มาตรฐานผลิตภัณฑ์อุตสาหกรรม

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ข้อกำหนดสำหรับอุปกรณ์และวิธีการวัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน

เล่ม 1–3 อุปกรณ์วัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน – บริภัณฑ์ช่วย – กำลังไฟฟ้ารบกวน

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS–

PART 1–3 : RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS – ANCILLARY EQUIPMENT – DISTURBANCE POWER

สำนักงานมาตรฐานผลิตภัณฑ์อุตสาหกรรม

กระทรวงอุตสาหกรรม

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สำนักงานมาตรฐานผลิตภัณฑ์อุตสาหกรรม

กระทรวงอุตสาหกรรม ถนนพระรามที่ 6 กรุงเทพฯ 10400

โทรศัพท์ 0 2202 3300

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วันที่ 10 สิงหาคม พุทธศักราช 2549

บริภัณฑ์ไฟฟ้าและอิเล็กทรอนิกส์ ตลอดจนบริภัณฑ์เทคโนโลยีสารสนเทศในขณะใช้งานจะต้องไม่ส่งสัญญาณรบกวนเข้าสู่ระบบไฟฟ้าหรือรบกวนการทำงานของบริภัณฑ์ข้างเคียง รวมทั้งตัวบริภัณฑ์เองก็ต้องมีภูมิคุ้มกันในระดับเพียงพอที่จะทำงานในสภาวะแวดล้อมทางแม่เหล็กไฟฟ้าในระดับหนึ่งได้ จึงกำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม ข้อกำหนดสำหรับอุปกรณ์และวิธีการวัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน เล่ม 1-3 อุปกรณ์วัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน - บริภัณฑ์ช่วย - กำลังไฟฟ้ารบกวน ขึ้น

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้กำหนดขึ้นโดยรับ CISPR 16-1-3(2004-06) Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-3 : Radio disturbance and immunity measuring apparatus - Ancillary equipment - Disturbance power มาใช้ในระดับเหมือนกันทุกประการ(identical) โดยใช้ CISPR ฉบับ ภาษาอังกฤษเป็นหลัก

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้กำหนดขึ้นเพื่อใช้ในการอ้างอิง และเพื่อให้ทันกับความต้องการของผู้ใช้มาตรฐาน ซึ่งจะได้แปลเป็นภาษาไทยในโอกาสอันสมควรต่อไป หากมีข้อสงสัยโปรดติดต่อสอบถามสำนักงานมาตรฐานผลิตภัณฑ์อุตสาหกรรม

คณะกรรมการมาตรฐานผลิตภัณฑ์อุตสาหกรรมได้พิจารณามาตรฐานนี้แล้ว เห็นสมควรเสนอรัฐมนตรีประกาศตามมาตรา 15 แห่งพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม พ.ศ. 2511

ประกาศกระทรวงอุตสาหกรรม

ฉบับที่ 3488 (พ.ศ. 2549)

ออกตามความในพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม

พ.ศ. 2511

เรื่อง กำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม

ข้อกำหนดสำหรับอุปกรณ์และวิธีการวัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน

เล่ม 1–3 อุปกรณ์วัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน –

บริภัณฑ์ช่วย – กำลังไฟฟ้ารบกวน

อาศัยอำนาจตามความในมาตรา 15 แห่งพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม พ.ศ. 2511 รัฐมนตรีว่าการกระทรวงอุตสาหกรรมออกประกาศกำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม ข้อกำหนดสำหรับอุปกรณ์และวิธีการวัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน เล่ม 1–3 อุปกรณ์วัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน – บริภัณฑ์ช่วย – กำลังไฟฟ้ารบกวน มาตรฐานเลขที่ มอก. 1441 เล่ม 3 – 2549 ไว้ ดังมีรายละเอียดต่อท้ายประกาศนี้

ประกาศ ณ วันที่ 26 เมษายน พ.ศ. 2549

สุริยะ จึงรุ่งเรืองกิจ

รัฐมนตรีว่าการกระทรวงอุตสาหกรรม

มาตรฐานผลิตภัณฑ์อุตสาหกรรม
ข้อกำหนดสำหรับอุปกรณ์และวิธีการวัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน
เล่ม 1-3 อุปกรณ์วัดสัญญาณรบกวนวิทยุและภูมิคุ้มกัน - บริภัณฑ์ช่วย - กำลังไฟฟ้ารบกวน

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้กำหนดขึ้นโดยรับ CISPR 16-1-3(2004-06) Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-3 : Radio disturbance and immunity measuring apparatus - Ancillary equipment - Disturbance power มาใช้ในระดับเหมือนกันทุกประการ (identical) โดยใช้ CISPR ฉบับภาษาอังกฤษเป็นหลัก

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้ได้รับการระบุให้เป็นมาตรฐานพื้นฐาน ซึ่งกำหนดลักษณะเฉพาะและการสอบเทียบประกับดูดกลืน สำหรับวัดกำลังไฟฟ้ารบกวนวิทยุ ในพิสัยความถี่ 30 เมกะเฮิรตซ์ ถึง 1 จิกะเฮิรตซ์

รายละเอียดให้เป็นไปตาม CISPR 16-1-3(2004 - 06)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

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

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 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.

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:

$$P_{eut} = CF_{act} + V_{rec} \tag{1}$$

where

P_{eut} = the disturbance power of the EUT in dBpW;
V_{rec} = the measured voltage in dBμV;
CF_{act} = the actual clamp factor in dBpW/μV.

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

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

where

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

V_{rec} = measured voltage level in dBμV.

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:

$$P_{eut} - P_{rec} = CF_{act} + 17 \tag{3}$$

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).

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

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 mm ± 40 mm.

e) A 50 Ω 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 50 Ω 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:

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

and

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

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:

$$A_{\text{jig}} = P_{\text{gen}} - P_{\text{jig}} \tag{7}$$

and

$$CF = A_{\text{jig}} - 17 \tag{8}$$

c) The reference device method

The reference device method uses a reference site (without vertical reference plane) and a reference device that is fed through the lead under test, which is a coaxial structure for this purpose (see Figure 3d).

For this calibration configuration, P_{ref} is measured while the absorbing clamp is moved along the lead under test in accordance with the procedure described in Annex A such that for each frequency the maximum value is obtained. The minimum site attenuation A_{ref} and the absorbing clamp factor CF_{ref} can be determined using the following equations:

$$A_{\text{ref}} = P_{\text{gen}} - P_{\text{ref}} \tag{9}$$

and

$$CF_{\text{ref}} = A_{\text{ref}} - 17 \tag{10}$$

Annex B describes the three possible absorbing clamp calibration methods in more detail. A survey of the three clamp calibration methods is also given in Figure 1. Figure 1 also gives the relation of the clamp measurement method and the clamp calibration methods and the role of the reference site.

NOTE Calibration takes place on clamp, attenuator and cable. They have to be held together.

The absorbing clamp factors obtained through the jig method and the reference device method (CF_{jig}, CF_{ref}) differ systematically from the original absorbing clamp factor CF_{orig}. It is necessary to establish this systematic relation between these different clamp factors as follows.

The jig transfer factor *JTF* is calculated by

$$JTF = CF_{\text{jig}} - CF_{\text{orig}} \tag{11}$$

The *JTF* in dB is to be determined for each type of absorbing clamp by the clamp manufacturer. The manufacturer or an accredited calibration laboratory in charge shall determine the *JTF* by averaging the results of at least five reproduced calibrations for five devices of a production series. Similarly, the reference transfer factor *RTF* is determined by

$$RTF = CF_{\text{ref}} - CF_{\text{orig}} \tag{12}$$

Again, the *RTF* in dB is to be determined for each type of absorbing clamp by the clamp manufacturer. The manufacturer or an accredited calibration laboratory in charge shall determine the *RTF* by averaging the results of at least five reproduced calibrations for five devices of a production series.

In summary, the original calibration method directly gives the value of CF_{orig}. The jig and the reference device method give the CF_{jig} and the CF_{ref} respectively, from which the original absorbing clamp factor can be calculated using Equations (11) and (12).

4.4 The secondary absorbing device

In addition to the absorbing part of the clamp, a secondary absorbing device (SAD) directly behind the absorbing clamp shall be applied to reduce the uncertainty of the measurement. The function of this SAD is to provide an attenuation in addition to that provided by the decoupling attenuation of the absorbing clamp. The SAD shall be moved in the same way as the absorbing clamp during the calibration and measurement. Therefore the SAD needs wheels to accommodate the scanning. The SAD dimensions shall be such that the lead under test is at the same height as in the absorbing clamp.

The decoupling factor of the SAD shall be verified in accordance with the measurement procedure as described in Annex B. The decoupling factor for the SAD is measured together with the absorbing clamp.

NOTE New technologies may make it possible for the additional functionality of the SAD to be integrated in the absorbing clamp. Consequently, if the absorbing clamp itself meets the decoupling factor specification, then the SAD does not need to be applied.

4.5 The absorbing clamp test site (ACTS)

4.5.1 Description of the ACTS

The absorbing clamp test site (ACTS) is a site used for application of the ACMM. The ACTS can be either an outdoor or an indoor facility and includes the following elements (see Annex C, Figure C.1):

– the EUT table, which is a support for the EUT unit;
– the clamp slide, which is a support for the connected lead of the EUT (or lead under test, LUT) and for the absorbing clamp ;
– a gliding support for the receiver cable of the absorbing clamp;
– auxiliary means like a rope to move the absorbing clamp

All the above-mentioned ACTS elements (without EUT table) shall be measured in the ACTS validation procedure.

The near end of the clamp slide (at the side of the EUT) is denoted as the slide reference point (SRP, see Figure C.1). This SRP is used to define the horizontal distance to the CRP of the clamp.

4.5.2 The functions of the ACTS

The ACTS has the following functions.

a) Physical function: to provide specific supporting means for the EUT and the LUT.
b) Electrical function: to provide an ideal (for RF) site for the EUT and the clamp assembly and to provide a well-defined measurement environment for application of the absorbing clamp (no distortion of emissions by walls or by the supporting elements like the EUT table, the clamp slide, gliding support and rope).

4.5.3 Requirements for the ACTS

The following requirements apply for the ACTS:

a) The length of the clamp slide shall ensure that the absorbing clamp can be moved over a distance of 5 m. This means that the clamp slide shall have a length of 6 m.

NOTE For reproducibility reasons, the length of the clamp slide and the scanning distance of the clamp are fixed to at least 6 m and 5 m respectively. The length of the clamp slide is determined by the sum of the scanning length (5 m), the margin between the SRP and the CRP (0,15 m) and the length of the absorbing clamp (0,64 m) plus a margin to accommodate lead fixtures at the end (0,1 m). This totals a length of 6 m for the clamp slide.

b) The height of the clamp slide shall be 0,8 m ± 0,05 m. This implies that within the absorbing clamp and within the SAD, the height of the LUT above the reference plane will be a few centimetres larger.

c) The material of the EUT table and of the clamp slide shall be non-reflecting, non-conducting and the dielectric properties may be close to the dielectric properties of air. In this way, the EUT table is transparent from an electromagnetic point of view.

d) The material of the rope used to move the clamp along the clamp slide shall also be transparent from an electromagnetic point of view.

NOTE The influence of the material of the EUT table and the clamp slide may be significant for frequencies above 300 MHz.

e) The adequacy of the site (see the electrical ACTS function) is validated by comparing the in-situ measured clamp factor of the ACTS ($CF_{\text{in-situ}}$) with the clamp factor measured on the absorbing clamp reference site (ACRS) (CF_{orig}) using the original calibration method (see Annex C). The absolute difference between both clamp factors shall comply with the following requirement:

$$\Delta_{\text{ACTS}} = \left| CF_{\text{orig}} - CF_{\text{in-situ}} \right| \tag{13}$$

shall be

<2,5 dB between 30 MHz and 150 MHz,

2,5 dB to 2 dB between 150 MHz and 300 MHz, decreasing and

<2 dB between 300 MHz and 1 000 MHz

This site validation procedure is specified in more detail in the next subclause.

4.5.4 Validation methods for the ACTS

The characteristics for the ACTS are validated as follows.

– The physical requirements 4.5.3a) and 4.5.3b) can be validated by inspection.

– The electrical function of the ACTS (requirement 4.5.3e) shall be validated by comparing the clamp factor *CF* of the calibrated clamp with the clamp factor $CF_{\text{in-situ}}$ measured in-situ, in accordance with the "original calibration method" (see Annex C).

Investigations have shown that a 10 m OATS or SAR validated for radiated emission measurements can be considered as an ideal site for performing the ACMM. Therefore, a validated 10 m OATS or SAR is adopted as a reference site for electrical validation of the ACTS. Consequently, if a validated 10 m OATS or SAR is used as a clamp test site, then the electrical function of this site does not need to be validated further.

The validation procedure of the electrical function of a clamp test site is described in detail in Annex C.

4.6 Quality assurance procedures for the absorbing clamp instrumentation.

4.6.1 Overview

The performance of an absorbing clamp and secondary absorbing device may change over time due to use, aging or defects. Similarly, the ACTS performance may change due to modifications in the construction or by aging.

The jig calibration method and the reference device calibration method can be used conveniently for quality assurance procedures, provided that the jig clamp factor and the reference device clamp factor are initially known.

4.6.2 Quality assurance check for the ACTS

The data of the site attenuation A_{ref} of the ACTS determined at the time the site was validated can be used as a reference.

After a certain time interval and after modification of the site, this site attenuation measurement can be repeated, and the results compared with the reference data.

The advantage of this method is that all elements of the ACMM are evaluated at once.

4.6.3 Quality assurance check for the absorbing clamp

The decoupling functions and the clamp factor performance determined at the time the clamp has been validated can be used as reference performance data.

After certain time intervals or after a change made to the site, these performance parameters can be verified again by measuring the decoupling factors and by measuring the clamp factor using the jig method (Annex B).

4.6.4 Quality assurance pass/fail criteria

The pass/fail criteria for the quality assurance tests are related to the measurement uncertainty of the measurement parameter in question. This means that a change of the parameter in question is acceptable if this change is less than one times the measurement uncertainty.

ABSORBING CLAMP MEASUREMENT METHOD (ACMM)
(CISPR 16-2-2 Clause 7)

Requires:
- EUT
- *a calibrated clamp*
- *a validated abs. clamp test site (ACTS)*
- a calibrated receiver
- specified test set-up
- specified test procedure

Gives: disturbance power of an EUT

VALIDATION OF THE ABS CLAMP TEST SITE (ACTS)
(specified in Annex C)

Requires:
- the ACT (absorbing clamp test site) under validation
- *a calibrated clamp* with the SAD calibrated with the original method
- a calibrated receiver
- a specific test set-up
- a specific test procedure

Gives: a validated test absorbing clamp test site

CLAMP CALIBRATION METHODS
(specified in Annex B)

a. Validation of the clamp
Requires:
The validation of the decoupling functions of the clamp with the secondary absorbing device

b. The original method
Requires:
- the clamp under calibration with the SAD
- measurement equipment
- *a validated site: ACRS (absorbing clamp reference site)*
- a specified source (generator + large vertical reference plane)
- a specified test set-up
- a specified test procedure

Gives: the original clamp factor (CF_{orig})

c. The jig method
Requires:
- the clamp under calibration with the SAD
- measurement equipment
- a calibration jig
- a specified source
- a specified test set-up
- a specified test procedure

Gives: the clamp factor CF_{jig} and CF_{orig} can be calculated using the jig transfer factor JTF.

d. The reference device method
Requires:
- the clamp under calibration with the SAD
- measurement equipment
- *a validated site: ACRS (absorbing clamp reference site)*
- the clamp reference device
- a specified test set-up
- a specified test procedure

Gives: the clamp factor CF_{ref} and CF_{orig} can be calculated using the reference transfer factor RTF.

VALIDATION OF DECOUPLING FUNCTIONS OF THE ABSORBING CLAMP WITH THE SECONDARY DEVICE (Annex B)

Requires:
- the clamp with the SAD
- a jig
- a specified source
- measurement equipment
- specified test setup
- specified test procedure

ABS CLAMP REFERENCE SITE (ACRS)

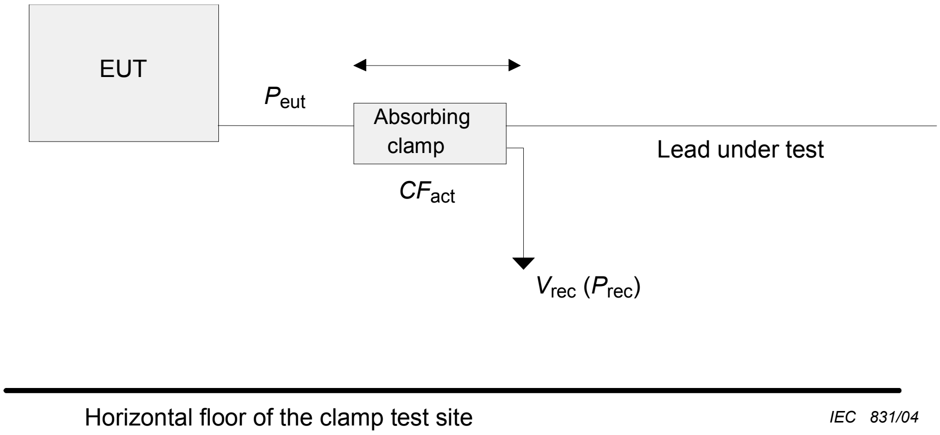
A 10 m OATS or SAR, validated for radiated emission measurements between 30 MHz and 1 000 MHz is considered also valid as a site for clamp calibration.

IEC 830/04

Figure 1 – Overview of the absorbing clamp measurement method and the associated calibration and validation procedures

Table 1 – Overview of the characteristics of the three-clamp calibration methods and their relation

Name of the calibration method	Test Site used	EUT used	Advantages (+), disadvantages (-) and remarks (•)	Applications
The original method	An absorbing clamp reference site	Large vertical reference plane and fed behind this reference plane by a generator	• Calibration set-up resembles an actual measurement with a large EUT – Handling of the large vertical reference plane is laborious – A reference site (ACRS) required + By definition this method gives the *CF* directly because this method is the original calibration method and therefore considered as the reference	Direct calibration of the absorbing clamp
The jig method	An absorbing clamp calibration jig	One of the vertical flanges of the jig and fed behind this jig flange by a generator	– Calibration set-up does not resemble an actual test + Convenient handling + No reference site (ACRS) required + Good reproducibility – Does not give the *CF* directly; *CF* is calculated using the JTF	Indirect calibration of the absorbing clamp Quality assurance check of the clamp
The reference device method	An absorbing clamp reference site	Small reference device fed from the far end by a generator	• Calibration set-up resembles an actual measurement with a large EUT + Reference device easy to handle – A reference site (ACRS) required – Does not give the *CF* directly; *CF* is calculated using the RTF	Indirect calibration of the absorbing clamp Validation of the ACTS Quality assurance check of the overall clamp measurement set-up
NOTE An ACRS is a validated 10 m OATS or SAR facility.				



Key

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

V_{rec} the measured voltage in dBμV;

CF_{act} the actual clamp factor in dBpW/μV;

P_{rec} the received power level in dBpW.

Figure 2 – Schematic overview of the absorbing clamp test method

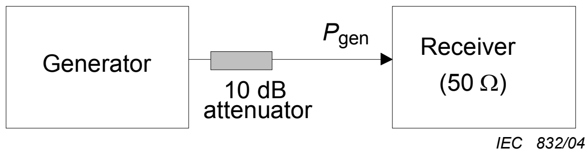


Figure 3a

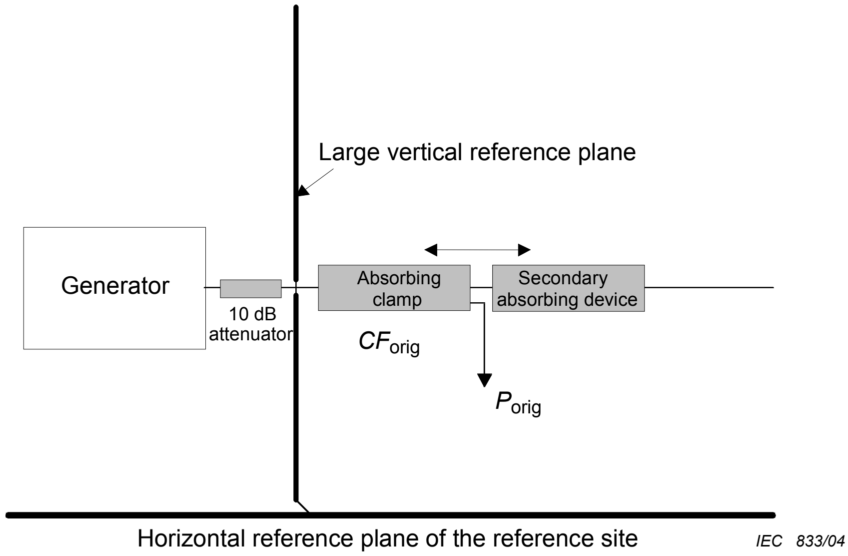


Figure 3b

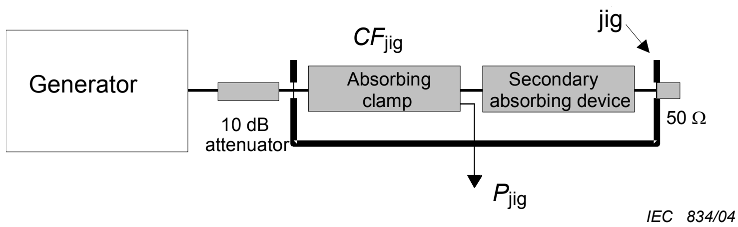


Figure 3c

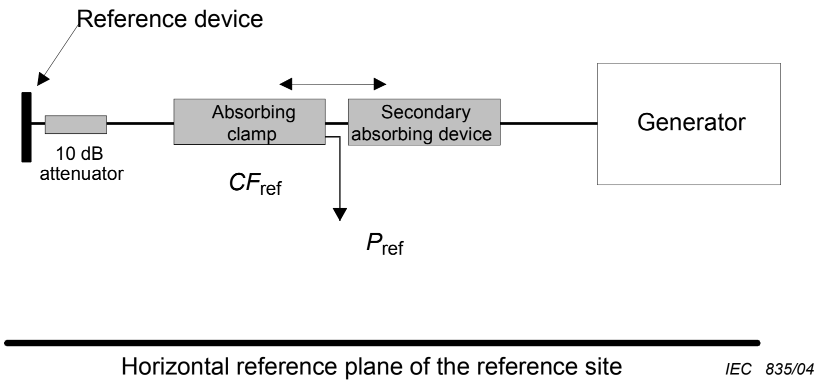


Figure 3d

Key

CF_{orig}, CF_{jig}, CF_{ref}	Absorbing clamp factors
P_{orig}, P_{ref}, P_{jig}	Measurement of *P* depending on validation method used
P_{gen}	Output power of the generator and 10 dB attenuator

NOTE Figures 3b., 3c., and 3d correspond respectively to the three methods of Table 1.

Figure 3 – Schematic overview of the clamp calibration methods

(informative)

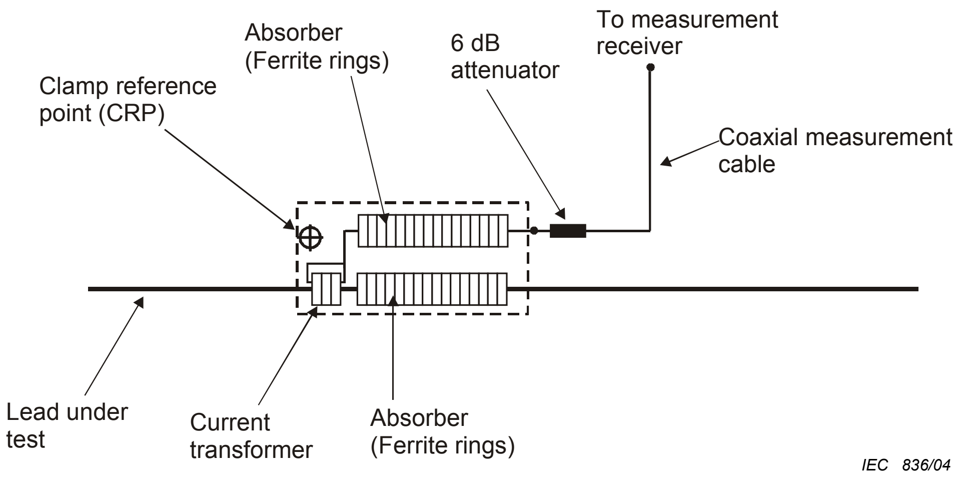
Construction of the absorbing clamp
(Subclause 4.2)

A.1 Examples of absorbing clamp construction

Figures A.1 and A.2 describe the basic assembly of the 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 (possibly via the 6 dB attenuator). C and D are mounted close together and aligned on the same axis to permit movement along the lead under test B. 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.

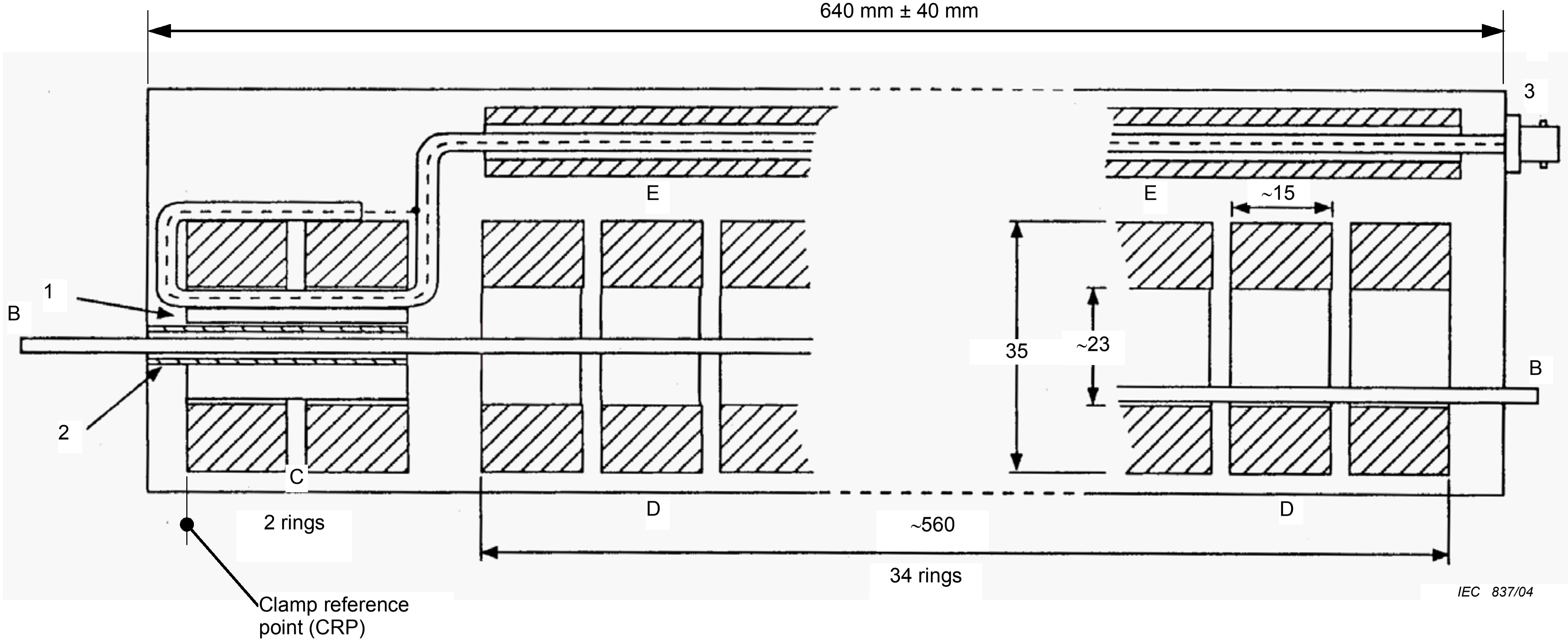
The example in Figure A.2 shows also some features of improvements to the absorbing clamp performance. A metal cylinder (1) is mounted inside the core of the transformer C to act as a capacitive shield. This cylinder is split into two halves. An insulating tube (2) is used to centralize the lead within 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 constructed to cover the frequency range 30 MHz to 1 000 MHz using suitable ferrite rings.



NOTE The 6 dB attenuator and measurement cable are integral part of the clamp assembly.

Figure A.1 – The absorbing clamp assembly and its parts



Key

B	lead under test
C	current transformer
D	absorbing section
E	absorbing section on cable from transformer
1	metal cylinder - two halves
2	centralizing tube for lead B
3	coaxial connector (for the 6 dB attenuator)

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

Annex B
(normative)

Calibration and validation methods for the absorbing clamp and the secondary absorbing device
(Clause 4)

B.1 Introduction

This annex gives details on the various calibration and validation methods for the absorbing clamp assembly and for the secondary absorbing device.

The methods for the calibration of the clamp factor of the absorbing clamp (see also 4.3) are given in B.2.

The methods for validation of the decoupling functions *DF* and *DR* are given in Article B.3.

B.2 Calibration methods of the absorbing clamp assembly

For all three methods, the clamp factor (*CF*) of the absorbing clamp assembly including the attenuator of at least 6 dB and the receiver cable is determined. Since the decoupling of the clamp is not perfect, the clamp interacts with the cable. The type and length of the cable may thus influence the resultant uncertainty. Therefore the calibration shall be done including the receiver cable.

B.2.1 The original calibration method

B.2.1.1 Calibration set-up and equipment

Figure B.1 shows the calibration set-up. The calibration set-up must be located on an ACRS to avoid influencing its immediate surroundings. If the ACRS does not have a metallic ground plane, a horizontal ground plane of typically 6 m × 2 m is required.

An ACRS that is valid for this calibration procedure is an OATS or a SAR for a 10 m measurement distance that complies with the CISPR NSA requirements.

The calibration set-up is comprised of the following components:

– a clamp slide constructed of non-reflective material about 6 m long, to ensure that the lead under test is at a height of 0,8 m ± 0,05 m above the ground. This implies that within the absorbing clamp and within the SAD, the height of the LUT above the reference plane will be a few centimetres larger;
– a vertical ground plane larger than 2,0 m × 2,0 m, connected to the metallic ground plane and with a type N jack mounted in its vertical symmetrical axis at a height of 0,87 m. This vertical ground plane is positioned close to the front of the clamp slide, which is called the absorbing clamp test site reference point (SRP);
– an insulated lead for test purposes, with a length of 7,0 m ± 0,05 m and made of lead with 4 mm diameter not counting the insulation, with one end of the lead connected (e.g. soldered) to the mounting jack. The other end of the lead is connected to the line and neutral of a type M CDN (see CISPR 16-1-2 Figure C.2), which is connected to the metallic (horizontal) ground plane; the measurement output of the CDN is terminated with

50 Ω (**for safety reasons the CDN is not connected to the mains!**). This CDN provides in the frequency range up to 40 MHz to 50 MHz a required stable asymmetrical impedance at the far end of the lead under test;

– an appropriate non-metallic clamping device at the other end of the clamp slide, to slightly stretch the lead under test;
– a secondary absorbing device (SAD) positioned on the clamp slide 50 mm from the clamp under calibration. The secondary absorbing device may be a (gliding) ferrite clamp with a decoupling function *DF* larger than or equal to that defined in Clause 4;
– a buffer of electromagnetically-transparent material near the vertical ground plane to ensure that the CRP is never less than 150 mm from the vertical ground plane.

A receiver or a network analyzer is used to measure the generator output and clamp output. The measured signal levels shall be 40 dB higher than the ambient signals measured at the output of the absorbing clamp when the generator is switched off. The non-linearity of the measurement system shall be less than 0,1 dB.

As reference measurement, the tracking generator output of the receiver or network analyser (NA) is connected via the coaxial cable through a 10 dB attenuator to the input of the NA.

B.2.1.2 Calibration procedure

A non-metallic guide for the lead under test is mounted on the outside of the absorbing clamp under test so that the lead passes through the centre of the current transformer (Figure B.2).

Both clamps – the clamp under test and the second absorbing clamp (SAD) – are positioned on the clamp slide as shown in Figure B.1. The current transformer of the clamp under test is placed with its side towards the vertical ground plane. The front edge of the current transformer is the clamp reference point (CRP) and shall be marked by the manufacturer. The clamp is positioned with a distance of 150 mm between the CRP and the vertical ground plane. The lead under test is passed through both clamps and should be stretched slightly using an appropriate non-metallic clamping device at the end of the clamp slide. The lead under test must not touch the metallic groundplane before it is connected to the CDN.

The output of the NA is connected to the mounting jack via a coaxial cable and a 10 dB attenuator. The receiver cable of the absorbing clamp is connected to the input of the NA.

The site attenuation is measured at least up to 60 MHz in 1 MHz steps, up to 120 MHz in 2 MHz steps, up to 300 MHz in 5 MHz steps, and above 300 MHz in 10 MHz steps.

The minimum site attenuation is measured while the two clamps (absorbing clamp plus SAD) are moved together at a suitable speed along the clamp slide. The clamps may be pulled by means of a non-metallic rope. The speed at which the clamps are moved must allow the site attenuation to be measured at each frequency at intervals of less than 10 mm.

The clamp factor CF_{orig} of the absorbing clamp assembly is calculated from the clamp site attenuation using Equation (5) of 4.3.

B.2.2 The jig calibration method

B.2.2.1 Specification of the absorbing clamp calibration jig

As described in Clause 4, the absorbing clamp calibration jig can be used for the calibration of the absorbing clamp. The jig is used for the measurement of the insertion loss of the absorbing clamp together with the SAD in a 50 Ω measuring system. Note that the empty jig characteristic impedance is not 50 Ω. The measurement in a jig allows this insertion loss to be measured in isolation from environment. The dimensional specifications of the jig and the arrangement of the clamps are shown in Figures B.3 to B.5.

B.2.2.2 Calibration procedure

A non-metallic guide for the lead under test is mounted on the front side of the absorbing clamp under test so that the lead passes through the centre of the current probe (Figure B.2). The absorbing clamp is then positioned in the jig with the clamp reference point (CRP) of the absorbing clamp 30 mm from the vertical flange as shown in Figure B.3 and B.4. The same distance of 30 mm is used for the end of the SAD to the other vertical flange. The lead under test is connected to the sockets in the vertical flanges by banana plugs.

The insertion loss is measured using a NA. The measured signal level shall be 40 dB higher than the ambient signals measured at the output of the absorbing clamp. The non-linearity of the insertion loss measurement shall be less than 0,1 dB.

The output of the NA is connected via a coaxial cable and a 10 dB attenuator to the input of the NA to calibrate the measurement set-up.

After the measurement set-up has been calibrated, the output of the NA is connected via the coaxial cable and a 10 dB attenuator to the mounting jack on the side of the jig where the CRP of the clamp is positioned. The mounting jack opposite the CRP is terminated with 50 Ω. The output of the absorbing clamp is connected via a 6 dB attenuator and the receiver cable to the input of the NA.

The insertion loss is then measured at least up to 60 MHz in 1 MHz steps, up to 120 MHz in 2 MHz steps, up to 300 MHz in 5 MHz steps, and above 300 MHz in 10 MHz steps.

The clamp factor CF_{jig} is calculated from the insertion loss using Equation (7). The manufacturer shall determine at least the jig transfer factor *JTF* defined in 4.3, Equation (11), which allows the CF_{orig} for this type of absorbing clamp to be calculated.

B.2.3 The reference device calibration method

B.2.3.1 Specification and use of the reference device and test site

The reference device shall be able to excite by capacitive coupling a defined current on the lead under test, independent of any environment, supply voltage and measurement equipment. This is ensured when the reference device is fed with an RF voltage through a coaxial cable via a 10 dB attenuator. The reference device is constructed with same material as single-sided circuit boards. In the middle of the board there is a coaxial connector mounted in such a way that the middle-pin only is connected to the copper-foil. The coaxial connector is connected to the 10 dB attenuator (see Figure B.7). A double shielded cable shall be used to connect this reference device to ensure that the asymmetrical currents induced on the lead under test are caused by the reference device and not from direct leakage within the cable.

The reference device replaces the large vertical ground plane in the original calibration procedure on an ACRS. The calibration set-up is shown in Figure B.6. The site suitable for this calibration method is the ACRS. An ACRS that is valid for this calibration procedure is an OATS or a SAR for a 10 m measurement distance that complies with the CISPR NSA requirements.

B.2.3.2 Calibration procedure

A non-metallic guide for the lead under test is mounted on the outside of the absorbing clamp under test so that the lead passes through the centre of the current transformer (Figure B.2).

Both clamps – the clamp under test and the second (ferrite) clamp (SAD) – are positioned on the clamp slide as shown in Figure B.7. The current transformer of the clamp under test is placed with its side towards the reference device, which is positioned at the SRP of the clamp slide. The front edge of the current transformer is the clamp reference point (CRP) and shall be marked on the clamp case by the manufacturer. The clamp is positioned with a distance of 150 mm between the CRP and the reference device. The lead under test (the coaxial cable from the network analyzer) is passed through both clamps and should be stretched slightly using an appropriate non-metallic clamping device at both ends of the clamp slide.

The coaxial cable (lead under test) with the 10 dB attenuator is connected to the output of the NA. The receiver cable of the absorbing clamp is connected to the input of the NA.

The site attenuation is measured at least up to 60 MHz in 1 MHz steps, up to 120 MHz in 2 MHz steps, up to 300 MHz in 5 MHz steps, and above 300 MHz in 10 MHz steps.

The minimum site attenuation is measured while the two clamps are moved at a suitable speed from 150 mm to approximately 4,5 m from the reference device. The clamps may be pulled by means of a non-metallic rope. The speed at which the clamps are moved must allow the insertion loss to be measured at each frequency at intervals of less than 10 mm.

The clamp factor *CF* of the absorbing clamp assembly is calculated from the lowest measured site attenuation using Equation (9) of 4.3.

The manufacturer shall determine at least the reference device transfer factor *RTF* using 4.3, Equation (12), which allows the CF_{orig} for this type of absorbing clamp to be calculated.

B.2.4 Measurement uncertainty of the absorbing clamp calibration

The calibration uncertainty is to be mentioned in every calibration report. The calibration report shall consider the following uncertainty factors.

– The original calibration method:
  - the uncertainty of the measurement equipment,
  - the mismatch between the output of the absorbing clamp (with a 6 dB attenuator and receiver cable) and the measurement equipment, and
  - the repeatability of the calibrations, which includes factors such as centring the lead under test in the current transformer and guidance of the receiver cable to the network analyzer.

  The absorbing clamp is to fulfill the minimum requirement of the decoupling factors *DF* and *DR*.

– The jig calibration method:
  - the uncertainty of the clamp factor *CF*,
  - the uncertainty of the measurement equipment,
  - the mismatch between the output of the absorbing clamp (with a 6 dB attenuator and receiver cable) and the measurement equipment, and
  - repeatability of the calibrations, which includes factors such as centring the lead under test in the current transformer.

  The absorbing clamp is to fulfil the minimum requirement of the decoupling factors *DF* and *DR*.

– The reference device calibration method:
  - the uncertainty of the clamp factor *CF*,
  - the uncertainty of the measurement equipment,
  - the mismatch between the output of the absorbing clamp (with a 6 dB attenuator and receiver cable) and the measurement equipment, and
  - the repeatability of the calibrations, which includes factors such as centering the lead under test in the current transformer and guidance of the receiver cable to the network analyzer.

  The absorbing clamp is to fulfil the minimum requirement of the decoupling factors *DF* and *DR*.

Detailed guidance on the determination of the uncertainty budget of the clamp calibration method is given in CISPR 16-4-2.

B.3 Validation methods of the decoupling functions

B.3.1 The decoupling factor *DF* of the absorbing clamp with the secondary absorbing device

The measurement method of the decoupling factor applies for the absorbing clamp with the secondary absorbing device as a requirement for the clamp manufacturer and an option for quality management proposes.

The decoupling factor *DF* is measured using the clamp calibration jig (see Figures B.3, B.4 and B.5). The decoupling factor *DF* measurement uses a 50 Ω measuring system for both the reference measurement and for the measurement with the device under test. A reference to an empty jig would give unrealistic measurement values, since the impedance of the jig changes when the clamp is inserted in the jig. Note that the empty jig is not a 50 Ω system!

The procedure for the measurement of the decoupling factor *DF* is as follows. Figure B.8 shows the two measurements steps that are necessary when using a spectrum analyzer. First a reference measurement is performed. The output of the generator is measured through two 10 dB attenuators. Then, the output P_{ref} is measured. After this the absorbing clamp with SAD is positioned as described in B.2.2.2. At both connections of the jig, a 10 dB attenuator is applied. The distance between the vertical flange of the jig and the reference point of the device under test (*CRP* in case of the clamp) and of the end of the clamp shall be 30 mm. Then the output P_{fil} is the measured. The decoupling factor *DF* is determined as follows:

$$DF = P_{ref} + P_{fil} \qquad \text{(B.1)}$$

The decoupling factor for the absorbing clamp with the SAD shall be at least 21 dB over the frequency band in question.

NOTE For information, the *DF* of the separated measured SAD should be about 15 dB.

This measurement may be performed also with a NA. In this case the application of the attenuators may be omitted if the NA calibration is performed at the interfaces that are connected to the jig.

B.3.2 The decoupling factor *DR* of the absorbing clamp

The decoupling factor *DR* is measured using the clamp calibration jig (see Figures B.3, B.4 and B.5) as a requirement for the clamp manufacturer and an option for quality management purposes.

The procedure for the measurement of the decoupling factor *DR* is as follows (see Figures B.8 and B.9). For the measurement of the asymmetrical voltage on the coaxial cable from the current transformer, the absorbing clamp without SAD is positioned in the jig as described in B.2.2.2. The measurement output is connected with a CDN type A (see CISPR 16-1-2, Figure C.1) via a short coaxial cable. The CDN is positioned on the metallic ground plane. A 50 Ω load shall be used to terminate the connection of the jig at the opposite side of the clamps CRP.

Figure B.8, step 1 shows the reference measurement that is necessary when using a spectrum analyzer. The output of the generator is measured through two 10 dB attenuators. Then, the output P_{ref} is measured.

After this, the absorbing clamp is set up as indicated in Figure B.9. The generator is connected to the jig (at the side that is closest to the *CRP* of the clamp) through a 10 dB attenuator. The other jig connection is terminated with a 50 Ω load. The output of the clamp is connected to a CDN. The measuring output of the CDN is connected to the receiver through a 10 dB attenuator. The output of the CDN is terminated with 50 Ω. Then the output P_{fil} is measured. The decoupling factor *DR* is determined as follows:

$$DR = P_{\mathrm{ref}} - P_{\mathrm{fil}} \qquad \text{(B.2)}$$

The decoupling factor for the absorbing clamp shall be at least 30 dB over the frequency band in question. The 30 dB contains 20,5 dB attenuation from the absorbing clamp and 9,5 dB from the CDN.

This measurement may be performed also with a NA. In this case the application of the attenuators may be omitted if the NA calibration is performed at the interfaces that are connected to the jig and CDN.

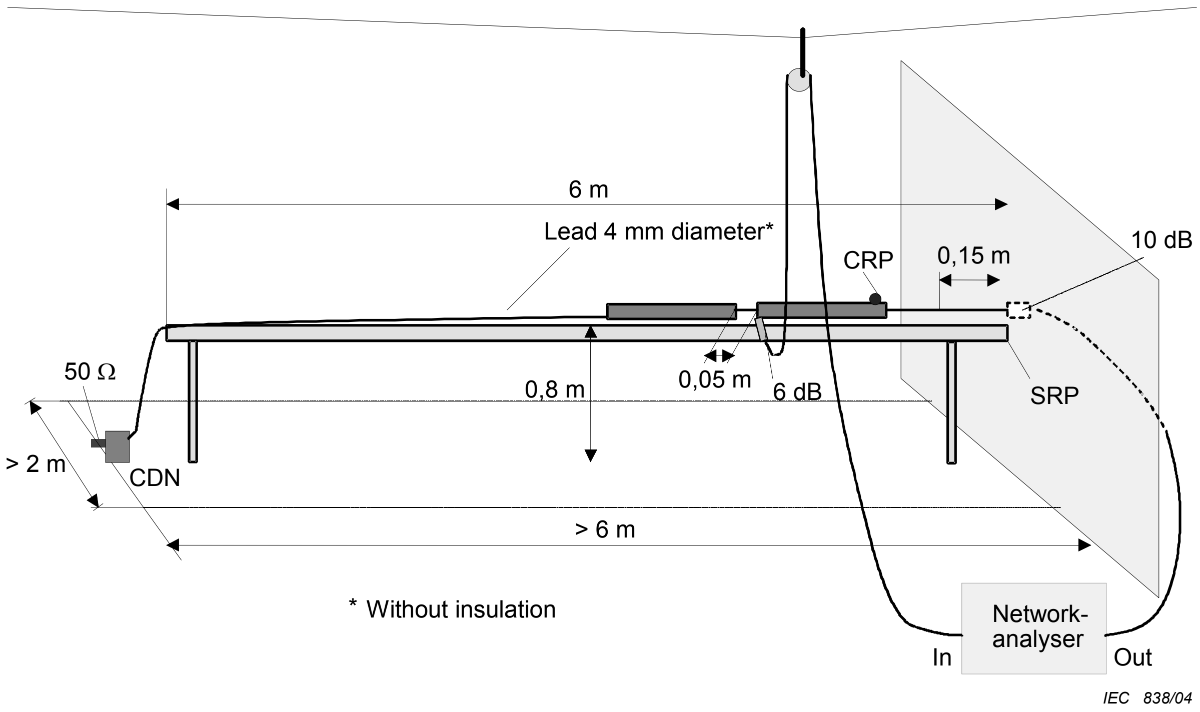
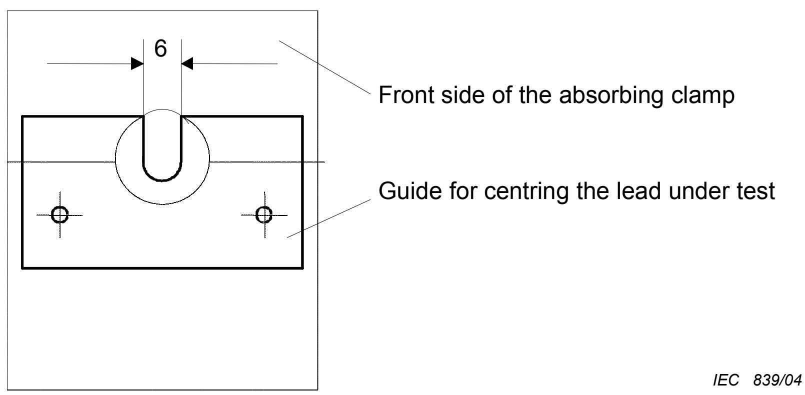


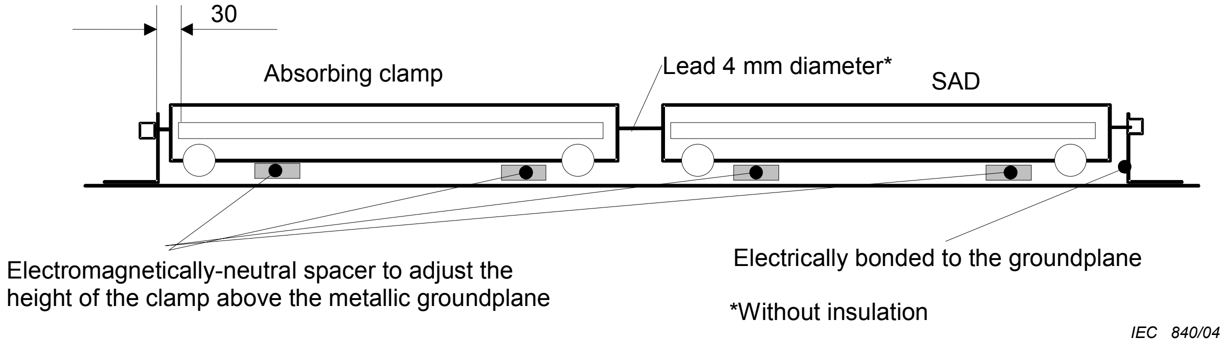
Figure B.1 – The original calibration site



Dimensions in mm

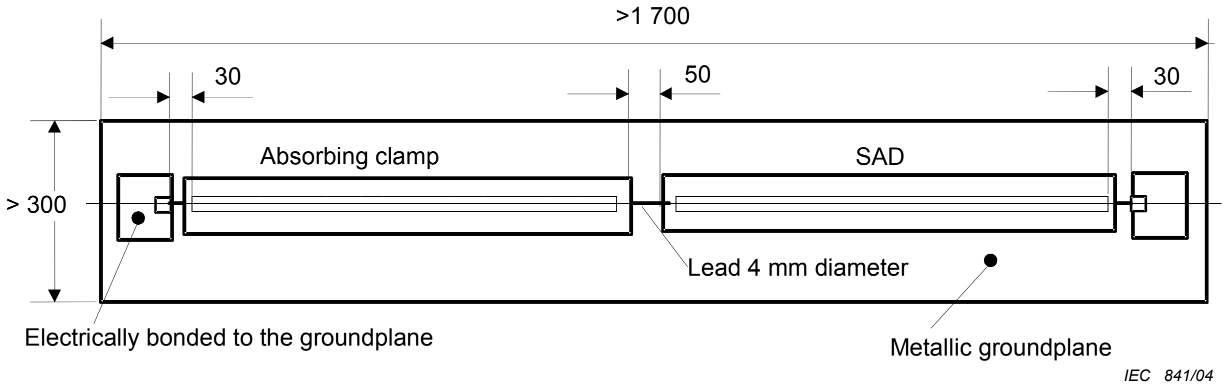
When using coaxial cable for the reference device, the slot shall be corrected to coaxial cables diameter.

Figure B.2 – Position of guide for centring the lead under test



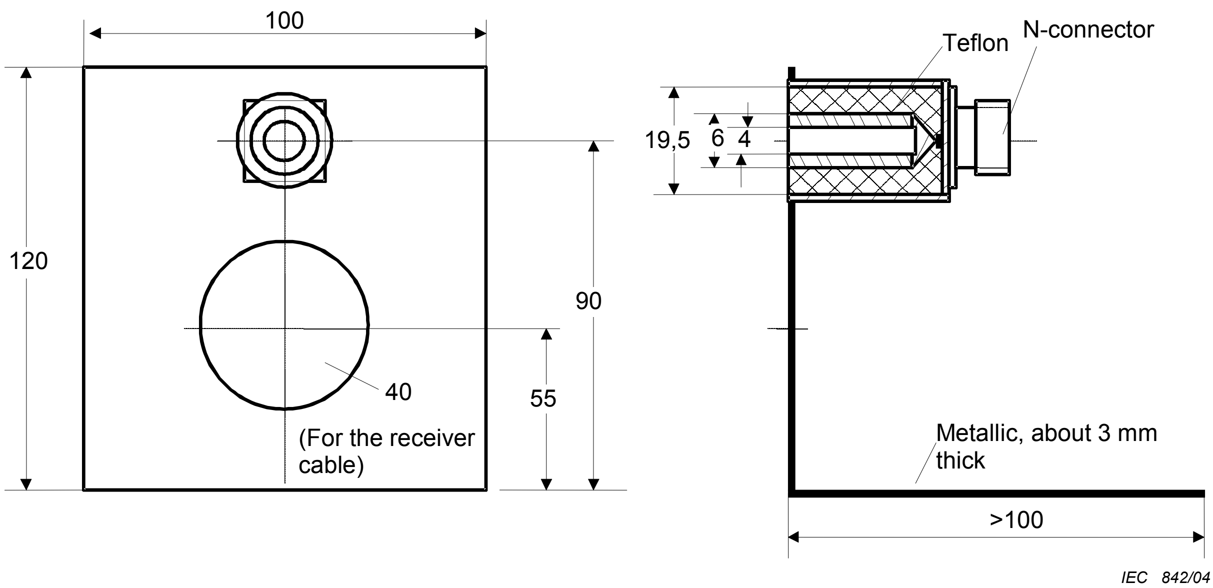
Dimensions in mm

Figure B.3 – Side view of the calibration jig



Dimensions in mm

Figure B.4 – Top view of the jig



Dimensions in mm

The bottom sides have to be electrically bonded to the metallic ground plane.

Figure B.5 – View of the jigs vertical flange

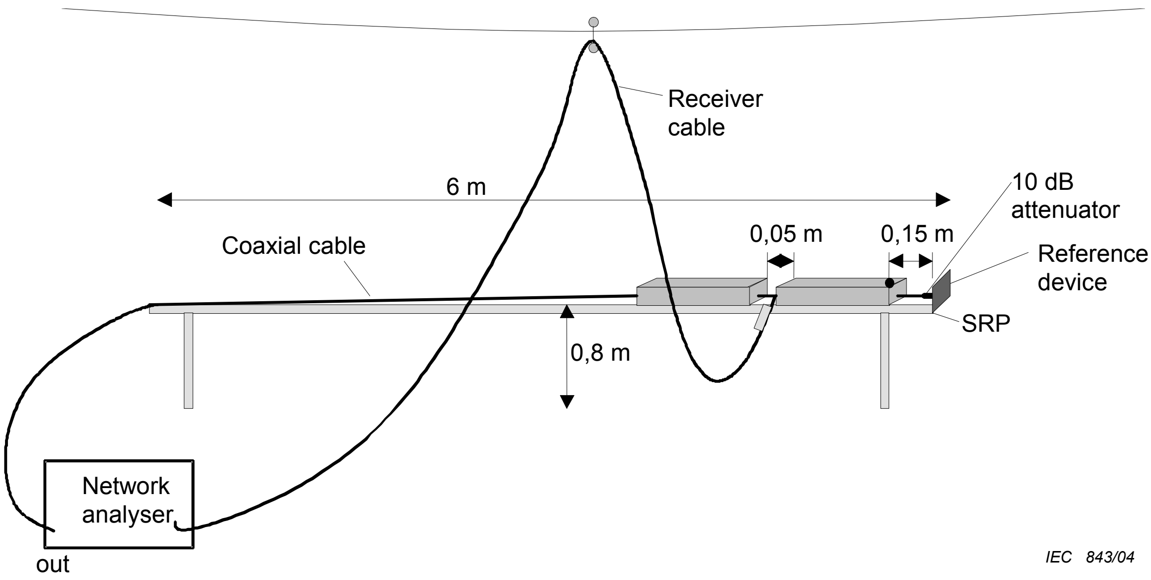
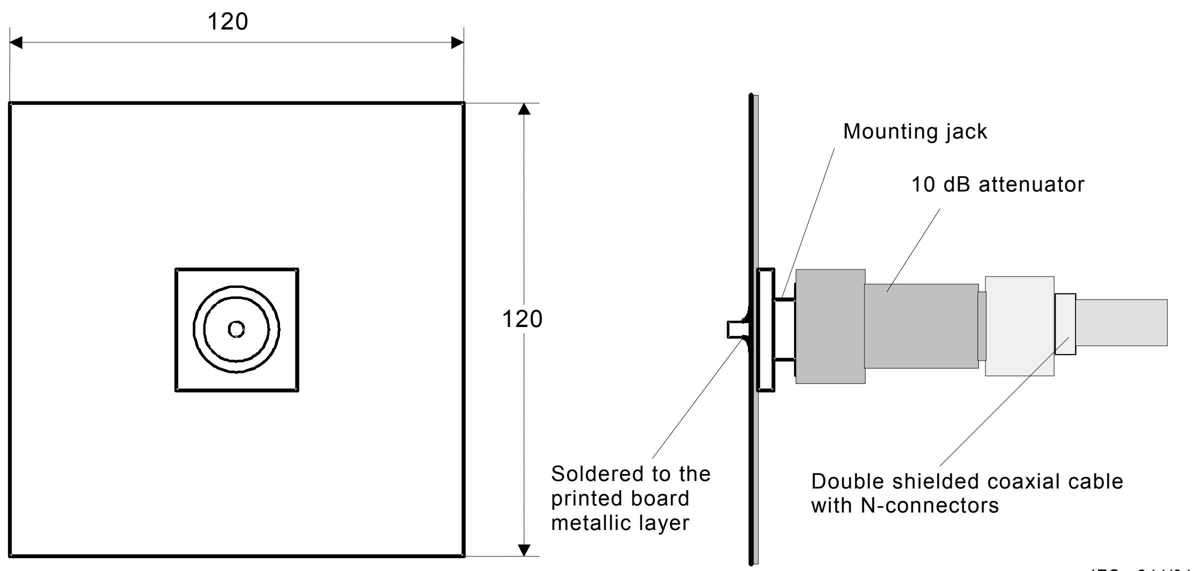


Figure B.6 – Test set-up for the reference device calibration method



Dimensions in mm

Figure B.7 – Specification of the reference device

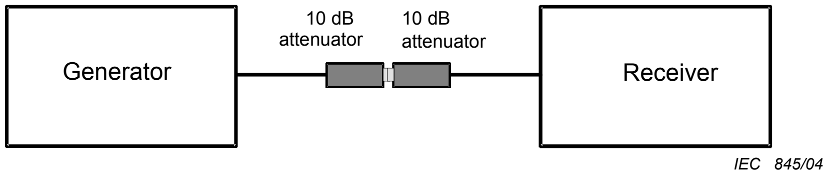


Figure B.8a – Reference measurement

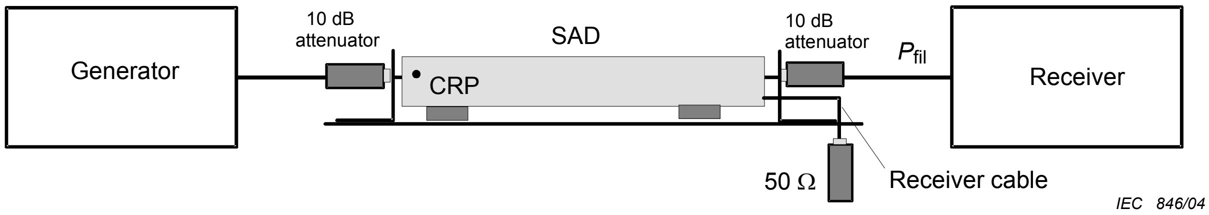
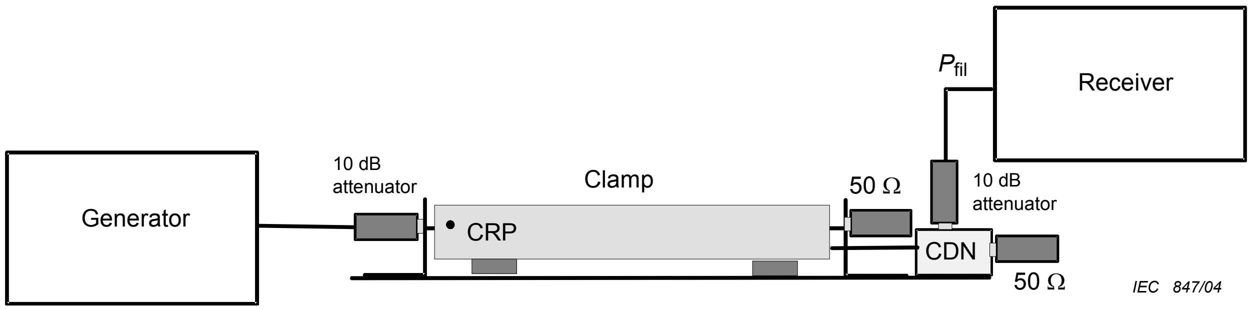


Figure B.8b – Measurement with the absorbing clamp and SAD placed in the jig

Figure B.8 – Measurement set-up of the decoupling factor *DF*



P_{fil} = Measured P attenuated by the absorbing filter

Figure B.9 – Measurement set-up of the decoupling factor *DR*

Annex C
(normative)

Validation of the absorbing clamp test site
(Clause 4)

C.1 Introduction

This annex gives the details on the method for the validation of the absorbing clamp test site.

An absorbing clamp test site (ACTS) shall be verified by comparing the clamp factor *CF* of a calibrated clamp with the in-situ at the ACTS measured clamp factor $CF_{\text{in-situ}}$ using the original calibration method (see 4.3 and Annex B).

C.2 Equipment requirements for validation

The original method (see Annex B.2.1) with vertical ground plane and the specific lead under test is used to generate a defined common mode current on the lead under test. This common mode current may be influenced by the environment of the ACTS, which may deviate from the ACRS.

C.3 Validation measurement procedure

The following calibration procedure is carried out on the ACTS to be validated.

- **The site attenuation measurement procedure**

- Step 1 – Reference measurement of generator power

First, as a reference, the output power P_{gen} of the generator is measured directly through the used cables and a 10 dB attenuator using a receiver (Figure C.1a).

- Step 2 – Measurement of the in-situ clamp factor on the ACTS

Secondly, the maximum disturbance power P_{ref} on the LUT is measured using the same generator setting and 10 dB attenuator and using the set-up given in Figure C.1b.

The two clamps – the absorbing clamp and the secondary absorbing device (SAD) – are positioned on the clamp slide as shown in Figure C.1b. The clamp reference point of the clamp under test is placed in the direction of the vertical ground plane. The vertical ground plane is positioned at the SRP of the clamp slide. A non-metallic guide for the LUT is mounted on the outside of the absorbing clamp under test so that the lead passes through the centre of the current transformer (Figure B.2). The clamp is positioned with a distance of 150 mm between the CRP and the vertical ground plane. The lead under test is passed through both clamps and should be stretched slightly using an appropriate non-metallic clamping device at both ends of the clamp slide. The lead under test is connected to the mounting jack on the vertical ground plane.

The output of the NA is connected to the mounting jack at the vertical ground plane via the 10 dB attenuator. The receiver cable of the absorbing clamp is connected to the input of the NA.

The signal is measured at least up to 60 MHz in 1 MHz steps, up to 120 MHz in 2 MHz steps, up to 300 MHz in 5 MHz steps, and above 300 MHz in 10 MHz steps.

The maximum disturbance power is measured while the clamps are moved at a suitable speed from 150 mm to approximately 4,5 m from the vertical ground plane. The clamps may be pulled by means of a non-metallic rope. The speed at which the clamps are moved must allow the insertion loss to be measured at each frequency at intervals of less than 10 mm.

- Step 3 – Calculation of the in-situ clamp factor

The in situ clamp factor (in dB) of the site under consideration (ACTS) can be determined using the following equation:

$$CF_{\text{in-situ}} = (P_{\text{gen}} - P_{\text{ref}}) - 17 \qquad \text{(C.1)}$$

This determination of CF_{orig} and $CF_{\text{in-situ}}$ can be done by the test house or by a third party (calibration test house) .

C.4 Validation of the ACTS

The original clamp factor CF_{orig} shall be compared with the in-situ clamp factor $CF_{\text{in-situ}}$. The acceptance criterion for the validation of the ACTS is given by Equation (13) (see 4.5.3) if the validation measurement and the calibration procedures (Clause C.3 and B.2.1) are done by the test house itself and provided that the uncertainty requirements given in Clause C.5 are met.

If the clamp factor is determined by a third party the acceptance criterion for the validation is changed to:

<3 dB	between 30 MHz and 150 MHz
3 to 2,5 dB	between 150 MHz and 300 MHz decreasing
<2 dB	between 300 MHz and 1 000 MHz

C.5 Uncertainties of the ACTS validation method

The measurement uncertainty of the ACTS validation depends on:

– the measurement uncertainty of the measurement equipment,
– the mismatch between the output of the absorbing clamp (with a 6 dB attenuator) and the measurement equipment, and
– the repeatability of the measurement, which includes the uncertainty centring the lead under test in the current transformer, and guidance of the receiver cable to the network analyzer.

For the clamp site validation procedure, the above mentioned uncertainty requirements shall be taken into account.

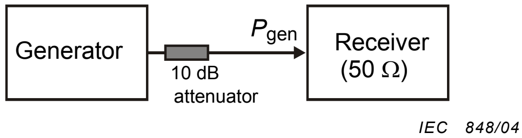


Figure C.1a – Reference measurement of generator power

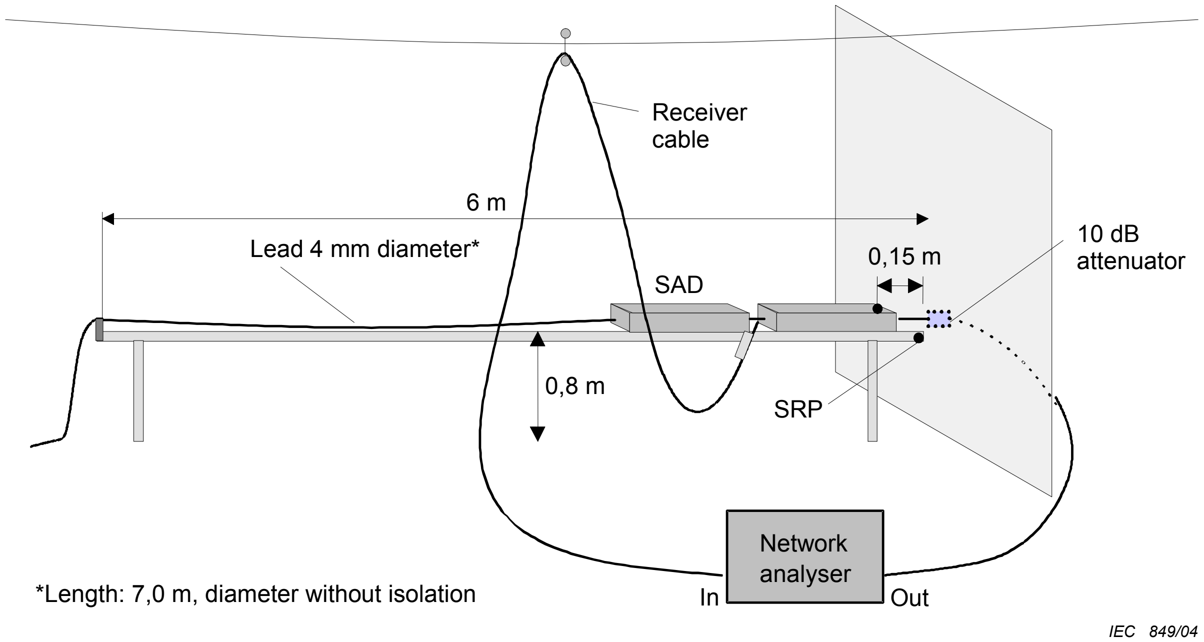


Figure C.1b – Set-up for power measurements on the ACTS or on the ACRS

Figure C.1 – Test set-ups for the site attenuation measurement for clamp site validation using the reference device