other spurious responses

The ratio of the input sine-wave voltage at frequencies other than those specified in 4.7 and 4.8 to that at the tuned frequency that produces the same indication on the measuring receiver shall be not less than 40 dB. Examples of the frequencies from which such spurious responses can occur are as follows:

$$\left(\frac{1}{m}\right)(nf_L \pm f_i) \text{ and } \left(\frac{1}{k}\right)(f_0) \quad (7)$$

where

- m, n, k are integers;
- f_L is the local oscillator frequency;
- f_i is the intermediate frequency;
- f_0 is the tuned frequency.

NOTE Where more than one intermediate frequency is used, the frequencies f_L and f_i can refer to each of the local oscillator and intermediate frequencies used. In addition, spurious responses can occur when no input signal is applied to the measuring receiver, for example, when harmonics of the local oscillators differ in frequency by one of the intermediate frequencies. The requirements of 4.9 therefore cannot apply in these latter cases. The effect of these spurious responses is dealt with in 4.11. Examples of sources of spurious signals include local oscillators (or their harmonics), internal clocks, computer boards, and their mixing products with the input signal into the receiver.

4.10 Limitation of intermodulation effects

The influence of intermodulation effects on the response of the measuring receiver shall be minimized. The following method shall be applied to determine the suitability of a measuring instrument. This method uses a quasi-peak (QP) detector only.

- Arrange the apparatus as shown in Figure 5. For the frequencies given in Table 4, the pulse generator has a spectrum substantially uniform up to the column 3) frequency but at least 10 dB down at the column 4) frequency. The band-stop filter has attenuation at the test frequency of at least 40 dB. Its bandwidth, B_6 , relative to the maximum attenuation of the filter shall lie between the column 1) and 2) frequencies given in Table 4.
- Connect the sine-wave generator output directly to the measuring receiver input and adjust for a convenient reading. Substitute the pulse generator for the sine-wave generator and adjust for the same reading. The pulse repetition frequency shall be 100 Hz for Band A and 1 000 Hz for the other bands. These PRFs are for use with a quasi-peak detector only.
- With the pulse generator connected as described in the preceding paragraph, switching the filter into circuit shall introduce attenuation of not less than 36 dB for measuring receivers, and of not less than 20 dB for spectrum analyzers without preselection.
- Concerning a preselection filter for Band E, when measuring weak spurious signals in the presence of a strong fundamental signal from certain equipment under test, a filter shall be provided at the input of the measuring receiver to ensure adequate attenuation at the fundamental frequency to protect the input circuits of the receiver from overload and damage, and to prevent the generation of harmonic and intermodulation signals.

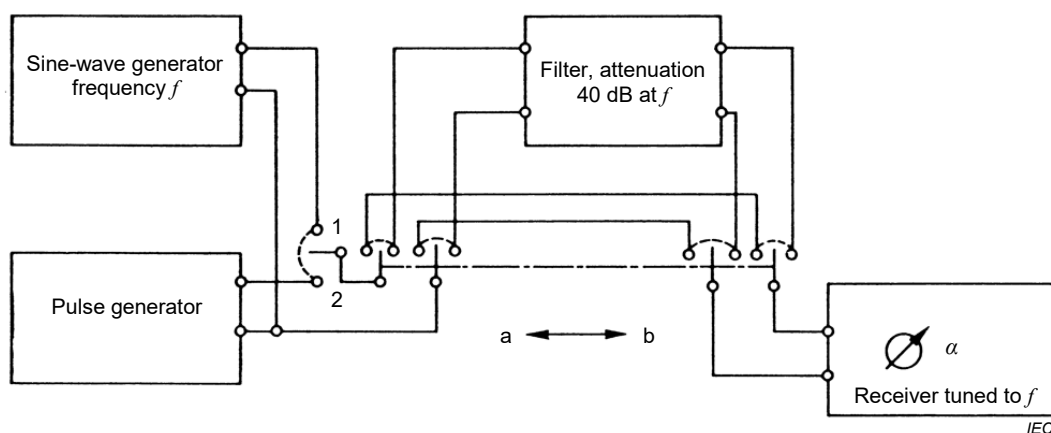
NOTE 1 A 30 dB filter attenuation at the fundamental frequency of the equipment under test is normally adequate.

NOTE 2 A number of such filters can be required to deal with more than one fundamental frequency.

NOTE 3 For Band E, requirements for intermodulation effects are under consideration.

Table 4 – Bandwidth characteristics for intermodulation test of quasi-peak measuring receivers

Frequency range	1) kHz	2) kHz	3) MHz	4) MHz
9 kHz to 150 kHz (Band A)	0,4	4	0,15	0,3
0,15 MHz to 30 MHz (Band B)	20	200	30	60
30 MHz to 300 MHz (Band C)	500	2 000	300	600
300 MHz to 1 000 MHz (Band D)	500	6 000	1 000	2 000



NOTE Following the discussion in 4.10, the measuring receiver responses are:

$$\begin{aligned}\alpha_{1a} &= \alpha_{2a} \\ \alpha_{1b} &= \alpha_{1a} - 40 \text{ dB} \\ \alpha_{2b} &= \alpha_{2a} - 36 \text{ dB}\end{aligned}$$

Figure 5 – Arrangement for testing intermodulation effects

4.11 Limitations of receiver noise and internally-generated spurious signals

4.11.1 Random noise

Background noise shall not introduce an error in excess of 1 dB.

NOTE The point where the background noise causes an error of 1 dB can be found by applying a signal, S , such that the meter indication is much larger (e.g. 40 dB) than the noise level N . By reducing the signal level S , the meter indication will reach a point, S_1 , where $(S_1 + N)$ deviates by 1 dB from the linear characteristic.

4.11.2 Continuous wave

The existence of spurious responses as described in the note to 4.9 shall not introduce a measurement error in excess of 1 dB for any signal input to the measuring receiver. This requirement shall be regarded as satisfied if the receiver complies with 4.11.1 when tested as described in 4.11.1.

4.12 Limitation of radio-frequency emissions from the measuring receiver

4.12.1 Conducted emissions

The radio disturbance voltage at any connecting pin of external lines (not only the mains terminals) shall not exceed the limits for class B equipment given in CISPR 11. The measurement of the radio disturbance voltage is however not required on the inner conductors of screened connections to screened equipment. The local oscillator injection power at the measuring receiver input terminated with its characteristic impedance shall not exceed 34 dB(pW) which is equivalent to 51 dB(μV) across 50 Ω.

4.12.2 Radiated emissions

The radio disturbance field strength emitted by the measuring receiver shall not exceed the limits for class B equipment given in CISPR 11, for the frequency range of 9 kHz to 1 000 MHz. The limits shall also apply for frequency bands (industrial, scientific and medical (ISM) frequencies) listed in Table 1 of CISPR 11:2015. In the frequency range of 1 GHz to 18 GHz, a limit of 45 dB(pW) shall apply, based on an equivalent radiated power (ERP) measurement.

Before performing radiated and conducted emission measurements, the user shall ensure that the noise contributions of the test equipment do not affect the measured results (e.g. computer control).

4.13 Facilities for connection to a discontinuous disturbance analyzer

For all bands, the disturbance measuring receiver shall have an intermediate-frequency output if the instrument is to be used for the measurement of discontinuous disturbance. The loading of this output shall have no influence on the indication of the measurement result.

5 Quasi-peak measuring receivers for the frequency range 9 kHz to 1 000 MHz

5.1 General

The receiver specification depends on the frequency of operation. There is one receiver specification covering the frequency range 9 kHz to 150 kHz (Band A), one covering 150 kHz to 30 MHz (Band B), one covering 30 MHz to 300 MHz (Band C), and one covering 300 MHz to 1 000 MHz (Band D). Fundamental characteristics of a quasi-peak measuring instrument are provided in Annex H.

5.2 Response to pulses

5.2.1 Amplitude relationship (absolute calibration)

Referring to the columns of Table 5 (labelled as columns a), b) and c)), the response of the measuring receiver to pulses of impulse area of a) μVs (microvolt second) EMF at 50 Ω source impedance, having a uniform spectrum up to at least b) MHz, repeated at a frequency of c) Hz shall, for all frequencies of tuning, be equal to the response to an unmodulated sine-wave signal at the tuned frequency having an EMF of RMS value 2 mV [66 dB(μV)].

When external preamplifiers are used, refer to Annex J for applicable requirements.

The source impedances of the pulse generator and the signal generator shall both be the same. The sine-wave voltage level tolerance is $\pm 1,5$ dB.

NOTE Annexes B and C describe methods for determining the output characteristics of a pulse generator for use in testing the requirements of Subclause 5.2.1.

Table 5 – Test pulse characteristics for quasi-peak measuring receivers

Frequency range	a) μVs	b) MHz	c) Hz
9 kHz to 150 kHz	13,5	0,15	25
0,15 MHz to 30 MHz	0,316	30	100
30 MHz to 300 MHz	0,044	300	100
300 MHz to 1 000 MHz	0,044	1 000	100

5.2.2 Variation with repetition frequency (relative calibration)

The response of the measuring receiver to repeated pulses shall be such that for a constant indication on the measuring receiver of for example 20 dB(μV), the relationship between pulse amplitude and repetition frequency is in accordance with Figures 6, 7, 8, and 9.

As an alternative, the response of the measuring receiver to repeated pulses shall be such that for a constant voltage setting of the pulse generator of for example 50 dB(μ V) at repetition frequencies of 25 Hz (Band A) and 100 Hz (Bands B, C, and D), the relationship between receiver indication and repetition frequency is in accordance with Figures 6, 7, 8 and 9 under opposite sign conditions.

For all measurements, a sufficient signal-to-noise ratio is required. The use of a 10 dB attenuator at the output of the pulse generator is recommended.

The response curve for a particular measuring receiver shall lie between the limits defined in the appropriate figure and quantified in Table 6. For spectrum analyzers without preselection, the requirements in Table 6 for pulse repetition frequencies less than 20 Hz are not applicable. The use of such instruments for compliance testing is conditional. If such spectrum analyzers are used for measurements, the user shall verify and document that the equipment under test does not emit broadband signals with pulse repetition frequencies of 20 Hz or lower. A determination of the suitability of a spectrum analyzer for testing shall be made by performing the procedure documented in Annex B of CISPR 16-2-1:2014, Annex B of CISPR 16-2-2:2010, or Annex E of CISPR 16-2-3:2016.

The pulse response is restricted due to overload at the input to the receiver at frequencies above 300 MHz. The values marked with an asterisk (*) in Table 6 are optional and are not essential.

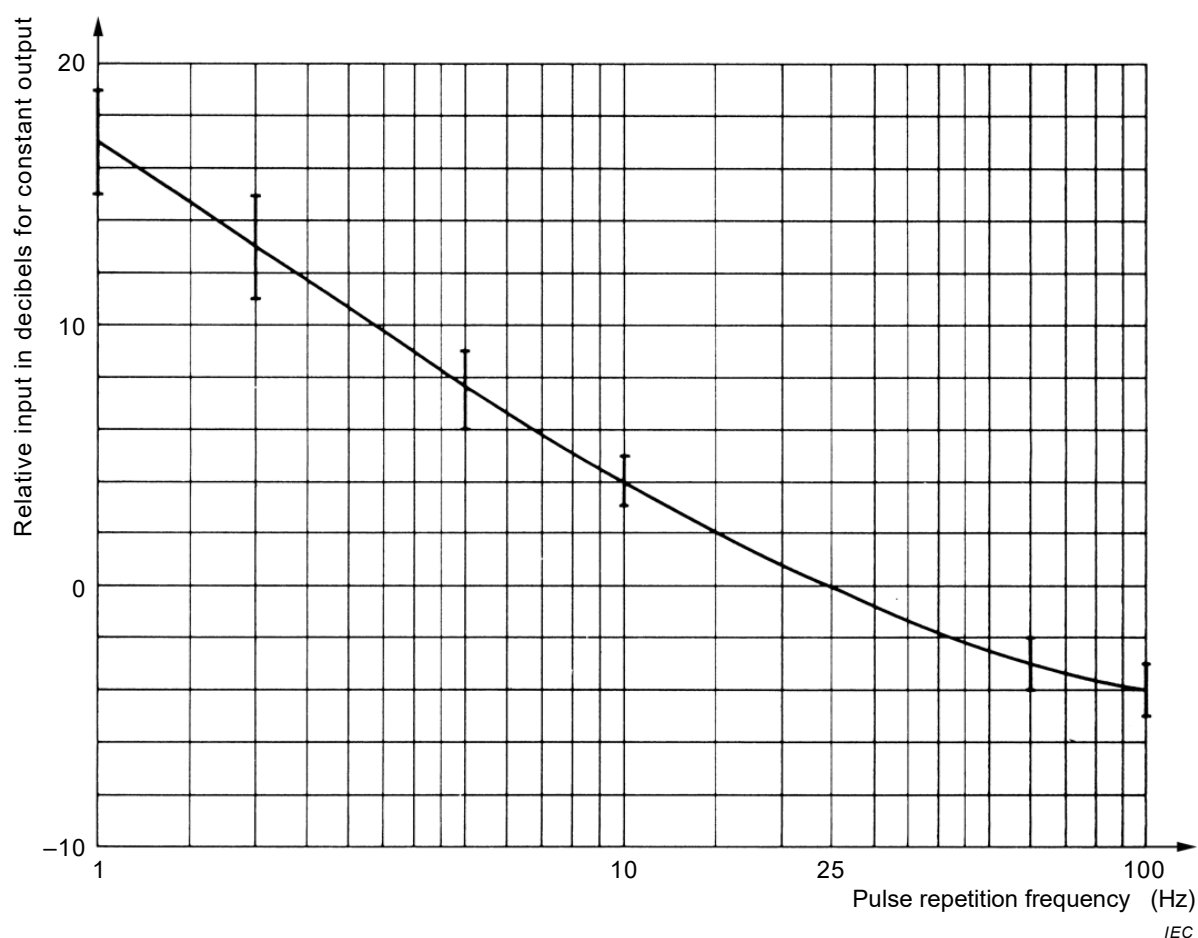


Figure 6 – Pulse response curve (Band A)

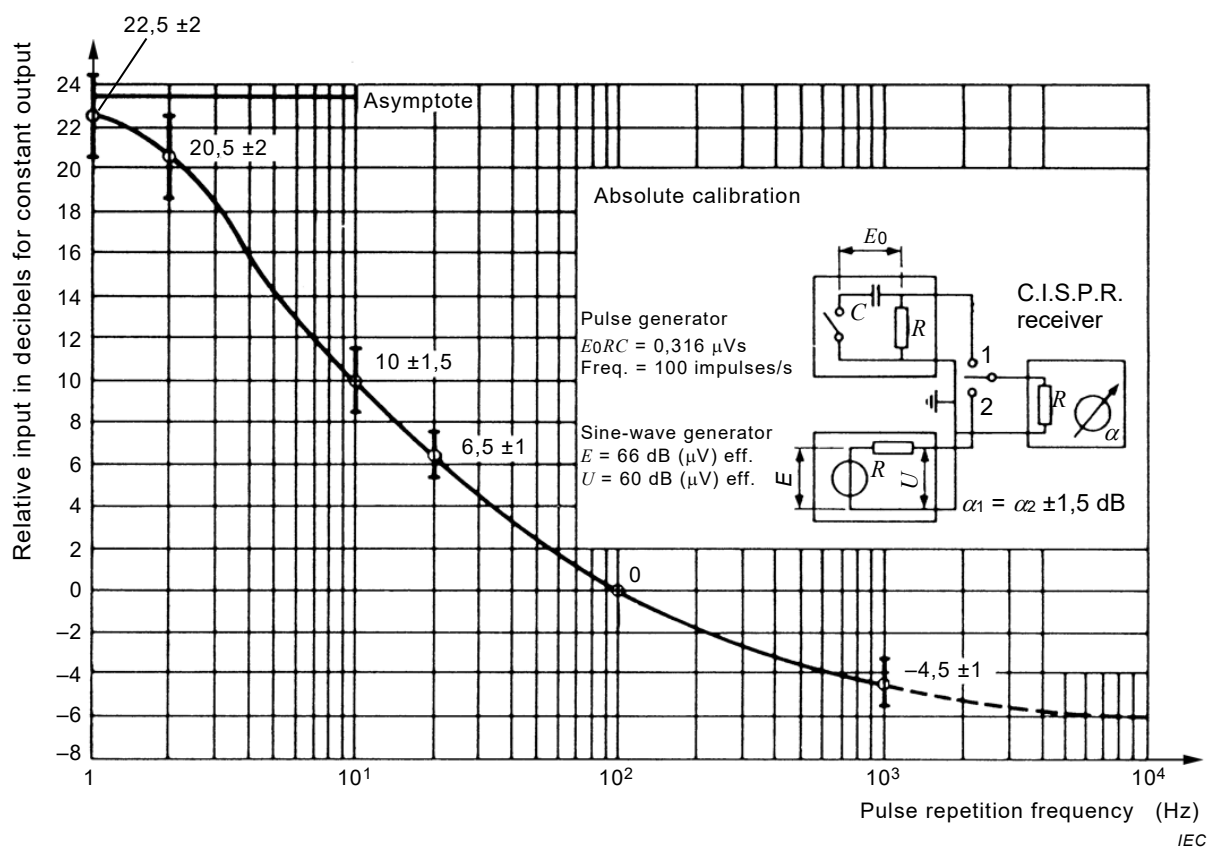


Figure 7 – Pulse response curve (Band B)

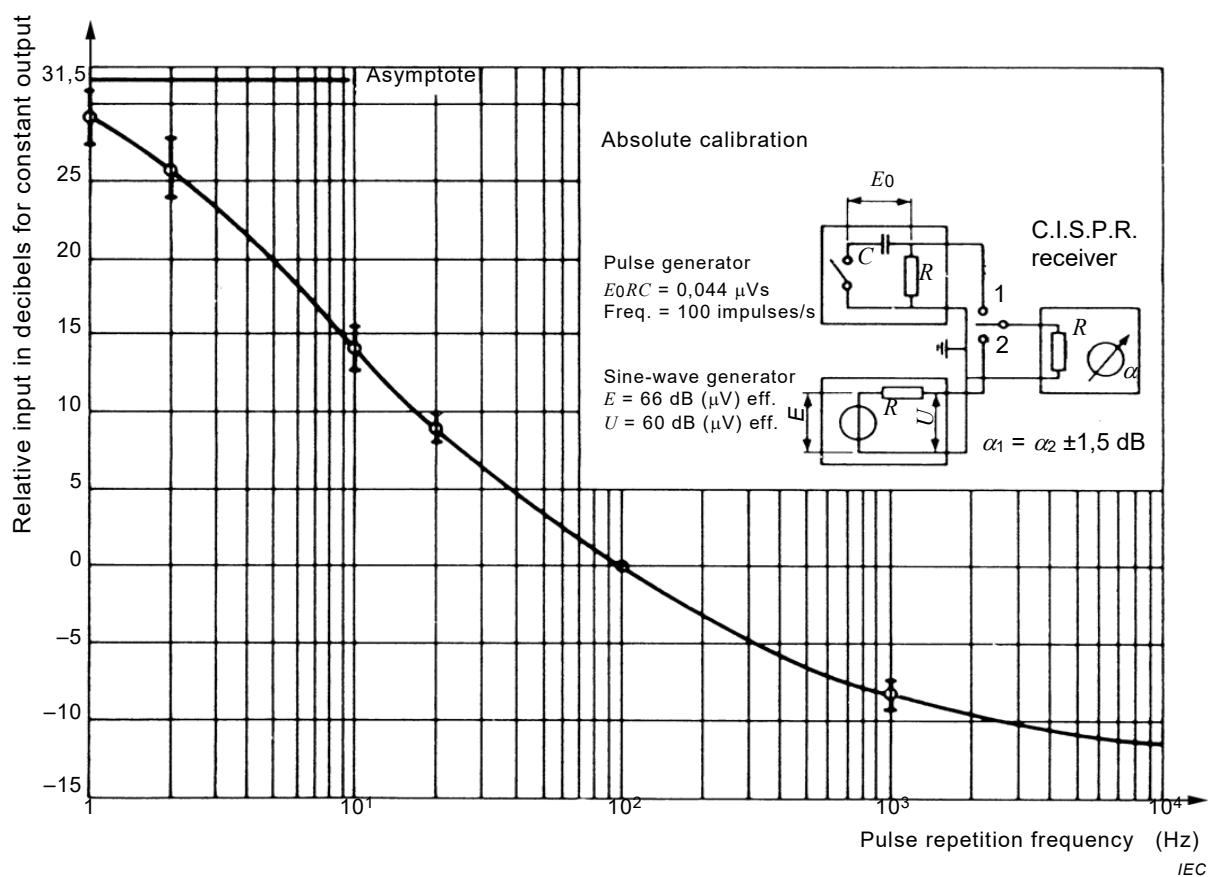
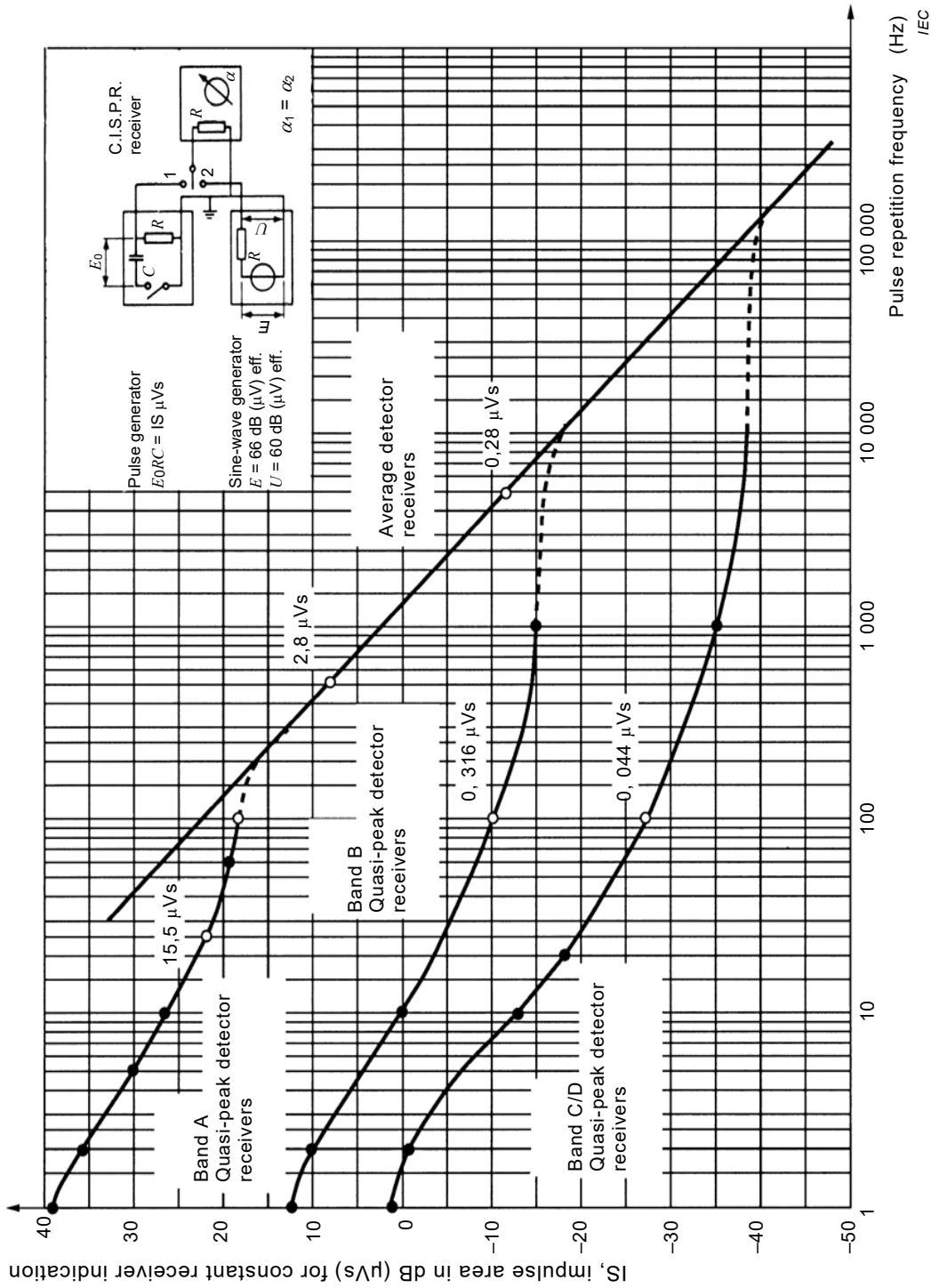


Figure 8 – Pulse response curve (Bands C and D)



NOTE 'IS' is the abbreviation used for A_{imp} in previous editions.

Figure 9 – Theoretical pulse response curve of quasi-peak detector receivers and average detector receiver