

# REDLINE VERSION



BASIC EMC PUBLICATION

**Electromagnetic compatibility (EMC) –  
Part 6-4: Generic standards – Emission standard for industrial environments**

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Part 6-4: Generic standards – Emission standard for industrial environments**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 33.100.10

ISBN 978-2-8322-5388-5

**Warning! Make sure that you obtained this publication from an authorized distributor.**

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**ELECTROMAGNETIC COMPATIBILITY (EMC) –****Part 6-4: Generic standards –  
Emission standard for industrial environments**

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**This Redline version provides you with a quick and easy way to compare all the changes between this standard and its previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.**

International Standard IEC 61000-6-4 has been prepared by CISPR subcommittee H: Limits for the protection of radio services.

This third edition cancels and replaces the second edition published in 2006 and Amendment 1:2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) possible future requirements on DC ports;
- b) possible future radiated polarity specific emission limits within a FAR;
- c) the definition of which average detector is used for emission measurements at frequencies above 1GHz and that results using a peak detector are acceptable for all measurements;
- d) the definition of different EUT test arrangements.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
CIS/H/339A/FDIS	CIS/H/350/RVD

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

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

It forms Part 6-4 of the IEC 61000 series of standards. It has the status of a basic EMC publication in accordance with IEC Guide 107.

A list of all parts in the CISPR 61000 series, published under the general title *Electromagnetic compatibility*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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

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## INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

### **Part 1: General**

General considerations (introduction, fundamental principles)

Definitions, terminology

### **Part 2: Environment**

Description of the environment

Classification of the environment

Compatibility levels

### **Part 3: Limits**

Emission limits

Immunity limits (insofar as they do not fall under the responsibility of the product committees)

### **Part 4: Testing and measurement techniques**

Measurement techniques

Testing techniques

### **Part 5: Installation and mitigation guidelines**

Installation guidelines

Mitigation methods and devices

### **Part 6: Generic standards**

### **Part 9: Miscellaneous**

Each part is further subdivided into several parts published either as International Standards or technical reports/specifications, some of which have already been published as sections. Others will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

# ELECTROMAGNETIC COMPATIBILITY (EMC) –

## Part 6-4: Generic standards – Emission standard for industrial environments

### 1 ~~Scope and object~~

~~This part of IEC 61000 for EMC emission requirements applies to electrical and electronic apparatus intended for use in industrial environments as described below.~~

~~Emission requirements in the frequency range 0 Hz to 400 GHz are covered. No measurement needs to be performed at frequencies where no requirement is specified.~~

~~This generic EMC emission standard is applicable if no relevant dedicated product or product-family EMC emission standard exists.~~

~~This standard applies to a apparatus intended to be connected to a power network supplied from a high or medium voltage transformer dedicated to the supply of an installation feeding manufacturing or similar plant, and intended to operate in or in proximity to industrial locations, as described below. This standard applies also to apparatus, which is battery operated and intended to be used in industrial locations.~~

~~The environments encompassed by this standard are industrial, both indoor and outdoor.~~

~~Industrial locations are in addition characterised by the existence of one or more of the following examples:~~

- ~~— industrial, scientific and medical (ISM<sup>1)</sup>) apparatus;~~
- ~~— heavy inductive or capacitive loads that are frequently switched;~~
- ~~— high currents and associated magnetic fields.~~

~~The object of this standard is to define the emission test requirements for apparatus defined in the scope in relation to continuous and transient, conducted and radiated disturbances.~~

~~The emission requirements have been selected so as to ensure that disturbances generated by apparatus operating normally in industrial locations do not exceed a level that could prevent other apparatus from operating as intended. Fault conditions of apparatus are not taken into account. Not all disturbance phenomena have been included for testing purposes in this standard but only those considered as relevant for the equipment covered by this standard. These requirements represent essential electromagnetic compatibility emission requirements.~~

This part of IEC 61000 for emission requirements applies to electrical and electronic equipment intended for use within the environment existing at industrial (see 3.1.12) locations.

This document does not apply to equipment that fall within the scope of IEC 61000-6-3.

The environments encompassed by this document cover both indoor and outdoor locations.

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<sup>1)</sup> As defined in CISPR 11.

Emission requirements in the frequency range 9 kHz to 400 GHz are covered in this document and have been selected to provide an adequate level of protection of radio reception in the defined electromagnetic environment. No measurement needs to be performed at frequencies where no requirement is specified. These requirements are considered essential to provide an adequate level of protection to radio services.

Not all disturbance phenomena have been included for testing purposes but only those considered relevant for the equipment intended to operate within the environments included within this document.

Requirements are specified for each port considered.

This generic EMC emission standard is to be used where no applicable product or product-family EMC emission standard is available.

NOTE 1 Safety considerations are not covered by this document.

NOTE 2 In special cases, situations will arise where the levels specified in this document will not offer adequate protection; for example where a sensitive receiver is used in close proximity to an ~~apparatus~~ equipment. In these instances, special mitigation measures may have to be employed.

NOTE 3 Disturbances generated in fault conditions of equipment are not covered by this document.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

IEC 61000-4-20:2010, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguide*

CISPR 11:2015, *Industrial, scientific and medical (ISM) radio-frequency equipment – ~~Electromagnetic~~ Radio-frequency disturbance characteristics – Limits and methods of measurement*  
CISPR 11:2015/AMD1:2016

CISPR 14-1:2016, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

CISPR 16-1-1:2015, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-2:~~2003~~ 2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – ~~Ancillary equipment~~ Coupling devices for conducted disturbances ~~s~~ measurements*

CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*

CISPR 16-1-4:2010/AMD1:2012

CISPR 16-1-4:2010/AMD2:2017

CISPR 16-1-6:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-6: Radio disturbance and immunity measuring apparatus – EMC antenna calibration*

CISPR 16-1-6:2014/AMD1:2017

CISPR 16-2-1:~~2003~~ 2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-1:2014/AMD1:2017

CISPR 16-2-3:2016, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR 16-4-2:2011, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – ~~Uncertainty in EMC measurements~~ Measurement instrumentation uncertainty*

CISPR 16-4-2:2011/AMD1:2014

~~CISPR 22, Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement~~

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

### 3 Terms, definitions and abbreviated terms

#### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the following apply.

~~NOTE Definitions related to EMC and to relevant phenomena are given in IEC 60050-161 and in other IEC and CISPR publications.~~

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

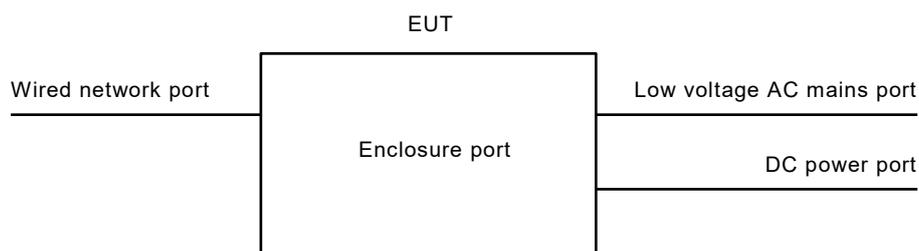
- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

##### 3.1.1

##### port

~~particular~~ physical interface of the specified ~~apparatus~~ equipment with the external electromagnetic environment

Note 1 to entry: See Figure 1.



IEC

Figure 1 – Examples of ports

**3.1.2****enclosure port**

physical boundary of the ~~apparatus~~ equipment which electromagnetic fields may radiate through or impinge on

**3.1.3****cable port**

port at which a conductor or a cable is connected to the ~~apparatus~~ equipment

Note 1 to entry: Examples are signal, ~~wired network~~, control and power ports.

**3.1.4****~~telecommunications/~~ wired network port**

point of connection for voice, data and signalling transfers intended to interconnect widely-dispersed systems ~~via such means as~~ by direct connection to a ~~single-user~~ or multi-user ~~telecommunications networks (e.g. public switched telecommunications networks (PSTN), integrated services digital networks (ISDN), x-type digital subscriber lines (xDSL), etc.), local area networks (e.g. Ethernet, Token Ring, etc.) and similar networks)~~

Note 1 to entry: Examples of these include CATV, PSTN, ISDN, xDSL, LAN and similar networks.

Note 2 to entry: These ports may support screened or unshielded cables and may also carry AC or DC power where this is an integral part of the telecommunication specification.

Note 3 to entry: A port generally intended for interconnection of components of an ~~ITE~~ system under test (e.g. RS-232, RS-485, field buses in the scope of IEC 61158, IEEE Standard 1284 (parallel printer), Universal Serial Bus (USB), IEEE Standard 1394 ("Fire Wire"), etc.) and used in accordance with its functional specifications (e.g. for the maximum length of cable connected to it), is not considered to be a ~~telecommunications~~ wired network port.

Note 4 to entry: In previous editions of this document and many product standards, this port was defined as a telecommunications or network port.

**3.1.5****power port**

~~port at which a conductor or cable carrying the primary electrical power needed for the operation (functioning) of an apparatus or associated apparatus is connected to the apparatus~~ for the connection of the equipment to the primary electrical power supply

**3.1.6****public mains network**

electricity lines to which all categories of consumers have access and which are operated by a supply or distribution undertaking for the purpose of supplying electrical energy

**3.1.7****low voltage****LV**

~~low tension~~

~~voltage having a value below a conventionally adopted limit~~

a set of voltage levels used for the distribution of electricity and whose upper limit is generally accepted to be 1 000 V AC or 1 500 V DC

~~NOTE—For the distribution of AC electric power, the upper limit is generally accepted to be 1 000 V.~~

[SOURCE: IEC 60050-601:1985, 601-01-26, modified – addition of the words "or 1 500 V DC"]

**3.1.8****DC distribution network**

local supply network in the infrastructure of a site or building intended for use by one or more different types of equipment and providing power independent of the public mains network

Note 1 to entry: Connection to a remote local battery is not regarded as a DC distribution network, if such a link comprises only power supply for a single piece of equipment.

### 3.1.9

#### low voltage AC mains port

port used to connect to the low voltage AC mains supply network to power the equipment

Note 1 to entry: Equipment with a DC power port is considered low voltage AC mains powered if it is powered from an AC/DC power converter.

Note 2 to entry: The low voltage AC mains supply could be public or non-public.

### 3.1.10

#### highest internal frequency $F_x$

highest fundamental frequency generated or used within the EUT, or the highest frequency at which it operates

### 3.1.11

#### small equipment

equipment, either positioned on a table top or standing on the floor which, including its cables fits in a cylindrical test volume of 1,2 m in diameter and 1,5 m above the ground plane

Note 1 to entry: These dimensions are currently under discussion in CISPR.

### 3.1.12

#### industrial location

location characterized by a separate power network, supplied from a high- or medium-voltage transformer, dedicated for the supply of the installation

Note 1 to entry: Industrial locations can generally be described by the existence of an installation with one or more of the following characteristics:

- items of equipment installed and connected together and working simultaneously;
- significant amount of electrical power generated, transmitted and/or consumed;
- frequent switching of heavy inductive or capacitive loads;
- high currents and associated magnetic fields;
- presence of industrial, high power scientific and medical (ISM) equipment (for example, welding machines).

The electromagnetic environment at an industrial location is predominantly produced by the equipment and installation present at the location. There are types of industrial locations where some of the electromagnetic phenomena appear in a more severe degree than in other installations.

Example locations include metalworking, pulp and paper, chemical plants, car production, farm building, high-voltage areas of airports

Note 2 to entry: The connection between location and electromagnetic environment is given in 3.1.13.

### 3.1.13

#### electromagnetic environment

totality of electromagnetic phenomena existing at a given location

Note 1 to entry: In general, the electromagnetic environment is time-dependent and its description may need a statistical approach.

Note 2 to entry: It is very important not to confuse the electromagnetic environment and the location itself.

[SOURCE IEC 60050-161:1990, 161-01-01, modified – Note 2 to entry has been added.]

## 3.2 Abbreviated terms

AAN	Asymmetric Artificial Network
AC	Alternating Current
AMN	Artificial Mains Network
CATV	Cable TV network
DC	Direct Current

DSL	Digital Subscriber Line
EUT	Equipment Under Test
FAR	Fully Anechoic Room
FSOATS	Free Space Open Area Test Site
ISDN	Integrated Services Digital Network
ITE	Information Technology Equipment
LAN	Local Area Network
MME	Multi Media Equipment
OATS	Open Area Test Site
PSTN	Public Switched Telephone Network
SAC	Semi Anechoic Chamber
TEM	Transverse Electromagnetic Mode
USB	Universal Serial Bus
xDSL	Generic term for all types of DSL technology

#### 4 Conditions during testing

The EUT shall be tested in the operating mode producing the largest emission in the frequency band being ~~investigated, e.g. based on limited pre-tests and~~ measured, consistent with normal applications. The configuration of the test sample shall be varied to achieve maximum emission consistent with typical applications and installation practice. ~~Pre-testing may be used to reduce test time.~~

If the ~~apparatus~~ EUT is part of a system, or can be connected to ~~auxiliary apparatus~~ associated equipment, the ~~apparatus~~ EUT shall be tested while connected to the minimum representative configuration of ~~auxiliary apparatus~~ associated equipment necessary to exercise the ports in a similar manner to that described in CISPR 11 ~~and~~ or CISPR ~~22~~ 32.

The EUT shall be arranged in accordance with the requirements of Table 1.

**Table 1 – Test arrangements of EUT**

Intended operational arrangement(s) of EUT	Test arrangement	Remarks
Table-top only	Table-top	
Floor-standing only	Floor-standing	
Can be floor-standing or table-top	Table-top	
Rack mounted	In a rack or table-top	
Other, for example wall mounted, ceiling mounted, handheld, body worn	Table-top	With normal orientation  If the equipment is designed to be mounted on a ceiling, the downward-facing portion of the EUT may be oriented facing upward.
If a physical hazard would be caused by testing the device on a table-top, then it can be tested as floor standing and the test report shall document the decision and justification.		

In cases where a manufacturer's specification requires external filtering and/or shielding devices or measures that are clearly specified in the user's manual, the test requirements of this document shall be applied with the specified devices or measures in place.

The configuration and mode of operation during the measurements shall be precisely noted in the test report. If the ~~apparatus~~ EUT has a large number of similar ports or ports with many similar connections, a sufficient number shall be selected to simulate actual operating conditions and to ensure that all the different types of termination are covered.

The measurements shall be carried out at one single set of parameters within the operating ranges of temperature, humidity and atmospheric pressure specified for the product and at the rated supply voltage, unless otherwise indicated in the basic standard. **The relevant conditions shall be recorded in the test report.**

Where applicable, additional information on EUT configuration can be found in CISPR 16-2-1, CISPR 16-2-3, CISPR 11 or CISPR 32 as referenced in Table 3 to Table 5.

## 5 Product documentation

The purchaser/user/installer shall be informed **within the product documentation** if special measures have to be taken to achieve compliance. One example **would be the need to use** ~~of~~ shielded or special cables.

## 6 Applicability

The application of measurements for emission(s) depends on the particular ~~apparatus~~ **equipment**, its configuration, its ports, its technology and its operating conditions.

Measurements shall be applied to the relevant ports of the ~~apparatus~~ **equipment** according to **the requirements defined in Table 4 3 to Table 5**. Measurements shall only be carried out where the relevant ports exist.

It may be determined from consideration of the electrical characteristics and usage of particular ~~apparatus~~ **equipment** that some of the measurements are inappropriate and therefore unnecessary. In such a case it is required that the decision and justification not to measure shall be recorded in the test report.

## 7 Measurement uncertainty

~~The results of measurements of emissions from ITE shall reference the measurement instrumentation uncertainty considerations contained in CISPR 16-4-2.~~

~~Determining compliance with the limits in this standard shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.~~

~~However measurement uncertainty of the measurement instrumentation and its associated connections between the various instruments in the measurement chain shall be calculated and both the measurement results and the calculated uncertainty shall appear in the test report.~~

**Table 1 — Emission**

Port	Frequency range	Limits	Basic standard	Applicability note	Remarks
1) Enclosure port — Open area test site or semi-anechoic method	30 MHz — 230 MHz 230 MHz — 1 000 MHz	40 dB(µV/m) Quasi-peak at 10 m 47 dB(µV/m) Quasi-peak at 10 m	CISPR 16-2-4, 7.4.1	See Note 1.	May be measured at 30 m distance using the limits decreased by 10 dB.
2) Low voltage AC mains port	0,15 MHz — 0,5 MHz	79 dB(µV) quasi-peak 66 dB(µV) average	CISPR 16-2-4, 7.4.1 CISPR 16-1-2, 4.3	See Note 2.	
3) Telecommunications/network port	0,5 MHz — 30 MHz 0,15 MHz — 0,5 MHz	73 dB(µV) quasi-peak 60 dB(µV) average 97 dB(µV) — 87 dB(µV) quasi-peak 84 dB(µV) — 74 dB(µV) average 53 dB(µA) — 43 dB(µA) quasi-peak 40 dB(µA) — 30 dB(µA) average	CISPR 22	See Notes 3, 4 and 5.	
	0,5 MHz — 30 MHz	87 dB(µV) quasi-peak 74 dB(µV) average 43 dB(µA) quasi-peak 30 dB(µA) average		See Notes 3 and 5.	

NOTE 1 — If the internal emission source(s) is operating at a frequency below 9 kHz then measurements need only to be performed up to 230 MHz.

NOTE 2 — Impulse noise (clicks) which occur less than five times per minute is not considered. For clicks appearing more often than 30 times per minute the limits apply. For clicks appearing between 5 and 30 times per minute, a relaxation of the limits is allowed of  $20 \log_{10} N$  dB (where N is the number of clicks per minute). Criteria for separated clicks may be found in CISPR 14-1.

NOTE 3 — At transitional frequencies the lower limit applies.

NOTE 4 — The limits decrease linearly with the logarithm of the frequency in the range 0,15 MHz to 0,5 MHz.

NOTE 5 — The current and voltage disturbance limits are derived for use with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 150 Ω to the telecommunication port under test (conversion factor is  $20 \log_{10} 150 / 1 = 44$  dB).

Where guidance for the calculation of the instrumentation uncertainty of a measurement is specified in CISPR 16-4-2 this shall be followed, and for these measurements the determination of compliance with the limits in this document shall take into consideration the measurement instrumentation uncertainty in accordance with CISPR 16-4-2. Calculations to determine the measurement result and any adjustment of the test result required when the test laboratory uncertainty is larger than the value for  $U_{\text{CISPR}}$  given in CISPR 16-4-2 shall be included in the test report.

## 8 Compliance with this document

Where this document gives options for testing particular requirements with a choice of test methods, compliance can be shown against any of the relevant test methods, using the specific limits with the restrictions provided in the relevant tables clauses. For example, floor standing shall be assessed against table clause 3.1, considering table clause 3.2 is limited to small equipment and table clause 3.3 is limited to table top equipment.

In any situation where it is necessary to retest the equipment the test method originally chosen shall be used in order to ensure consistency of the results.

Equipment which fulfils the requirements across the frequency ranges specified in Table 3 to Table 5 in this document is deemed to fulfil the requirements in the entire frequency range from 9 kHz to 400 GHz.

Measurements do not need to be performed at frequencies where no limits are specified.

NOTE CISPR TR 16-4-3 provides guidance on the applicability of limits to series produced equipment.

## 9 Emission requirements

The emission requirements for ~~apparatus~~ equipment covered by this document are given on a port by port basis and defined in Table 3 to Table 5. Annex A is provided for information purposes only and lists proposed limits for DC power ports.

The measurements shall be conducted in a well-defined and reproducible manner and performed in any order.

~~The measurements may be performed in any order.~~

The description of the measurement, the measurement instrumentation, the measurement methods, and the measurement set-up to be used are given in the standards, which are referred to in Table ~~4~~ 3 to Table 5. These standards are not repeated here, however modifications or additional information needed for the practical application of the measurements are given in this document.

~~The contents of the standards referenced in the tables are not repeated here, however modifications or additional information needed for the practical application of the measurements are given in this standard.~~

The following shall be taken into account during the application of the measurements defined in Table 3 to Table 5.

- At transitional frequencies, the lower limit applies.
- Where the limit value varies over a given frequency range, it changes linearly with respect to the logarithm of the frequency.
- The test site shall be validated for the measurement distance chosen.

- Where the table clause defines more than one detector, then the measurements shall be performed using both types of detector. Results obtained using a peak detector may be used instead of the other defined detectors.
- Where a different measurement distance is chosen, other than the reference distance defined in the limit column of Table 3, the limits shall be offset based upon the following formula:

$$\text{new limit} = \text{defined limit} - 20 \log (\text{measurement distance/reference distance})$$

The unit of metres shall be used for distance and dB(µV/m) for the limits.

With regard to each table clause, the measurements shall be performed at only one distance.

- For radiated emission measurements, Table 2 shows the highest frequency up to which radiated emission measurements shall be performed based up the value of  $F_x$ .

**Table 2 – Required highest frequency for radiated measurement**

Highest internal frequency ( $F_x$ )	Highest measured frequency
$F_x \leq 108$ MHz	1 GHz
$108 \text{ MHz} < F_x \leq 500$ MHz	2 GHz
$500 \text{ MHz} < F_x \leq 1$ GHz	5 GHz
$F_x > 1$ GHz	$5 \times F_x$ up to a maximum of 6 GHz

NOTE 1 Where the highest internal frequency is not known, tests are performed up to 6 GHz.  
NOTE 2  $F_x$  is defined in 3.1.10.

- For emission measurements above 1 GHz, the peak detector limits shall not be applied to disturbances produced by arcs or sparks that are high voltage breakdown events. Such disturbances arise when devices contain or control mechanical switches that control current in inductors, or when devices contain or control subsystems that create static electricity (such as paper handling devices). The average limits apply to disturbances from arcs or sparks, and both peak and average limits will apply to other disturbances from such devices.
- For radiated emission measurements using a FSOATS, FAR or SAC, the measurement distance is the horizontal distance between the vertical projections of the calibration point of the receiving antenna and the boundary of the EUT. The boundary of the EUT is the smallest imaginary circular periphery around the most compact arrangement of the EUT, using typical spacing.
- Where this document specifies the use of an average detector, the linear average detector defined in Clause 6 of CISPR 16-1-1:2015 shall be used.

NOTE In the measurement specifics columns of Table 3 to Table 5, where relevant, the format is as follows: characteristic, basic standard, clause. For example, from table clause 3.1, Instrumentation, CISPR 16-1-1:2015, Clause 4.

**Table 3 – Requirements for radiated emissions – enclosure port**

Table clause	Test facility	Frequency range MHz	Limits dB( $\mu$ V/m)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector / measurement distance		
3.1	OATS or SAC	30 to 230	40 Quasi-peak / 10 m	Instrumentation, CISPR 16-1-1, Clause 4  Antennas, CISPR 16-1-4, 4.5  Test site, CISPR 16-1-4, Clause 5  Method, CISPR 16-2-3, 7.3	Allowed measurement distances: 3 m, 5 m, 10 m or 30 m  For equipment meeting the size criterion defined in 3.1.11, the measurements may be performed at the 3 m distance. Note this size criterion is currently under discussion.  For measurement distances less than 30 m, the receiving antenna height shall be varied between 1 m to 4 m, else 1 m to 6 m shall be used. Additional guidance on the test method can be found in CISPR 16-2-3, 7.3 and Clause 8.
		230 to 1 000	47 Quasi-peak / 10 m		
3.2	TEM	30 to 230	40 Quasi-peak / n/a	IEC 61000-4-20	Only applicable to battery powered equipment not intended to have external cables attached.  Restricted to equipment complying with the definition of small equipment within 6.2 in IEC 61000-4-20.
		230 to 1 000	47 Quasi-peak / n/a		
3.3	FAR	30 to 230	52 to 45 Quasi-peak / 3 m	Instrumentation, CISPR 16-1-1, Clause 4  Antennas, CISPR 16-1-4, 4.5  Test site, CISPR 16-1-4, 5.4.7  Method, CISPR 16-2-3, 7.4.	Restricted to table top equipment, and floor-standing equipment which can be placed on table during the test.  Allowed measurement distances: 3 m, 5 m or 10 m  The limitations on EUT size in CISPR 16-2-3 apply.
		230 to 1 000	52 Quasi-peak / 3 m		
3.4	FSOATS  OATS FAR SAC (see limitations)	1 000 to 3 000	76 Peak / 3 m	Instrumentation, CISPR 16-1-1, Clauses 5 and 6  Antennas, CISPR 16-1-4, Clause 4.5	Allowed measurement distances: 3 m, 5 m or 10 m.  Other facilities, such as FAR, SAC or OATS may be used provided they satisfy the free space conditions as defined in CISPR 16-1-4. For SAC and OATS, additional absorber may be required.
			56 Average / 3 m		
		3 000 to 6 000	80 Peak / 3 m	Test site, CISPR 16-1-4, Clause 8  Method, CISPR 16-2-3, Clause 7.6.	
			60 Average / 3 m		

The equipment is deemed to comply with the enclosure port requirement below 1 GHz if it meets the requirements defined in one or more of the table clauses 3.1, 3.2 or 3.3.

Antenna calibration shall be in accordance with CISPR 16-1-6:2014/AMD1:2017.

<sup>a</sup> Within this table, the version of the references are as follows:

CISPR 16-1-1 is CISPR 16-1-1:2015, CISPR 16-1-4 is CISPR 16-1-4:2010, CISPR 16-1-4:2010/AMD1:2012 and CISPR 16-1-4:2010/AMD1:2012/AMD2:2017, CISPR 16-2-3 is CISPR 16-2-3:2016 and IEC 61000-4-20 is IEC 61000-4-20:2010.

**Table 4 – Requirements for conducted emissions – low voltage AC mains port**

Table clause	Measurement network	Frequency range MHz	Limits dB(μV)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector		
4.1	AMN	0,15 to 0,5	79 Quasi-peak	Instrumentation, CISPR 16-1-1, Clauses 4 and 6	For clicks appearing between 5 and 30 times per minute, a relaxation of the limits is allowed of 20 log 30/N dB (where N is the number of clicks per minute). Criteria for separated clicks shall be found in CISPR 14-1.
			66 Average		
		0,5 to 30	73 Quasi-peak	Method, CISPR 16-2-1, Clause 7	
			60 Average	Set-up, CISPR 16-2-1, Clause 7	

The AMN characteristics shall be 50 Ω / 50 μH as defined in CISPR 16-1-2, 4.4, unless this network interferes with the operation of the EUT. In these cases, the AMN characteristics and the justification shall be recorded in the test report.

<sup>a</sup> Within this table, the version of the references are as follows:

CISPR 14-1 is CISPR 14-1:2016, CISPR 16-1-1 is CISPR 16-1-1:2015, CISPR 16-1-2 is CISPR 16-1-2:2014, CISPR 16-2-1 is CISPR 16-2-1:2014 and CISPR 16-2-1:2014/AMD1:2017.

**Table 5 – Requirements for conducted emissions – wired network port**

Table clause	Measurement network	Frequency range MHz	Limits dB(μV)	Limits dB(μA)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector	Detector		
5.1	As defined in CISPR 32	0,15 to 0,5	97 to 87 Quasi-peak	53 to 43 Quasi-peak	As defined in CISPR 32	The current and voltage disturbance limits are derived for use with an Asymmetric Artificial Network (AAN) which presents a common mode (asymmetric mode) impedance of 150 Ω to the wired network port under test (conversion factor is 20 log <sub>10</sub> 150 / 1 = 44 dB).  When performing measurements using an AAN, only the voltage limits apply.  All elements within CISPR 32 shall be followed, including but not limited to selection of test method, test configuration, cable characteristics.
			84 to 74 Average	40 to 30 Average		
		0,5 to 30	87 Quasi-peak	43 Quasi-peak		
			74 Average	30 Average		

<sup>a</sup> Within this table, the version of the reference CISPR 32 is CISPR 32:2015.

**8 Application of limits in tests for conformity of equipment in series production**

**8.1 Tests shall be made:**

- either on a sample of equipment of the type using the statistical method of evaluation set out in 8.2,
- or, for simplicity's sake, on one equipment only.

~~8.2 Statistically assessed compliance with limits shall be made as follows:~~

~~This test shall be performed on a sample of not less than five and not more than 12 items of the type. If, in exceptional circumstances, five items are not available, a sample of four or three shall be used. Compliance is judged from the following relationship:~~

$$\underline{\bar{x} + kS_n \leq L}$$

~~where~~

~~$\bar{x}$  is the arithmetic mean of the measured value of  $n$  items in the sample~~

$$\underline{S_n^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$$

~~$x_n$  is the value of the individual item~~

~~$L$  is the appropriate limit~~

~~$k$  is the factor derived from tables of the non-central  $t$  distribution which assures with 80 % confidence that 80 % of the type is below the limit; the value of  $k$  depends on the sample size  $n$  and is stated below.~~

~~The quantities  $x_n$ ,  $\bar{x}$ ,  $S_n$  and  $L$  are expressed logarithmically: dB( $\mu$ V), dB( $\mu$ V/m) or dB(pW).~~

$n$	3	4	5	6	7	8	9	10	11	12
$k$	2,04	1,69	1,52	1,42	1,35	1,30	1,27	1,24	1,21	1,20

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**Annex A**  
(informative)

**Testing of DC powered systems**

This annex is informative containing proposed requirements for conducted emissions on DC power ports, defined in Table A.1, with further specifics for which ports need to be measured given in Table A.2.

**Table A.1 – Proposed requirements for conducted emissions – DC power port**

Table Clause	Measurement network	Frequency range MHz	Limits dB(µV)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector		
A.1.1	AMN	0,15 to 0,5	89 Quasi-peak	Instrumentation, CISPR 16-1-1, Clauses 4 and 6	See Table A.2, for DC power ports that require testing.
			76 Average		
		0,5 to 30	83 Quasi-peak	Method, CISPR 16-2-1, Clause 7	
			70 Average	Set-up, CISPR 16-2-1, Clause 7	

These informative limits have been considered by CISPR H (in conjunction with Table A.2) and are provided as a possible basis for new requirements.

<sup>a</sup> Within this table, the version of the references are as follows:

CISPR 16-1-1 is CISPR 16-1-1:2015, CISPR 16-1-2 is CISPR 16-1-2:2014, CISPR 16-2-1 is CISPR 16-2-1:2014 and CISPR 16-2-1:2014/AMD1:2017.

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**Table A.2 – Conducted testing of DC powered equipment**

Table clause	Description of DC power source connection <sup>e</sup>	Testing to be required on DC power port	Proposed Intended cable connection <sup>d, e</sup>	Specifics and additional recommendations
A.2.1	Internal batteries, with no external DC input	No DC input port	None	No tests are required.
A.2.2	Distribution network <sup>a</sup>	Yes	All types	
A.2.3	Wired network port	No	As defined in CISPR 32	Port should be treated as a wired network port and tested against the requirements of Table 5.
A.2.4	Remote battery	Yes	Is longer than 3 m	
A.2.5	External AC/DC converter or battery charger	Yes	Is longer than 3 m <sup>b</sup>	The AC input port of the charger/converter <sup>c</sup> should also be tested against the requirements of Table 4.
A.2.6	External DC/DC converter or battery charger	Yes	Is longer than 3 m <sup>b</sup>	The DC input port of the charger/converter <sup>c</sup> should also be tested against the requirements of table clause A.2.7.
A.2.7	All other systems not defined above	Yes	Is longer than 3 m	Should be tested against the requirements of Table A.1.
<p><sup>a</sup> DC distribution networks include:</p> <ul style="list-style-type: none"> <li>• those with an overall length greater than 3 m.</li> </ul> <p><sup>b</sup> The length of the cable between the DC port on the EUT and the convertor or charger.</p> <p><sup>c</sup> Where possible, use a device specified by the manufacturer, else use a typical device capable of developing the necessary DC voltage/current.</p> <p><sup>d</sup> Where the limitation is satisfied then the test is applicable, for example, for table clause A.2.4, where the cable attached to a DC power port is 10 m long (longer than the 3 m requirement), then testing would be required against the requirements of Table A.1.</p> <p><sup>e</sup> Based upon the intended use of the equipment as defined by the manufacturer and documented in the user documentation.</p>				

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**Annex B**  
(informative)

**Further information on measurements using a FAR**

**B.1 General**

During the development of the limits for table top equipment using a FAR measurement facility, as defined in Table 3, the committee analysed various options, including polarity specific limits. During the original discussions, these were considered far too radical and hence dismissed.

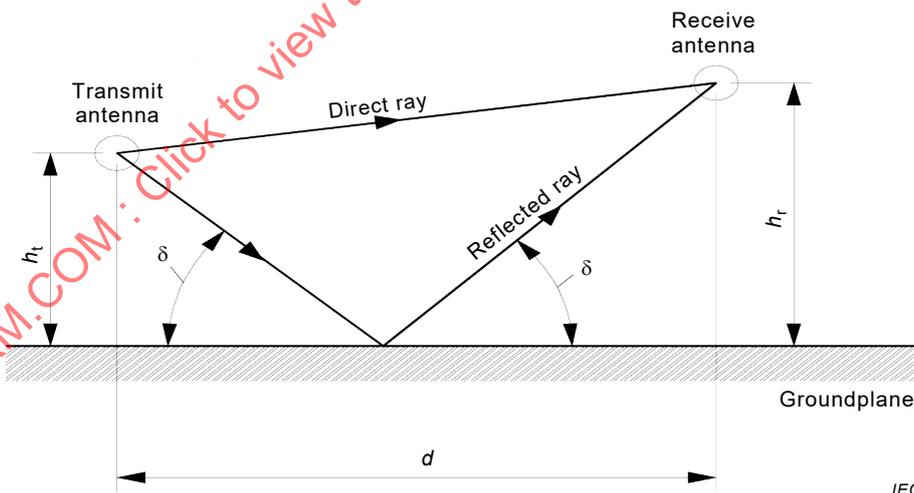
During the following years, there have been repeated requests by various national committees to improve the limits defined in Table 3 by the adaption of polarity specific types. Hence, this informative annex is intended to communicate how the originals limits were derived and the possible improvements if these alternative limits were adopted.

There is a significant amount of additional data and information presented in CISPR 16-4-5, CENELEC R210-010 and in SMT4-CT96-2133.

**B.2 Analysis**

**B.2.1 Theoretical analysis of simple radiators**

A difference of 6 dB is expected for measured field strengths above a ground plane (for example, using an OATS) compared with free space (for example using a FAR). A simple OATS geometrical optic model is shown in Figure B.1, two rays impinge on the receive antenna above a ground plane; namely the one transmitted directly between the transmit and receive antenna and the one reflected by the ground plane.



**Figure B.1 – Geometrical optics model for OATS measurements**

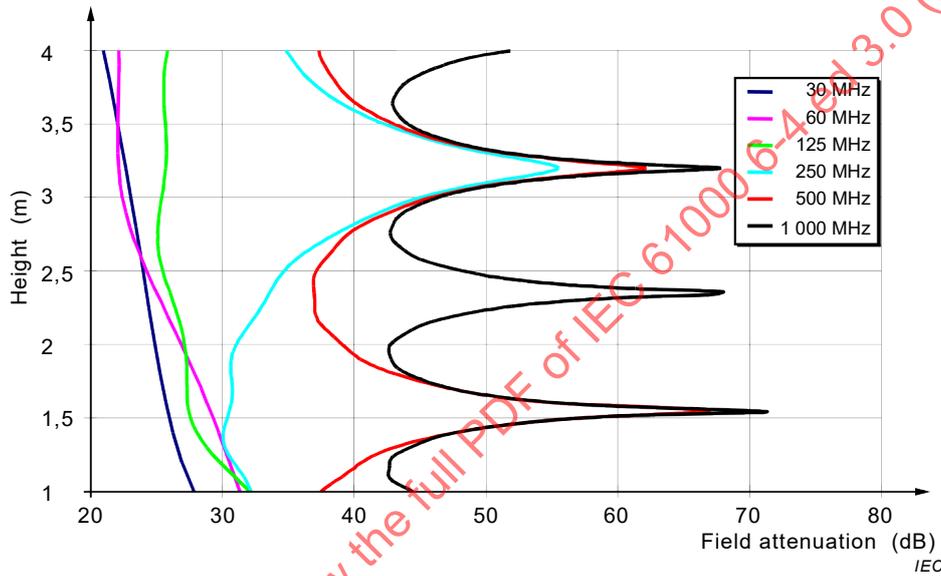
The difference in phase relation of these two rays results in an interference pattern which corresponds to the function of the height of the receive antenna above the ground. The resulting effect ranges from cancellation to doubling of the direct ray. As such, during OATS measurements  $h_r$  is varied until constructive interference (or doubling) is obtained.

Therefore, based upon this model, the limits when using a FAR should be 6 dB lower, in comparison with those of an OATS because within a FAR, there is no reflected ray, hence no doubling of emission levels will occur.

**B.2.2 Limitations with the basic model**

**B.2.2.1 Theoretical analysis of simple radiators**

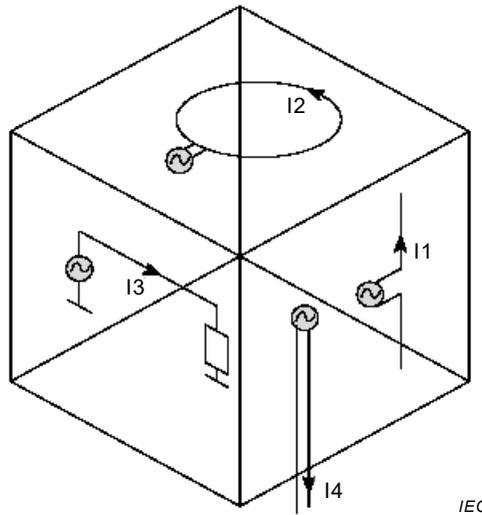
Figure B.2 illustrates typical interference patterns via the height of the receive antenna above a ground plane. The interference pattern depends on the distance between transmit and receive antenna, height of the transmit antenna above the ground plane, polarisation, frequency and type of antennas. As there is no reflected ray in free space, it is assumed that no interference patterns exist in a FAR. This begins to question the basic model, because the two facilities are in reality different.



**Figure B.2 – Field attenuation between two half-wave dipoles above ground plane with fixed transmit antenna height and variable receive antenna height**

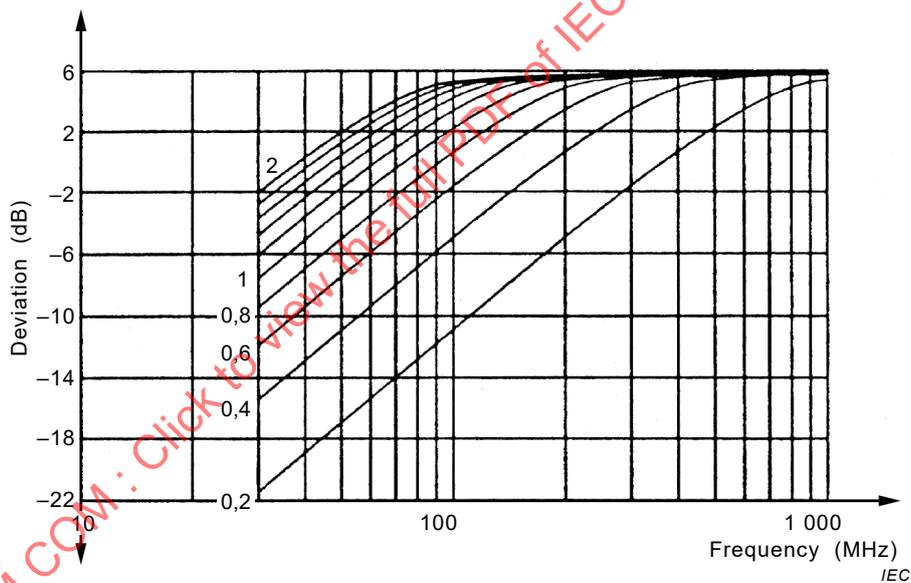
**B.2.2.2 Analysis of an EUT**

A real EUT can be represented by a number of RF sources driving different types of transmitting antennas with associated currents. Four possible sources are shown in Figure B.3, illustrating the different position, type of antenna, associated source and possible currents flowing. Within a typical EUT, the actual position of these sources, are generally unknown.



**Figure B.3 – Equivalent circuit diagram of a typical EUT**

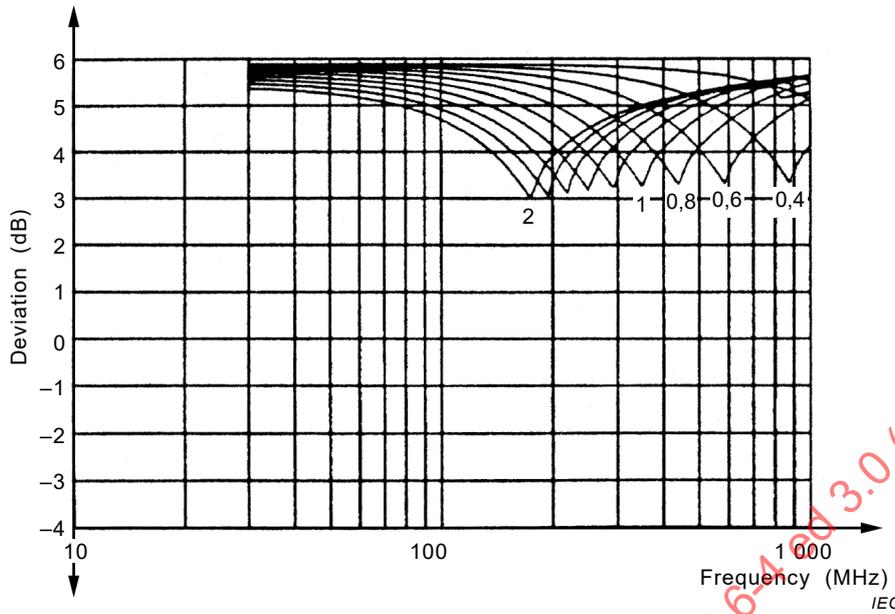
In order to establish a base line of the possible differences, a theoretical investigation<sup>2</sup> was performed and the results are shown in Figure B.4 and Figure B.8 for a 10 m distance and in Figure B.6 and Figure B.7 for a 3 m distance.



NOTE The numbers within the graph are the positions of the source above the ground plane on an OATS.

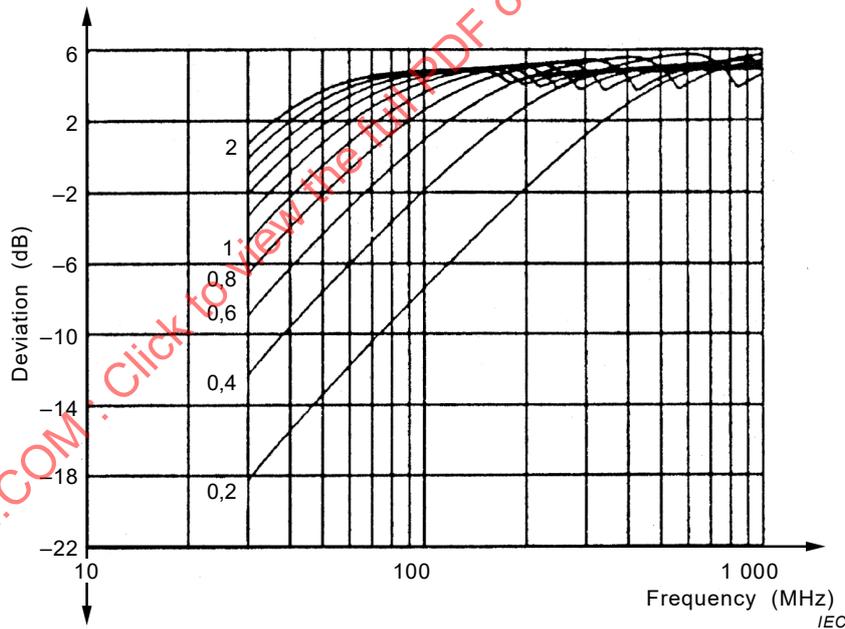
**Figure B.4 – 10 m distance, horizontal polarization, calculated differences for an electrically short straight wire above the ground plane on an OATS compared with a FAR ( $E_{OATS} - E_{FAR}$ )**

<sup>2</sup> Dr. Garn, 'Proposal for a new radiated emission test method using a completely absorber lined Room without ground plane', 9<sup>th</sup> Zurich symposium on EMC.



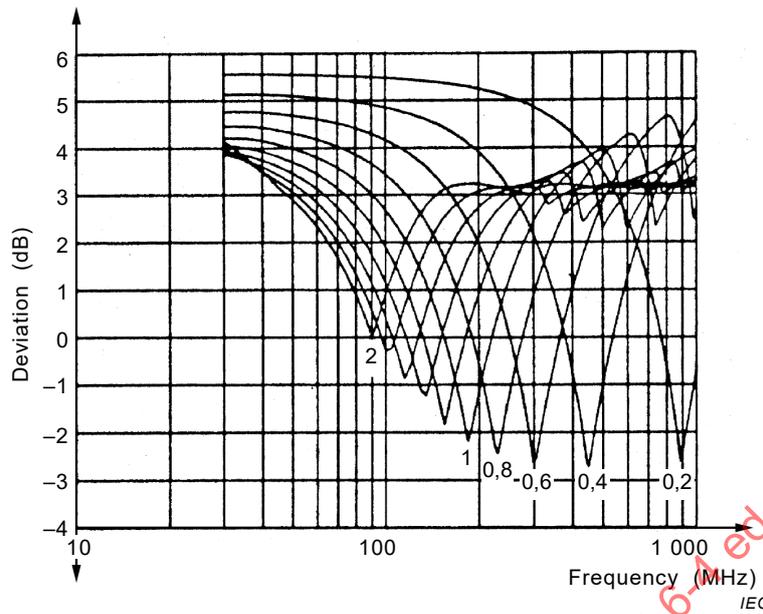
NOTE The numbers within the graph are the positions of the source above the ground plane on an OATS.

**Figure B.5 – 10 m distance, vertical polarization, calculated differences for an electrically short straight wire above the ground plane on an OATS compared with a FAR ( $E_{OATS} - E_{FAR}$ )**



NOTE The numbers within the graph are the positions of the source above the ground plane on an OATS.

**Figure B.6 – 3 m distance, horizontal polarization, calculated differences for an electrically short straight wire above the ground plane on an OATS compared with a FAR ( $E_{OATS} - E_{FAR}$ )**



NOTE The numbers within the graph are the positions of the source above the ground plane on an OATS.

**Figure B.7 – 3 m distance, vertical polarization, calculated differences for an electrically short straight wire above the ground plane on an OATS compared with a FAR ( $E_{OATS} - E_{FAR}$ )**

Figure B.4 to Figure B.7 shows the difference between the received field strength for different polarised electrically short straight wires placed above a ground plane and in free space. The receive antenna is moved between 1 m and 4 m above the ground plane and is fixed in the free space situation. The distance between the transmitting and the receiving antenna is the same for both sites.

For vertical polarized signals, the 2 models provide similar results, but for horizontal, the results are very different. As an example, Figure B.4 shows that the maximum difference in calculated field strengths above a ground plane and in free space is up to -22 dB for an EUT height of 0,2 m. The expected difference is +6 dB based on a simple model. That implies a difference of up to 28 dB in calculated field strength.

One of the reasons for this is the wave propagation on an OATS. In horizontal polarisation, below 100 MHz the constructive interference of direct and ground reflected signal cannot be found in the 1 m to 4 m height scan range. Therefore the same magnitude of radiated emission will give a different reading in the received field strength for horizontal and vertical polarisation on an OATS (13 dB at 10 m distance, 1 m source height).

### B.2.2.3 OATS as a reference

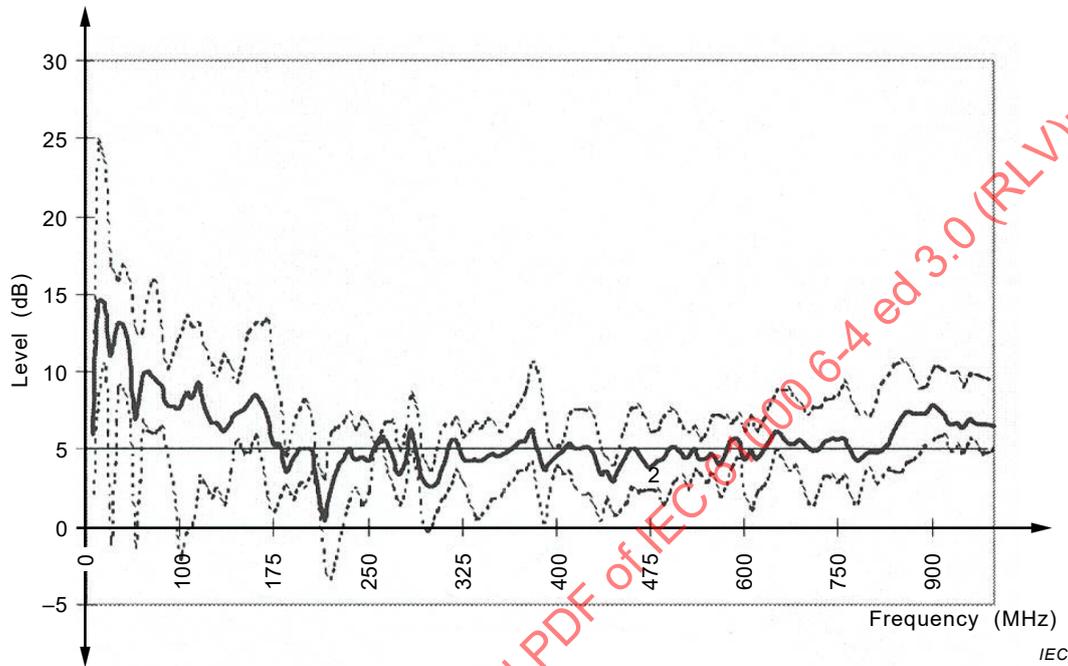
For many years, measurements using an OATS facility have been used to assess products. This solution has been very successful at controlling interference; therefore, if we blindly accepted 5 dB as the good compromise we would be ignoring the data and in reality tightening the limits when there is no justification.

### B.2.3 Measurements on an EUT

Many measurements have been performed to verify the limits, a very small sample is show in Figure B.8. This shows the differences of the horizontal polarised emissions of a small EUT with mains lead measured in 3 m FARs and on 10 m OATS. These measurements then contributed to the definition within CISPR 16-2-3 which effectively states that the maximum width and height of an EUT (including cables and associated equipment) shall be less than half of the measurement distance.

It is noticeable that the response is well above the 5 dB level at 30 MHz. This is caused by destructive interference on the OATS, as described in B.2.2.2. This phenomenon does not occur for vertical polarisation as the signal does not undergo a 180 phase change on reflection. That means the former proposed 5 dB difference in the limit values between 10 m OATS and 3 m FAR are not acceptable in the whole frequency range.

For further examples, see CISPR 16-4-5, CENELEC R210-010, etc.



**Figure B.8 – Differences of the horizontal polarised emission of the small EUT with mains lead in the 3 m FARs and on 10 m OATS**

#### B.2.4 Derivation of limits

The limits were derived, based upon the details presented in B.2.1 to B.2.3 and summarized in the following:

- Polarity specific limits were considered too radical; hence any compromise would probably mean for vertical polarized signals, the FAR would be too strict and for horizontally polarized signals it would be a relaxation.
- Signals from horizontal polarized sources close to the ground plane give the biggest variants (see results at a height of 0,02 m in Figure B.4 and Figure B.6) hence only table top equipment should be assessed using a FAR. As the source of emissions is moved away from the ground plane, this variance decreases so this would be problematic for floor standing equipment.
- A compromise was finally adopted which would give a relaxation over those of an OATS, but only in the lower frequency range. The relaxation of 7 dB was based on approximately half of the difference between 5 dB and the -9 dB, where 5 dB is the idea response and -9 dB is the error associated emission from a 0,8 m high cable, derived from Figure B.4.

NOTE The half value would not be relevant if polarity specific limits were used, in the case the relaxation would then be 14 dB.

### B.3 Requirements

The following limits and requirements, defined in Table B.1, are provided for information purposes only. They may provide equivalent protection to radio reception as those defined in Table 3 and are included to give the user of these types of facilities an indication of the validity of the results.

**Table B.1 – Proposed requirements for radiated emissions, FAR**

Table clause	Test facility	Frequency range MHz	Limits dB( $\mu$ V/m)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector / measurement distance		
B.1.1	FAR	30 to 230	<b>Horizontally polarized emissions</b> 59 to 45 Quasi-peak / 3 m	Instrumentation, CISPR 16-1-1, Clause 4  Antennas, CISPR 16-1-4, 4.5  Test site, CISPR 16-1-4, 5.4.7	Allowed measurement distances: 3 m, 5 m or 10 m.  The limitations on EUT size in CISPR 16-2-3 apply.  The measurement distance is from the receiving antenna to the boundary of the calibrated test volume.  The horizontally exposed cabling shall be at a minimum, and not at 0,8 m as required by CISPR 16-2-3.
			<b>Vertically polarized emissions</b> 45 Quasi-peak / 3 m		
		230 to 1 000	52 Quasi-peak / 3 m		

<sup>a</sup> Within this table, the version of the references are as follows:  
CISPR 16-1-1 is CISPR 16-1-1:2015, CISPR 16-1-4 is CISPR 16-1-4:2010, CISPR 16-1-4:2010/AMD1:2012 and CISPR 16-1-4:2010/AMD2:2017, CISPR 16-2-3 is CISPR 16-2-3:2016.

The following key points shall be noted.

- 1) Vertically polarized emission should correlate very well to those measured using an SAC/OATS.
- 2) The limits defined within Table B.1 would apply to both floor standing equipment and table top equipment.
- 3) Because of the correlation issues with FAR and SAC/OATS, the horizontally exposed cable shall be as short as possible. Not 0,8 m as required by CISPR 16-2-3. This will minimise these types of emissions.
- 4) The horizontal limit of 59 dB( $\mu$ V/m) was developed to improve the correlation for cables close to the ground plane, see Figure B.6, this value may need to be different for table top equipment, for example 52 dB( $\mu$ V/m).

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Part 6-4: Generic standards – Emission standard for industrial environments**

**Compatibilité électromagnétique (CEM) –  
Partie 6-4: Normes génériques – Norme sur l'émission pour les environnements  
industriels**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTROMAGNETIC COMPATIBILITY (EMC) –****Part 6-4: Generic standards –  
Emission standard for industrial environments**

## FOREWORD

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International Standard IEC 61000-6-4 has been prepared by CISPR subcommittee H: Limits for the protection of radio services.

This third edition cancels and replaces the second edition published in 2006 and Amendment 1:2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) possible future requirements on DC ports;
- b) possible future radiated polarity specific emission limits within a FAR;
- c) the definition of which average detector is used for emission measurements at frequencies above 1GHz and that results using a peak detector are acceptable for all measurements;
- d) the definition of different EUT test arrangements.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
CIS/H/339A/FDIS	CIS/H/350/RVD

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

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

It forms Part 6-4 of the IEC 61000 series of standards. It has the status of a basic EMC publication in accordance with IEC Guide 107.

A list of all parts in the CISPR 61000 series, published under the general title *Electromagnetic compatibility*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

### **Part 1: General**

General considerations (introduction, fundamental principles)

Definitions, terminology

### **Part 2: Environment**

Description of the environment

Classification of the environment

Compatibility levels

### **Part 3: Limits**

Emission limits

Immunity limits (insofar as they do not fall under the responsibility of the product committees)

### **Part 4: Testing and measurement techniques**

Measurement techniques

Testing techniques

### **Part 5: Installation and mitigation guidelines**

Installation guidelines

Mitigation methods and devices

### **Part 6: Generic standards**

### **Part 9: Miscellaneous**

Each part is further subdivided into several parts published either as International Standards or technical reports/specifications, some of which have already been published as sections. Others will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

# ELECTROMAGNETIC COMPATIBILITY (EMC) –

## Part 6-4: Generic standards –

### Emission standard for industrial environments

## 1 Scope

This part of IEC 61000 for emission requirements applies to electrical and electronic equipment intended for use within the environment existing at industrial (see 3.1.12) locations.

This document does not apply to equipment that fall within the scope of IEC 61000-6-3.

The environments encompassed by this document cover both indoor and outdoor locations.

Emission requirements in the frequency range 9 kHz to 400 GHz are covered in this document and have been selected to provide an adequate level of protection of radio reception in the defined electromagnetic environment. No measurement needs to be performed at frequencies where no requirement is specified. These requirements are considered essential to provide an adequate level of protection to radio services.

Not all disturbance phenomena have been included for testing purposes but only those considered relevant for the equipment intended to operate within the environments included within this document.

Requirements are specified for each port considered.

This generic EMC emission standard is to be used where no applicable product or product-family EMC emission standard is available.

NOTE 1 Safety considerations are not covered by this document.

NOTE 2 In special cases, situations will arise where the levels specified in this document will not offer adequate protection; for example where a sensitive receiver is used in close proximity to an equipment. In these instances, special mitigation measures may have to be employed.

NOTE 3 Disturbances generated in fault conditions of equipment are not covered by this document.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

IEC 61000-4-20:2010, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguide*

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*  
CISPR 11:2015/AMD1:2016

CISPR 14-1:2016, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

CISPR 16-1-1:2015, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*

CISPR 16-1-4:2010/AMD1:2012

CISPR 16-1-4:2010/AMD2:2017

CISPR 16-1-6:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-6: Radio disturbance and immunity measuring apparatus – EMC antenna calibration*

CISPR 16-1-6:2014/AMD1:2017

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-1:2014/AMD1:2017

CISPR 16-2-3:2016, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR 16-4-2:2011, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty*

CISPR 16-4-2:2011/AMD1:2014

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

### **3 Terms, definitions and abbreviated terms**

#### **3.1 Terms and definitions**

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the following apply.

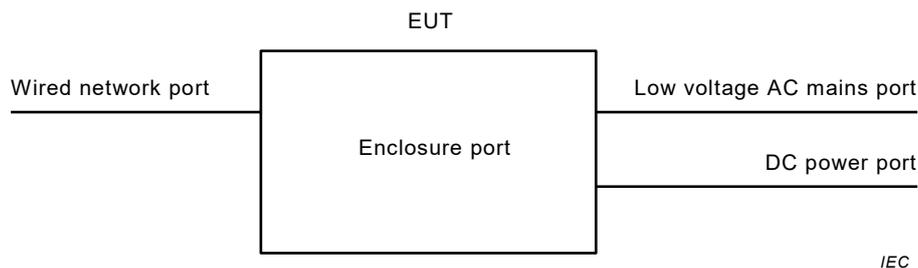
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

##### **3.1.1 port**

physical interface of the specified equipment with the external electromagnetic environment

Note 1 to entry: See Figure 1.



**Figure 1 – Example of ports**

### 3.1.2 enclosure port

physical boundary of the equipment which electromagnetic fields may radiate through or impinge on

### 3.1.3 cable port

port at which a conductor or a cable is connected to the equipment

Note 1 to entry: Examples are signal, wired network, control and power ports.

### 3.1.4 wired network port

point of connection for voice, data and signalling transfers intended to interconnect widely-dispersed systems by direct connection to a single-user or multi-user communication network

Note 1 to entry: Examples of these include CATV, PSTN, ISDN, xDSL, LAN and similar networks.

Note 2 to entry: These ports may support screened or unscreened cables and may also carry AC or DC power where this is an integral part of the telecommunication specification.

Note 3 to entry: A port generally intended for interconnection of components of a system under test (e.g. RS-232, RS-485, field buses in the scope of IEC 61158, IEEE Standard 1284 (parallel printer), Universal Serial Bus (USB), IEEE Standard 1394 ("Fire Wire"), etc.) and used in accordance with its functional specifications (e.g. for the maximum length of cable connected to it), is not considered to be a wired network port.

Note 4 to entry: In previous editions of this document and many product standards, this port was defined as a telecommunications or network port.

### 3.1.5 power port

port for the connection of the equipment to the primary electrical power supply

### 3.1.6 public mains network

electricity lines to which all categories of consumers have access and which are operated by a supply or distribution undertaking for the purpose of supplying electrical energy

### 3.1.7 low voltage LV

a set of voltage levels used for the distribution of electricity and whose upper limit is generally accepted to be 1 000 V AC or 1 500 V DC

[SOURCE: IEC 60050-601:1985, 601-01-26, modified – addition of the words "or 1 500 V DC"]

### 3.1.8 DC distribution network

local supply network in the infrastructure of a site or building intended for use by one or more different types of equipment and providing power independent of the public mains network

Note 1 to entry: Connection to a remote local battery is not regarded as a DC distribution network, if such a link comprises only power supply for a single piece of equipment.

### 3.1.9

#### **low voltage AC mains port**

port used to connect to the low voltage AC mains supply network to power the equipment

Note 1 to entry: Equipment with a DC power port is considered low voltage AC mains powered if it is powered from an AC/DC power converter.

Note 2 to entry: The low voltage AC mains supply could be public or non-public.

### 3.1.10

#### **highest internal frequency $F_x$**

highest fundamental frequency generated or used within the EUT, or the highest frequency at which it operates

### 3.1.11

#### **small equipment**

equipment, either positioned on a table top or standing on the floor which, including its cables fits in a cylindrical test volume of 1,2 m in diameter and 1,5 m above the ground plane

Note 1 to entry: These dimensions are currently under discussion in CISPR.

### 3.1.12

#### **industrial location**

location characterized by a separate power network, supplied from a high- or medium-voltage transformer, dedicated for the supply of the installation

Note 1 to entry: Industrial locations can generally be described by the existence of an installation with one or more of the following characteristics:

- items of equipment installed and connected together and working simultaneously;
- significant amount of electrical power generated, transmitted and/or consumed;
- frequent switching of heavy inductive or capacitive loads;
- high currents and associated magnetic fields;
- presence of industrial, high power scientific and medical (ISM) equipment (for example, welding machines).

The electromagnetic environment at an industrial location is predominantly produced by the equipment and installation present at the location. There are types of industrial locations where some of the electromagnetic phenomena appear in a more severe degree than in other installations.

Example locations include metalworking, pulp and paper, chemical plants, car production, farm building, high-voltage areas of airports

Note 2 to entry: The connection between location and electromagnetic environment is given in 3.1.13.

### 3.1.13

#### **electromagnetic environment**

totality of electromagnetic phenomena existing at a given location

Note 1 to entry: In general, the electromagnetic environment is time-dependent and its description may need a statistical approach.

Note 2 to entry: It is very important not to confuse the electromagnetic environment and the location itself.

[SOURCE IEC 60050-161:1990, 161-01-01, modified – Note 2 to entry has been added.]

## 3.2 Abbreviated terms

AAN	Asymmetric Artificial Network
AC	Alternating Current
AMN	Artificial Mains Network

CATV	Cable TV network
DC	Direct Current
DSL	Digital Subscriber Line
EUT	Equipment Under Test
FAR	Fully Anechoic Room
FSOATS	Free Space Open Area Test Site
ISDN	Integrated Services Digital Network
ITE	Information Technology Equipment
LAN	Local Area Network
MME	Multi Media Equipment
OATS	Open Area Test Site
PSTN	Public Switched Telephone Network
SAC	Semi Anechoic Chamber
TEM	Transverse Electromagnetic Mode
USB	Universal Serial Bus
xDSL	Generic term for all types of DSL technology

#### 4 Conditions during testing

The EUT shall be tested in the operating mode producing the largest emission in the frequency band being measured, consistent with normal applications. The configuration of the test sample shall be varied to achieve maximum emission consistent with typical applications and installation practice. Pre-testing may be used to reduce test time.

If the EUT is part of a system, or can be connected to associated equipment, the EUT shall be tested while connected to the minimum representative configuration of associated equipment necessary to exercise the ports in a similar manner to that described in CISPR 11 or CISPR 32.

The EUT shall be arranged in accordance with the requirements of Table 1.

**Table 1 – Test arrangements of EUT**

Intended operational arrangement(s) of EUT	Test arrangement	Remarks
Table-top only	Table-top	
Floor-standing only	Floor-standing	
Can be floor-standing or table-top	Table-top	
Rack mounted	In a rack or table-top	
Other, for example wall mounted, ceiling mounted, handheld, body worn	Table-top	With normal orientation If the equipment is designed to be mounted on a ceiling, the downward-facing portion of the EUT may be oriented facing upward.
If a physical hazard would be caused by testing the device on a table-top, then it can be tested as floor standing and the test report shall document the decision and justification.		

In cases where a manufacturer's specification requires external filtering and/or shielding devices or measures that are clearly specified in the user's manual, the test requirements of this document shall be applied with the specified devices or measures in place.

The configuration and mode of operation during the measurements shall be precisely noted in the test report. If the EUT has a large number of similar ports or ports with many similar connections, a sufficient number shall be selected to simulate actual operating conditions and to ensure that all the different types of termination are covered.

The measurements shall be carried out at one single set of parameters within the operating ranges of temperature, humidity and atmospheric pressure specified for the product and at the rated supply voltage, unless otherwise indicated in the basic standard. The relevant conditions shall be recorded in the test report.

Where applicable, additional information on EUT configuration can be found in CISPR 16-2-1, CISPR 16-2-3, CISPR 11 or CISPR 32 as referenced in Table 3 to Table 5.

## 5 Product documentation

The purchaser/user/installer shall be informed within the product documentation if special measures have to be taken to achieve compliance. One example, would be the need to use shielded or special cables.

## 6 Applicability

The application of measurements for emission(s) depends on the particular equipment, its configuration, its ports, its technology and its operating conditions.

Measurements shall be applied to the relevant ports of the equipment according to the requirements defined in Table 3 to Table 5. Measurements shall only be carried out where the relevant ports exist.

It may be determined from consideration of the electrical characteristics and usage of particular equipment that some of the measurements are inappropriate and therefore unnecessary. In such a case it is required that the decision and justification not to measure shall be recorded in the test report.

## 7 Measurement uncertainty

Where guidance for the calculation of the instrumentation uncertainty of a measurement is specified in CISPR 16-4-2 this shall be followed, and for these measurements the determination of compliance with the limits in this document shall take into consideration the measurement instrumentation uncertainty in accordance with CISPR 16-4-2. Calculations to determine the measurement result and any adjustment of the test result required when the test laboratory uncertainty is larger than the value for  $U_{\text{CISPR}}$  given in CISPR 16-4-2 shall be included in the test report.

## 8 Compliance with this document

Where this document gives options for testing particular requirements with a choice of test methods, compliance can be shown against any of the relevant test methods, using the specific limits with the restrictions provided in the relevant tables clauses. For example, floor standing shall be assessed against table clause 3.1, considering table clause 3.2 is limited to small equipment and table clause 3.3 is limited to table top equipment.

In any situation where it is necessary to retest the equipment the test method originally chosen shall be used in order to ensure consistency of the results.

Equipment which fulfils the requirements across the frequency ranges specified in Table 3 to Table 5 in this document is deemed to fulfil the requirements in the entire frequency range from 9 kHz to 400 GHz.

Measurements do not need to be performed at frequencies where no limits are specified.

NOTE CISPR TR 16-4-3 provides guidance on the applicability of limits to series produced equipment.

## 9 Emission requirements

The emission requirements for equipment covered by this document are given on a port by port basis and defined in Table 3 to Table 5. Annex A is provided for information purposes only and lists proposed limits for DC power ports.

The measurements shall be conducted in a well-defined and reproducible manner and performed in any order.

The description of the measurement, the measurement instrumentation, the measurement methods, and the measurement set-up to be used are given in the standards, which are referred to in Table 3 to Table 5. These standards are not repeated here, however modifications or additional information needed for the practical application of the measurements are given in this document.

The following shall be taken into account during the application of the measurements defined in Table 3 to Table 5.

- At transitional frequencies, the lower limit applies.
- Where the limit value varies over a given frequency range, it changes linearly with respect to the logarithm of the frequency.
- The test site shall be validated for the measurement distance chosen.
- Where the table clause defines more than one detector, then the measurements shall be performed using both types of detector. Results obtained using a peak detector may be used instead of the other defined detectors.
- Where a different measurement distance is chosen, other than the reference distance defined in the limit column of Table 3, the limits shall be offset based upon the following formula:

$$\text{new limit} = \text{defined limit} - 20 \log (\text{measurement distance}/\text{reference distance})$$

The unit of metres shall be used for distance and dB( $\mu$ V/m) for the limits.

With regard to each table clause, the measurements shall be performed at only one distance.

- For radiated emission measurements, Table 2 shows the highest frequency up to which radiated emission measurements shall be performed based up the value of  $F_x$ .

**Table 2 – Required highest frequency for radiated measurement**

Highest internal frequency ( $F_x$ )	Highest measured frequency
$F_x \leq 108$ MHz	1 GHz
$108$ MHz $< F_x \leq 500$ MHz	2 GHz
$500$ MHz $< F_x \leq 1$ GHz	5 GHz
$F_x > 1$ GHz	$5 \times F_x$ up to a maximum of 6 GHz

NOTE 1 Where the highest internal frequency is not known, tests are performed up to 6 GHz.  
NOTE 2  $F_x$  is defined in 3.1.10.

- For emission measurements above 1 GHz, the peak detector limits shall not be applied to disturbances produced by arcs or sparks that are high voltage breakdown events. Such disturbances arise when devices contain or control mechanical switches that control current in inductors, or when devices contain or control subsystems that create static electricity (such as paper handling devices). The average limits apply to disturbances from arcs or sparks, and both peak and average limits will apply to other disturbances from such devices.
- For radiated emission measurements using a FSOATS, FAR or SAC, the measurement distance is the horizontal distance between the vertical projections of the calibration point of the receiving antenna and the boundary of the EUT. The boundary of the EUT is the smallest imaginary circular periphery around the most compact arrangement of the EUT, using typical spacing.
- Where this document specifies the use of an average detector, the linear average detector defined in Clause 6 of CISPR 16-1-1:2015 shall be used.

NOTE In the measurement specifics columns of Table 3 to Table 5, where relevant, the format is as follows: characteristic, basic standard, clause. For example, from table clause 3.1, Instrumentation, CISPR 16-1-1:2015, Clause 4.

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**Table 3 – Requirements for radiated emissions – enclosure port**

Table clause	Test facility	Frequency range MHz	Limits dB( $\mu$ V/m)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector / measurement distance		
3.1	OATS or SAC	30 to 230	40 Quasi-peak / 10 m	Instrumentation, CISPR 16-1-1, Clause 4  Antennas, CISPR 16-1-4, 4.5  Test site, CISPR 16-1-4, Clause 5  Method, CISPR 16-2-3, 7.3	Allowed measurement distances: 3 m, 5 m, 10 m or 30 m  For equipment meeting the size criterion defined in 3.1.11, the measurements may be performed at the 3 m distance. Note this size criterion is currently under discussion.  For measurement distances less than 30 m, the receiving antenna height shall be varied between 1 m to 4 m, else 1 m to 6 m shall be used. Additional guidance on the test method can be found in CISPR 16-2-3, 7.3 and Clause 8.
		230 to 1 000	47 Quasi-peak / 10 m		
3.2	TEM	30 to 230	40 Quasi-peak / n/a	IEC 61000-4-20	Only applicable to battery powered equipment not intended to have external cables attached.  Restricted to equipment complying with the definition of small equipment within 6.2 in IEC 61000-4-20.
		230 to 1 000	47 Quasi-peak / n/a		
3.3	FAR	30 to 230	52 to 45 Quasi-peak / 3 m	Instrumentation, CISPR 16-1-1, Clause 4  Antennas, CISPR 16-1-4, 4.5  Test site, CISPR 16-1-4, 5.4.7  Method, CISPR 16-2-3, 7.4.	Restricted to table top equipment, and floor-standing equipment which can be placed on table during the test.  Allowed measurement distances: 3 m, 5 m or 10 m  The limitations on EUT size in CISPR 16-2-3 apply.
		230 to 1 000	52 Quasi-peak / 3 m		
3.4	FSOATS OATS FAR SAC (see limitations)	1 000 to 3 000	76 Peak / 3 m	Instrumentation, CISPR 16-1-1, Clauses 5 and 6  Antennas, CISPR 16-1-4, Clause 4.5	Allowed measurement distances: 3 m, 5 m or 10 m.  Other facilities, such as FAR, SAC or OATS may be used provided they satisfy the free space conditions as defined in CISPR 16-1-4. For SAC and OATS, additional absorber may be required.
			56 Average / 3 m		
		3 000 to 6 000	80 Peak / 3 m	Test site, CISPR 16-1-4, Clause 8  Method, CISPR 16-2-3, Clause 7.6.	
			60 Average / 3 m		

The equipment is deemed to comply with the enclosure port requirement below 1 GHz if it meets the requirements defined in one or more of the table clauses 3.1, 3.2 or 3.3.

Antenna calibration shall be in accordance with CISPR 16-1-6:2014/AMD1:2017.

<sup>a</sup> Within this table, the version of the references are as follows:

CISPR 16-1-1 is CISPR 16-1-1:2015, CISPR 16-1-4 is CISPR 16-1-4:2010, CISPR 16-1-4:2010/AMD1:2012 and CISPR 16-1-4:2010/AMD1:2012/AMD2:2017, CISPR 16-2-3 is CISPR 16-2-3:2016 and IEC 61000-4-20 is IEC 61000-4-20:2010.

**Table 4 – Requirements for conducted emissions – low voltage AC mains port**

Table clause	Measurement network	Frequency range MHz	Limits dB(μV)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector		
4.1	AMN	0,15 to 0,5	79 Quasi-peak	Instrumentation, CISPR 16-1-1, Clauses 4 and 6  Networks, CISPR 16-1-2, 4.4	For clicks appearing between 5 and 30 times per minute, a relaxation of the limits is allowed of 20 log 30/N dB (where N is the number of clicks per minute). Criteria for separated clicks shall be found in CISPR 14-1.
			66 Average		
		0,5 to 30	73 Quasi-peak	Method, CISPR 16-2-1, Clause 7	
			60 Average		

The AMN characteristics shall be 50 Ω / 50 μH as defined in CISPR 16-1-2, 4.4, unless this network interferes with the operation of the EUT. In these cases, the AMN characteristics and the justification shall be recorded in the test report.

<sup>a</sup> Within this table, the version of the references are as follows:

CISPR 14-1 is CISPR 14-1:2016, CISPR 16-1-1 is CISPR 16-1-1:2015, CISPR 16-1-2 is CISPR 16-1-2:2014, CISPR 16-2-1 is CISPR 16-2-1:2014 and CISPR 16-2-1:2014/AMD1:2017.

**Table 5 – Requirements for conducted emissions – wired network port**

Table clause	Measurement network	Frequency range MHz	Limits dB(μV)	Limits dB(μA)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector	Detector		
5.1	As defined in CISPR 32	0,15 to 0,5	97 to 87 Quasi-peak	53 to 43 Quasi-peak	As defined in CISPR 32	The current and voltage disturbance limits are derived for use with an Asymmetric Artificial Network (AAN) which presents a common mode (asymmetric mode) impedance of 150 Ω to the wired network port under test (conversion factor is 20 log <sub>10</sub> 150 / 1 = 44 dB).  When performing measurements using an AAN, only the voltage limits apply.  All elements within CISPR 32 shall be followed, including but not limited to selection of test method, test configuration, cable characteristics.
			84 to 74 Average	40 to 30 Average		
		0,5 to 30	87 Quasi-peak	43 Quasi-peak		
			74 Average	30 Average		

<sup>a</sup> Within this table, the version of the reference CISPR 32 is CISPR 32:2015.

## Annex A (informative)

### Testing of DC powered systems

This annex is informative containing proposed requirements for conducted emissions on DC power ports, defined in Table A.1, with further specifics for which ports need to be measured given in Table A.2.

**Table A.1 – Proposed requirements for conducted emissions – DC power port**

Table Clause	Measurement network	Frequency range MHz	Limits dB( $\mu$ V)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector		
A.1.1	AMN	0,15 to 0,5	89 Quasi-peak	Instrumentation, CISPR 16-1-1, Clauses 4 and 6	See Table A.2, for DC power ports that require testing.
			76 Average		
		0,5 to 30	83 Quasi-peak	Method, CISPR 16-2-1, Clause 7	
			70 Average	Set-up, CISPR 16-2-1, Clause 7	

These informative limits have been considered by CISPR H (in conjunction with Table A.2) and are provided as a possible basis for new requirements.

<sup>a</sup> Within this table, the version of the references are as follows:  
CISPR 16-1-1 is CISPR 16-1-1:2015, CISPR 16-1-2 is CISPR 16-1-2:2014, CISPR 16-2-1 is CISPR 16-2-1:2014 and CISPR 16-2-1:2014/AMD1:2017.

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**Table A.2 – Conducted testing of DC powered equipment**

Table clause	Description of DC power source connection <sup>e</sup>	Testing to be required on DC power port	Proposed Intended cable connection <sup>d, e</sup>	Specifics and additional recommendations
A.2.1	Internal batteries, with no external DC input	No DC input port	None	No tests are required.
A.2.2	Distribution network <sup>a</sup>	Yes	All types	
A.2.3	Wired network port	No	As defined in CISPR 32	Port should be treated as a wired network port and tested against the requirements of Table 5.
A.2.4	Remote battery	Yes	Is longer than 3 m	
A.2.5	External AC/DC converter or battery charger	Yes	Is longer than 3 m <sup>b</sup>	The AC input port of the charger/converter <sup>c</sup> should also be tested against the requirements of Table 4.
A.2.6	External DC/DC converter or battery charger	Yes	Is longer than 3 m <sup>b</sup>	The DC input port of the charger/converter <sup>c</sup> should also be tested against the requirements of table clause A.2.7.
A.2.7	All other systems not defined above	Yes	Is longer than 3 m	Should be tested against the requirements of Table A.1.
<p><sup>a</sup> DC distribution networks include:</p> <ul style="list-style-type: none"> <li>• those with an overall length greater than 3 m.</li> </ul> <p><sup>b</sup> The length of the cable between the DC port on the EUT and the convertor or charger.</p> <p><sup>c</sup> Where possible, use a device specified by the manufacturer, else use a typical device capable of developing the necessary DC voltage/current.</p> <p><sup>d</sup> Where the limitation is satisfied then the test is applicable, for example, for table clause A.2.4, where the cable attached to a DC power port is 10 m long (longer than the 3 m requirement), then testing would be required against the requirements of Table A.1.</p> <p><sup>e</sup> Based upon the intended use of the equipment as defined by the manufacturer and documented in the user documentation.</p>				

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## Annex B (informative)

### Further information on measurements using a FAR

#### B.1 General

During the development of the limits for table top equipment using a FAR measurement facility, as defined in Table 3, the committee analysed various options, including polarity specific limits. During the original discussions, these were considered far too radical and hence dismissed.

During the following years, there have been repeated requests by various national committees to improve the limits defined in Table 3 by the adaption of polarity specific types. Hence, this informative annex is intended to communicate how the originals limits were derived and the possible improvements if these alternative limits were adopted.

There is a significant amount of additional data and information presented in CISPR 16-4-5, CENELEC R210-010 and in SMT4-CT96-2133.

#### B.2 Analysis

##### B.2.1 Theoretical analysis of simple radiators

A difference of 6 dB is expected for measured field strengths above a ground plane (for example, using an OATS) compared with free space (for example using a FAR). A simple OATS geometrical optic model is shown in Figure B.1, two rays impinge on the receive antenna above a ground plane; namely the one transmitted directly between the transmit and receive antenna and the one reflected by the ground plane.

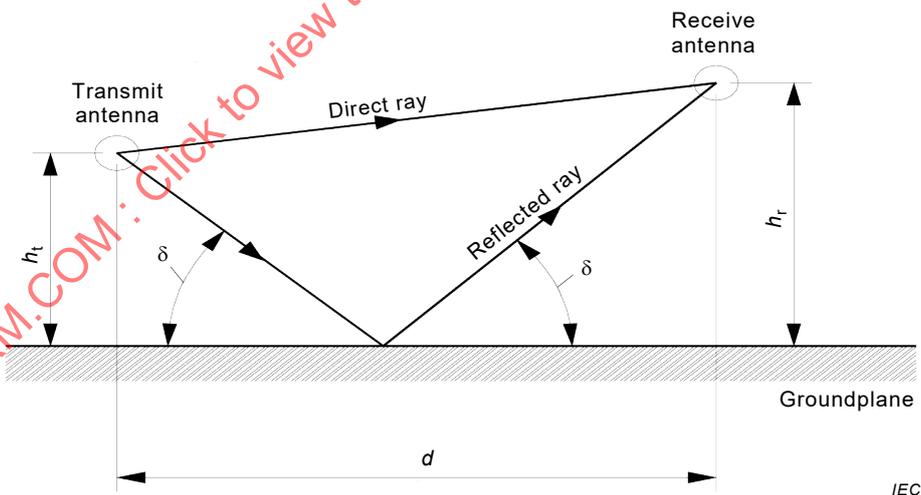


Figure B.1 – Geometrical optics model for OATS measurements

The difference in phase relation of these two rays results in an interference pattern which corresponds to the function of the height of the receive antenna above the ground. The resulting effect ranges from cancellation to doubling of the direct ray. As such, during OATS measurements  $h_r$  is varied until constructive interference (or doubling) is obtained.

Therefore, based upon this model, the limits when using a FAR should be 6 dB lower, in comparison with those of an OATS because within a FAR, there is no reflected ray, hence no doubling of emission levels will occur.

### B.2.2 Limitations with the basic model

#### B.2.2.1 Theoretical analysis of simple radiators

Figure B.2 illustrates typical interference patterns via the height of the receive antenna above a ground plane. The interference pattern depends on the distance between transmit and receive antenna, height of the transmit antenna above the ground plane, polarisation, frequency and type of antennas. As there is no reflected ray in free space, it is assumed that no interference patterns exist in a FAR. This begins to question the basic model, because the two facilities are in reality different.

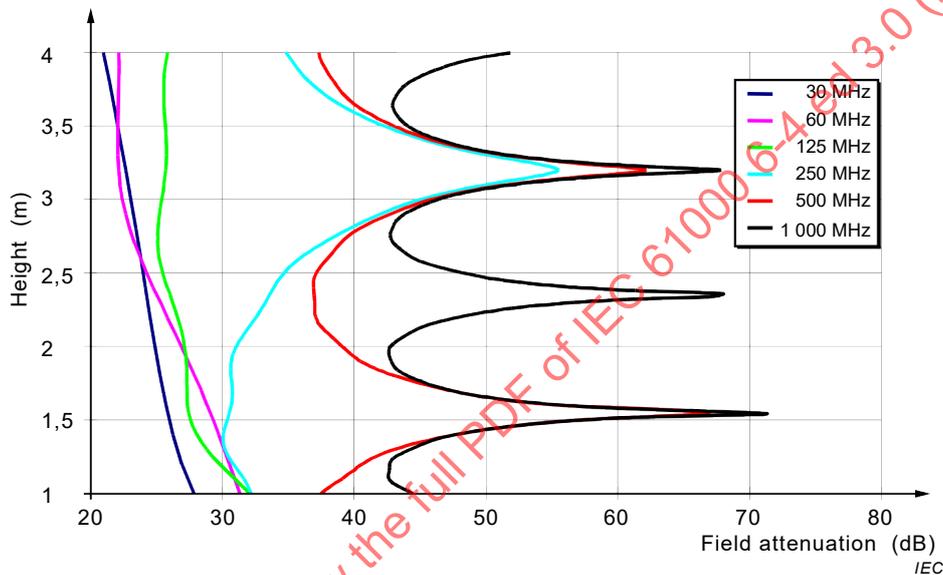
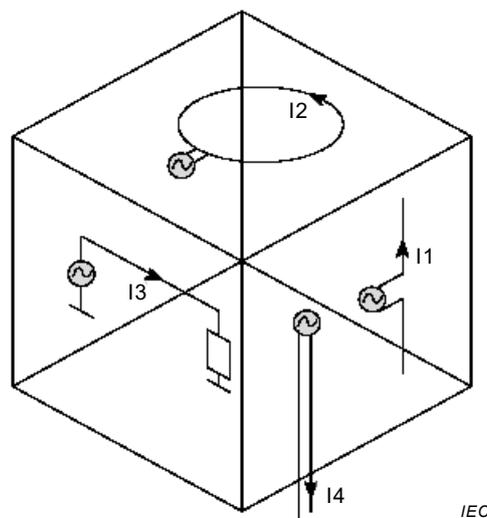


Figure B.2 – Field attenuation between two half-wave dipoles above ground plane with fixed transmit antenna height and variable receive antenna height

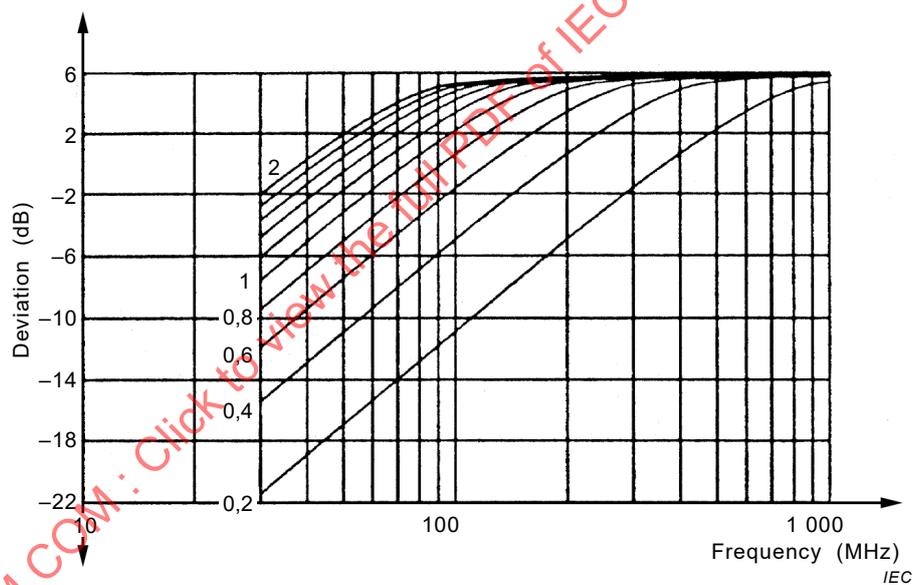
#### B.2.2.2 Analysis of an EUT

A real EUT can be represented by a number of RF sources driving different types of transmitting antennas with associated currents. Four possible sources are shown in Figure B.3, illustrating the different position, type of antenna, associated source and possible currents flowing. Within a typical EUT, the actual position of these sources, are generally unknown.



**Figure B.3 – Equivalent circuit diagram of a typical EUT**

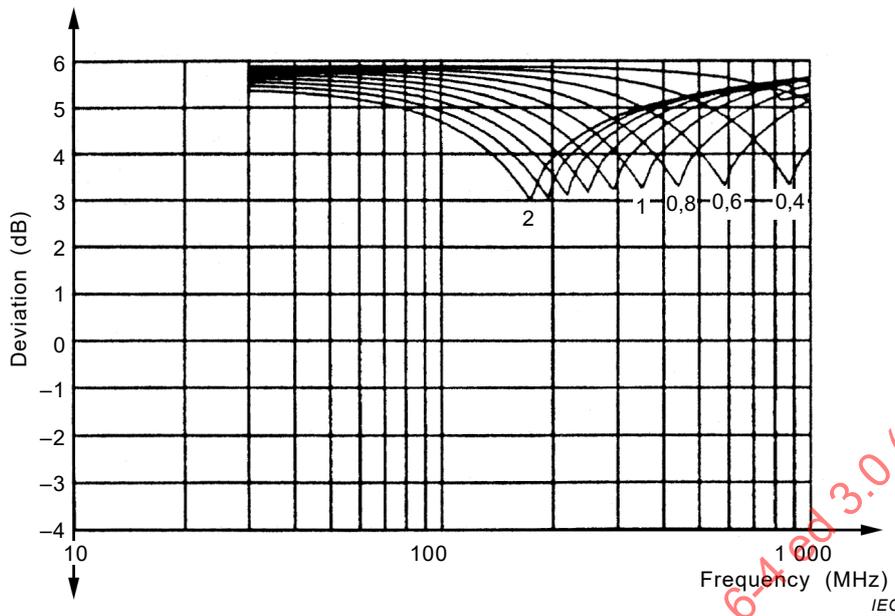
In order to establish a base line of the possible differences, a theoretical investigation<sup>1</sup> was performed and the results are shown in Figure B.4 and Figure B.8 for a 10 m distance and in Figure B.6 and Figure B.7 for a 3 m distance.



NOTE The numbers within the graph are the positions of the source above the ground plane on an OATS.

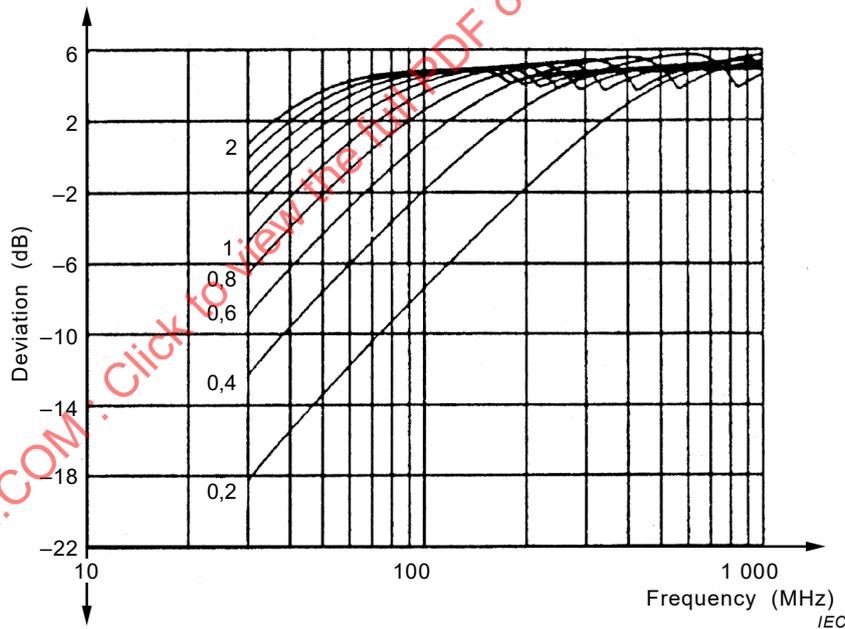
**Figure B.4 – 10 m distance, horizontal polarization, calculated differences for an electrically short straight wire above the ground plane on an OATS compared with a FAR ( $E_{OATS} - E_{FAR}$ )**

<sup>1</sup> Dr. Garn, 'Proposal for a new radiated emission test method using a completely absorber lined Room without ground plane', 9<sup>th</sup> Zurich symposium on EMC.



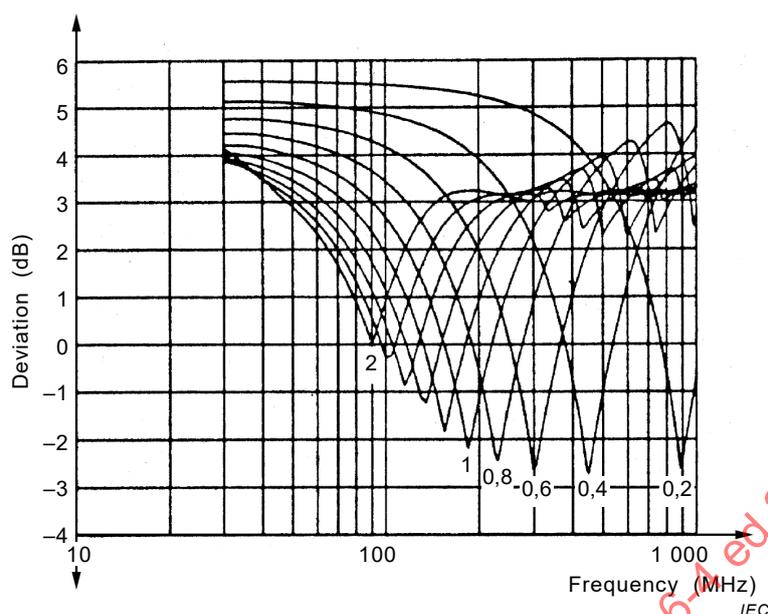
NOTE The numbers within the graph are the positions of the source above the ground plane on an OATS.

**Figure B.5 – 10 m distance, vertical polarization, calculated differences for an electrically short straight wire above the ground plane on an OATS compared with a FAR ( $E_{OATS} - E_{FAR}$ )**



NOTE The numbers within the graph are the positions of the source above the ground plane on an OATS.

**Figure B.6 – 3 m distance, horizontal polarization, calculated differences for an electrically short straight wire above the ground plane on an OATS compared with a FAR ( $E_{OATS} - E_{FAR}$ )**



NOTE The numbers within the graph are the positions of the source above the ground plane on an OATS.

**Figure B.7 – 3 m distance, vertical polarization, calculated differences for an electrically short straight wire above the ground plane on an OATS compared with a FAR ( $E_{\text{OATS}} - E_{\text{FAR}}$ )**

Figure B.4 to Figure B.7 shows the difference between the received field strength for different polarised electrically short straight wires placed above a ground plane and in free space. The receive antenna is moved between 1 m and 4 m above the ground plane and is fixed in the free space situation. The distance between the transmitting and the receiving antenna is the same for both sites.

For vertical polarized signals, the 2 models provide similar results, but for horizontal, the results are very different. As an example, Figure B.4 shows that the maximum difference in calculated field strengths above a ground plane and in free space is up to –22 dB for an EUT height of 0,2 m. The expected difference is +6 dB based on a simple model. That implies a difference of up to 28 dB in calculated field strength.

One of the reasons for this is the wave propagation on an OATS. In horizontal polarisation, below 100 MHz the constructive interference of direct and ground reflected signal cannot be found in the 1 m to 4 m height scan range. Therefore the same magnitude of radiated emission will give a different reading in the received field strength for horizontal and vertical polarisation on an OATS (13 dB at 10 m distance, 1 m source height).

### B.2.2.3 OATS as a reference

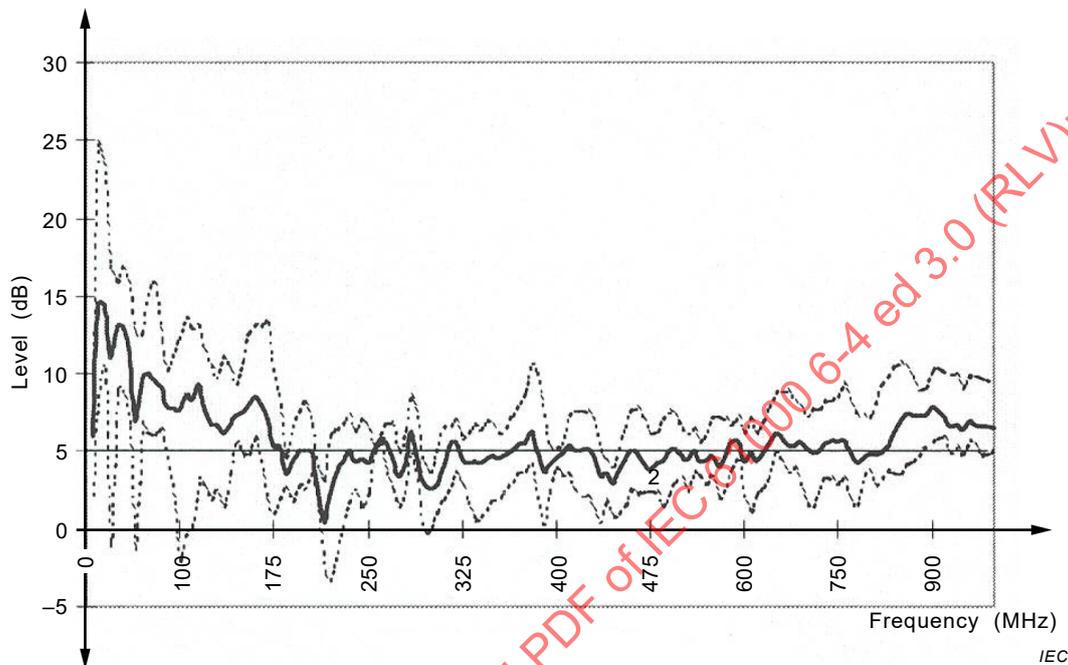
For many years, measurements using an OATS facility have been used to assess products. This solution has been very successful at controlling interference; therefore, if we blindly accepted 5 dB as the good compromise we would be ignoring the data and in reality tightening the limits when there is no justification.

### B.2.3 Measurements on an EUT

Many measurements have been performed to verify the limits, a very small sample is show in Figure B.8. This shows the differences of the horizontal polarised emissions of a small EUT with mains lead measured in 3 m FARs and on 10 m OATS. These measurements then contributed to the definition within CISPR 16-2-3 which effectively states that the maximum width and height of an EUT (including cables and associated equipment) shall be less than half of the measurement distance.

It is noticeable that the response is well above the 5 dB level at 30 MHz. This is caused by destructive interference on the OATS, as described in B.2.2.2. This phenomenon does not occur for vertical polarisation as the signal does not undergo a 180 phase change on reflection. That means the former proposed 5 dB difference in the limit values between 10 m OATS and 3 m FAR are not acceptable in the whole frequency range.

For further examples, see CISPR 16-4-5, CENELEC R210-010, etc.



**Figure B.8 – Differences of the horizontal polarised emission of the small EUT with mains lead in the 3 m FARs and on 10 m OATS**

### B.2.4 Derivation of limits

The limits were derived, based upon the details presented in B.2.1 to B.2.3 and summarized in the following:

- Polarity specific limits were considered too radical; hence any compromise would probably mean for vertical polarized signals, the FAR would be too strict and for horizontally polarized signals it would be a relaxation.
- Signals from horizontal polarized sources close to the ground plane give the biggest variants (see results at a height of 0,02 m in Figure B.4 and Figure B.6) hence only table top equipment should be assessed using a FAR. As the source of emissions is moved away from the ground plane, this variance decreases so this would be problematic for floor standing equipment.
- A compromise was finally adopted which would give a relaxation over those of an OATS, but only in the lower frequency range. The relaxation of 7 dB was based on approximately half of the difference between 5 dB and the -9 dB, where 5 dB is the idea response and -9 dB is the error associated emission from a 0,8 m high cable, derived from Figure B.4.

NOTE The half value would not be relevant if polarity specific limits were used, in the case the relaxation would then be 14 dB.

### B.3 Requirements

The following limits and requirements, defined in Table B.1, are provided for information purposes only. They may provide equivalent protection to radio reception as those defined in

Table 3 and are included to give the user of these types of facilities an indication of the validity of the results.

**Table B.1 – Proposed requirements for radiated emissions, FAR**

Table clause	Test facility	Frequency range MHz	Limits dB( $\mu$ V/m)	Measurement specifics <sup>a</sup>	Limitations and restrictions <sup>a</sup>
			Detector / measurement distance		
B.1.1	FAR	30 to 230	<b>Horizontally polarized emissions</b> 59 to 45 Quasi-peak / 3 m	Instrumentation, CISPR 16-1-1, Clause 4  Antennas, CISPR 16-1-4, 4.5	Allowed measurement distances: 3 m, 5 m or 10 m  The limitations on EUT size in CISPR 16-2-3 apply.  The measurement distance is from the receiving antenna to the boundary of the calibrated test volume.  The horizontally exposed cabling shall be at a minimum, and not at 0,8 m as required by CISPR 16-2-3.
			<b>Vertically polarized emissions</b> 45 Quasi-peak / 3 m	Test site, CISPR 16-1-4, 5.4.7  Method, CISPR 16-2-3, 7.4	
		230 to 1 000	52 Quasi-peak / 3 m		
<sup>a</sup> Within this table, the version of the references are as follows: CISPR 16-1-1 is CISPR 16-1-1:2015, CISPR 16-1-4 is CISPR 16-1-4:2010, CISPR 16-1-4:2010/AMD1:2012 and CISPR 16-1-4:2010/AMD2:2017, CISPR 16-2-3 is CISPR 16-2-3:2016.					

The following key points shall be noted.

- 1) Vertically polarized emission should correlate very well to those measured using an SAC/OATS.
- 2) The limits defined within Table B.1 would apply to both floor standing equipment and table top equipment.
- 3) Because of the correlation issues with FAR and SAC/OATS, the horizontally exposed cable shall be as short as possible. Not 0,8 m as required by CISPR 16-2-3. This will minimise these types of emissions.
- 4) The horizontal limit of 59 dB( $\mu$ V/m) was developed to improve the correlation for cables close to the ground plane, see Figure B.6, this value may need to be different for table top equipment, for example 52 dB( $\mu$ V/m).

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47 CFR 15, TITLE 47 – *Telecommunication Chapter I – Federal Communications Commission, Subchapter A Part 15 – Radio Frequency Devices*

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## COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

## COMPATIBILITÉ ÉLECTROMAGNÉTIQUE (CEM) –

**Partie 6-4: Normes génériques – Norme sur l'émission  
pour les environnements industriels**

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Cette troisième édition annule et remplace la seconde édition parue en 2016 et son Amendement 1:2010. Cette édition constitue une révision technique.

La présente édition inclut les modifications techniques suivantes par rapport à l'édition précédente:

- a) les exigences ultérieures possibles sur les accès en courant continu;
- b) les limites futures possibles d'émissions rayonnées spécifiques à la polarité dans une FAR;

- c) la définition du type de détecteur de valeur moyenne est utilisée pour les mesures des émissions à des fréquences supérieures à 1GHz et les résultats obtenus à l'aide d'un détecteur de crête sont acceptables pour tous les mesurages;
- d) la définition des différentes dispositions d'essais de l'EUT.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
CIS/H/339A/FDIS	CIS/H/350/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

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## INTRODUCTION

L'IEC 61000 est publiée en plusieurs parties, conformément à la structure suivante:

### **Partie 1: Généralités**

Considérations générales (introduction, principes fondamentaux)

Définitions, terminologie

### **Partie 2: Environnement**

Description de l'environnement

Classification de l'environnement

Niveaux de compatibilité

### **Partie 3: Limites**

Limites d'émission

Limites d'immunité (dans la mesure où elles ne relèvent pas de la responsabilité des comités de produits)

### **Partie 4: Techniques d'essai et de mesure**

Techniques de mesure

Techniques d'essai

### **Partie 5: Guide d'installation et d'atténuation**

Guide d'installation

Méthodes et dispositifs d'atténuation

### **Partie 6: Normes génériques**

### **Partie 9: Divers**

Chaque partie est à son tour subdivisée en parties qui sont publiées soit comme Normes internationales, soit comme rapports techniques/spécifications techniques, certaines d'entre elles ayant déjà été publiées comme sections. D'autres seront publiées avec le numéro de la partie suivi d'un tiret et d'un second chiffre identifiant la subdivision (exemple: IEC 61000-6-1).

## COMPATIBILITÉ ÉLECTROMAGNÉTIQUE (CEM) –

### Partie 6-4: Normes génériques – Norme sur l'émission pour les environnements industriels

#### 1 Domaine d'application

La présente partie de l'IEC 61000 concernant les exigences d'émissions s'applique aux appareils électriques et électroniques destinés à être utilisés dans des environnements existants (voir 3.1.12) sur des sites industriels.

Le présent document ne s'applique pas aux appareils entrant dans le domaine d'application de l'IEC 61000-6-3.

Les environnements couverts par le présent document sont les sites intérieurs et extérieurs.

Les exigences en matière d'émission dans la plage de fréquences comprises entre 9 kHz et 400 GHz sont couvertes dans le présent document et ont été choisies de manière à assurer un niveau adéquat de protection de la réception radioélectrique dans l'environnement électromagnétique défini. Il n'est pas nécessaire de réaliser des mesures aux fréquences pour lesquelles aucune exigence n'a été spécifiée. Ces exigences sont considérées comme étant essentielles à l'obtention d'un niveau adéquat de protection des services radioélectriques.

Tous les phénomènes perturbateurs n'ont pas été inclus pour les besoins de l'essai. Seuls l'ont été ceux considérés comme pertinents pour l'équipement destiné à fonctionner dans l'environnement couvert par le présent document.

Les exigences sont spécifiées pour chacun des accès considérés.

La présente Norme d'émission CEM générique doit être utilisée lorsqu'aucune norme d'émission CEM spécifique à un produit ou à une famille de produits n'est disponible.

NOTE 1 Le présent document ne traite pas des aspects de sécurité.

NOTE 2 Dans des cas particuliers, des situations apparaissent dans lesquelles les niveaux spécifiés dans le présent document ne peuvent offrir le niveau de protection adéquat (lorsqu'un récepteur sensible est utilisé à très grande proximité d'un appareil, par exemple). Dans de tels cas, des mesures particulières d'atténuation peuvent devoir être employées.

NOTE 3 Les perturbations générées dans les conditions de défaut de l'équipement ne sont pas couvertes par le présent document.

#### 2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050-161, *Vocabulaire Electrotechnique International – Chapitre 161 – Compatibilité électromagnétique*

IEC 61000-4-20:2010, *Compatibilité électromagnétique (CEM) – Partie 4-20: Techniques d'essai et de mesure – Essais d'émission et d'immunité dans les guides d'onde TEM*

CISPR 11:2015, *Appareils industriels, scientifiques et médicaux – Caractéristiques de perturbations radioélectriques – Limites et méthodes de mesure*  
CISPR 11:2015/AMD 1:2016

CISPR 14-1:2016, *Compatibilité électromagnétique – Exigences pour les appareils électrodomestiques, outillages électriques et appareils analogues – Partie 1: Émission*

CISPR 16-1-1:2015, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 1-1: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Appareils de mesure*

CISPR 16-1-2:2014, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 1-2: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Dispositifs de couplage pour la mesure des perturbations conduites*

CISPR 16-1-4:2010, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 1-4: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Antennes et emplacements d'essai pour les mesures des perturbations rayonnées*

CISPR 16-1-4:2010/AMD1:2012

CISPR 16-1-4:2010/AMD2:2017

CISPR 16-1-6:2014, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 1-6: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Étalonnage des antennes CEM*

CISPR 16-1-6:2014/AMD1:2017

CISPR 16-2-1:2014, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 2-1: Méthodes de mesure des perturbations et de l'immunité – Mesures des perturbations conduites*

CISPR 16-2-1:2014/AMD1:2017

CISPR 16-2-3:2016, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 2-3: Méthodes de mesure des perturbations et de l'immunité – Mesurages des perturbations rayonnées*

CISPR 16-4-2:2011, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 4-2: Incertitudes, statistiques et modélisation des limites – Incertitudes de mesure de l'instrumentation*

CISPR 16-4-2:2011/AMD 1:2014

CISPR 32:2015, *Compatibilité électromagnétique des équipements multimédia – Exigences d'émission*

### **3 Termes, définitions et termes abrégés**

#### **3.1 Termes et définitions**

Pour les besoins de ce document, les termes et définitions donnés dans l'IEC 60050-161 ainsi que les suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse <http://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <http://www.iso.org/obp>

### 3.1.1

#### accès

interface physique de l'équipement spécifié avec l'environnement électromagnétique extérieur

Note 1 à l'article: Voir la Figure 1.

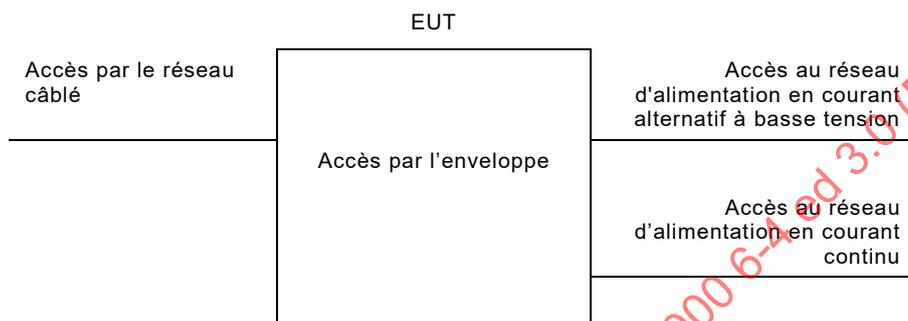


Figure 1 – Exemple d'accès

IEC

### 3.1.2

#### accès par l'enveloppe

frontière physique de l'équipement à travers laquelle les champs électromagnétiques peuvent rayonner ou à laquelle ils peuvent se heurter

### 3.1.3

#### accès par les câbles

point auquel un conducteur ou un câble est connecté à l'équipement

Note 1 à l'article: Il s'agit par exemple des accès de signaux, par le réseau câblé et de commande et des accès au réseau d'alimentation.

### 3.1.4

#### accès par le réseau câblé

point de connexion pour le transfert de la voix, des données et de la signalisation, destiné à être relié à des systèmes largement étendus par une connexion directe à un réseau de communication à plusieurs utilisateurs ou à un seul utilisateur

Note 1 à l'article: Il s'agit par exemple des réseaux CATV, PSTN, ISDN, xDSL, LAN et analogues.

Note 2 à l'article: Ces accès peuvent prendre en charge des câbles blindés ou non blindés et peuvent également transporter l'alimentation en courant alternatif ou en courant continu s'il s'agit d'une partie intégrante de la spécification de télécommunication.

Note 3 à l'article: Un accès généralement prévu pour l'interconnexion des composants d'un système en essai (RS-232, RS-485, bus de terrain dans le domaine d'application de l'IEC 61158, norme IEEE 1284 (imprimante parallèle), bus série universel (USB, Universal Serial Bus), norme IEEE 1394 (Fire Wire), par exemple) et utilisé selon ses spécifications fonctionnelles (pour la longueur maximale du câble connecté, par exemple) n'est pas considéré comme un accès par le réseau câblé.

Note 4 à l'article: Dans les éditions précédentes du présent document et dans la majorité des normes de produits, cet accès a été défini comme étant un accès de télécommunication ou de réseau.

### 3.1.5

#### accès au réseau d'alimentation

accès prévu pour la connexion de l'équipement à l'alimentation électrique primaire

### 3.1.6

#### **réseau public d'alimentation**

lignes électriques auxquelles toutes les catégories de consommateurs ont accès et qui sont régies par une entreprise assurant la fourniture ou la distribution d'énergie électrique

### 3.1.7

#### **basse tension**

BT

ensemble des niveaux de tensions utilisés pour la distribution d'énergie électrique et dont la limite supérieure généralement admise est de de 1 000 V en courant alternatif ou de 1 500 V en courant continu

[SOURCE: IEC 60050-601:1985, 601-01-26 modifiée – ajout des termes "ou 1 500 V en courant continu"]

### 3.1.8

#### **réseau de distribution en courant continu**

réseau d'alimentation local dans l'infrastructure d'un site ou d'un bâtiment destiné à un ou plusieurs types d'appareils différents et assurant l'alimentation indépendamment des conditions du réseau public

Note 1 à l'article: La connexion à une batterie locale ou distante n'est pas considérée comme un réseau de distribution en courant continu si une telle liaison ne comprend que la source d'alimentation pour un seul équipement.

### 3.1.9

#### **accès au réseau d'alimentation en courant alternatif à basse tension**

accès utilisé pour être relié au réseau d'alimentation en courant alternatif à basse tension, pour alimenter l'appareil

Note 1 à l'article: Un appareil avec un accès d'alimentation en courant continu est considéré comme alimenté en courant alternatif à basse tension s'il est alimenté à partir d'un convertisseur d'alimentation alternative/continue.

Note 2 à l'article: L'alimentation en courant alternatif à basse tension peut être publique ou non publique.

### 3.1.10

#### **fréquence interne la plus élevée $F_x$**

fréquence fondamentale la plus élevée produite ou utilisée dans l'EUT ou fréquence la plus élevée à laquelle il fonctionne

### 3.1.11

#### **petit appareil**

appareil posé sur une table ou au sol et qui tient (y compris ses câbles) dans un volume d'essai cylindrique de 1,2 m de diamètre et 1,5 m au-dessus du plan de masse

Note 1 à l'article: Ces dimensions sont en cours de discussion au CISPR.

### 3.1.12

#### **site industriel**

lieu caractérisé par un réseau d'alimentation séparé, alimenté par un transformateur haute ou moyenne tension et dédié à l'alimentation de l'installation

Note 1 à l'article: Les sites industriels peuvent habituellement être décrits par l'existence d'une installation pour laquelle une ou plusieurs des caractéristiques suivantes s'appliquent:

- éléments d'appareils installés et connectés ensemble et fonctionnant simultanément;
- quantité importante de puissance électrique produite, transmise et/ou consommée;
- commutation fréquente de charges importantes inductives ou capacitives;
- courants élevés et champs magnétiques associés;
- présence d'appareils industriels, scientifiques et médicaux (ISM) de tensions et courants élevés (par exemple machine à souder).