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Specification for radio disturbance and immunity measuring apparatus and methods

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

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National foreword

This British Standard is the UK implementation of EN 55016-1-1:2010+A2:2014, incorporating corrigendum October 2011. It is identical to CISPR 16-1-1:2010, incorporating amendments 1:2010 and 2:2014 and corrigendum October 2011. It supersedes BS EN 55016-1-1:2010+A1:2010 which will be withdrawn on 4 August 2017.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Text indicating changes to IEC text carry the number of the CISPR amendment. For example text altered by CISPR amendment A1 is indicated by A1 A1.

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Amendments/corrigenda issued since publication

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30 November 2011	Implementation of CISPR corrigendum October 2011: corrected values in fifth line after Table E.1
30 September 2014	Implementation of CISPR amendment 2:2014 with CENELEC endorsement A2:2014

**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)**

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
(CISPR 16-1-1:2010)

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 16-1-1:2010)

This European Standard was approved by CENELEC on 2010-03-01. 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 Central Secretariat or to any CENELEC member.

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CENELEC

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

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document CIS/A/867/FDIS, future edition 3 of CISPR 16-1-1, prepared by CISPR SC A, Radio-interference measurements and statistical methods, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 55016-1-1 on 2010-03-01.

This European Standard supersedes EN 55016-1-1:2007 + A1:2007 + A2:2008.

This main technical change with respect to EN 55016-1-1:2007 and its amendments consists of the addition of new provisions for the use of spectrum analyzers for compliance measurements.

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

The following dates were fixed:

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at national level by publication of an identical
national standard or by endorsement (dop) 2010-12-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2013-03-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard CISPR 16-1-1:2010 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:

- | | | | |
|-----|-------------------|------|---|
| [1] | CISPR 16-1-2:2003 | NOTE | Harmonized as EN 55016-1-2:2004 (not modified). |
| [2] | CISPR 16-1-3:2004 | NOTE | Harmonized as EN 55016-1-3:2006 (not modified). |
| [3] | CISPR 16-1-4:2007 | NOTE | Harmonized as EN 55016-1-4:2007 (not modified). |
| [4] | CISPR 16-1-5:2003 | NOTE | Harmonized as EN 55016-1-5:2004 (not modified). |
| [5] | CISPR 16-2 series | NOTE | Harmonized in EN 55016-2 series (not modified). |
| [6] | CISPR 16-2-4:2003 | NOTE | Harmonized as EN 55016-2-4:2004 (not modified). |
| [7] | CISPR 16-4 series | NOTE | Harmonized in EN 55016-4 series (not modified). |
| [9] | CISPR 16-4-2:2003 | NOTE | Harmonized as EN 55016-4-2:2004 (not modified). |

Foreword to amendment A1

The text of document CISPR/A/876/CDV, future amendment 1 to CISPR 16-1-1:2010, prepared by CISPR SC A, Radio-interference measurements and statistical methods, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 55016-1-1:2010 on 2010-10-01.

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Endorsement notice

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Foreword to amendment A2

The text of document CIS/A/1070/FDIS, future CISPR 16-1-1:2010/A2, 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 55016-1-1:2010/A2:2014.

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CISPR 15	NOTE	Harmonized as EN 55015.
CISPR 22	NOTE	Harmonized as EN 55022.
CISPR 25	NOTE	Harmonized as EN 55025.
CISPR 32	NOTE	Harmonized as EN 55032.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
CISPR 11 (mod)	2009	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement	EN 55011	2009
CISPR 14-1	2005	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission	EN 55014-1	2006
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	EN 55016-2-1	2009
CISPR 16-2-2 + A1 + A2	2003 2004 2005	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 + A1 + A2	2004 2005 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	EN 55016-2-3	2006
CISPR 16-3 + A1 + A2	2003 2005 2006	Specification for radio disturbance and immunity measuring apparatus and methods - Part 3: CISPR technical reports	- - -	- - -
IEC 60050-161 + A1 + A2	1990 1997 1998	International Electrotechnical Vocabulary (IEV) - Chapter 161: Electromagnetic compatibility	- - -	- - -

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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

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:

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

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

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

3.6 impulse bandwidth

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

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.

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 respectively the bandwidths at the -6 dB and -3 dB points

NOTE See A.2 for further information.

3.7 measuring receiver

[A1] 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 parts of this standard

NOTE See Annex I for further information. **[A1]**

3.8 mechanical time constant of a critically damped indicating instrument

$$T_M = \frac{T_L}{2\pi} \quad (4)$$

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

NOTE 1 For a critically damped instrument, the equation of motion of the system may be written as:

$$T_M^2 \left(\frac{d^2 \alpha}{dt^2} \right) + 2T_M \frac{d\alpha}{dt} + \alpha = ki \quad (5)$$

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 The methods of measurement and adjustment are deduced from one of the following:

- a) the period of free oscillation having been adjusted to $2\pi T_M$, damping is added so that $\alpha T = 0,35\alpha_{\max}$.
- b) when the period of oscillation cannot be measured, the damping is adjusted to be just below critical such that the overshoot 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 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

symmetric voltage

radio-frequency disturbance voltage appearing between the two wires in a two-wire circuit, such as a single-phase mains supply. This is sometimes called the differential mode voltage. If V_a is the vector voltage between one of the mains terminals and earth and V_b is the vector voltage between the other mains terminal and earth, the symmetric voltage is the vector difference ($V_a - V_b$)

3.11

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

3.11.1

weighted disturbance measurement

measurement of disturbance using a weighting detector

3.11.2

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

3.11.3

weighting detector

detector which provides an agreed weighting function

3.11.4

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.

3.11.5

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

A₁ 3.12

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 detector, the effective time to determine the rms of the signal envelope **A₁**

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

4.1 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.

A₁ Spectrum analyzers and FFT-based measuring instruments that meet the requirements of this clause can be used for compliance measurements. For emission measurements, FFT-based measuring instruments shall sample and evaluate the signal continuously during the measurement time. **A₁**

4.2 Input impedance

The input circuit of measuring receivers shall be unbalanced. For receiver control settings within the CISPR indication range, the input impedance shall be nominally 50 Ω with a voltage standing wave ratio (VSWR) not to exceed 2,0:1 when the radio frequency (RF) attenuation is 0 dB and 1,2:1 when the RF attenuation is 10 dB or greater.

Symmetric input impedance in the frequency range 9 kHz to 30 MHz: to permit symmetrical measurements a balanced input transformer is used. The preferred input impedance for the frequency range 9 kHz to 150 kHz is 600 Ω . This symmetric input impedance may be incorporated either in the relevant symmetrical artificial network necessary to couple to the receiver or optionally in the measuring receiver.

4.3 Sine-wave voltage accuracy

The accuracy of measurement of sine-wave voltages shall be better than ± 2 dB when the instrument measures a sine-wave signal with 50 Ω resistive source impedance.

4.4 Response to pulses

4.4.1 Amplitude relationship (absolute calibration)

Referring to Table 1, the response of the measuring receiver to pulses of impulse area of a) μ Vs (microvolt second) e.m.f. 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 e.m.f. of rms value 2 mV [66 dB(μ V)].

A₂ When external preamplifiers are used, refer to Annex J for applicable requirements. **A₂**

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

Table 1 – Test pulse characteristics for quasi-peak measuring receivers (see 4.4.1)

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

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

4.4.2 Variation with repetition frequency (relative calibration)

A1 The response of the measuring receiver to repeated pulses shall be such that for a constant indication on the measuring receiver of e.g. 20 dB(μV), the relationship between pulse amplitude and repetition frequency is in accordance with Figure 1.

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 e.g. 50 dB(μV) 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 Figure 1 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. **A1**

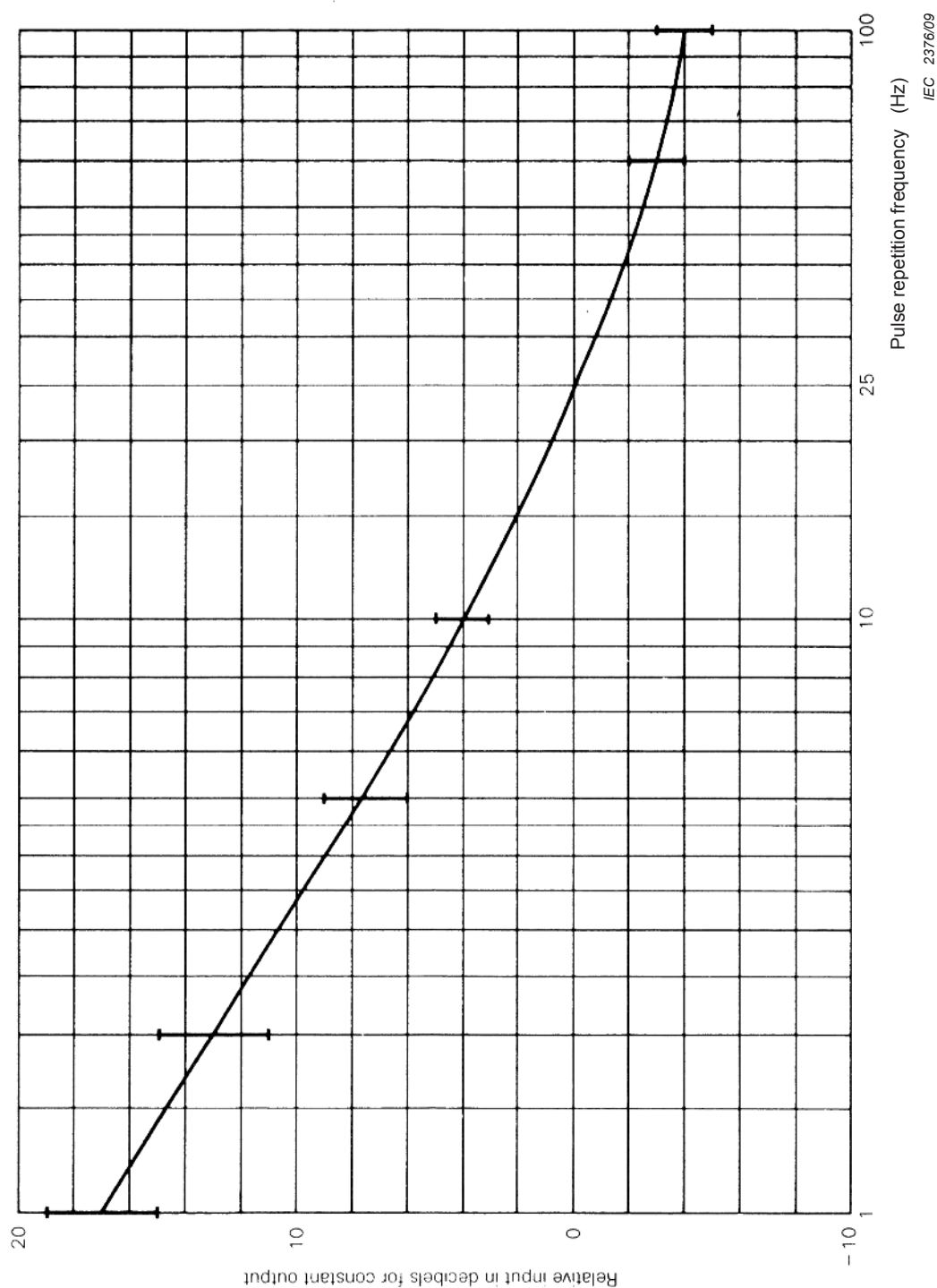


Figure 1a) – Pulse response curve (Band A)

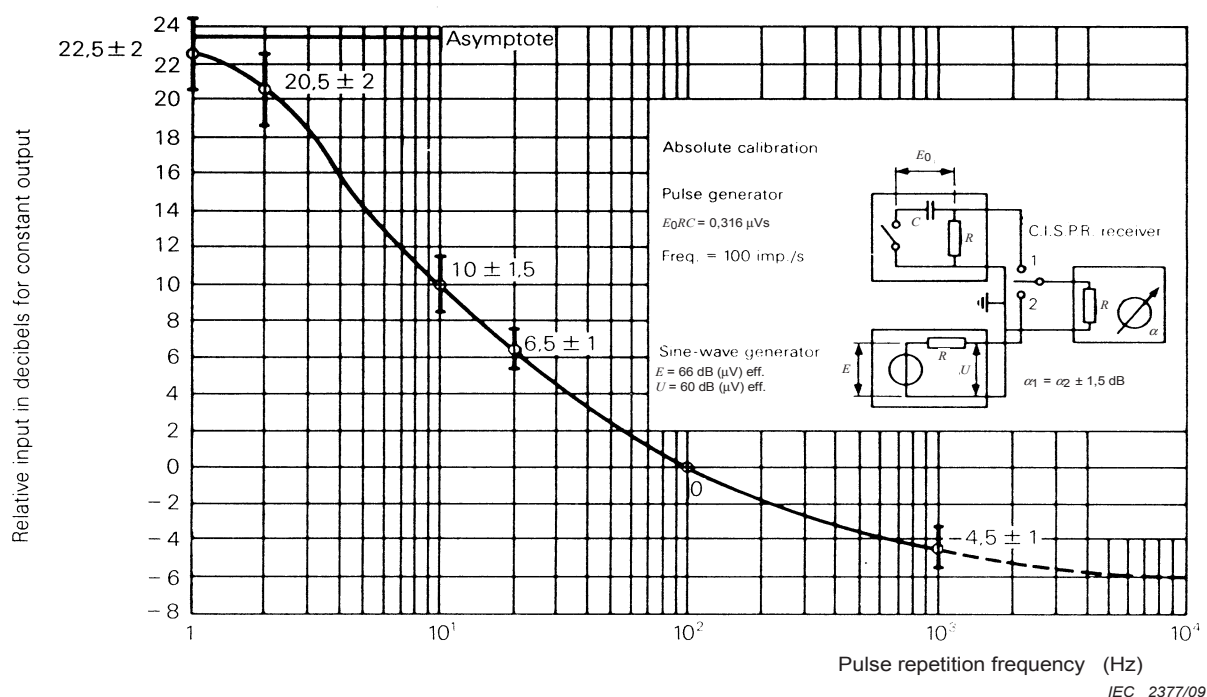


Figure 1b) – Pulse response curve (Band B)

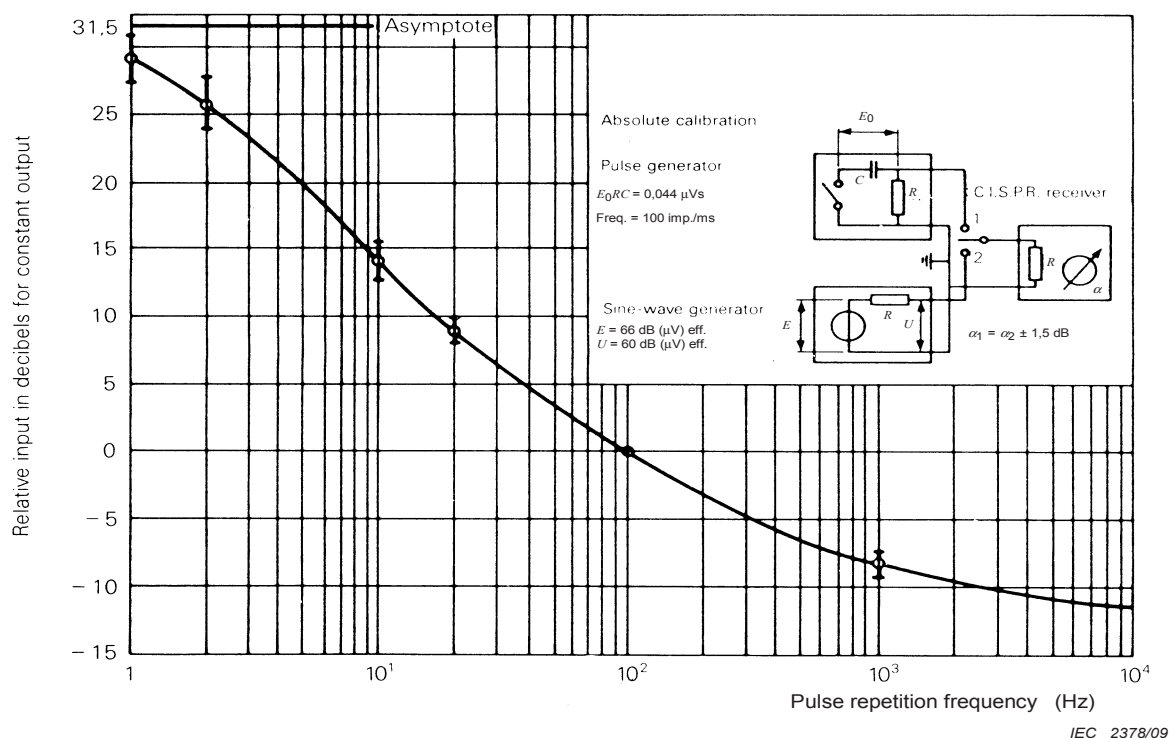
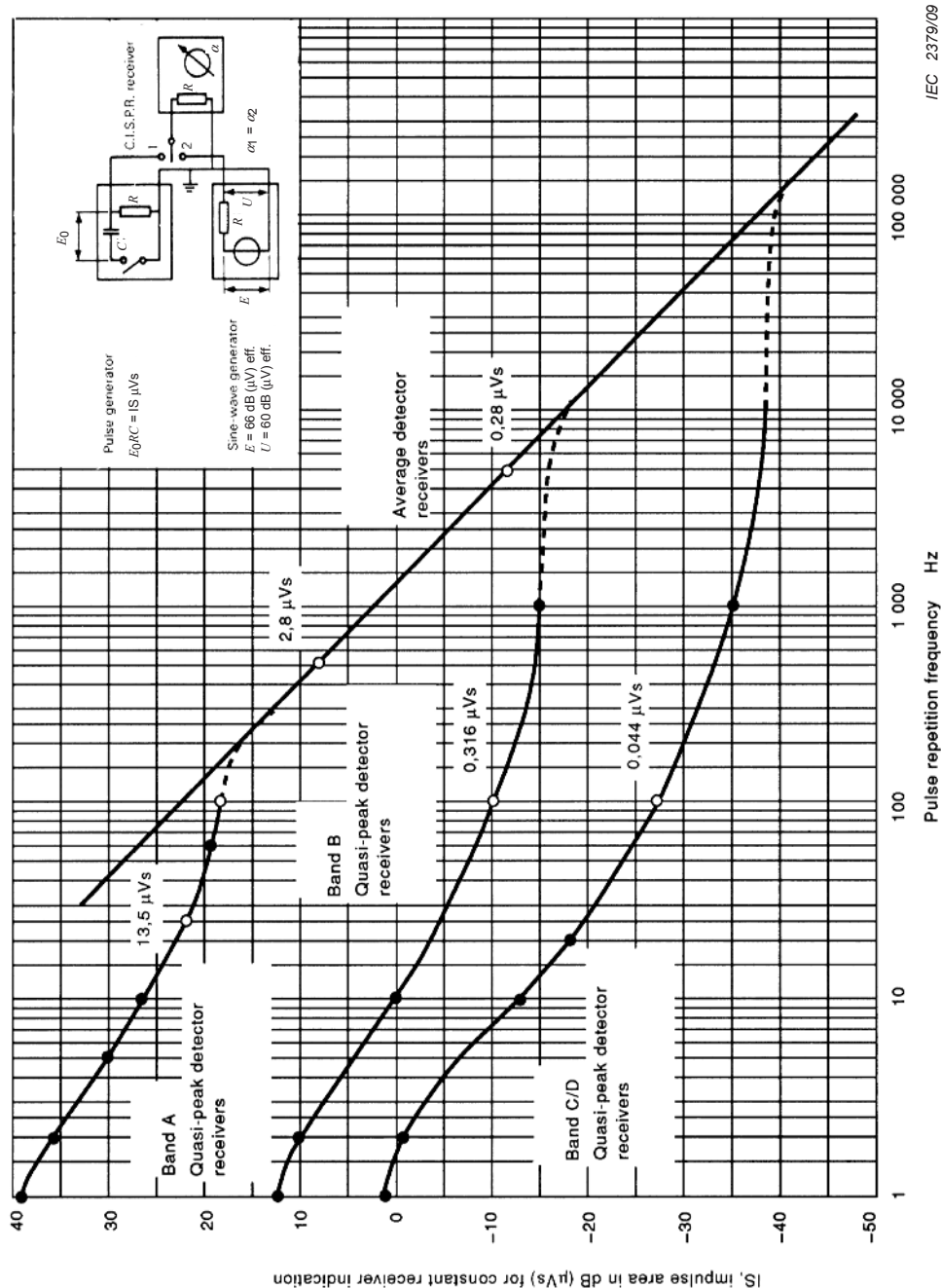


Figure 1c) – Pulse response curve (Bands C and D)



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

Figure 1d) – Theoretical pulse response curve of quasi-peak detector receivers and average detector receiver (see 6.5.4)

Figure 1 – Pulse response curves

The response curve for a particular measuring receiver shall lie between the limits defined in the appropriate figure and quantified in Table 2. For spectrum analyzers without preselection, the requirements in Table 2 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 of 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, Annex B of CISPR 16-2-2, or Annex B of CISPR 16-2-3.

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 2 are optional and are not essential.

Table 2 – Pulse response of quasi-peak measuring receivers

Repetition frequency Hz	Relative equivalent level in dB of pulse for stated band			
	Band A 9 kHz to 150 kHz	Band B 0,15 MHz to 30 MHz	Band C 30 MHz to 300 MHz	Band D 300 MHz to 1 000 MHz
1 000	Note 4	$-4,5 \pm 1,0$	$-8,0 \pm 1,0$	$-8,0 \pm 1,0$
100	$-4,0 \pm 1,0$	0 (ref.)	0 (ref.)	0 (ref.)
60	$-3,0 \pm 1,0$	–	–	–
25	0 (ref.)	–	–	–
20	–	$+6,5 \pm 1,0$	$+9,0 \pm 1,0$	$+9,0 \pm 1,0$
10	$+4,0 \pm 1,0$	$+10,0 \pm 1,5$	$+14,0 \pm 1,5$	$+14,0 \pm 1,5$
5	$+7,5 \pm 1,5$	–	–	–
2	$+13,0 \pm 2,0$	$+20,5 \pm 2,0$	$+26,0 \pm 2,0$	$+26,0 \pm 2,0^*$
1	$+17,0 \pm 2,0$	$+22,5 \pm 2,0$	$+28,5 \pm 2,0$	$+28,5 \pm 2,0^*$
Isolated pulse	$+19,0 \pm 2,0$	$+23,5 \pm 2,0$	$+31,5 \pm 2,0$	$+31,5 \pm 2,0^*$

* These values are optional and not essential.

NOTE 1 The influence of the receiver characteristics upon its pulse response is considered in Annex D.

NOTE 2 The relationships between the pulse responses of a quasi-peak receiver and receivers with other detector types are given in 5.5, 6.5 and 7.5.

NOTE 3 The theoretical pulse response curves of quasi-peak and average detector receivers combined on an absolute scale are shown in Figure 1d. The ordinate of Figure 1d shows the open-circuit impulse areas in dB(μ Vs) corresponding to the open-circuit sine-wave voltage of 66 dB(μ V) rms. The indication on a measuring receiver with an input matched to the calibrating generators will then be 60 dB(μ V). Where the measuring bandwidth is less than the pulse repetition frequency, the curves of Figure 1d are valid when the receiver is tuned to a discrete line of the spectrum.

NOTE 4 It is not possible to specify a response above 100 Hz in the frequency range 9 kHz to 150 kHz because of the overlapping of pulses in the IF amplifier.

NOTE 5 Annex A deals with the determination of the curve of response to repeated pulses.

4.5 Selectivity

4.5.1 Overall selectivity (passband)

The curve representing the overall selectivity of the measuring receiver shall lie within the limits shown in Figure 2 a), b) or c).

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.

NOTE 1 For the measurement of equipment that requires higher selectivity at the transition between 130 kHz and 150 kHz (e.g. mains signalling equipment as defined in EN 50065-1), a high-pass filter may be added in front of the

measuring receiver to achieve the combined selectivity of CISPR measuring receiver and high-pass filter as shown in Table 3.

Table 3 – 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

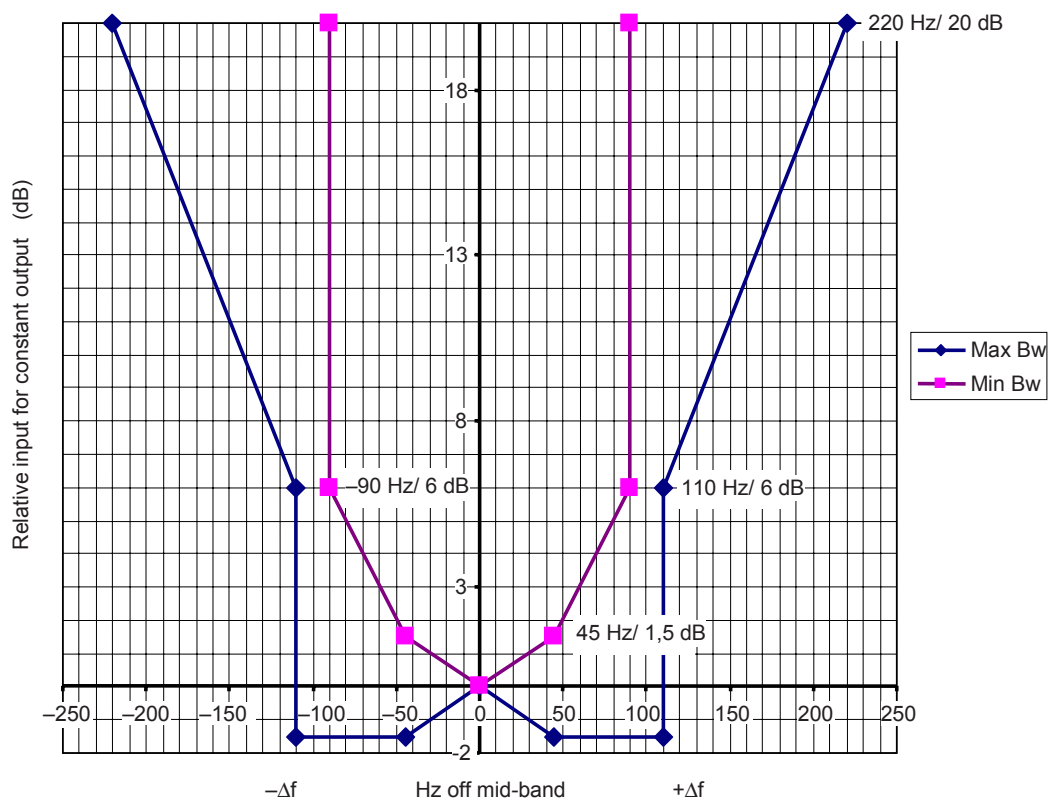
NOTE 2 The measuring receiver in conjunction with the high-pass filter should meet the requirements of this standard.

4.5.2 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.

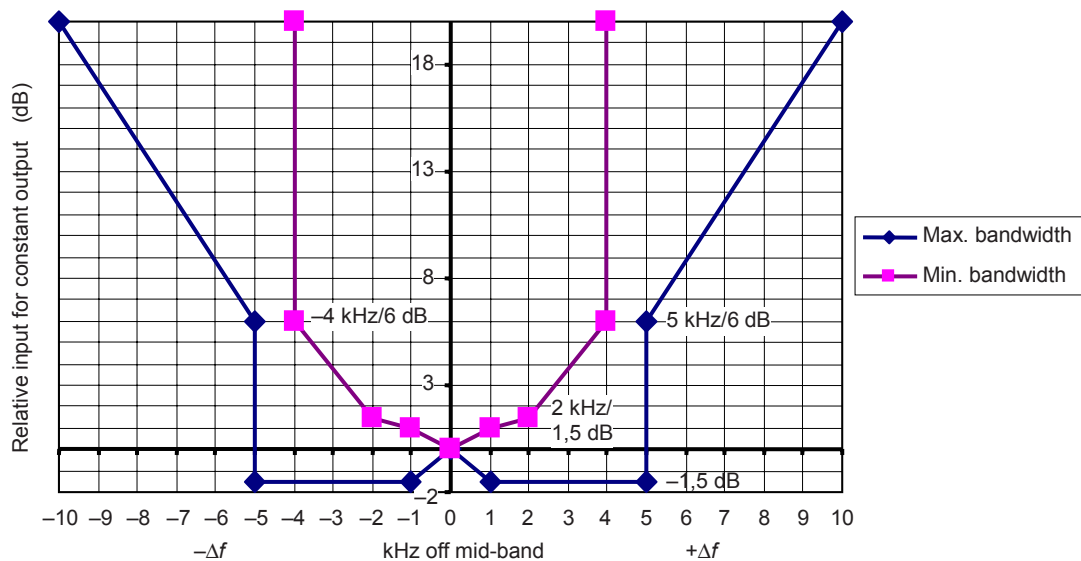
4.5.3 Image frequency rejection ratio

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.



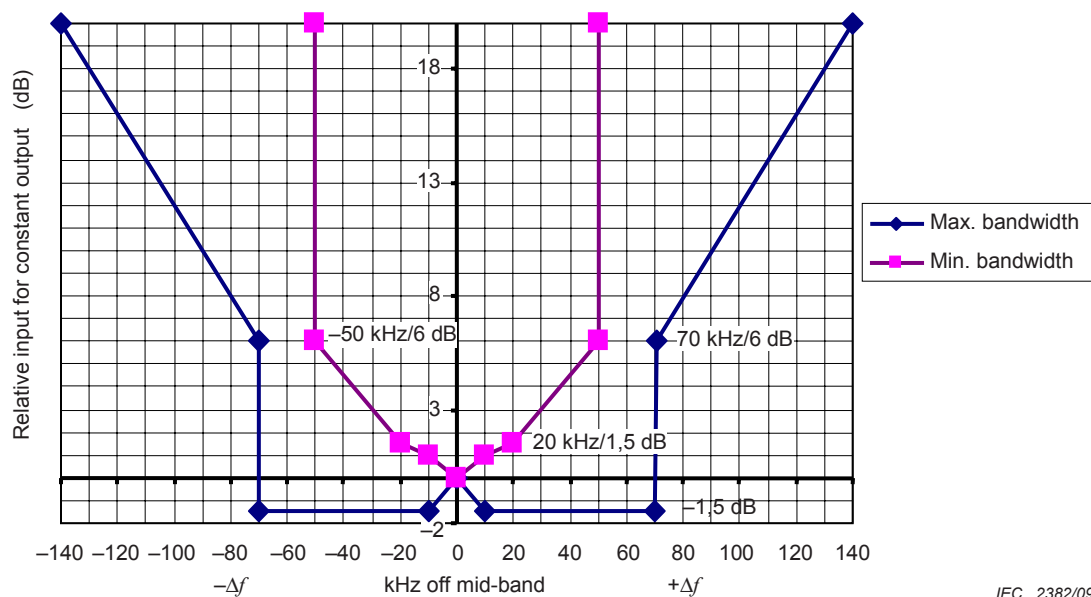
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Figure 2a) – Limits of overall selectivity – Pass band
(see 4.5.1, 5.6, 6.6, 7.6) (Band A)



IEC 2381/09

**Figure 2b) – Limits of overall selectivity –
Pass band (see 4.5.1, 5.6, 6.6, 7.6) (Band B)**



IEC 2382/09

**Figure 2c) – Limits of overall selectivity –
Pass band (see 4.5.1, 5.6, 6.6, 7.6) Bands (C and D)**

Figure 2 – Limits of overall selectivity

4.5.4 Other spurious responses

The ratio of the input sine-wave voltage at frequencies other than those specified in 4.5.2 and 4.5.3 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 may occur are as follows:

$$\left(\frac{1}{m}\right)(nf_L \pm f_i) \text{ and } \left(\frac{1}{k}\right)(f_o) \quad (6)$$

where

m, n, k are integers;

f_L is the local oscillator frequency;

f_i is the intermediate frequency;

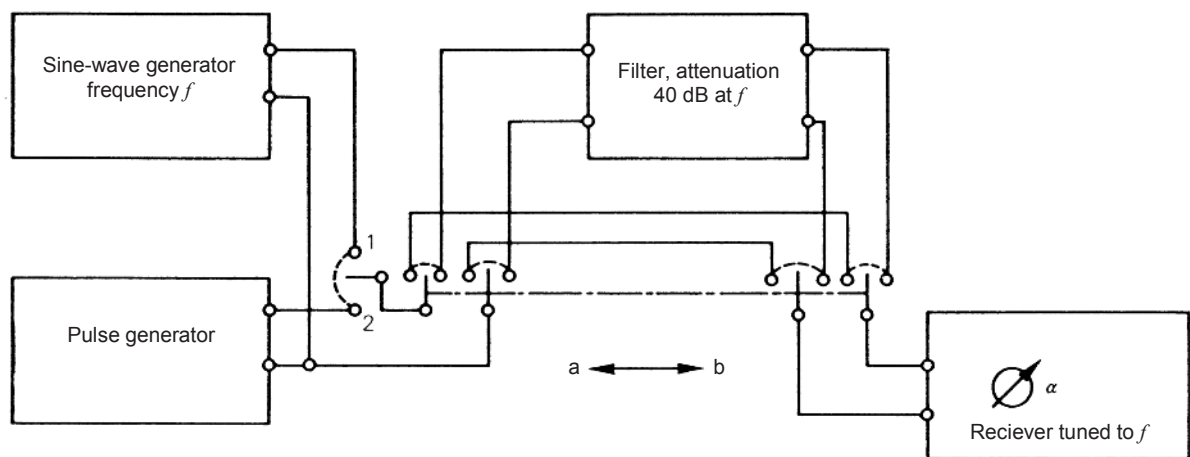
f_o is the tuned frequency.

A1 NOTE Where more than one intermediate frequency is used, the frequencies f_L and f_i may refer to each of the local oscillator and intermediate frequencies used. In addition, spurious responses may 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 this subclause therefore cannot apply in these latter cases. The effect of these spurious responses is dealt with in 4.7. 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. **A1**

4.6 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.

Arrange the apparatus as shown in Figure 3. The pulse generator has a spectrum substantially uniform up to frequency 3) but at least 10 dB down at frequency 4) of the frequencies given in Table 4. The band-stop filter has an 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 frequencies 1) and 2) given in Table 4.



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NOTE Following the discussion in 4.6, the measuring receiver responses are:

$$\alpha_{1a} = \alpha_{2a}$$

$$\alpha_{1b} = \alpha_{1a} - 40 \text{ dB}$$

$$\alpha_{2b} = \alpha_{2a} - 36 \text{ dB}$$

Figure 3 – Arrangement for testing intermodulation effects

Table 4 – Bandwidth characteristics for intermodulation test of quasi-peak measuring receivers (see 4.6)

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

Connect the sine-wave generator output direct 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.

With the pulse generator connected as described above, 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.

4.7 Limitation of receiver noise and internally generated spurious signals

4.7.1 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.

4.7.2 Continuous wave

A1 The existence of spurious responses as described in the note to 4.5.4 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 4.7.1 when tested as described in 4.7.1. **A1**

4.8 Screening effectiveness

4.8.1 General

Screening effectiveness is a measure of the ability of the measuring receiver to operate in an electromagnetic field without degradation. The requirement applies to receivers operating within the "CISPR indication range" specified by the manufacturer as defined in 3.2.

The screening of the receiver shall be such that when it is immersed in an ambient electromagnetic field of 3 V/m (unmodulated) at any frequency in the range 9 kHz to 1 000 MHz, an error of not greater than 1 dB is produced at the maximum and minimum of the CISPR indication range as specified by the manufacturer of the receiver. In cases where a measuring receiver is not immune to the requirement of 3 V/m, the field strength and frequency at which the error exceeds 1 dB shall be stated by the manufacturer. The test shall be performed as described below.

The receiver is placed inside a screened enclosure. An input signal is applied to the receiver via a 2 m long well-screened cable (e.g. semi-rigid), through a feedthrough in the enclosure wall, to a signal generator placed outside the enclosure. The level of the input signal shall be at the maximum and the minimum of the CISPR indication range as specified by the manufacturer of the receiver. All other coaxial terminals of the receiver shall be terminated in their characteristic impedance.

Only essential leads (e.g. mains and input cables) for the normal use of the measuring receiver in its minimum configuration (excluding options such as headphones) shall be connected during the test. The leads shall have the lengths and be arranged as in typical use.

The strength of the ambient field in the vicinity of the measuring receiver shall be measured by a field strength monitor.

The receiver meter indication in the presence of the ambient electromagnetic field shall differ by not more than 1 dB from the meter indication when the field is absent.

4.8.2 Limitation of radio-frequency emissions from the measuring receiver

4.8.2.1 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(μ V) across 50 Ω .

4.8.2.2 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 (ISM frequencies) listed in Table 1 of the same publication. In the frequency range of 1 GHz to 18 GHz, a limit of 45 dB(pW) shall apply, based on an ERP measurement.

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

4.9 Facilities for connection to a discontinuous disturbance analyzer

- A1** 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. **A1**

5 Measuring receivers with peak detector for the frequency range 9 kHz to 18 GHz

5.1 General

This clause specifies requirements for measuring receivers employing a peak detector when used for the measurement of impulsive or pulse-modulated disturbance.

- A1** Spectrum analyzers and FFT-based measuring instruments that meet the requirements of this clause can be used for compliance measurements. For emission measurements, FFT-based measuring instruments shall sample and evaluate the signal continuously during the measurement time. **A1**

5.2 Input impedance

The input port of the measuring receivers shall be unbalanced. For receiver control settings within the CISPR indication range, the nominal input impedance shall be 50 Ω with a VSWR not to exceed the values in Table 5.

Table 5 – VSWR requirements for receiver input impedance

Frequency range	RF 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

Symmetric input impedance in the frequency range 9 kHz to 30 MHz: a balanced input transformer is to be used for symmetric (that is, ungrounded) measurements. (The preferred input impedance is 600 Ω for the frequency range 9 kHz to 150 kHz.) Symmetric input impedance may be incorporated either in the relevant symmetrical artificial network required to couple to the receiver or, optionally, in the measuring receiver itself.

5.3 Fundamental characteristics

5.3.1 Bandwidth

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 6.

Table 6 – Bandwidth requirements for measuring receivers with peak detector

Frequency range	Bandwidth B_6	Reference BW
9 kHz to 150 kHz (Band A)	100 Hz to 300 Hz ^a	200 Hz (B_6)
0,15 MHz to 30 MHz (Band B)	8 kHz to 10 kHz ^a	9 kHz (B_6)
30 MHz to 1 000 MHz (Bands C and D)	100 kHz to 500 kHz ^a	120 kHz (B_6)
1 GHz to 18 GHz (Band E)	300 kHz to 2 MHz ^a	1 MHz ^b (B_{imp})
^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 may introduce an error. Therefore, data measured with the reference bandwidth shall take precedence. ^b The bandwidth selected shall be defined as the impulse bandwidth of the measuring receiver with a tolerance of ±10 %.		

5.3.2 Charge and discharge time constants ratio

In order to achieve a meter reading within 10 % of the true value of the peak at a repetition rate of 1 Hz, the ratio of discharge time constant to charge time constant shall be equal to or greater than the following values:

- a) $1,89 \times 10^4$ in the frequency range 9 kHz to 150 kHz;
- b) $1,25 \times 10^6$ in the frequency range 150 kHz to 30 MHz;
- c) $1,67 \times 10^7$ in the frequency range 30 MHz to 1 000 MHz;
- d) $1,34 \times 10^8$ in the frequency range 1 GHz to 18 GHz.

If the test receiver has a peak-hold capability, the hold time shall be adjustable to values between 30 ms and 3 s.

NOTE For receivers that use peak hold (and forced discharge after the hold time) or digital peak detection techniques, the requirement on the charge/discharge time constants ratio is not relevant. A maximum-hold function of the display may be used for signals with time-varying amplitudes.

If a spectrum analyzer is used for peak measurements, the video bandwidth (B_{video}) shall be set to a value greater than or equal to the resolution bandwidth (B_{resol}). For peak measurements, the result can be read from the spectrum analyzer display with the detector operating either in the linear or logarithmic mode.

5.3.3 Overload factor

For peak measuring receivers, the overload factor does not need to be as high as it is for other types of measuring receivers. For most direct-reading detectors, the overload factor shall be slightly larger than unity. The overload factor shall be adequate for the time-constants used (see 5.3.2).

5.4 Sine-wave voltage accuracy

The accuracy 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.

5.5 Response to pulses

Up to 1 000 MHz, the response of the measuring receiver to pulses with impulse area $1,4/B_{\text{imp}}$ mVs (where B_{imp} is in Hz) e.m.f. at 50 Ω source impedance shall be equal to the response to an unmodulated sine-wave signal at the tuned frequency having an e.m.f. with rms value of 2 mV [66 dB(μ V)]. The source impedances of both the pulse generator and the signal generator shall be the same. The pulses shall have a uniform spectrum according to Table 2. A tolerance of $\pm 1,5$ dB is permitted in the sine-wave voltage level, and this is a requirement for all pulse repetition frequencies for which no overlapping pulses occur at the output of the IF amplifier.

NOTE 1 Annexes B and C describe methods for determining the output characteristics of pulse generators for use in testing for the requirements of this subclause.

NOTE 2 At a repetition rate of 25 Hz for Band A and 100 Hz for the other bands, the relationship between the indications of a peak measuring receiver and a quasi-peak measuring receiver with the preferred bandwidth are given in Table 7.

Table 7 – Relative pulse response of peak and quasi-peak measuring receivers for the same bandwidth (frequency range 9 kHz to 1 000 MHz)

Frequency	A_{imp} mVs	B_{imp} Hz	Ratio peak/quasi-peak (dB) for pulse repetition rate	
			25 Hz	100 Hz
Band A	$6,67 \times 10^{-3}$	$0,21 \times 10^3$	6,1	–
Band B	$0,148 \times 10^{-3}$	$9,45 \times 10^3$	–	6,6
Bands C and D	$0,011 \times 10^{-3}$	$126,0 \times 10^3$	–	12,0
NOTE The pulse response is based on the use of the reference bandwidth only (see Table 6).				

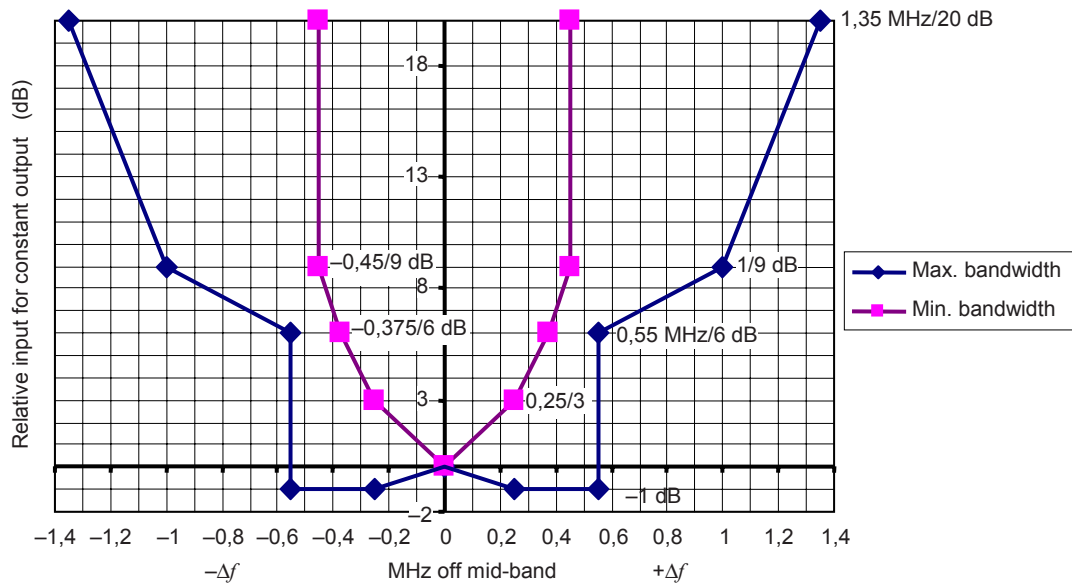
Above 1 GHz, the required impulse area is defined using a pulse-modulated carrier at the frequency of test, since pulse generators with a uniform spectrum up to 18 GHz are not feasible. See E.6.

5.6 Selectivity

Since the bandwidth requirements stated in 5.3.1 allow variations from the bandwidths shown in Figure 2 a), 2b) and 2c), these selectivity curves apply to peak measuring receivers in regard to shape only, and the frequency axis shall be scaled accordingly. For example, $B_6/2$ corresponds to 100 Hz in Figure 2 a).

The requirements in 4.5.2, 4.5.3 and 4.5.4 apply.

The curve representing the overall selectivity of the measuring receiver reference bandwidth for Band E shall lie within the limits of Figure 4.



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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. Therefore 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)

5.7 Intermodulation effects, receiver noise, and screening

For the frequency range below 1 GHz, the requirements stated in 4.6, 4.7 and 4.8 apply. Subclauses 4.7 and 4.8.2 apply also for Band E.

In addition, the following applies for Band E.

- Requirements for intermodulation effects are under consideration.
- Preselection filter for Band E: when measuring low level spurious signals in the presence of a strong fundamental signal for certain equipment-under-test, insert a filter at the measuring receiver's input (internally or externally) which provides 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 30 dB filter attenuation at the fundamental frequency of the equipment-under-test is normally adequate.

NOTE 2 Several filters may be required to deal with more than one fundamental frequency.

Requirements for screening effectiveness, that is, the immunity to high ambient radiated disturbances, are under consideration.