

**Specification for radio disturbance and immunity
measuring apparatus and methods –**

Part 1-3:

**Radio disturbance and immunity measuring
apparatus – Ancillary equipment –
Disturbance power**

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

[CISPR 16-1-3:2004](https://standards.iteh.ai/catalog/standards/iec/1fcaedbd-4356-43c4-8f2-84e2e7f7d517/cispr-16-1-3-2004)

<https://standards.iteh.ai/catalog/standards/iec/1fcaedbd-4356-43c4-8f2-84e2e7f7d517/cispr-16-1-3-2004>

*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.*

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site** (www.iec.ch)

- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications (www.iec.ch/online_news/justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: custserv@iec.ch

Tel: +41 22 919 02 11

Fax: +41 22 919 03 00

[CISPR 16-1-3:2004](#)

<https://standards.iteh.ai/> <https://standards.iteh.ai/document/iec/1fcaedbd-4356-43c4-8ff2-84e2e7f7d517/cispr-16-1-3-2004>

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**

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

[CISPR 16-1-3:2004](https://standards.iteh.ai)

<https://standards.iteh.ai/catalog/standards/iec/1fcaedbd-4356-43c4-8ff2-84e2e7f7d517/cispr-16-1-3-2004>

© IEC 2004 Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CONTENTS

FOREWORD	5
1 Scope	9
2 Normative references	9
3 Terms, definitions and abbreviations	9
4 Absorbing clamp instrumentation	11
Annex A (informative) Construction of the absorbing clamp (Subclause 4.2)	35
Annex B (normative) Calibration and validation methods for the absorbing clamp and the secondary absorbing device (Clause 4)	39
Annex C (normative) Validation of the absorbing clamp test site (Clause 4)	59
Figure 1 – Overview of the absorbing clamp measurement method and the associated calibration and validation procedures	27
Figure 2 – Schematic overview of the absorbing clamp test method	31
Figure 3 – Schematic overview of the clamp calibration methods	33
Figure A.1 – The absorbing clamp assembly and its parts	35
Figure A.2 – Example of the construction of an absorbing clamp	37
Figure B.1 – The original calibration site	51
Figure B.2 – Position of guide for centering the lead under test	51
Figure B.3 – Side view of the calibration jig	53
Figure B.4 – Top view of the jig	53
Figure B.5 – View of the jigs vertical flange	53
Figure B.6 – Test set-up for the reference device calibration method	55
Figure B.7 – Specification of the reference device	55
Figure B.8 – Measurement set-up of the decoupling factor DF	57
Figure B.9 – Measurement set-up of the decoupling factor DR	57
Figure C.1 – Test set-ups for the site attenuation measurement for clamp site validation using the reference device	63
Table 1 – Overview of the characteristics of the three-clamp calibration methods and their relation	29

INTERNATIONAL ELECTROTECHNICAL COMMISSION
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**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

This second edition cancels and replaces the first edition published in 2003. It constitutes a technical revision. In this edition a more detailed calibration method for the absorbing clamp is specified. Furthermore, new alternative calibration methods are introduced which are more practicable than the one which was specified previously. Additional parameters to describe the absorbing clamp are defined, like the decoupling factor for the broadband absorber (DF) and the decoupling factor for the current transformer (DR), along with their validation methods. A procedure for the validation of the absorbing clamp test site (ACTS) is also included in the document.

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

FDIS	Report on voting
CISPR/A/517/FDIS	CISPR/A/532/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 committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

The contents of the corrigendum of February 2006 have been included in this copy.

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

[CISPR 16-1-3:2004](#)

<https://standards.iteh.ai/catalog/standards/iec/1fcaedbd-4356-43c4-8f2-84e2e7f7d517/cispr-16-1-3-2004>

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 16-1-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Conducted disturbances*

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 16-4-2, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements*

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

3 Terms, definitions and abbreviations

3.1 Terms and definitions

See IEC 60050-161, where applicable.

3.2 Abbreviations

ACA	Absorbing clamp assembly
ACMM	Absorbing clamp measurement method
ACRS	Absorbing clamp reference site
ACTS	Absorbing clamp test site
CF	Clamp factor

CRP	Clamp reference point
DF	Decoupling factor
DR	Decoupling factor that specifies the decoupling of the current transformer from the common mode impedance of the measurement receiver
JTF	Jig transfer factor
LUT	Lead under test
RTF	Reference transfer factor
SAD	Secondary absorbing device
SAR	Semi-anechoic room
SRP	Slide reference point

4 Absorbing clamp instrumentation

4.1 Introduction

The measurement of disturbance power using an absorbing clamp is a method for the determination of the radiated disturbance in the frequency range above 30 MHz. This measurement method represents an alternative approach to the measurement of the disturbance field strength on an OATS. The absorbing clamp measurement method (ACMM) is described in Clause 7 of CISPR 16-2-2.

The ACMM uses the following measurement instrumentation:

- the absorbing clamp assembly;
- the secondary absorbing device;
- the absorbing clamp test site.

Figure 1 gives an overview of the absorbing clamp measurement method including the instrumentation required for this method and the calibration and validation methods for the instrumentation. The requirements for the instrumentation necessary for the ACMM are specified in this clause. Details of the absorbing clamp calibration method, and validation of other properties of the clamp and the secondary absorbing device, are described in Annex B. Details of the absorbing clamp test site validation are described in Annex C. Absorbing clamps are suitable for the measurement of disturbances 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) has a dimension that approaches $1/4$ of the wavelength, direct cabinet radiation may occur. The disturbance capability of an appliance having a mains lead as the only external lead may be taken as the power the appliance could supply to its mains lead, which acts as a transmitting 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 at a maximum. Direct radiation from the appliance is not taken into account. Equipment having external leads other than a mains lead can radiate disturbance energy from such leads, whether shielded or unshielded, in the same manner as radiation from the mains lead. Measurements using the absorbing clamp can be made on these types of lead as well.

The application of the ACMM is specified in more detail in 7.9 of CISPR 16-2-2.

4.2 The absorbing clamp assembly

4.2.1 Description of the absorbing clamp assembly

Annex A describes the construction of the clamp and gives a typical example of such a construction.

The absorbing clamp assembly consists of the following five parts:

- a broadband RF current transformer;
- a broadband RF power absorber and impedance stabilizer for the lead under test;
- an absorbing sleeve and assembly of ferrite rings to reduce RF current on the surface of the coaxial cable from the current transformer to the measuring receiver;
- a 6 dB attenuator between the output of the absorbing clamp and the coaxial cable connecting to the measuring receiver;
- a coaxial cable as receiver cable.

The clamp reference point (CRP) indicates the longitudinal position of the front of the current transformer within the clamp. This reference point is used to define the position of the clamp during the measurement procedure. The CRP shall be indicated on the outside housing of the absorbing clamp.

4.2.2 The clamp factor and the clamp site attenuation

An actual measurement of an EUT using the ACMM is depicted schematically in Figure 2. Details on the ACMM are given in Clause 7 of CISPR 16-2-2.

The disturbance power measurement is based on measurement of the asymmetrical current generated by the EUT, which is measured at the input of the absorbing clamp using a current probe. The absorbing ferrites of the clamp around the lead under test isolate the current transformer from disturbances on the mains. The maximum current is determined by moving the absorbing clamp along the stretched lead, which acts as a transmission line. The transmission line transforms the input impedance of the absorbing clamp to the output of the EUT. At the point of optimal adjustment, the maximum disturbance current at the current probe or the maximum disturbance voltage at the receiver input can be measured.

For this situation the actual clamp factor CF_{act} of an absorbing clamp relates the output signal of the clamp V_{rec} to the measurand of interest, i.e. the disturbance power P_{eut} of an EUT as follows:

$$P_{eut} = CF_{act} + V_{rec} \quad (1)$$

where

P_{eut} = the disturbance power of the EUT in dBpW;

V_{rec} = the measured voltage in dB μ V;

CF_{act} = the actual clamp factor in dBpW/ μ V.

Ideally, the received power level P_{rec} in dBpW at the receiver input can be calculated using the following formula:

$$P_{rec} = V_{rec} - 10 \cdot \log(Z_i) = V_{rec} - 17 \quad (2)$$

where

Z_i = 50 Ω , input impedance of the measuring receiver, and

V_{rec} = measured voltage level in dB μ V.

Using Equations (1) and (2) one can derive a relation between the disturbance power P_{eut} emitted by the EUT and the power P_{rec} received by the receiver as follows:

$$P_{eut} - P_{rec} = CF_{act} + 17 \quad (3)$$

This ideal relation between the disturbance power of the EUT and the power received by the measuring receiver is defined as the actual clamp site attenuation A_{act} (in dB).

$$A_{act} \equiv P_{eut} - P_{rec} = CF_{act} + 17 \quad (4)$$

This actual clamp site attenuation depends on three properties:

- the clamp response properties,
- the site properties and
- the EUT properties.

4.2.3 Decoupling functions of the absorbing clamp

Whereas the current transformer of the absorbing clamp measures the disturbance power, the decoupling attenuation of the ferrites around the lead under test establishes an asymmetrical impedance and separates the current transformer from the far end of the lead under test. This separation reduces the disturbing influence of the connected mains and of the impedance of the far end and its influence on the measured current. This decoupling attenuation is called the decoupling factor (DF).

A second decoupling function is needed for the absorbing clamp. The second decoupling function is the decoupling of the current transformer from the asymmetrical (or common mode) impedance of the receiver cable. This decoupling is achieved by the absorbing section of ferrite rings on the cable from the current transformer to the measurement receiver. This decoupling attenuation is called the decoupling factor to the measurement receiver (DR).

4.2.4 Requirements for the absorbing clamp assembly (ACA)

Absorbing clamps used for disturbance power measurements shall meet the following requirements:

- a) The actual clamp factor (CF_{act}) of the absorbing clamp assembly, as defined in 4.2.1 shall be determined in accordance with the normative methods described in Annex B. The uncertainty of the clamp factor shall be determined in accordance with the requirements given in Annex B.
- b) The decoupling factor (DF) of the broadband RF absorber and the impedance stabilizer for the lead under test shall be verified in accordance with the measurement procedure as described in Annex B. The decoupling factor shall be at least 21 dB for the whole frequency range.
- c) The decoupling function from the current transformer to the measuring output (DR) of the absorbing clamp shall be determined in accordance with the measurement procedure as described in Annex B. The decoupling factor to the measurement receiver shall be at least 30 dB for the whole frequency range. The 30 dB contains 20,5 dB attenuation from the absorbing clamp and 9,5 dB from the coupling/decoupling network (CDN).

- d) The length of the clamp housing shall be $600 \text{ mm} \pm 40 \text{ mm}$.
- e) A 50Ω RF attenuator of at least 6 dB shall be used directly at the clamp output.

4.3 The absorbing clamp assembly calibration methods and their relations

The purpose of the clamp calibration is to determine the clamp factor CF in a situation that resembles an actual measurement with an EUT as much as possible. However, in 4.2.2 it is stated that the clamp factor is a function of the EUT, the clamp properties and the site performance. For standardization (reproducibility) reasons, the calibration method shall use a test site with a specified and reproducible performance, and a signal generator and receiver with reproducible performance. Under these conditions, the only variable left is the absorbing clamp under consideration.

Three absorbing clamp calibration methods are developed below, each with their own advantages, disadvantages and applications (see Table 1). Figure 3 gives a schematic overview of the three possible methods.

In general, each of the calibration methods comprises the following two steps.

First, as a reference, the output power P_{gen} of the RF generator (with 50Ω output impedance) is measured directly through a 10 dB attenuator using a receiver (Figure 3a). Secondly, the disturbance power of the same generator and 10 dB attenuator is measured through the clamp using one of the following three possible methods.

a) The original method

The original absorbing clamp set-up calibration method uses a reference site including a large vertical reference plane (Figure 3b). By definition this method gives the CF directly, because this is the original calibration method, which is used for the determination of the limits and therefore considered as the reference. The lead under test is connected to the centre conductor of the feed-through connector in the vertical reference plane. At the back of this vertical plane, the feed-through connector is connected to the generator. For this calibration configuration, P_{orig} is measured while the clamp is moved along the lead under test, in accordance with the procedure described in Annex B such that for each frequency the maximum value is obtained. The minimum site attenuation A_{orig} and the absorbing clamp factor CF_{orig} can be determined using the following equations:

$$A_{\text{orig}} = P_{\text{gen}} - P_{\text{orig}} \quad (5)$$

and

$$CF_{\text{orig}} = A_{\text{orig}} - 17 \quad (6)$$

The minimum site attenuation A_{orig} is in the range of about 13 dB to 22 dB.

b) The jig calibration method

The jig calibration method uses a jig that can be adapted to the length of the absorbing clamp under calibration and the secondary absorbing device (SAD). This jig serves as a reference structure for the absorbing clamp (see Figure 3c). For this calibration configuration P_{jig} is measured as a function of frequency while the clamp is in a fixed position within the jig. The site attenuation A_{jig} and the absorbing clamp factor CF_{jig} can be determined using the following equations: