INTERNATIONAL ELECTROTECHNICAL COMMISSION

CISPR 16-1-1

Second edition
2006-03

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

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

This second edition of CISPR 16-1-1 cancels and replaces the first edition published in 2003 and its amendment 1 (2005). It constitutes a technical revision.

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

FDIS	Report on voting
CISPR/A/642/FDIS	CISPR/A/651/RVD

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

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

The CISPR 16 series, published under the general title *Specification for radio disturbance and immunity measuring apparatus and methods,* consists of Parts 1, 2, 3 and 4, each of which is further subdivided into parts:

– measurement instrumentation specifications are given in the five parts of CISPR 16-1;
– methods of measurement are covered in the four parts of CISPR 16-2;
– various reports with further information and background on CISPR and radio disturbances in general are given in CISPR 16-3;
– information related to uncertainties, statistics and limit modelling is contained in CISPR 16-4.

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:*

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- 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

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The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

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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

1 Scope

This part of CISPR 16 is designated a basic standard, which specifies the characteristics and performance of equipment for the measurement of radio disturbance voltages, currents and fields in the frequency range 9 kHz to 18 GHz. In addition, requirements are specified for specialized equipment for discontinuous disturbance measurements. The requirements include the measurement of broadband and narrowband types of radio disturbance.

The receiver types covered include the following:

a) the quasi-peak measuring receiver,

b) the peak measuring receiver,

c) the average measuring receiver,

d) the r.m.s. measuring receiver.

The requirements of this publication shall be complied with at all frequencies and for all levels of radio disturbance voltages, currents, power or field strengths within the CISPR indicating range of the measuring equipment.

Methods of measurement are covered in Part 2, and further information on radio disturbance is given in Part 3 of CISPR 16. Uncertainties, statistics and limit modelling are covered in Part 4 of CISPR 16.

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2 Normative references

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

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

CISPR 11:2003, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic 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*

CISPR 16-3:2003, *Specification for radio disturbance and Immunity measuring apparatus and methods – Part 3: CISPR technical reports*

BIPM / IEC / IFCC / ISO / IUPAC / IUPAP / OIML:1993, *International vocabulary of basic and general terms in metrology*

3 Terms and definitions

For the purpose of this document, the following definitions apply. Also see IEC 60050(161) and the *International vocabulary of basic and general terms in metrology.*

3.1
bandwidth
B_n
the width of the overall selectivity curve of the receiver between two points at a stated attenuation, below the midband response. The bandwidth is represented by the symbol B_n, where n is the stated attenuation in decibels.

3.2
impulse bandwidth
B_{imp}

$$B_{imp} = A(t)_{max} / (2\ G_o \times IS)$$

where

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

G_o is the gain of the circuit at the centre frequency.

Specifically for two critically-coupled tuned transformers,

$$B_{imp} = 1{,}05 \times B_6 = 1{,}31 \times B_3$$

where

B_6 and B_3 are respectively the bandwidths at the –6 dB and –3 dB points (see Clause A.2 for further information).

3.3
impulse area
IS
the impulse area (sometimes called impulse strength, IS) is the voltage-time area of a pulse defined by the integral:

$$IS = \int_{-\infty}^{+\infty} V(t)\ dt \quad \text{(expressed in µVs or dB(µVs))}$$

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

3.4
electrical charge time constant
T_C
the 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

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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 i.f. amplifier is applied to the input of the stage immediately preceding the detector. The indication, *D*, of an instrument having no inertia (e.g., a cathode-ray 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.

3.5
electrical discharge time constant
T_D
the 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.

3.6
mechanical time constant of a critically damped indicating instrument
T_M

$$T_M = T_L / 2\pi$$

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:

$$T_M^2 (d^2\alpha / dt^2) + 2T_M (d\alpha / dt) + \alpha = ki$$

where

α is the deflection;

i is the current through the instrument;

k is a constant.

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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 overswing is not greater than 5 % and the moment of inertia of the movement is such that $\alpha T = 0,35\alpha_{max}$.

3.7
overload factor
the 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

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).

3.8
symmetric voltage
in a two-wire circuit, such as a single-phase mains supply, the symmetric voltage is the radio-frequency disturbance voltage appearing between the two wires. This is sometimes called the differential mode voltage. If *Va* is the vector voltage between one of the mains terminals and earth and *Vb* is the vector voltage between the other mains terminal and earth, the symmetric voltage is the vector difference (*Va*-*Vb*)

3.9
CISPR indicating range
it is the range specified by the manufacturer which gives the maximum and the minimum meter indications within which the receiver meets the requirements of this section of CISPR 16

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

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).

4.1 Input impedance

The input circuit of measuring receivers shall be unbalanced. For receiver control settings within the CISPR indicating range, the input impedance shall be nominally 50 Ω with a v.s.w.r. not to exceed 2,0 to 1 when the RF attenuation is 0 and 1,2 to 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.

4.2 Fundamental characteristics

The responses to pulses as specified in 4.4 are calculated on the basis of the measuring receivers having the following fundamental characteristics.

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Table 1 – Fundamental characteristics of quasi-peak receivers

Characteristics	Frequency band		
	Band A **9 kHz to 150 kHz**	**Band B** **0,15 MHz to 30 MHz**	**Bands C and D** **30 MHz to 1 000 MHz**
Bandwidth at the –6 dB points B_6 in kHz	0,20	9	120
Detector electrical charge time constant, in ms	45	1	1
Detector electrical discharge time constant, in ms	500	160	550
Mechanical time constant of critically damped indicating instrument, in ms	160	160	100
Overload factor of circuits preceding the detector, in dB	24	30	43,5
Overload factor of the d.c. amplifier between detector and indicating instrument, in dB	6	12	6

NOTE 1 The definition of mechanical time constant (see 3.6) assumes that the indicating instrument is linear, i.e., equal increments of current produce equal increments of deflection. An indicating instrument having a different relation between current and deflection may be used provided that the instrument satisfies the requirements of this subclause. In an electronic instrument, the mechanical time-constant may be simulated by a circuit.

NOTE 2 No tolerance is given for the electrical and mechanical time constants. The actual values used in a specific receiver will be determined by the design to meet the requirements in 4.4

4.3 Sine-wave voltage accuracy

The accuracy of measurement of sine-wave voltages shall be better than ±2 dB when supplied with a sine-wave signal at 50 Ω resistance source impedance.

4.4 Response to pulses

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.

4.4.1 Amplitude relationship (absolute calibration)

The response of the measuring receiver to pulses of impulse area of a) µVs (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 r.m.s. value 2 mV (66 dB(µV)). The source impedances of the pulse generator and the signal generator shall both be the same. A tolerance of ±1,5 dB shall be permitted on the sine-wave voltage level.

Table 2 – 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

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4.4.2 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, the relationship between amplitude and repetition frequency is in accordance with Figures 1a, 1b or 1c.

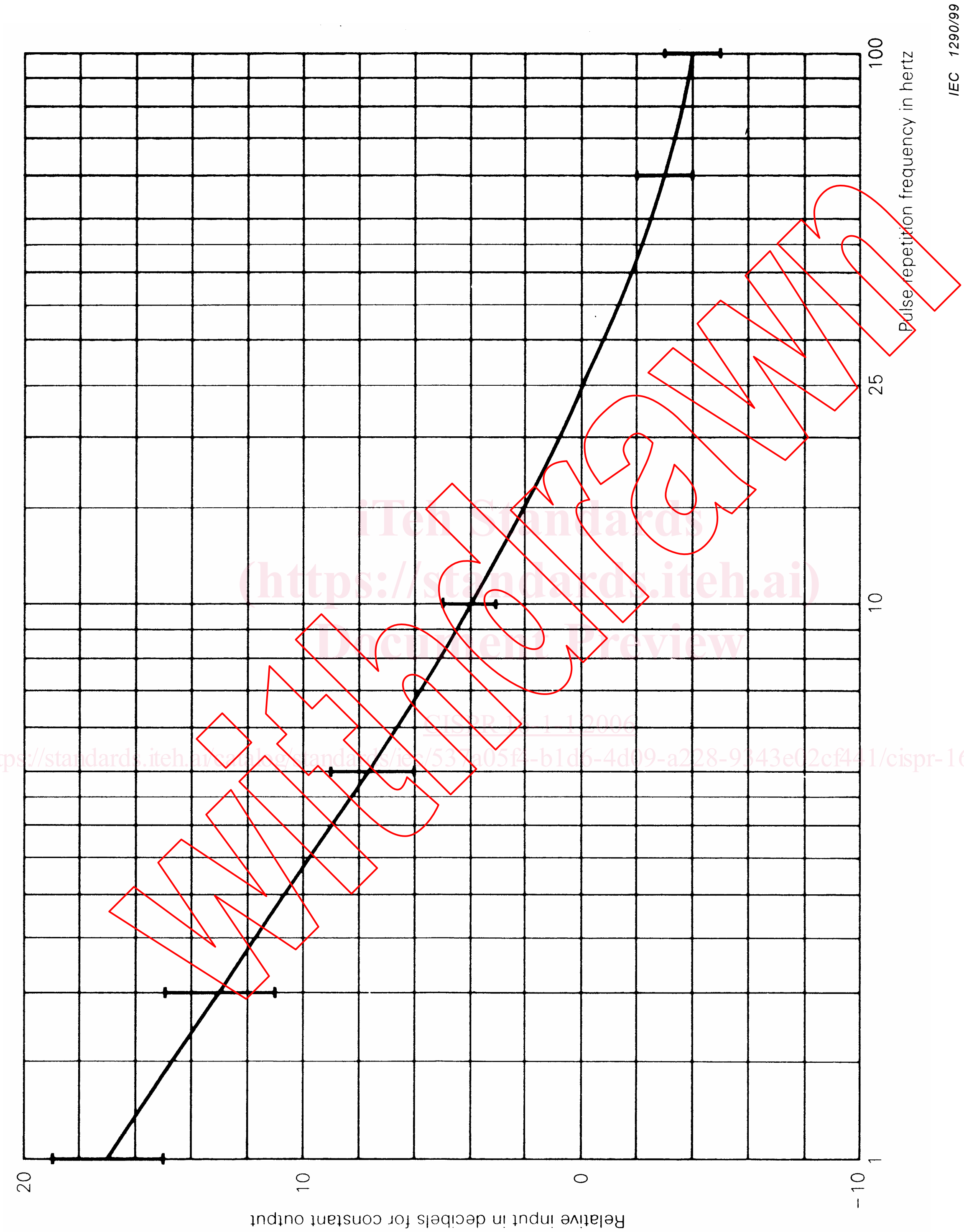

Figure 1a – Pulse response curve (Band A)

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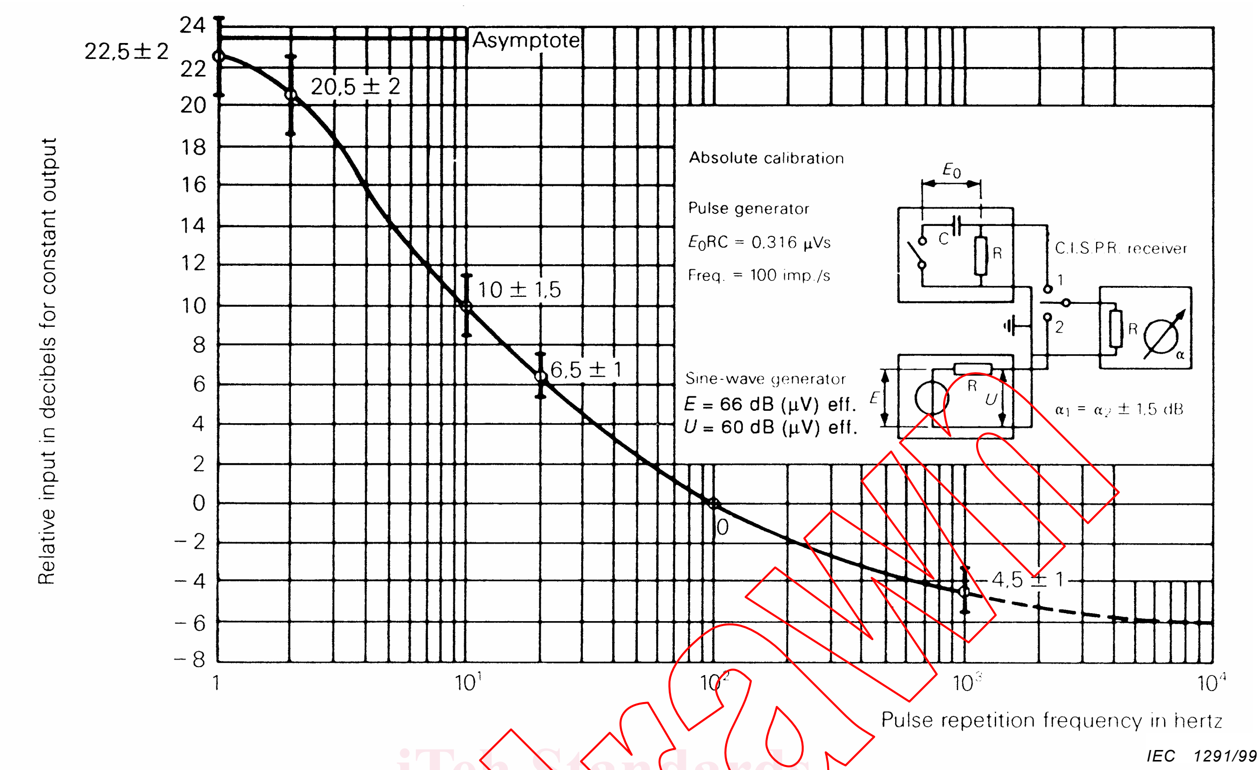

Figure 1b – Pulse response curve (Band B)

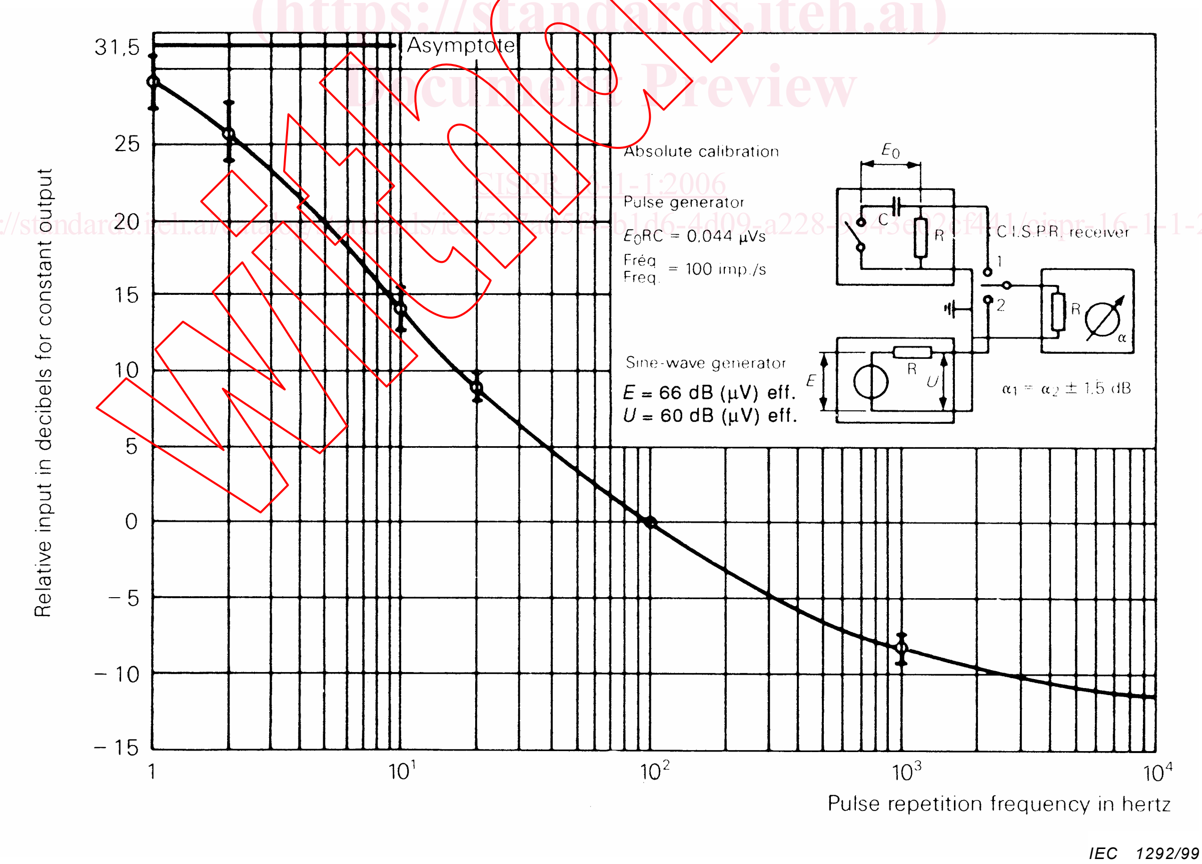

Figure 1c – Pulse response curve (Bands C and D)

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