INTERNATIONAL ELECTROTECHNICAL COMMISSION

CISPR 16-1-3

First edition
2003-11

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

Specification for radio disturbance and immunity measuring apparatus and methods –

Part 1-3: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Disturbance power

This ***English-language*** *version is derived from the original* ***bilingual*** *publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

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FOREWORD

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International Standard CISPR 16-1-3 has been prepared by CISPR subcommittee A: Radio interference measurements and statistical methods.

This first edition of CISPR 16-1-3, together with CISPR 16-1-1, CISPR 16-1-2, CISPR 16-1-4 and CISPR 16-1-5, cancels and replaces the second edition of CISPR 16-1, published in 1999, amendment 1 (2002) and amendment 2 (2003). It contains the relevant clauses of CISPR 16-1 without technical changes.

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

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

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- withdrawn;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

INTRODUCTION

CISPR 16-1, CISPR 16-2, CISPR 16-3 and CISPR 16-4 have been reorganised into 14 parts, to accommodate growth and easier maintenance. The new parts have also been renumbered. See the list given below.

Old CISPR 16 publications

CISPR 16-1	Radio disturbance and immunity measuring apparatus
CISPR 16-2	Methods of measurement of disturbances and immunity
CISPR 16-3	Reports and recommendations of CISPR
CISPR 16-4	Uncertainty in EMC measurements

New CISPR 16 publications

CISPR 16-1-1	Measuring apparatus
CISPR 16-1-2	Ancillary equipment – Conducted disturbances
CISPR 16-1-3	Ancillary equipment – Disturbance power
CISPR 16-1-4	Ancillary equipment – Radiated disturbances
CISPR 16-1-5	Antenna calibration test sites for 30 MHz to 1 000 MHz
CISPR 16-2-1	Conducted disturbance measurements
CISPR 16-2-2	Measurement of disturbance power
CISPR 16-2-3	Radiated disturbance measurements
CISPR 16-2-4	Immunity measurements
CISPR 16-3	CISPR technical reports
CISPR 16-4-1	Uncertainties in standardised EMC tests
CISPR 16-4-2	Measurement instrumentation uncertainty
CISPR 16-4-3	Statistical considerations in the determination of EMC compliance of mass-produced products
CISPR 16-4-4	Statistics of complaints and a model for the calculation of limits

More specific information on the relation between the 'old' CISPR 16-1 and the present 'new' CISPR 16-1-3 is given in the table after this introduction (TABLE RECAPITULATING CROSS REFERENCES).

Measurement instrumentation specifications are given in five new parts of CISPR 16-1, while the methods of measurement are covered now in four new 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. CISPR 16-4 contains information related to 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.

TABLE RECAPITULATING CROSS-REFERENCES

Second edition of CISPR 16-1 Clauses, subclauses	First edition of CISPR 16-1-3 Clauses, subclauses
1	1
2	2
3	3
5.3	4
5.3.1	4.1
5.3.2	4.2
5.3.3	4.3
Annexes	Annexes
J	A
H	B
Figures	Figures
38, 39	A.1, A.2
40, 41, 42	B.1, B.2, B.3

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 1-3: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Disturbance power

1 Scope

This part of CISPR 16 is designated a basic standard, which specifies the characteristics and calibration of the absorbing clamp for the measurement of radio disturbance power in the frequency range 30 MHz to 1 GHz.

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

CISPR 16-1-1: 2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-2-1:2003, *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*

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

CISPR 16-4-1:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-1: Uncertainties, statistics and limit modelling – Uncertainties in standardized EMC tests*

CISPR 16-4-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainties*

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility,* including its Amendments 1 (1997) and 2 (1998)

International Vocabulary of Basic and General Terms in Metrology, International Organization for Standardization, Geneva, 2nd edition, 1993

3 Definitions

None of the definitions of CISPR 16-1:1999 apply to this new part of CISPR 16. For further definitions, see IEC 60050(161).

4 Absorbing clamp for use in the frequency range 30 MHz to 1 000 MHz

4.1 General

Absorbing clamps are suitable for the measurement of disturbance from some types of equipment depending on construction and size. The precise measuring procedure and its applicability is to be specified for each category of equipment. If the EUT itself (without connecting leads) approaches a 1/4 of a wavelength of the measuring frequency, direct cabinet radiation may occur.

The disturbance capability of an appliance with a mains lead being the only external lead may be taken as the power it could supply to its mains lead acting as a radiating antenna. This power is nearly equal to that supplied by the appliance to a suitable absorbing device placed around the lead at the position where the absorbed power is maximum. The absorbing device is known as the absorbing clamp or the ferrite clamp.

Equipment having external leads other than a mains lead can radiate disturbing energy from such leads, shielded or unshielded, in the same manner as radiation from the mains lead. Absorbing clamp measurements can be done on these leads also.

Radiation from leads at frequencies above 300 MHz, up to 1 000 MHz, may be measured with a suitable absorbing clamp. Such measurements could be of considerable use. However, it should be noted that substantial amount of radiation could emanate directly from the equipment.

4.2 Construction

The absorbing clamp shall consist of three parts as follows:

a) a broadband RF current transformer;

b) a broadband RF power absorber and impedance stabilizer for the lead under measurement;

c) an absorbing sleeve or assembly of ferrite rings to reduce RF current on the surface of the coaxial cable from the current transformer to the measuring receiver.

Annex A describes the construction of some examples of absorbing clamps.

NOTE The transformer and the absorber described in a) and b) above respectively are maintained in fixed relative positions as close together as convenient. They may be constructed of split rings to avoid the necessity of disconnecting a fitted plug from the lead, but care should be taken to keep the air gap small.

4.3 Characteristics

The use of the absorbing clamp relies on a calibrating factor obtained by a specific calibration procedure, as described in annex B and figure B.1. The absorbing clamp shall have a characteristic response of output power versus input power from the calibration signal generator, P_0, that shows no pronounced resonance at any frequency.

The absorbing clamp shall present an impedance between 100 Ω and 250 Ω and not more than 20 % reactive when measured as shown in figure B.1 with the signal generator and 10 dB attenuator replaced by an impedance measuring instrument. At each frequency of measurement the clamp is positioned along the lead, W, to obtain the maximum indication on the measuring receiver. It may be necessary to make a small adjustment in the position of the clamp to satisfy the reactance requirement. In a satisfactory clamp, the readjustment will not produce a significant change in the measured power.

Requirements for absorber attenuation are under consideration.

Annex A
(informative)

Construction of the absorbing clamp

Examples of absorbing clamp construction

Figures A.1 and A.2 show two examples of the absorbing clamp. The three main parts of the absorbing clamp described in 4.2 are the current transformer C, the power absorber and impedance stabilizer D, and the absorbing sleeve E. D consists of a number of ferrite rings and E consists of ferrite rings or tubes. The core of the transformer C has two or three rings of the type used in D. The secondary winding of the current transformer consists of a turn of a miniature coaxial cable encircling the rings and connected as shown. The cable is passed through the sleeve E to a coaxial terminal on the clamp. C and D are mounted close together and aligned on the same axis to permit movement along the lead B under measurement. Sleeve E is usually mounted alongside absorber D for practical reasons. Both D and E serve to attenuate asymmetric currents on the leads through them.

The example in figure A.2 shows some features of improvements to the absorbing clamp performance. A metal cylinder (1) is mounted inside the core of the transformer C to act as a capacitive shield. This cylinder is split into two halves. A insulating tube (2) is used to centralize the lead within the transformer. This tube extends from the input end of the transformer to the first ring of the absorber D, and is for use during clamp calibration and for small diameter leads.

The absorbing clamp may be made to cover the frequency range 30 MHz to 1 000 MHz using suitable ferrite rings.

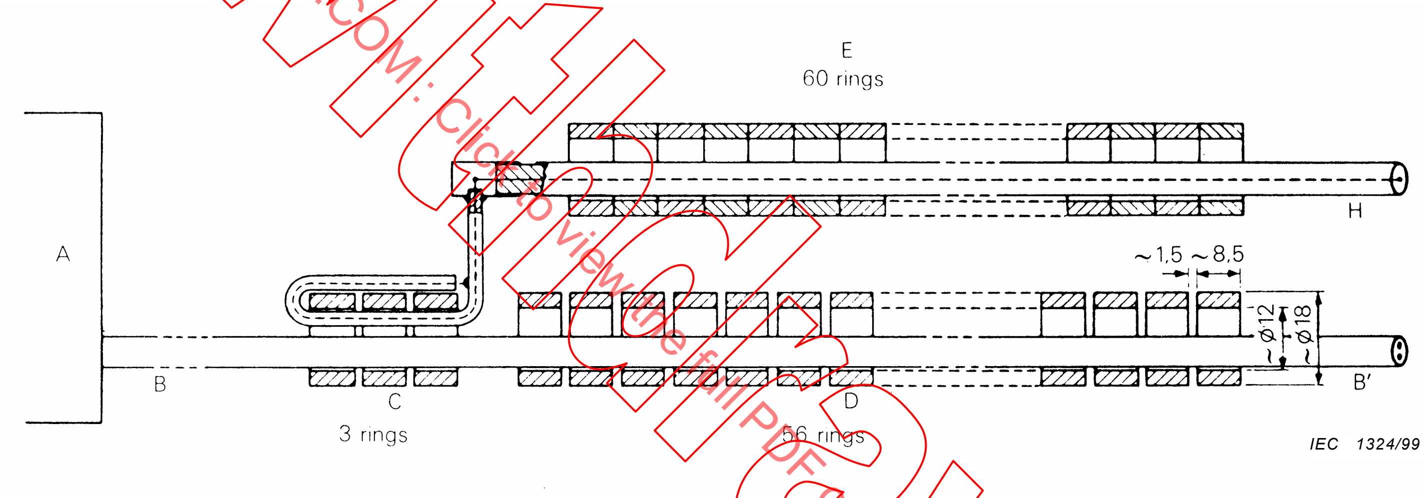
A is the equipment under test

B is the lead under test

C is the current transformer

D is the absorbing section

E is the absorbing section on cable from transformer



Dimensions in millimetres

Figure A.1 – Example of the construction of an absorbing clamp

B is the lead under test
C is the current transformer
D is the absorbing section
E is the absorbing section on cable from transformer
1 is the metal cylinder-two halves
2 is the centralizing tube for lead B
3 is the coaxial connector

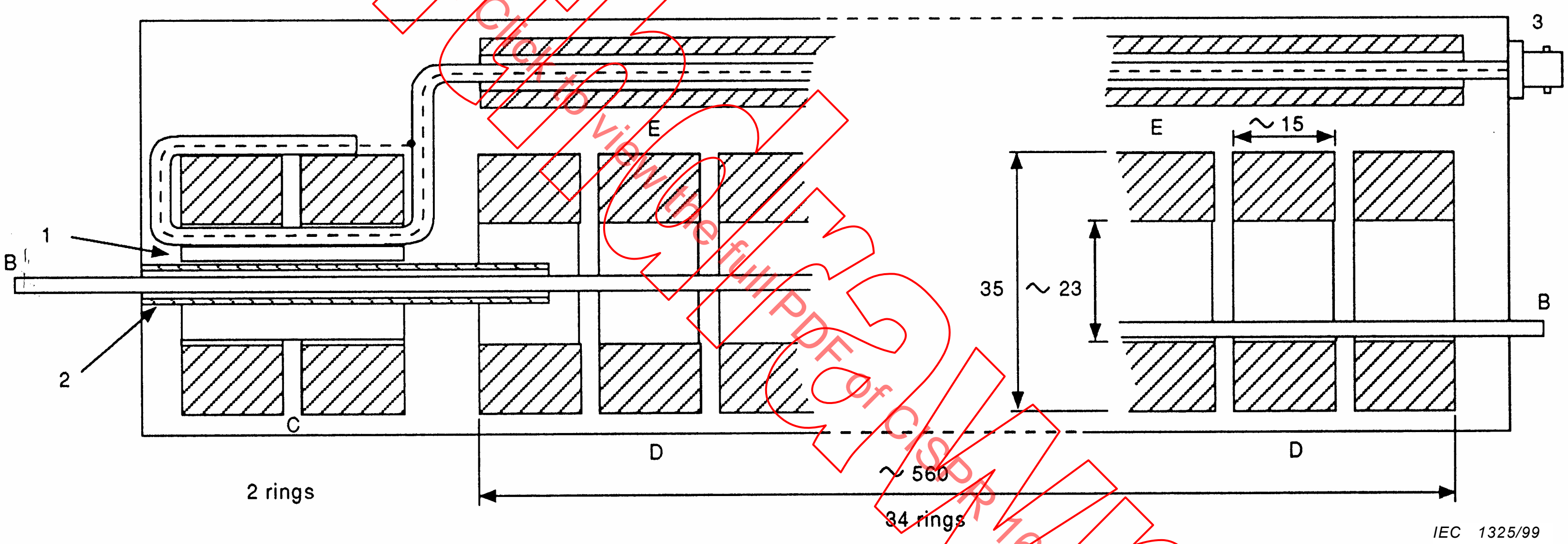


Figure A.2 – Example of the construction of an absorbing clamp with additional features

Annex B
(normative)

Calibration of the absorbing clamp

Connect and arrange the clamp as shown in figure B.1. Lead W consists of an insulated wire of 1 mm or 2 mm effective cross-section connected to the centre pin of a 50 Ω connector mounted on a metal screen such that only the centre pin protrudes from the screen. The screen may be the outer surface of a screened enclosure or a large metal sheet, say 2,5 m by 2,5 m. Lead W shall be centralized within the current transformer as shown in figure B.1.

If the RF isolation provided by an actual absorbing clamp is insufficient at lower frequencies, particularly below 50 MHz and especially during calibration, a second absorber should be placed around the lead behind the absorbing clamp under calibration. It may be in a fixed position about 4 m from the starting of the lead.

Connect a generator with a 50 Ω resistive output impedance to the other end of the connector through a 50 Ω, 10 dB attenuator, and a measuring receiver having a 50 Ω resistive input impedance to the RF terminal of the clamp. The coaxial cable from the clamp to the receiver shall have ferrite absorbing rings or sleeves fitted around both ends.

The calibration is a measurement of the insertion loss of the absorbing clamp and calibration wire set-up between the coaxial connectors C1 and C2. With the coaxial cables in positions a and b as shown by the solid lines in figure B.1 the absorbing clamp is moved along the wire from the metal screen up to a distance of a half-wavelength at the frequency of calibration: and the maximum indication I on the measuring receiver is noted. With the generator signal level kept constant, the coaxial cables are connected in positions a′ and b′ as shown by the dotted lines in figure B.1 and the receiver indication I' is noted. The insertion loss L is given by $L = I' - I$ (dB). This is done throughout the desired frequency range.

An example of the calibration results is shown in figure B.2. The measured insertion loss normally lies within the range 14 dB to 22 dB.

The measuring receivers specified in this standard have an input impedance of 50 Ω. For such an impedance it can be shown that:

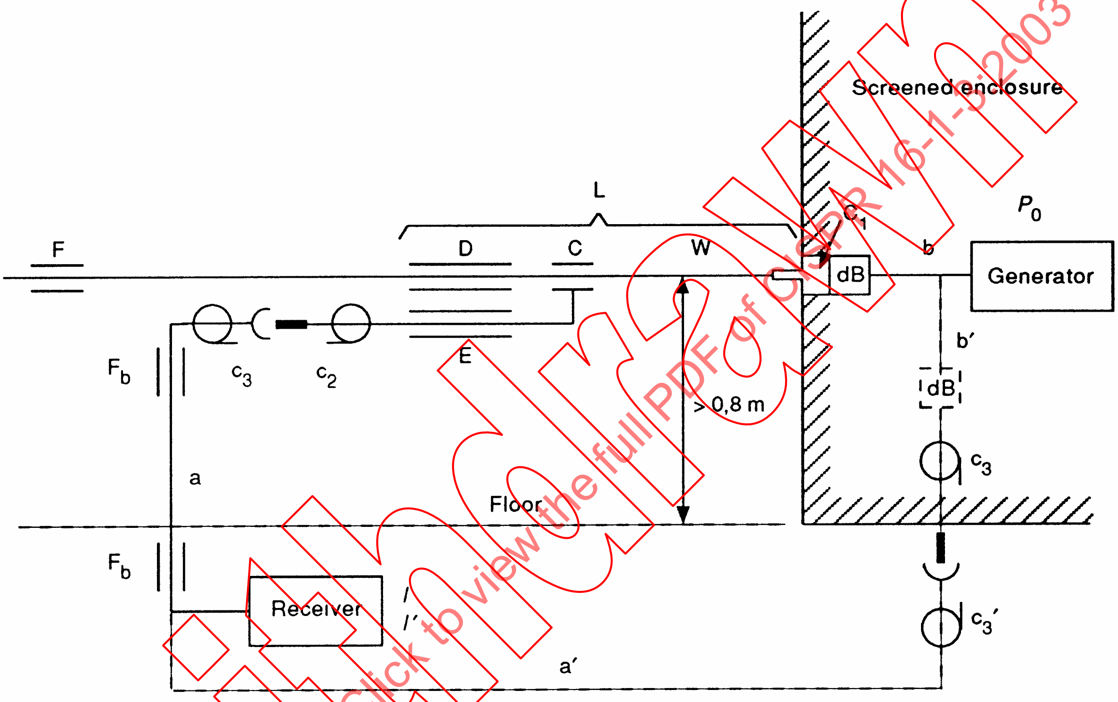
if P is the input power, and V is the input voltage,

$$10 \lg P = 10 \lg (V^2/50) = 20 \lg V - 10 \lg 50 = (20 \lg V) - 17$$

If the power, P, is expressed in picowatts, the equivalent voltage, V, is in microvolts. The numerical value of P, expressed in dB can be found by subtracting 17 dB from the numerical value of V in dB. Thus, if 17 dB is subtracted from the insertion loss the remainder may be added to the meter reading in dB(μV) to give directly the disturbance power in dB(pW). This is the reason for the correction scale shown in figure B.2. The correction scale gives the factor in dB to be added to the indication of the measuring receiver in dB(μV) to convert to power dB(pW).

It is normally possible to position the clamp at more than one maximum. The maximum nearest the end of the conductor that is attached to the 50 Ω connector gives the maximum reading on the receiver. It has been found in practice that the second maximum gives an insertion loss which is about 1 dB greater than that obtained with the first maximum.

For some practical applications it is convenient to use the second maximum, and thus it is useful to calibrate the clamp for this. An example of a calibration employing the second maximum is shown in figure B.3, curve B.



IEC 1326/99

W is the wire for calibration

C, D, E are the parts of the absorbing clamp (see also figure A.2)

F is the additional absorber for f < 50 MHz

c_1 is the coaxial connector for calibration wire W.

c_2 is the coaxial connector on internal coaxial cable of clamp

c_3 is the coaxial connector mating c_2, on cable to receiver

a is the coaxial cable from absorbing clamp to the receiver

b is the coaxial cable from generator to attenuator, attenuation

Att. is the attenuator pad, minimum 10 dB attenuation

c_3', a′, b′, att′ are different positions of C_3, a, b and att., respectively when aligning generator and receiver readings including attenuation of coaxial cables and attenuator

L is the insertion loss of absorbing clamp with wire, in position for maximum indication

P_0 is the constant output of generator over a 50 Ω load

I is the maximum indication on receiver when connected to the clamp

I' is the indication on measuring receiver when connected to generator via attenuator and coaxial cables (dotted lines)

F_b is the ferrite absorbing rings or sleeve

Figure B.1 – Arrangement for calibration of the absorbing clamp

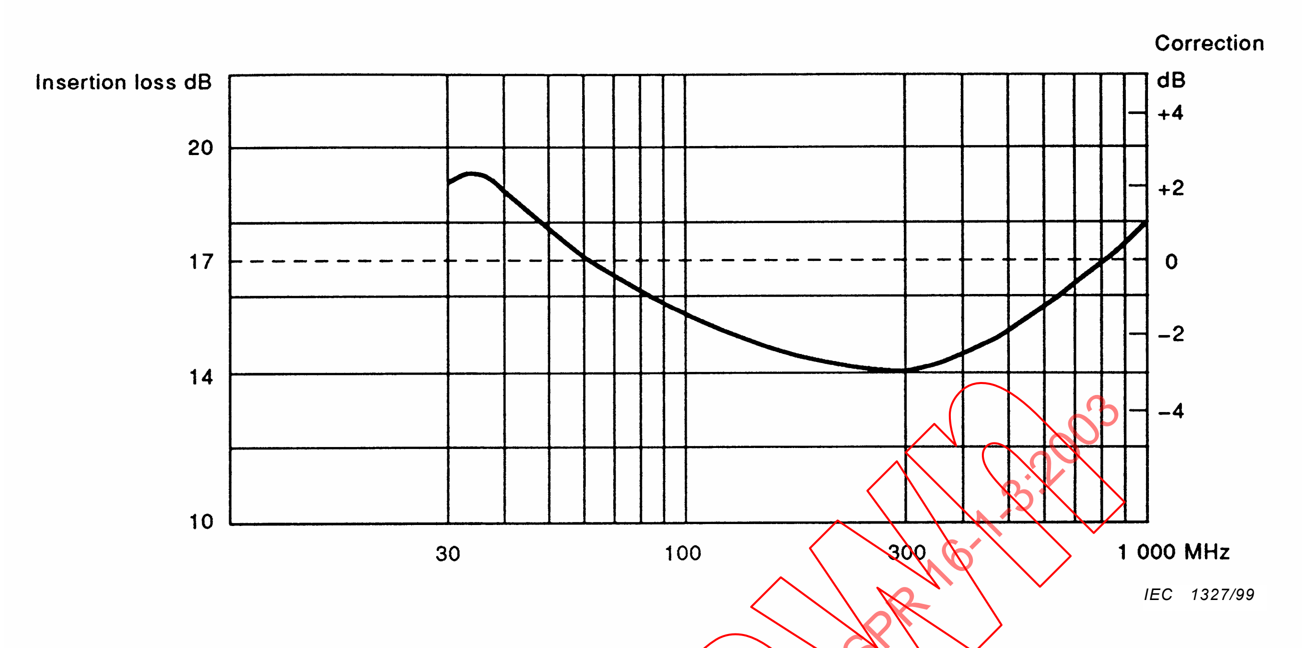


Figure B.2 – Example of calibration curve of the absorbing clamp

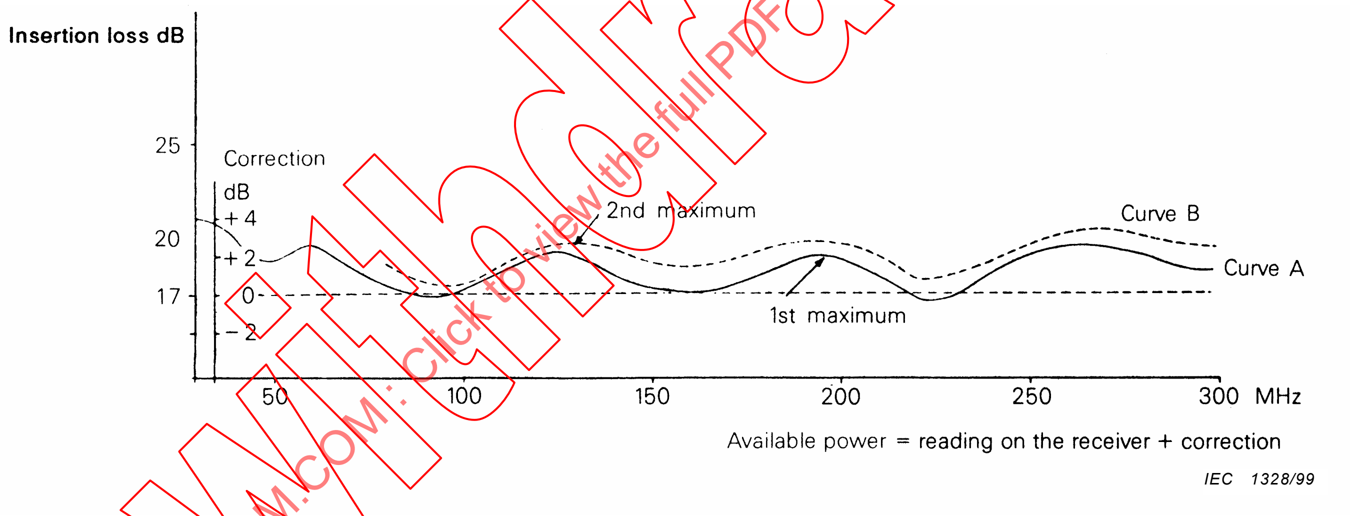


Figure B.3 – Calibration of the absorbing clamp