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INTERNATIONAL STANDARD

colour inside

Uninterruptible power systems (UPS) –
Part 2: Electromagnetic compatibility (EMC) requirements

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IEC 62040-2

Edition 3.0 2016-11

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 2: Electromagnetic compatibility (EMC) requirements

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by subcommittee 22H: Uninterruptible power systems (UPS), of IEC technical committee 22: Power electronic systems and equipment.

The text of this interpretation sheet is based on the following documents:

FDIS	Report on voting
22H/232/FDIS	22H/236/RVD

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

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Interpretation of 5.3.2.4, Limits at the network ports

Introduction

Sub-clause 5.3.2.4 states that the **network port** limits applicable to **UPS** of **category C1, C2** and **C3** are located in Table 1, Table 2 and Annex C.

It was not clear whether 5.3.2.4 applies to **network ports** that originate and terminate within the **enclosure port** of the **UPS** (i.e. to **network ports** connected exclusively to circuits or devices forming an integral part of the **UPS**).

Interpretation

The **network port** limits in Table 1, Table 2 and Annex C apply only to **network ports** for which connection to circuits or devices external to the **enclosure port** of the **UPS** is allowed. This includes, without limitation, connection to PSTN, ISDN, xDSL and Ethernet networks. The limits in Table 1, Table 2 and Annex C do not apply to **network ports** that originate and terminate within the **enclosure port** of the **UPS** (i.e. to **network ports** connected exclusively to circuits or devices forming an integral part of the **UPS**).

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UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 2: Electromagnetic compatibility (EMC) requirements

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the 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 62040-2 has been prepared by subcommittee 22H: Uninterruptible power systems (UPS), of IEC technical committee 22: Power electronic systems and equipment.

This third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision.

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

a) the inclusion of **network port** limits in Table 1, Table 2 and Annex C for the sake of consistency with other standards;
b) a change of quasi-peak limit for **category C3 UPS** in Table 2 for the sake of consistency with other standards;
c) a clarification in Table 4 about the performance criteria for immunity tests;
d) a revision of some test configurations in Annex A.

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

FDIS	Report on voting
22H/210/FDIS	22H/212/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.

In this document, the following print types are used:

– requirements proper and normative annexes: in roman type;
– compliance statements and test specifications: *in italic type*;
– notes and other informative matter: in smaller roman type;
– normative conditions within tables: in smaller roman type;
– terms that are defined in Clause 3: **bold**.

A list of all parts in the IEC 62040 series, published under the general title *Uninterruptible power systems (UPS)*, 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.

The contents of the Interpretation sheet of June 2018 have been included in this copy.

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.

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 2: Electromagnetic compatibility (EMC) requirements

1 Scope

~~This part of IEC 62040 applies to UPS units intended to be installed~~

~~– as a unit or in UPS systems comprising a number of interconnected UPS and associated control/switchgear forming a single power system; and~~

~~– in any operator accessible area or in separated electrical locations, connected to low-voltage supply networks for either industrial or residential, commercial and light industrial environments.~~

~~This part of IEC 62040 is intended as a product standard allowing the EMC conformity assessment of products of categories C1, C2 and C3 as defined in this part of IEC 62040, before placing them on the market.~~

~~Equipment of category 4 is treated as a fixed installation. Checking is generally done after installation in its final place of use. Sometimes partial checking may be done before. See Annex E~~

~~The requirements have been selected so as to ensure an adequate level of electromagnetic compatibility (EMC) for UPS at public and industrial locations. These levels cannot, however, cover extreme cases, which may occur in any location but with extremely low probability of occurrence.~~

~~This part of IEC 62040 takes into account the differing test conditions necessary to encompass the range of physical sizes and power ratings of UPS.~~

~~A UPS unit or system shall meet the relevant requirements of this part of IEC 62040 as a stand-alone product. EMC phenomena produced by any customers' load connected to the output of the UPS equipment shall not be taken into account.~~

~~Special installation environments are not covered, nor are fault conditions of UPS taken into account.~~

~~This part of IEC 62040 does not cover d.c. supplied electronic ballast or UPS based on rotating machines.~~

~~This part of IEC 62040 states:~~

~~– EMC requirements;~~

~~– test methods;~~

~~– minimum performance levels.~~

This part of IEC 62040 is a type test product standard for electromagnetic compatibility (EMC) and applies to movable, stationary, fixed or built-in, pluggable and permanently connected UPS for use in low-voltage distribution systems with an environment being either residential, commercial, light industrial or industrial, which deliver output voltage with **port** voltages not exceeding 1 500 V DC or 1 000 V AC and which include an energy storage device.

Subject to installing, operating and maintaining the UPS in the manner prescribed by the manufacturer, this standard defines emission limits, immunity levels, test methods and performance criteria for a complete UPS to comply with the essential EMC requirements

necessary to avoid the UPS interfering with other apparatus, e.g. radio receivers, and to avoid the UPS being affected by external phenomena.

This standard does not address EMC phenomena produced by loads connected to the UPS or situations created by any apparatus external to the UPS other than as described in the immunity requirements.

This standard is harmonized with applicable IEC standards for electromagnetic emission limits and immunity levels. It contains additional requirements applicable to UPS.

This standard does not cover:

a) low-voltage DC power supply devices covered by IEC 61204 standards;

b) systems wherein the output voltage is derived from a rotating machine.

NOTE 1 UPS generally connect to their energy storage device through a DC link. A chemical battery is an example of an energy storage device. Alternative devices can be suitable, and as such, where "battery" appears in the text of this standard, this can be understood as "energy storage device".

NOTE 2 This type test-based product standard allows EMC conformity assessment of UPS included in one of categories C1, C2 and C3 before placing them on the market. It also provides guidance for conformity assessment of UPS included in category C4 (see Clause 4).

NOTE 3 The differing test conditions necessary to encompass the range of physical sizes and power ratings of a complete UPS are taken into account. A complete UPS can consist of one or more interconnected units. For UPS configuration details refer to IEC 62040-3:2011, Annex A.

NOTE 4 The requirements have been selected so as to permit an adequate level of EMC for UPS installed in residential, commercial, light industrial and industrial locations. The requirements are not always sufficient to cover situations with low probability of occurrence including UPS faults.

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 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*~~

IEC 61000-2-2:2002, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-3-2:~~2000~~ 2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤16 A per phase)*

IEC 61000-3-12:2011, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

~~IEC 61000-4-1:2000, *Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques – Overview of IEC 61000-4 series*~~

IEC 61000-4-2:~~1995~~ 2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:~~2002~~ 2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:~~2004~~ 2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:~~1995~~ 2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:~~2003~~ 2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances induced by radio-frequency fields*

IEC 61000-4-8:~~1993~~ 2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 62040-3:~~1999~~ 2011, *Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements*

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

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

CISPR 16-2-3:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*
CISPR 16-2-3:2010/AMD1:2010
CISPR 16-2-3:2010/AMD2:2014

CISPR 22:~~2005~~ 2008, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

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 related to EMC and to relevant phenomena~~ IEC 62040-3:2011 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
particular interface of the UPS with the external electromagnetic environment as shown in Figure 1

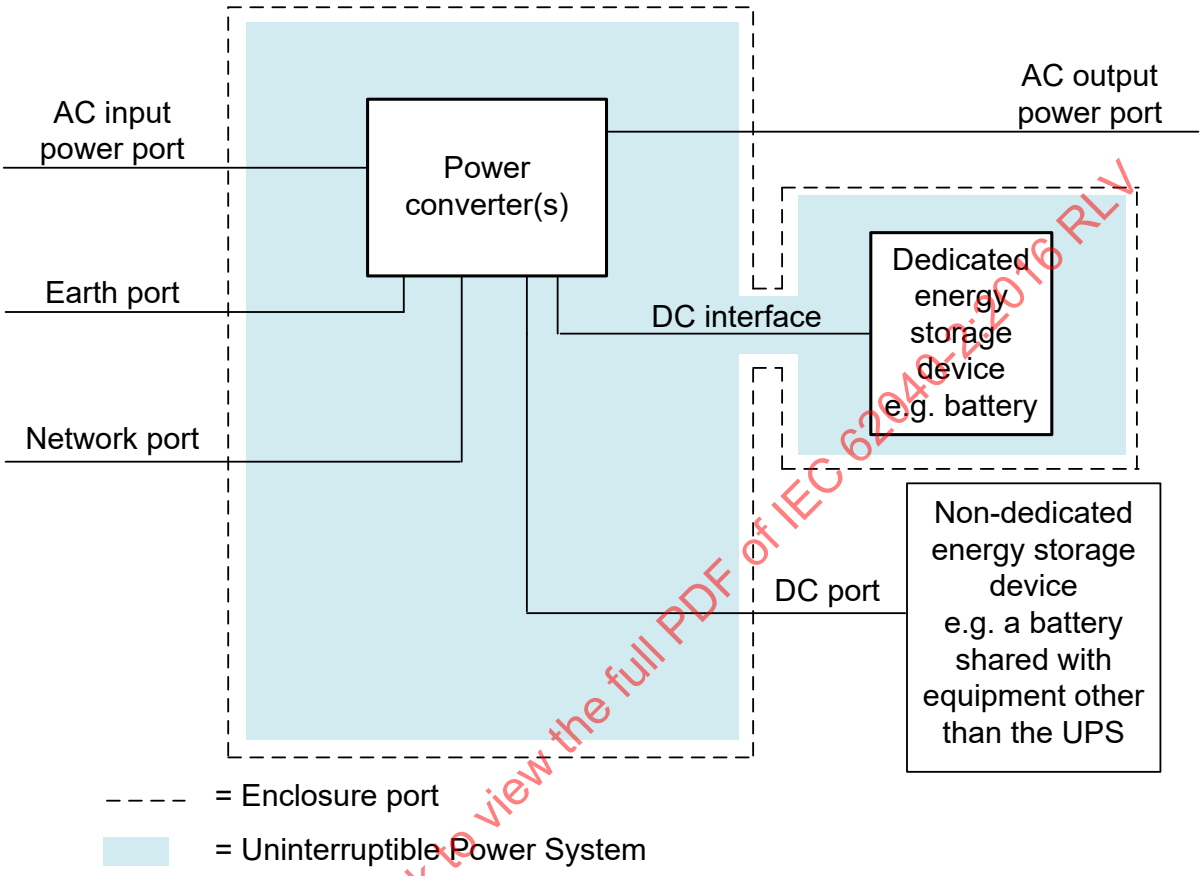


Figure 1 – UPS ports

3.1.2
DC interface
dedicated connection between the power converter and an energy storage device that is exclusively used by the UPS

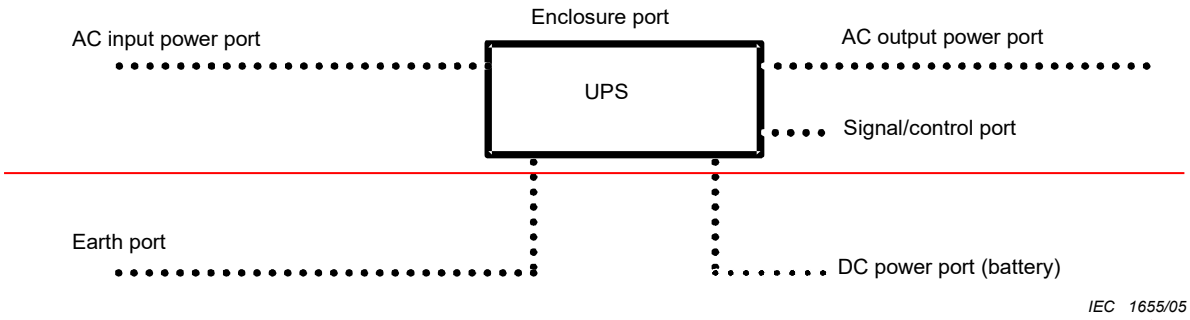
Note 1 to entry: The interface to an energy storage device intended for exclusive use of the UPS is not a **port** because this device is included in the UPS. The dedicated energy storage device shown in Figure 1 is connected through a **DC interface**.

3.1.3
DC port
connection from the power converter to an energy storage device that is not exclusively used by the UPS

Note 1 to entry: The non-dedicated energy storage device is connected through a **DC port**.

3.1.4
enclosure port
physical boundary of the ~~UPS~~ equipment under test (EUT) which electromagnetic fields ~~may~~ can radiate through or impinge on

Note 1 to entry: In Figure 1, the **enclosure port** represented by the dotted line around the power converter(s) and the dedicated energy storage device does not imply the existence of any shielding.



~~Figure 1 – Examples of ports~~

3.1.5
network port
signal, control or communication **ports** intended for the interconnection of components of an uninterruptible power system (UPS), or between a UPS and local associated equipment and used in accordance with relevant functional specifications for the purpose of control and/or monitoring of the UPS system and/or control of the associated equipment in accordance with the instruction manual

Note 1 to entry: The maximum length of cable connected to the **network port** is an example of relevant functional specifications.

3.1.6
first environment
environment that includes residential, commercial and light industrial premises directly connected, without intermediate transformers, to a public low-voltage mains supply

3.1.7
second environment
environment that includes all commercial, light industry and industrial locations other than those included in the **first environment**

Note 1 to entry: A building, or part of it, when supplied from a dedicated transformer or generator is an example of **second environment**.

3.1.8
category C1 UPS
UPS intended for use without any restriction in the **first environment**

Note 1 to entry: Such UPS are suitable for use in residential locations.

3.1.9
category C2 UPS
UPS intended for use without any restriction in the **second environment**

Note 1 to entry: Such UPS can also be used in the **first environment** under certain conditions.

3.1.10
category C3 UPS
UPS with an output current exceeding 16 A and intended for use in the **second environment** with certain restrictions

3.1.11
category C4 UPS
UPS that cannot be classified within any of the C1, C2 or C3 categories and intended for use in environments subject to particular requirements

3.2 Abbreviated terms

AAN asymmetric artificial network

NOTE 1 The terms impedance stabilization network (ISN) and AAN are used interchangeably.

AE auxiliary equipment

AMN artificial mains network

NOTE 2 The terms line impedance stabilization network (LISN) and AMN are used interchangeably.

CMAD common mode absorption device

EUT equipment under test

RF radio frequency

~~**4 Environment**~~

~~The following examples of environment cover the majority of UPS installations.~~

~~a) First environment: environment that includes residential, commercial and light industrial premises directly connected without intermediate transformers to a public low-voltage mains supply.~~

~~b) Second environment: environment that includes all commercial, light industry and industrial establishments other than those directly connected to a low-voltage mains that supplies buildings used for residential purposes.~~

4 UPS categories

4.1 Category C1 UPS

This category includes UPS intended for use without any restriction in the **first environment**. ~~Such UPS are suitable for use in residential establishments.~~

Category C1 UPS shall ~~meet~~ comply with category C1 requirements for emission limits (see Clause 5) and ~~withstand the~~ for immunity ~~requirements of Table 5~~ (see Clause 6).

4.2 Category C2 UPS

This category includes UPS ~~with an output current not exceeding 16 A and~~ intended for use without any restriction in the **second environment**. Such UPS may also be used in the **first environment** when ~~connected~~ the effect of the warning notice below is considered.

~~– through industrial plugs and sockets or~~

~~– through national plugs and sockets or~~

~~– permanently.~~

Category C2 UPS shall ~~meet~~ comply with category C2 requirements for emission limits (see Clause 5) and ~~withstand the~~ for immunity ~~requirements of Table 6~~ (see Clause 6).

The following ~~wording~~ warning shall be included in the ~~instructions for~~ user manual.

WARNING: This is a **category C2 UPS** product. In a residential environment, this product may cause radio interference, in which case the user may be required to take additional measures.

NOTE Such additional measures can require the services of a person or organization skilled with respect to EMC aspects.

4.3 Category C3 UPS

This category includes UPS with an output current exceeding 16 A and intended for use in the **second environment** with the following restrictions:

a) the UPS shall be installed and commissioned by a professional person or organization that is skilled with respect to EMC aspects;

b) the UPS location shall be physically separated from other buildings classified as **first environment** by a distance greater than 30 m or by a structure which acts as a barrier to radiated phenomena providing equivalent attenuation; and

c) the installation shall be supplied through a dedicated transformer or generator or through a device providing equivalent attenuation.

~~Such UPS are suitable for use in commercial or industrial installations having a minimum boundary of 30 m from other buildings classified as first environment.~~

Category C3 UPS shall ~~meet~~ comply with category C3 requirements for emission limits (see Clause 5) and ~~withstand the~~ for immunity ~~requirements of Table 6~~ (see Clause 6).

The following ~~wording~~ warning shall be included in the ~~instructions for~~ user manual.

WARNING: This is a product for commercial and industrial application in the **second environment** – installation restrictions or additional measures may be needed to prevent disturbances.

4.4 Category C4 UPS

This category includes UPS that cannot be classified within any of the C1, C2 or C3 categories intended for use in ~~complex~~ environments subject to ~~an agreement between supplier and customer regarding applicable emission and immunity levels~~ particular requirements.

Such UPS shall meet the specific emission and immunity levels applicable for the installation.

A **category C4 UPS** is not limited by current ratings.

NOTE Conformity assessment of a C4 UPS generally consists of a technical evaluation of the effect of combining complying UPS variants and subassemblies, and of a final site test to verify compliance with requirements that cannot be readily verified by technical evaluation. For details regarding site testing refer to Annex E.

4.5 Categories and environment

If the environment has been determined as the **first environment**, a **category C1** or **C2 UPS** should be used.

If the environment has been determined as the **second environment**, a **category C2** or **C3 UPS** should be used.

If the environment is not covered exclusively either by the **first** or **second environment**, a **category C4 UPS** should be used.

From the emission point of view, a UPS with a lower emission category, such as C1, can always be used instead of one with a higher emission category, such as C3.

Emission categories are independent of immunity. For example, a statement that a UPS has emission category C1 does not imply that the immunity is only suitable for the **first environment**.

4.6 Documentation ~~for the purchaser/user~~

~~a) The purchaser/user shall be informed if special measures have to be taken to achieve compliance, for example, the use of shielded or special cables. Any restriction on the length of the a.c. output cables shall also be indicated.~~

~~b) Notwithstanding that the scope of supply of the UPS shall comply with any local regulation, documentation shall be available to the purchaser/user upon request. A list of auxiliary accessories, together with the UPS complying with the emission requirements, shall be made available.~~

For EMC purposes, the following shall be included in the user documentation:

a) any special measures to be taken to achieve compliance, for example, the segregation of cables, the use of shielded or special cables and any restriction on the length of cables connected to the AC output and/or to the energy storage device;

b) upon request, a list of EMC-compatible UPS accessories;

c) warning notice for **category C1 UPS** as described in 6.3.2;

d) warning notice for **category C2** and **category C3 UPS** as applicable and as described in 4.2 and 4.3.

5 Emission

5.1 General

The applicable emission limits for each UPS category are specified in 5.3.

~~Disturbances~~ Emissions in the frequency range up to 1,0 GHz are covered.

The emission requirements have been selected so as to ensure that disturbances generated by UPS operating normally do not reach a level which could prevent other apparatus from operating as intended.

NOTE 1 There is a possibility that the limits in this standard ~~may~~ do not fully provide protection against interference to radio and television reception when the UPS is used closer than 10 m to the receiving antenna for **category C1** or **C2 UPS** and 30 m for **category C3 UPS**.

NOTE 2 In special cases, for instance, when highly susceptible apparatus is being used in proximity, additional mitigation measures ~~may have to~~ can be employed to reduce the electromagnetic emission further below the specified levels.

5.2 General test requirements

~~UPS shall comply with the emission limits of 5.3 to 5.4.~~

The UPS emission tests shall be performed under the following conditions:

a) rated input voltage;

b) normal mode(s) and stored energy mode of operation;

c) ~~linear~~ resistive load that results in the highest ~~interference~~ disturbance level.

~~The objective of 5.4 is to define limits and test methods for UPS defined in the scope of this part of IEC 62040 in relation to electromagnetic emissions which may cause interference in other apparatus, for example, radio receivers.~~

~~These emission limits represent essential electromagnetic compatibility requirements.~~

Test requirements are specified for each **port** considered. Refer to Annex A for test methodology.

5.3 ~~General~~ Measurement ~~conditions~~ requirements

5.3.1 General

~~The measurements shall be made in the operating mode producing the largest emission in the frequency band being investigated consistent with normal applications. UPS operating modes (normal mode and stored energy mode) shall be investigated.~~

~~An attempt should be made to maximise the emission by varying the test set-up configuration of the test sample.~~

~~UPS a.c. outputs shall be loaded with a linear load capable of operating the unit under test for any load condition within its output rating.~~

The emission of all **ports** shall be verified as follows.

If the UPS ~~is part of a system or~~ can be connected to auxiliary accessories, then the UPS shall be tested while connected to the minimum configuration including auxiliary and communication accessories necessary to exercise ~~the~~ all such **ports**, or ~~be terminated in~~ connected to an equivalent terminating impedance.

The configuration and mode of operation during measurement shall be precisely noted in the test report. Refer to Annex A for test set-up and measurement criteria. For *in situ* or user installation testing, see Annex E. ~~The tests shall be carried out within the specific operating environment range for the UPS and at its rated supply voltage, unless otherwise indicated.~~

~~**6.3.3 Applicability**~~

~~Measurements are made on the relevant ports of the UPS.~~

5.3.2 Conducted emission

5.3.2.1 Ports and limits

For UPS with additional mains terminals (**ports**) for the connection of separate supplies for static by-pass and/or maintenance by-pass circuits, these terminals (**ports**) ~~shall, wherever possible,~~ may be temporarily interconnected to the normal AC input **port** supply permitting the conducted emission tests to be performed at the resulting (common) AC input **port**. ~~Conducted emission tests in 5.3 shall include measurement of these additional circuits.~~

Measuring one of several identical **ports** is sufficient for conducted emission purposes.

NOTE Conducted emission in the frequency range from 2 kHz to 150 kHz is under consideration.

Where referred to in 5.3.2, the 0,15 MHz to 30 MHz conducted emission limits are listed in Tables 1 and 2.

Table 1 – Limits of mains terminal ~~interference~~ and network port disturbance voltage for category C1 and category C2 UPS in the frequency range 0,15 MHz to 30 MHz

Frequency range MHz	Limits dB (μV)							
	Category C1 UPS				Category C2 UPS			
	Mains terminal		Network port		Mains terminal		Network port	
	Quasi-peak	Average	Quasi-peak	Average	Quasi-peak	Average	Quasi-peak	Average
0,15 to 0,50[b]	66 to 56[a]	56 to 46[a]	84 to 74[a]	74 to 64[a]	79	66	97 to 87[a]	84 to 74[a]
0,50 to 5[b]	56	46	74	64	73	60	87	74
5 to 30	60	50			73	60		

[a] The limit decreases linearly with the logarithm of the frequency.

[b] The lower limit shall apply at the transition frequency.

Table 2 – Limits of mains terminal ~~interference~~ and network port disturbance voltage for category C3 UPS in the frequency range 0,15 MHz to 30 MHz

UPS rated output current A	Frequency range MHz	Limits dB (μV)			
		Mains terminal		Network port	
		Quasi-peak	Average	Quasi-peak	Average
> 16 to 100	0,15 to 0,50[b]	100	90	110 to 100[a]	94 to 84[a]
	0,50 to 5,0[b]	86	76	100	84
	5,0 to 30,0	90 to ~~70~~ 73[a]	80 to 60[a]		
> 100	0,15 to 0,50[b]	130	120	110 to 100[a]	94 to 84[a]
	0,50 to 5,0[b]	125	115	100	84
	5,0 to 30,0	115	105		

[a] The limits decrease linearly with the logarithm of the frequency.

[b] The lower limit shall apply at the transition frequency.

5.3.2.2 Limits ~~of mains terminal interference voltage~~ at the AC input port (mains)

The UPS shall not exceed the limits of either Table 1 or Table 2 according to the category and the rated output current of the UPS under test.

The UPS shall meet both the average and quasi-peak limit when using, respectively, an average detector receiver and a quasi-peak detector receiver, and measured in accordance with the methods described in A.6.

If the average limit is met when using a quasi-peak detector receiver, the test unit shall be deemed to meet both limits, and measurement with the average detector receiver is unnecessary.

If the reading on the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the highest reading shall be recorded, with the exception of any brief isolated high reading, which shall be ignored.

5.3.2.3 Limits at the AC output ~~interference voltage~~ port

The mains terminal limits in Table 1 and Table 2 apply.

An allowance of +14 dB is permitted for conducted ~~disturbances~~ emission at the output of the UPS as specified in Table 1 and Table 2, except for C3 greater than 100 A where no ~~increase~~ allowance is ~~allowed~~ permitted.

~~These~~ No limits ~~only~~ apply to UPS where the output cable, as declared by the manufacturer in the user~~s' instructions~~ manual, ~~can~~ does not exceed 10 m in length. When the manufacturer does not declare the maximum cable length, the limits apply.

The values shall be measured ~~using a voltage probe~~ in accordance with A.7.

5.3.2.4 Limits ~~of signal and telecommunication~~ at the network ports

~~For ports intended for connection to the public switched telecommunication network (PSTN), the test methods and limits of CISPR 22 apply (see also Annex C).~~

The **network port** limits in Table 1 and Table 2 apply.

No limits apply to UPS where the network cable, as declared by the manufacturer in the user manual, does not exceed 10 m in length. When the manufacturer does not declare the maximum cable length, the limits apply.

As an alternative to compliance with voltage limits, Annex C provides current limits that may be applied.

5.3.2.5 Limits for DC interface and DC port

~~The d.c. port is deemed an internal part of the UPS and, as such, is not subject to limits of conducted interference. The effect of conducted interference on the d.c. port may, however, cause radiated interference, but no further tests are required, provided that the UPS, in both normal and in stored energy modes of operation and when set-up as described in this clause, complies with the radiated requirements according to 6.5.55.~~

~~Where a UPS is provided with terminals for the connection of an external d.c. source, this port shall be included in the test set-up and tested as shown below.~~

~~For table-top UPS, the battery and its enclosure shall be installed in a position permitted by the manufacturer's instructions. For floor-standing UPS, the external d.c. source and its enclosure shall be positioned 0,8 m from the UPS and wired in accordance with the manufacturer's instructions. For large UPS, where the d.c. source will be installed at a distance from the UPS, the port shall be wired in accordance with the manufacturer's instructions, and a test battery or power supply shall be fitted to the d.c. source end of the cables to enable measurement in stored energy mode.~~

No conducted emission test is required at the **DC interface** (see Figure 1).

NOTE The effect of conducted emission on the **DC interface** can however cause radiated emission, but no conducted emission tests apply as the UPS is required to comply with the radiated emission limits described in 5.3.3.

The **DC port** limits are currently under consideration and their values pending determination in a future edition of CISPR 11.

5.3.2.6 Low-frequency emission – Input current harmonics

If the rated input current and voltage are within the scope of IEC 61000-3-2 or IEC 61000-3-12, the limits and test methodology therein shall apply.

5.3.3 Radiated emission

5.3.3.1 Electromagnetic field

The UPS shall meet the limits of Table 3. If the reading on the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the highest reading shall be recorded, with the exception of any brief isolated high reading, which shall be ignored.

No limits apply for radiated emission below 30 MHz.

~~Measurements methods and informative limits for study are given in Annex B.~~

Table 3 – Limits of radiated emission in the frequency range 30 MHz to 1 000 MHz

Frequency range MHz	**Quasi-peak limits** dB (μV/m)		
	Category C1 UPS	**Category C2 UPS**	**Category C3 UPS**
30 to 230 [a]	30	40	50
230 to 1 000	37	47	60
[a] The lower limit shall apply at the transition frequency.			

NOTE 1 The test distance is 10 m. If the emission measurement at 10 m cannot be made because of high ambient noise levels or for other reasons, measurements ~~may be~~ are made at a closer distance, for example 3 m ~~(see CISPR 22, 10.3.1, note)~~. An inverse proportionality factor of 20 dB per decade is used to normalize the measured data to the specified distance for determining compliance.

NOTE 2 Where interference occurs additional provisions ~~may~~ can be ~~required~~ necessary.

5.3.3.2 Magnetic field

No limits apply for magnetic emissions. Annex B provides guidance for measurement methods and informative levels.

6 Immunity

6.1 General

Immunity requirements in the frequency range 0 Hz to 1 GHz only are covered.

These test requirements represent essential electromagnetic compatibility immunity requirements. Test requirements are specified for each **port** considered.

The levels given in Clause 6 do not cover extreme cases, which may occur in any location but with an extremely low probability of occurrence. For such cases, higher levels may be required.

NOTE In special cases, situations ~~will~~ can arise where the level of disturbances ~~may~~ exceed the levels specified in this standard, for example, where a hand-held transmitter is used in proximity of a UPS. In these instances, there is a possibility that special mitigation measures ~~may have to be employed~~ become necessary.

6.2 General requirements and performance criteria

The equipment shall, as a minimum, comply with the immunity ~~limits~~ levels of 6.3. The performance criteria adequate for UPS are given in Table 4.

Table 4 – Performance criteria for immunity tests

	Criterion A	Criterion B
~~Output characteristics~~	~~Voltage permitted to vary only within the steady-state characteristics applicable (≥100 m sec limits in Figures 1, 2 or 3 of IEC 62040-3)~~	~~Voltage permitted to vary within the inverse time characteristics applicable (<100 m sec limits in Figures 1, 2 or 3 of IEC 62040-3)~~
External and internal indications and metering	Change only during test	Change only during test
Control signals to external devices	No change	Change only temporarily in consistency with the actual UPS mode of operation
Mode of operation[a]	No change	Change only temporarily
[a] At all times, the UPS shall remain within the performance classification as declared by the UPS manufacturer (see IEC 62040-3:2011).		

The tests shall be made with the UPS in the following conditions:

a) rated input voltage;

b) normal mode(s) of operation;

c) linear load at rated active output power or at light load according to IEC 62040-3:2011.

The UPS shall be specified with the proper level in case of different levels of performance criteria.

Refer to Annex D for test methodology.

6.3 Basic immunity requirements ~~– High-frequency disturbances~~

6.3.1 ~~Conditions~~ General

~~In Tables 5 and 6, the minimum immunity requirements for high-frequency disturbance tests, and acceptance criteria are stated.~~

Compliance is checked by testing against the immunity requirements listed in Table 5 and Table 6. The UPS shall continue to operate without degradation and in accordance with the applicable performance criterion. The ~~acceptance~~ performance criteria are detailed in Table 4.

6.3.2 ~~Equipment of~~ Category C1 UPS

The levels in Table 5 shall be applied to **category C1 UPS**. If a UPS is designed to have immunity according to Table 5, it shall include a written warning in the ~~catalogue~~ user manual or on the equipment which indicates that it is not intended to be used in an industrial environment.

Table 5 – Minimum immunity requirements for category C1 UPS

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance) criterion
Enclosure port	ESD	IEC 61000-4-2	4 kV CD or 8 kV AD if CD impossible	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80 MHz to 1 000 MHz 3 V/m 80 % AM (1 kHz)	A
	Immunity to power-frequency magnetic field	IEC 61000-4-8	3 A/m	A
AC input ~~and output~~ power **ports**	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz[a]	B
	Surge[b] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
	Immunity to low-frequency signals	See D.6 and IEC 61000-2-2	10 V 140 Hz to 360 Hz	A
AC output power **ports** and **DC port**	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz[a]	B
	Surge[b,e] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
DC ~~power port~~ **interface**	Fast transient-burst[e]	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
~~Signal and control ports~~ **Network ports**	Fast transient-burst[e]	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A

CD = contact discharge
AD = air discharge
AM = amplitude modulation
ESD = electrostatic discharge

[a] Power **ports** with current rating < 100 A: direct coupling using the coupling and decoupling network. Power **ports** with current rating ≥ 100 A: direct coupling or capacitive clamp without decoupling network. If the capacitive clamp is used, the test level shall be 2 kV/5 kHz.

[b] Light-load test condition is acceptable for power **ports** rated for current > 63 A.

[c] Coupling line to line.

[d] Coupling line to earth.

[e] Applicable only to **ports** or interfaces with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

6.3.3 ~~Equipment of~~ Category C2 and C3 UPS

The levels in Table 6 shall be applied to UPS, which are intended to be used in the **second environment**.

Table 6 – Minimum immunity requirements for category C2 and C3 UPS

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance) criterion
Enclosure port	ESD	IEC 61000-4-2	4 kV CD or 8 kV AD	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80 MHz to 1 000 MHz 10 V/m 80 % AM (1 kHz)	A
	Immunity to power-frequency magnetic field	IEC 61000-4-8	30 A/m	A
AC input ~~and output~~ power **ports**	Fast transient-burst	IEC 61000-4-4	2 kV/5 kHz[a]	B
	Surge[b] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A
	Immunity to low-frequency signals	See D.6 and IEC 61000-2-2	10 V/ 140 Hz to 360 Hz	A
AC output power **ports** and **DC port**	Fast transient-burst	IEC 61000-4-4	2 kV/5 kHz[a]	B
	Surge[b,e] 1,2/50 µs 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A
DC ~~power port~~ **interface**	Fast transient-burst[e]	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
~~Signal and control ports~~ **Network ports**	Fast transient-burst[e]	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
	Surge[b, f] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV~~[e], [f]~~	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A

CD = contact discharge
AD = air discharge
AM = amplitude modulation
ESD = electrostatic discharge

[a] Power **ports** with current rating < 100 A: direct coupling using the coupling and decoupling network. Power **ports** with current rating ~~>~~ ≥ 100 A: direct coupling or capacitive clamp without decoupling network. If the capacitive clamp is used, test level shall be 4 kV/5 kHz.

[b] Light-load test condition is applicable for power **ports** rated for current > 63 A.

[c] Coupling line to line.

[d] Coupling line to earth.

[e] Applicable only to **ports** or interfaces with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

[f] Applicable only to **ports** with cables whose total length according to the manufacturer's functional specification may exceed 30 m. In the case of shielded cable, a direct coupling to the shield is applied. This immunity requirement does not apply to field bus or other signal interfaces where the use of surge protection devices is not practical for technical reasons. The test is not required where normal functioning cannot be achieved because of the impact of the coupling/decoupling network on the EUT.

~~**7.4 Immunity to low-frequency signals**~~

~~The UPS in operation shall withstand the low-frequency conducted disturbances and signalling in the mains for mains compatibility as specified in IEC 61000-2-2 and as detailed in Annex D (see Clause D.6).~~

~~Compliance is checked by simulating the above conditions, and the UPS shall continue to operate without degradation of the specified performances. Criterion: A.~~

~~**7.5 Immunity to power-frequency magnetic field**~~

~~The UPS in operation shall withstand disturbances induced by power-frequency magnetic fields as specified in IEC 61000-4-8: level 2 (3 A/m) for category C1; level 4 (30 A/m) for categories C2 and C3.~~

~~Compliance is checked by simulating the above conditions. The UPS shall continue to operate without degradation of the specified performances. Criterion: B~~

6.4 Immunity to voltage dips, short interruptions and voltage variations

~~This feature relates to one of the main objectives of a UPS as specified in IEC 62040-3.~~

Immunity to voltage dips, short interruptions and voltage variations characterize intrinsic UPS performance, and no specific EMC tests are required.

NOTE Refer to IEC 62040-3:2011 for the related performance tests.

Annex A
(normative)

Electromagnetic emission – Test methods

A.1 General

The purpose of these tests is to measure the levels of electromagnetic emission produced by the UPS and propagated by conduction and radiation.

Annex A mainly concerns continuous electromagnetic emissions.

Due to the range of physical size and power ratings, the manufacturer may choose the most appropriate test site and configuration that is best to physically accommodate the UPS.

In some cases, for example for ~~multi-module systems~~ UPS consisting of two or more UPS units, the only solution will be a site-installed evaluation. Therefore, the following test set-ups and methods provide, as far as possible, the general criteria to cater for most UPS.

The tests shall be carried out within the specific operating environment specified for the UPS and as specified in Annex A.

A.2 Measuring equipment

A.2.1 Measuring instruments

Receivers with quasi-peak detectors and with average detectors shall be in accordance with CISPR 16-1-1:2015.

~~NOTE Measuring instruments having other detector characteristics may be used provided the measurement of the disturbance values can be proved to be the same. Attention is drawn to the convenience of using a panoramic receiver or a spectrum analyser, particularly if the working frequency of the equipment under test changes appreciably during the work cycle.~~

A.2.2 Artificial mains network (AMN)

Measurement of the mains terminal disturbance voltage shall be made using an AMN consisting of 50 Ω/50 μH network as specified in Clause 4 of CISPR 16-1-2:2014.

The AMN is required to provide a defined impedance at radio frequency across the mains supply at the point of measurement and also to provide for isolation of the equipment under test from ambient noise on the power lines.

A.2.3 Voltage probe

The voltage probe, in accordance with the requirements of Clause 5 of CISPR 16-1-2:2014, and shown in Figure A.1, shall be used where specified for UPS outputs, and when the AMN cannot be used due to the current rating of the input of the UPS. The probe is connected sequentially between each line and the reference ~~earth chosen (metal plate, metal tube)~~ ground plane.

The probe mainly consists of a blocking capacitor and a resistor so that the total resistance between the line and earth is at least 1 500 Ω. The effect on the accuracy of measurement of the capacitor or any other device which may be used to protect the measuring receiver against dangerous currents shall be either less than 1 dB or allowed for in calibration.

~~The ground connector of the probe is to be connected to reference ground with low impedance. The length of this connection shall be not less than 1/10th of the wavelength of the maximum measurement frequency (>1 m at 30 MHz). In addition, for frequencies below 3 MHz, the length of this connection shall not exceed 10 m.~~

The loop formed by the ground lead connected to the probe, the mains conductor tested and reference ground should be minimized to reduce the effects of any strong magnetic fields.

An extension ground braid may be used in this purpose when the measurement is performed at a terminal not reachable with the normal probe only.

A.2.4 Antennas

~~The test shall be carried out in accordance with the requirements of Clause 15 of CISPR 16-1-2.~~

The antenna shall comply with the requirements of CISPR 16-1-4:2010/AMD1:2012, Clause 4.

A.2.5 Common mode absorption device (CMAD)

Common mode absorption devices (CMADs) are applied on cables leaving the test volume during a radiated emission measurement. CMADs are used in radiated emission measurements to reduce variations in the measurement results between different test sites (see Clause 9 of CISPR 16-1-4:2010 for further information).

A.2.6 Asymmetric artificial network

Asymmetric artificial networks (AAN) are used to measure (or inject) asymmetric (common mode) voltages on unshielded symmetric signal (e.g. telecommunication) lines while rejecting the symmetric (differential mode) signal. (see Clause 7 of CISPR 16-1-2:2014 for further information).

A.3 Test unit configuration

A.3.1 Where not specified herein, the UPS shall be configured, installed, arranged and operated in a manner consistent with typical applications. Interface cables/loads/devices shall be connected to at least one of each type of interface **port** of the UPS, and, where practical, each cable shall be terminated in a device typical of actual usage.

Where there are multiple interface **ports** of the same type, additional interconnecting cables/loads/devices may have to be added to the UPS, depending upon the results of preliminary tests.

The number of additional cables should be limited to the condition in which the addition of another cable does not affect the emission level by more than 2 dB. The rationale for the selection of the configuration and loading of **ports** shall be included in the test report.

A.3.2 Interconnecting cables should be of the type and length specified in the individual equipment requirements. If the length can be varied, the length shall be selected to produce maximum emission.

A.3.3 If shielded or special cables are used during the tests to achieve compliance, then a note shall be included in the ~~instruction~~ user manual advising of the need to use such cables.

A.3.4 Excess lengths of cables shall be bundled at the approximate centre of the cable, with the bundles 0,3 m to 0,4 m in length. If it is impractical to do so because of cable bulk or stiffness, or because the testing is being made at a user installation, the disposition of the excess cable shall be precisely noted in the test report.

A.3.5 Any set of results shall be accompanied by a complete description of the cable and equipment orientation so that results can be repeated. If there are conditions of use, those conditions shall be specified and documented, for example, cable length, cable type, shielding and grounding. These conditions shall be included in the ~~instruction~~ user manual.

A.3.6 When equipment which interacts with other equipment to form a system is being evaluated, then the evaluation may be carried out using either additional equipment to represent the total system or with the use of simulators. Using either method, care shall be taken to ensure that the equipment under test is evaluated with the effects of the rest of the system, or simulators satisfying the ambient noise conditions specified in A.6.5. Any simulator used in lieu of an actual device shall properly represent the electrical and, in some cases, the mechanical characteristics of the interface, especially with respect to RF signals and impedances as well as cable configuration and types.

NOTE This procedure ~~is required~~ serves to ~~permit~~ enable the evaluation of equipment which will be combined with other equipment from different manufacturers to form a system.

A.3.7 ~~For UPS whose battery is external to the unit, the battery shall, where possible, be included in the test set-upand installed in accordance with the manufacturer's instructions.~~ Where a UPS is provided with terminals for the connection of an external DC source, these terminals shall be included in the test set-up. For table-top UPS, the battery and its enclosure shall be installed in a position permitted by the user manual. For floor-standing UPS, the external DC source and its enclosure shall be positioned in close proximity to the UPS and otherwise wired in accordance with the manufacturer's instructions. For large UPS, where the DC source is installed at a distance from the UPS, the **port** shall be wired in accordance with the manufacturer's instructions, and a test battery or power supply shall be fitted to the DC source end of the cables to enable measurement in stored energy mode.

Where this is not possible, or the battery including its housing is supplied by others, then this shall be noted in the test report.

A.3.8 AC outputs shall be loaded with resistive devices ~~and~~ which can be ~~capable of adjustment~~ adjusted to obtain the required levels of active power loading for the UPS under test.

A.3.9 The test unit situation relative to the ground plane shall be equivalent to that occurring in use, i.e. a floor-standing UPS is placed on a ground plane or on an isolating floor (for example, wood) close to a ground plane, and a table-top UPS is placed on a non-metallic table. The power and signal cables shall be oriented with respect to the ground plane in a manner equivalent to actual use. The ground plane may be of metal.

NOTE Specific ground plane requirements are given in A.6.3 for terminal voltage measurements and in A.9.1 for field strength measurements.

A.4 Determination of maximum emission configurations

Initial testing shall identify the frequency that has the highest emission relative to the limit while operating the UPS in typical modes of operation and cable positions in a test set-up which is representative of typical system configurations.

The identification of the frequency of the highest emission with respect to the limit shall be found by investigating emissions at a number of significant frequencies as detailed, to give confidence that the probable frequency of maximum emission has been found, and that the associated cable, UPS configurations and mode of operation are identified.

For initial testing, the UPS shall be set up in accordance with Figures A.3 to A.10. The distances between the UPS and peripherals are set according to the figures, and only the cables are to be manipulated in order to find the maximum.

For table-top systems during this process, cables should be manipulated within the range of typical configurations. For floor-standing equipment, the cables should be located in the same manner as the user would install them and no further manipulation has to be made. If the manner of cable installation is not known, or if it changes with each installation, cables for floor-standing equipment shall be manipulated to the extent practical to produce the maximum level of emissions.

Final measurements shall be conducted as in A.6, A.7 and A.8 for terminal ~~interference~~ disturbance voltage and ~~interference~~ disturbance field strength measurements, respectively.

A.5 Operation of the equipment under test

The UPS shall be operated at the rated (nominal) operating voltage and typical load conditions for which it is designed. Loads may be actual or simulated. The test programme or other means of exercising UPS should ensure that various parts of the system are exercised in a manner that permits detection of all system emissions, in any mode of operation of the UPS.

A.6 Method of measurement of mains terminal ~~interference~~ disturbance voltage

A.6.1 Measuring receivers

Measurements shall be carried out using the quasi-peak and average detector receivers described in A.2.1.

A.6.2 Artificial mains network (AMN)

A.6.2.1 General

An AMN as described in A.2.2 shall be used.

Connection of the test unit to the AMN is required, and the test unit is located so that the distance between the boundary of the test unit and the closest surface of the AMN is 0,8 m.

Where a mains flexible cord is provided by the manufacturer, this shall be 1 m long or if in excess of 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0,4 m in length.

Where a mains cable is specified in the manufacturer's ~~installation~~ instructions, a 1 m length of the type specified shall be connected between the test unit and the AMN.

The test unit shall be arranged and connected with cables terminated in accordance with the manufacturer's instructions.

Earth connections, where required for safety purposes, shall be connected to the reference earth point of the network, and where not otherwise provided or specified by the manufacturer, shall be 1 m long and run parallel to the mains connection at a distance of not more than 0,1 m.

Other earth connections (for example for EMC purposes), either specified or supplied by the manufacturer for connection to the same ultimate terminal as the safety earth connection, shall also be connected to the reference earth of the network.

~~It may not be possible to measure at some frequencies because of conducted ambient noise which couples from local broadcast service fields.~~ If because of the ambient noise it is not possible to measure the disturbances at some frequencies, a suitable additional radio-

frequency filter may be inserted between the AMN and the mains supply, or measurements may be performed in a shielded enclosure. The components forming the additional radio-frequency filter should be enclosed in a metallic screen directly connected to the reference earth of the measuring system. The requirements for the impedance of the AMN shall be satisfied, at the frequency of the measurement, with the additional radio-frequency filter connected.

A.6.2.2 Exception

For UPS whose rated power is beyond the normal ratings of AMNs, ~~it shall be permitted to measure~~ the mains terminal voltage may be measured by use of a voltage probe, in accordance with CISPR 16, and as shown in Figure A.1.

Where this is done, the mains supply current rating shall be at least the same rating as will be the mains supply of the installed UPS, in order to match as well as possible the site mains source impedance.

A.6.3 Ground plane

The test unit, if unearthed and non-floor-standing, shall be placed 0,4 m from a reference ground plane consisting of a horizontal or vertical metal surface of at least 2 m × 2 m and shall be kept at least 0,8 m from any other metal surface or other ground plane which is not part of the test unit. If the measurement is made in a screened enclosure, the distance of 0,4 m may be ~~referred~~ with respect to one of the walls of the enclosure.

Floor-standing test units are subject to the same provisions, with the exception that they shall be placed on a floor, the point(s) of contact being consistent with normal use. The floor may be of metal but shall not make metallic contact with the floor supports of the test unit. A metal floor may replace the reference ground plane. The reference ground plane shall extend at least 0,5 m beyond the boundaries of the test unit and have minimum dimensions of 2 m × 2 m.

The reference earth point of the AMN shall be connected to the reference ground plane with a conductor as short as possible, having a length to width ratio of less than 3:1, or be bolted to the reference ground plane.

A.6.4 Equipment set-up for conducted emission measurements

The UPS shall be configured and operated in accordance with the requirements of A.3 and set up in accordance with Figures A.3 to A.8 for table-top equipment and floor-standing equipment.

Table-top UPS shall be placed upon a non-metallic table 0,8 m above the horizontal ground plane (see A.6.3), and 0,4 m from a vertical ground plane which is connected to the horizontal ground plane.

Equipment designed for both table-top and floor operation shall be tested only in the table-top configuration, unless the typical installation is floor-standing, in which case the respective configuration is used.

Equipment designed for wall-mounted operation shall be tested as table-top UPS. The orientation of the equipment shall be consistent with that of normal operation.

A mains **port** is connected, via its mains cord, to an AMN, unless being tested in accordance with the exception of A.6.2 at a test site or *in situ*. An AC output **port** is connected to a load bank. A ~~signal~~ **network port** is connected, via its ~~signal~~ network cable, to an ~~impedance stabilisation network (ISN)~~ asymmetric artificial network (AAN) when intended for connection to an external ~~signal~~ network line ~~in practice~~.

A.6.5 Conducted emission measurement

As described in A.4, the one UPS configuration, the ~~one~~ cable configuration and the mode of operation which produce the highest emission relative to the limit are found.

~~Use~~ This configuration shall be used to measure and record data. Of those emissions no greater than 20 dB below the limit, ~~record~~ at least the six highest emission frequencies shall be recorded relative to the limit from the current-carrying mains **ports** and ~~telecommunications~~ **network ports** of the UPS. The specific conductor for each emission shall be identified.

The emission from a ~~signal~~ **network port** shall, when so specified, be measured as current instead of voltage by means of a current probe, in accordance with Clause 5 of CISPR 16-1-2:2014.

A.7 Method of measurement at AC output ports (where applicable)

The AC output **port** shall be connected to a resistive load bank, and the AC output active power shall be increased slowly from zero to the maximum rated value to determine worst-case disturbance voltage.

The load should be purely resistive to avoid errors of measurement with non-sinusoidal waveforms.

The output voltage for which the disturbance is maximum shall be measured by a voltage probe with a characteristic outlined in the CISPR 16 series and shown in Figure A.1.

The disturbance voltage shall not exceed the limits of 5.3.2.3 when measured at the UPS output terminals to the load equipment.

The effect of accuracy of measurement of the voltage probe capacitor or other device which may be used to protect the measuring receiver against dangerous currents shall be either < 1 dB or that allowed for in calibration.

The typical connection method is shown in Figure A.7 for connection of the voltage probe. The connection length shall be limited, where practicable, to 2 m in length or additional loss adjustment shall be taken into account.

The probe shall measure each output terminal to the reference ~~earth~~ ground plane, and the results shall be recorded.

Where practical, the load shall be positioned 0,8 m from floor-standing UPS or 0,1 m from table-top UPS under test with a load cable length of 1 m.

If the UPS mains input is connected via an AMN, this shall remain in circuit in order to maintain the defined impedance of the supply.

As an alternative to using the voltage probe as described above, an AMN may be used in the same principle as for AC input **port** measurement.

Attention may be required with respect to possible resonance.

A.8 Method of measurement of radiated emission

A.8.1 General

Measurements shall be conducted with a quasi-peak detector receiver in the frequency range of 30 MHz to 1 000 MHz.

Measurements of the radiated field shall be made at a distance measured from the boundary of the test unit. The boundary is defined by an imaginary straight line periphery describing a simple geometric configuration encompassing the test unit. All UPS inter-system cables and the UPS shall be included within this boundary.

The specific measurement distances for **category C2 UPS** and **category C1 UPS** are given in 5.3.3.1.

A.8.2 Measuring receivers

The measuring receivers shall be in accordance with the requirements of CISPR 16-1-1.

A.8.3 Antennas

The test shall be carried out in accordance with ~~the requirements of CISPR 16-1-3~~ Clause 7 of CISPR 16-2-3:2010, CISPR 16-2-3:2010/AMD1:2010 and CISPR 16-2-3:2010/AMD2:2014.

A.9 Measurement site

A.9.1 Test site

The test shall be carried out in accordance with the requirements of CISPR ~~16-1-5~~ 16-2-3.

A.9.2 Alternative test sites

In some cases, it may be necessary to conduct tests at sites that do not have all the characteristics described in A.9.1. Evidence shall be obtained that the errors due to such alternative sites do not invalidate the results obtained. Figure A.2 is an example of an alternative site. A ground plane not satisfying all the requirements of A.9.1 is another example.

A.10 Equipment set-up for radiated emission tests

A.10.1 General

The UPS shall be configured and operated in accordance with the requirements of A.6.4, and set up for table-top equipment in accordance with Figure A.11, and for floor-standing equipment in accordance with Figure A.12 or Figure A.13.

Table-top UPS shall be placed upon a non-metallic table 0,8 m above the horizontal ground plane of the radiated emission test site.

Floor-standing UPS shall be placed directly on the ground plane, the point(s) of contact being consistent with normal use, but separated from metallic contact with the ground plane by ~~up to 12 mm of~~ insulation of a thickness not exceeding 0,15 m.

Equipment designed for both table-top and floor-standing operation shall be tested only in the table-top configuration unless the typical installation is floor-standing, in which case the respective configuration is used.

Equipment designed for wall-mounted operation shall be tested as table-top UPS. The orientation of the equipment shall be consistent with that of normal operation.

Ferrite clamp type CMADs are used to reduce the influence of cables outside the test volume on radiated disturbance measurement results. If CMADs are used (optional), the cable leaving the test volume shall enter the CMAD at the point where it reaches the ground plane. The part of the cable between the exit point of the CMAD and the exit point of the turntable shall be kept as short as possible. Each cable shall be treated with a separate CMAD. Cables with diameters larger than the cable openings of commercially available CMADs do not have to be treated with CMADs.

NOTE The manufacturer needs to be aware about the magnitude of the common mode current within the unit under test so the proper CMAD can be selected.

For EUTs with up to three cables leaving the test volume, each cable shall be treated with a CMAD during radiated disturbance measurements. This requirement applies to any type of cable (e.g. power, **network ports**). For a test set-up with more than three cables leaving the test volume, only the three cables from which the highest emission is expected need to be equipped with CMADs. The cables on which the CMADs have been applied shall be documented in the test report.

The addition of CMADs is recommended for the sake of reproducibility of the test results.

When the test configuration uses long cables, it is advisable to limit the length visible to the antenna. The distance between the EUT and the CMAD should be 0,8 m.

A.10.2 Radiated emission measurement

As described in A.4, the ~~one~~ UPS configuration, the ~~one~~ cable configuration and the mode of operation which produce the highest emission relative to the limit ~~are~~ shall be found. This configuration ~~is~~ shall be used to measure and record data.

Variations in aerial heights, aerial polarization and UPS azimuth shall be explored while the frequency spectrum is monitored to produce the highest emission relative to the limit.

Of those emissions ~~no greater~~ less than 20 dB below the limit, ~~record~~ at least the six highest emission frequencies relative to the limit shall be recorded. ~~Record~~ The antenna polarization shall be recorded for each reported emission.

A.10.3 Measurement in the presence of high ambient signals

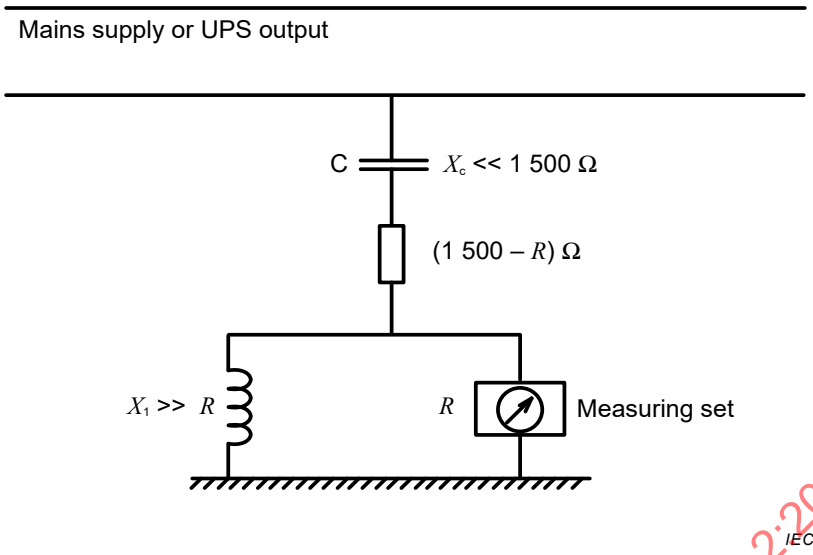
The test shall be carried out in accordance with the requirements of ~~10.7 of CISPR 22~~ 7.2 and Annex C of CISPR 11:2015.

A.11 Measurement of radiated magnetic disturbances

Refer to Annex B.

A.12 Measurement of network port disturbances

The test shall be carried out in accordance with H.5 in CISPR 16-2-1:2014.



NOTE $V = \frac{1500}{R} U$

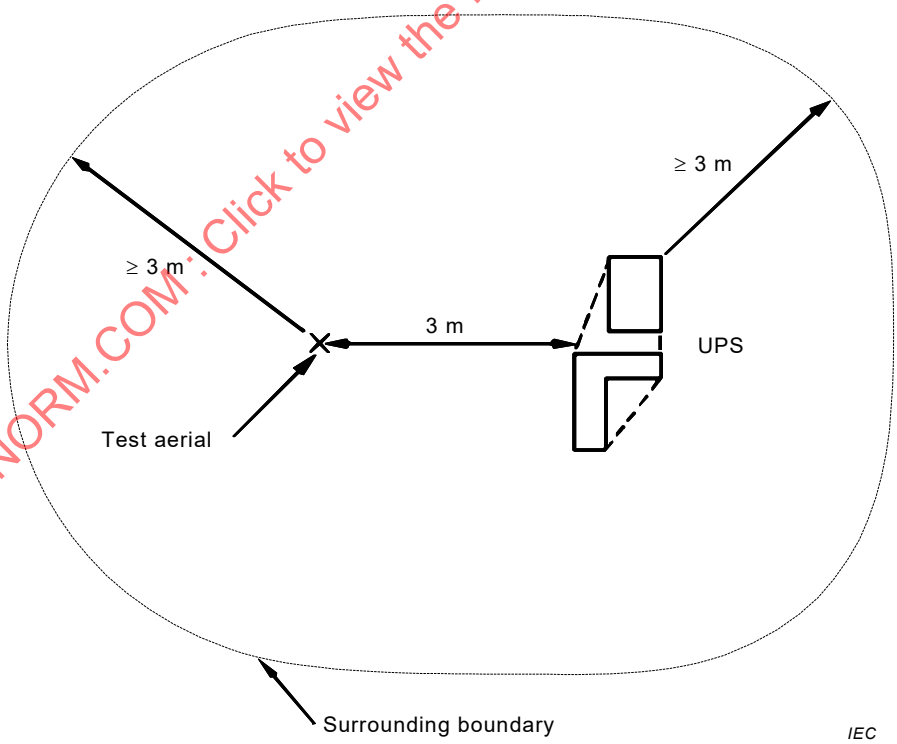
where

V is the disturbing voltage,

U is the voltage at the input of the measuring apparatus,

provided that X_c << 1 500 Ω and X_1 >> R at the frequency measured.

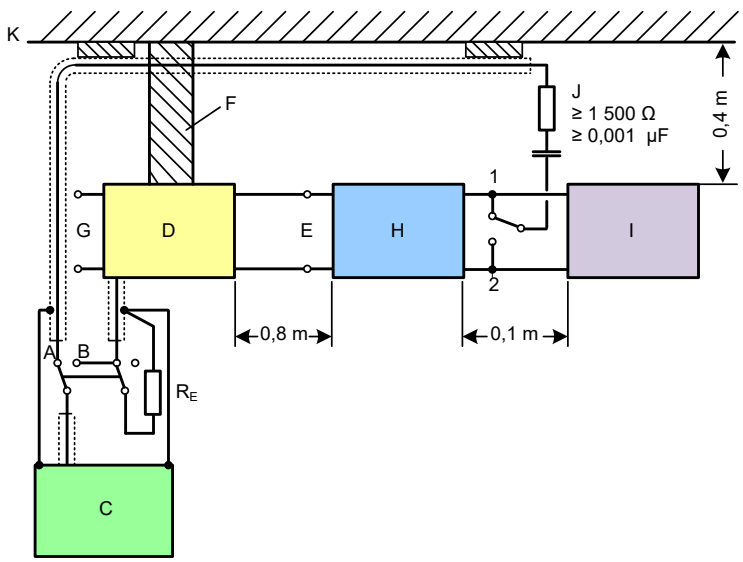
Figure A.1 – Circuit for disturbance voltage measurements on mains supply or UPS output



There shall be no reflecting object inside the volume defined on the ground by the line corresponding to the "surrounding boundary" and defined in height by a horizontal plane ≥ 3 m above the highest element of either aerial or equipment under test.

See A.9.2 for applicability of the alternative test site.

Figure A.2 – Minimum alternative test site



Key

A load measuring switch position
B mains measuring switch position
C RFI measuring receiver
D AMN
E AMN to UPS power connection
F grounding strap (length/width ratio 3:1 max.)
G input power connections
H UPS
I load
J voltage probe
K reference ground
R_E terminating resistor (50 Ω)

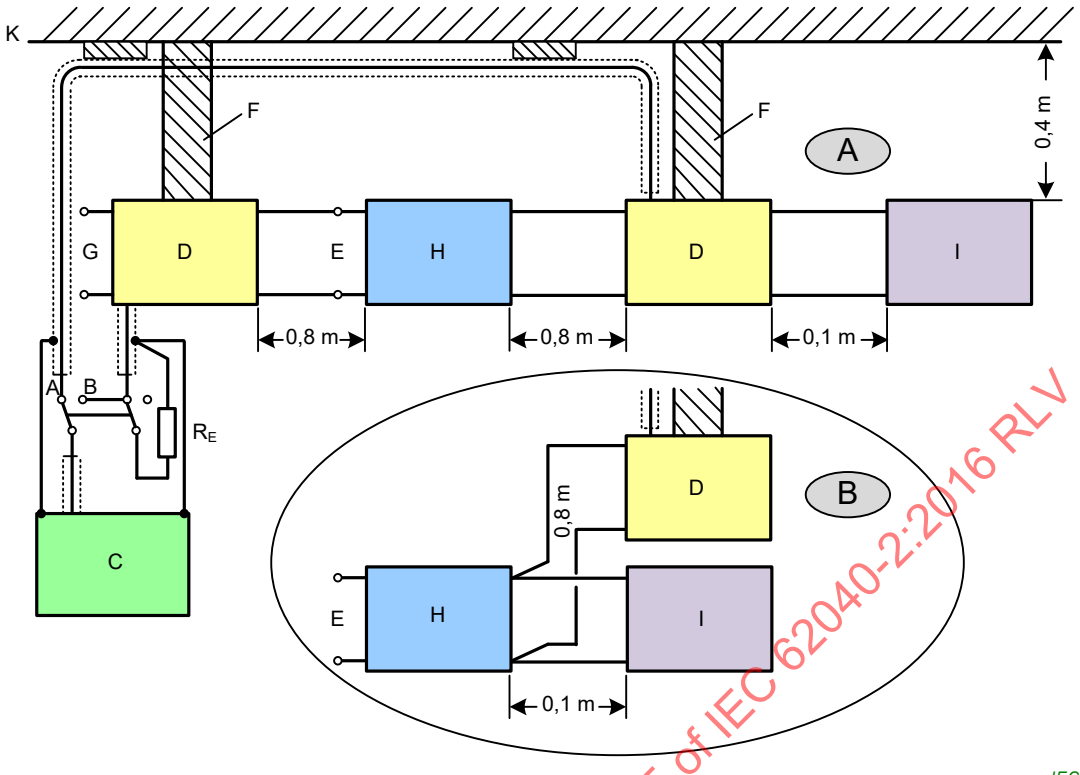
~~NOTE~~ The distance between the output terminals 1 and 2 of the UPS and the load should be 0,1 m. The connecting lines between them shall not exceed 1 m.

~~NOTE~~ The test ground of the RFI measurement ~~should~~ shall be securely fastened to the AMN ground.

~~NOTE~~ When the switch is in position A, the measuring set terminal on the AMN ~~should~~ shall be terminated with the appropriate terminating resistor, R_E.

~~NOTE~~ For UPS and/or loads of protection class 1, the ground safety conductor ~~should~~ shall be connected to the ground of the AMN.

Figure A.3 – Set-up for measurement of conducted emission for table-top units using voltage probe



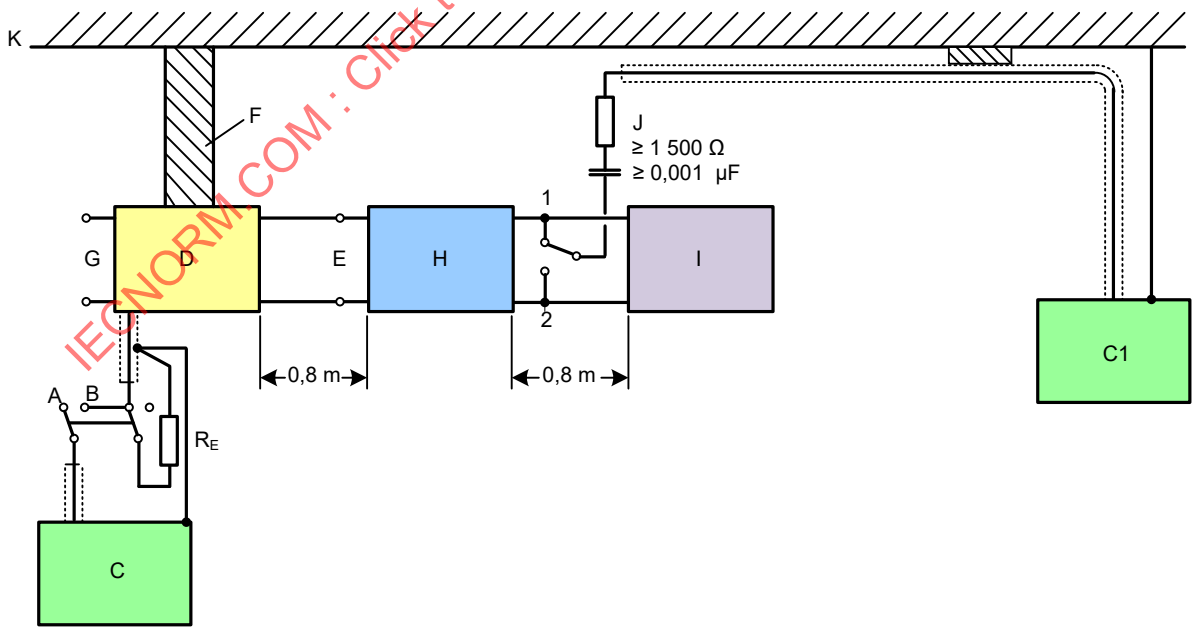
Key

See Figure A.3

Configuration A: In case the current flowing to the load is lower than or equal to the rated current of the AMN.

Configuration B: In case the current flowing to the load is higher than the rated current of the AMN, the load may be connected directly to the UPS output, the AMN consequently being used as a probe only.

Figure A.4 – Set-up for measurement of conducted emission for table-top units using AMN (alternative method)

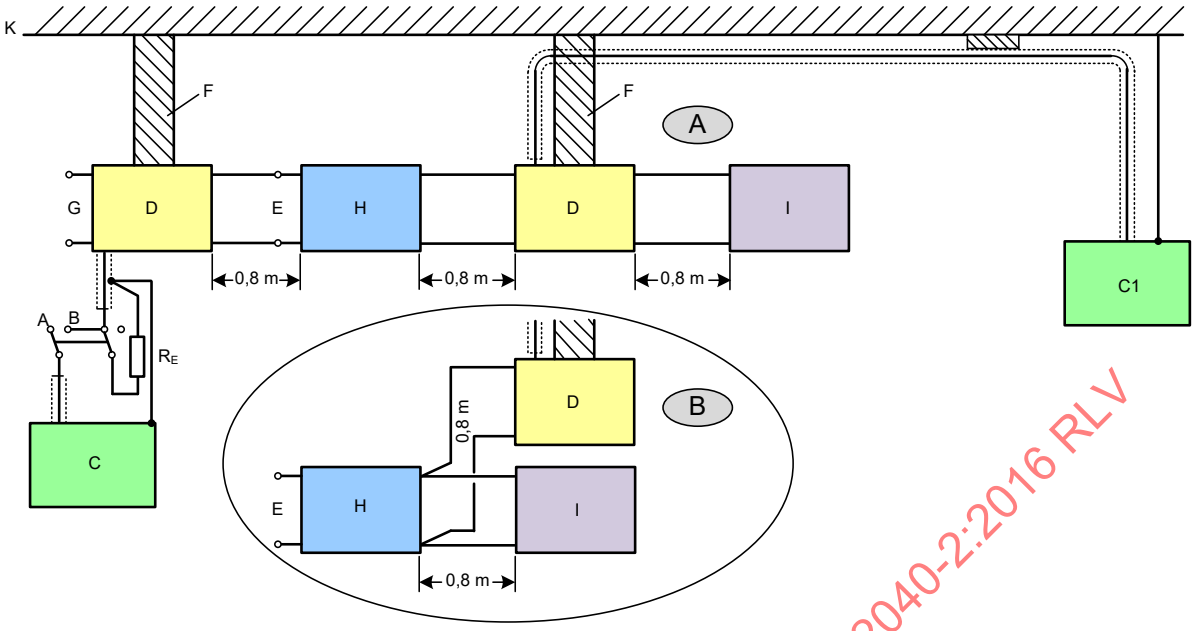


Key

See Figure A.3

C1 Alternative receiver position

Figure A.5 – Test set-up for floor-standing units



Key

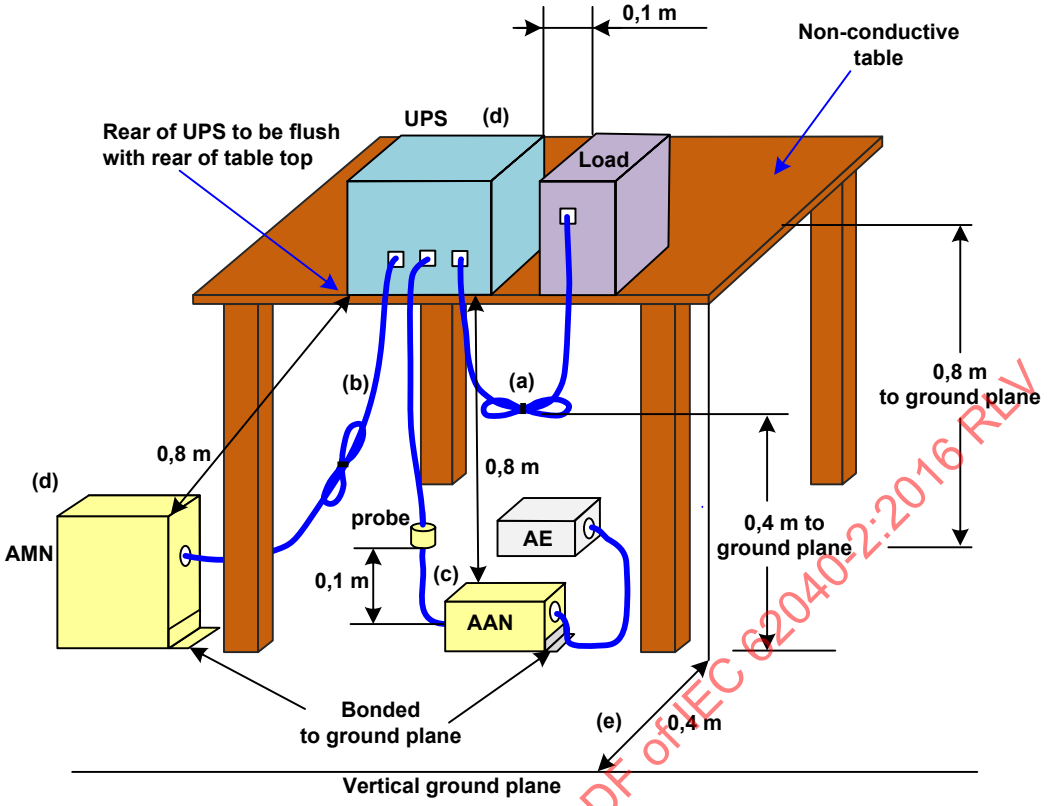
See Figure A.3

C1 Alternative receiver position

Configuration A: In case the current flowing to the load is lower than or equal to the rated current of the AMN.

Configuration B: In case the current flowing to the load is higher than the rated current of the AMN, the load may be connected directly to the UPS output, the AMN consequently being used as a probe only.

Figure A.6 – Test set-up for floor-standing units using AMN (alternative method)



Key

AE auxiliary equipment

AAN asymmetric artificial network

AMN artificial mains network

~~NOTE~~[a] Interconnecting cables which hang closer than 0,4 m to the ground-plane ~~should~~ shall be folded back and forth forming a bundle 0,3 m to 0,4 m long, hanging approximately in the middle between ground plane and table.

~~NOTE~~[b] Excess mains cord ~~should~~ shall be bundled in the centre or shortened to approximate length.

~~NOTE UPS should be connected to one AMN. All AMNs and ISNs may alternatively be connected to a vertical ground-plane or metal wall.~~

~~– AMN and ISN should be 0,8 m from the UPS and at least 0,8 m from other units and other metal planes.~~

~~– Mains cords and signal cables should be positioned for their entire lengths, as far as possible, at 0,4 m from the vertical ground-plane.~~

~~NOTE External battery assembly and I/O signal cables intended for external connection should be positioned as for normal use (where applicable). The end of the I/O cables which are not connected to an AE may be terminated if required using correct terminating impedance.~~

~~If used, the current probe shall be placed at 0,1 m from the ISN.~~

[c] Refer to H.5 in CISPR 16-2-1:2014 for use of an AAN or alternative method. If used, the current probe shall be placed at 0,1 m from the AAN. The end of the network cables not being measured shall be terminated using correct terminating impedance.

[d] The AMN shall be placed on top of, or immediately beneath, the ground-plane.

[e] Mains and network cables shall be positioned for their entire lengths, as far as possible, at 0,4 m from the vertical ground plane.

Figure A.7 – Test configuration for table-top equipment (conducted emission measurement)

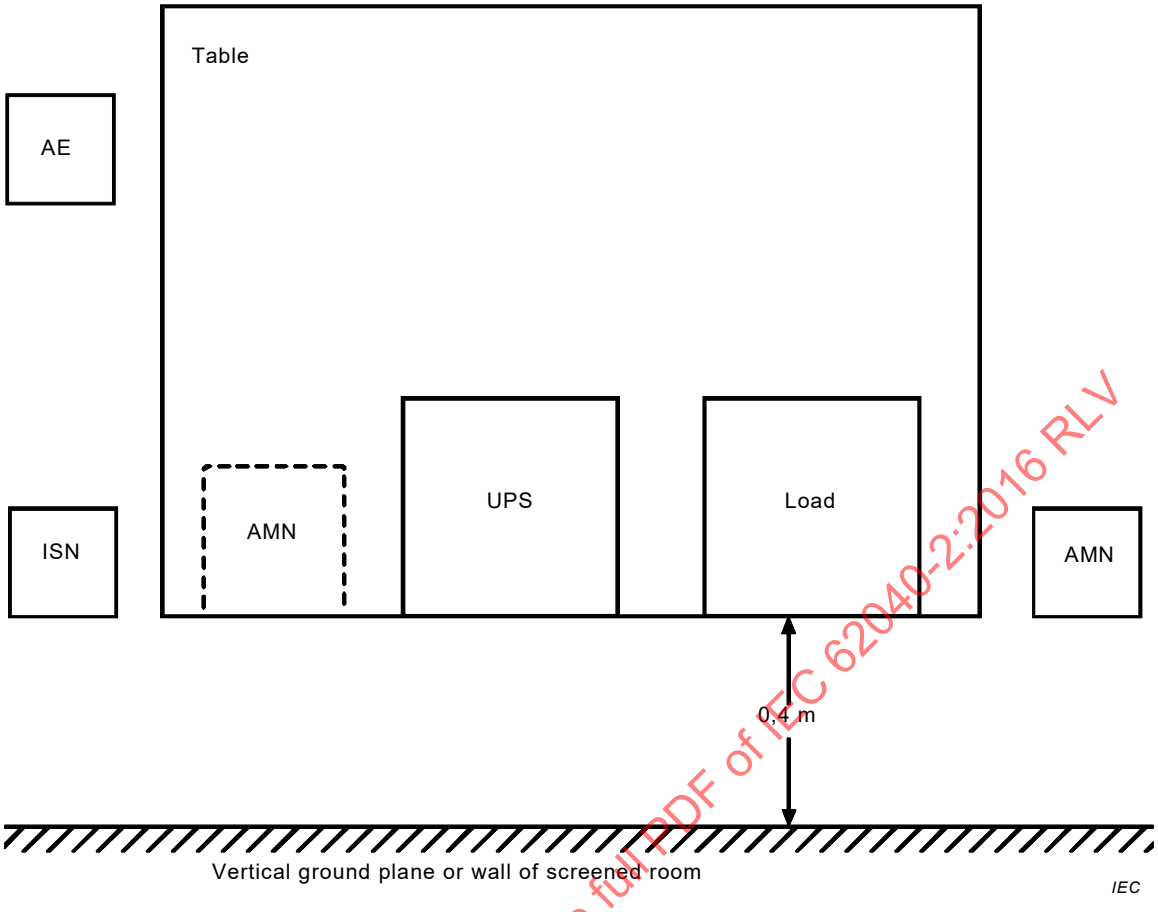


Figure A.8 – Test configuration for table-top equipment (conducted emission measurement) – Plan view

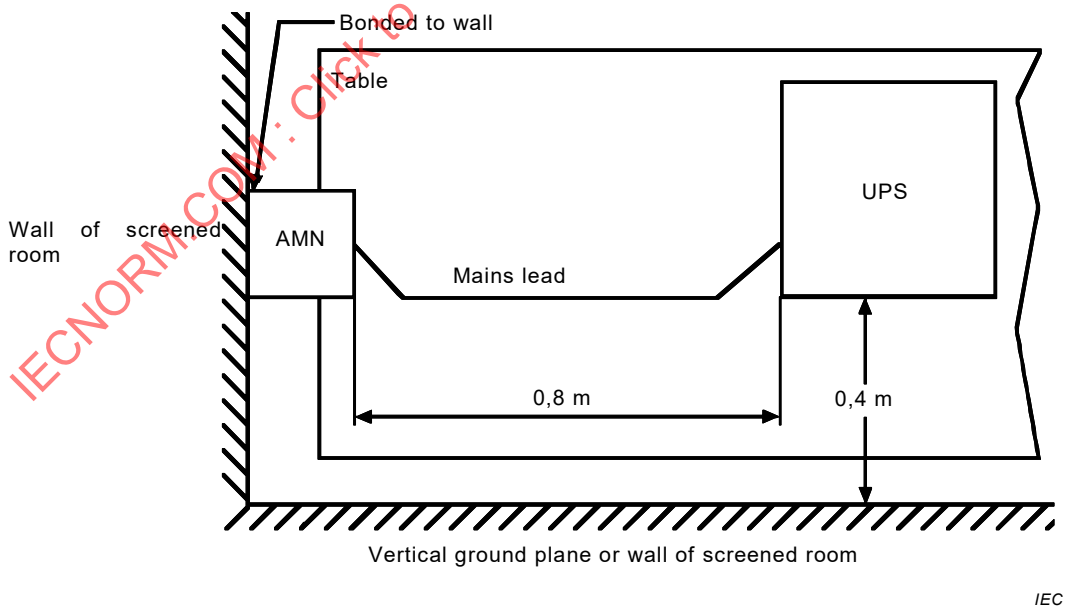
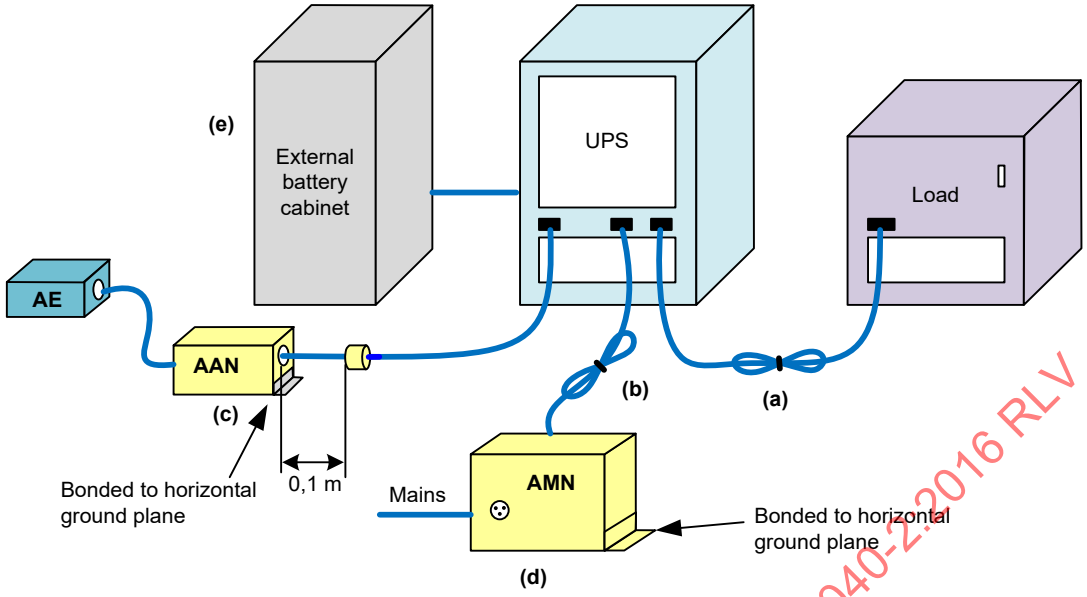


Figure A.9 – Alternative test configuration for table-top equipment (conducted emission measurement) – Plan view



~~NOTE~~[a] UPS and cables ~~should~~ shall be insulated (up to ~~12 mm~~ 0,15 m) from horizontal ground-plane. Excess ~~I/O~~ cables ~~should~~ shall be bundled in the centre. If bundling is not possible, the cables shall be arranged in a serpentine fashion.

~~NOTE~~[b] Excess mains cord ~~should~~ shall be bundled in the centre or shortened to ~~the appropriate~~ approximate length.

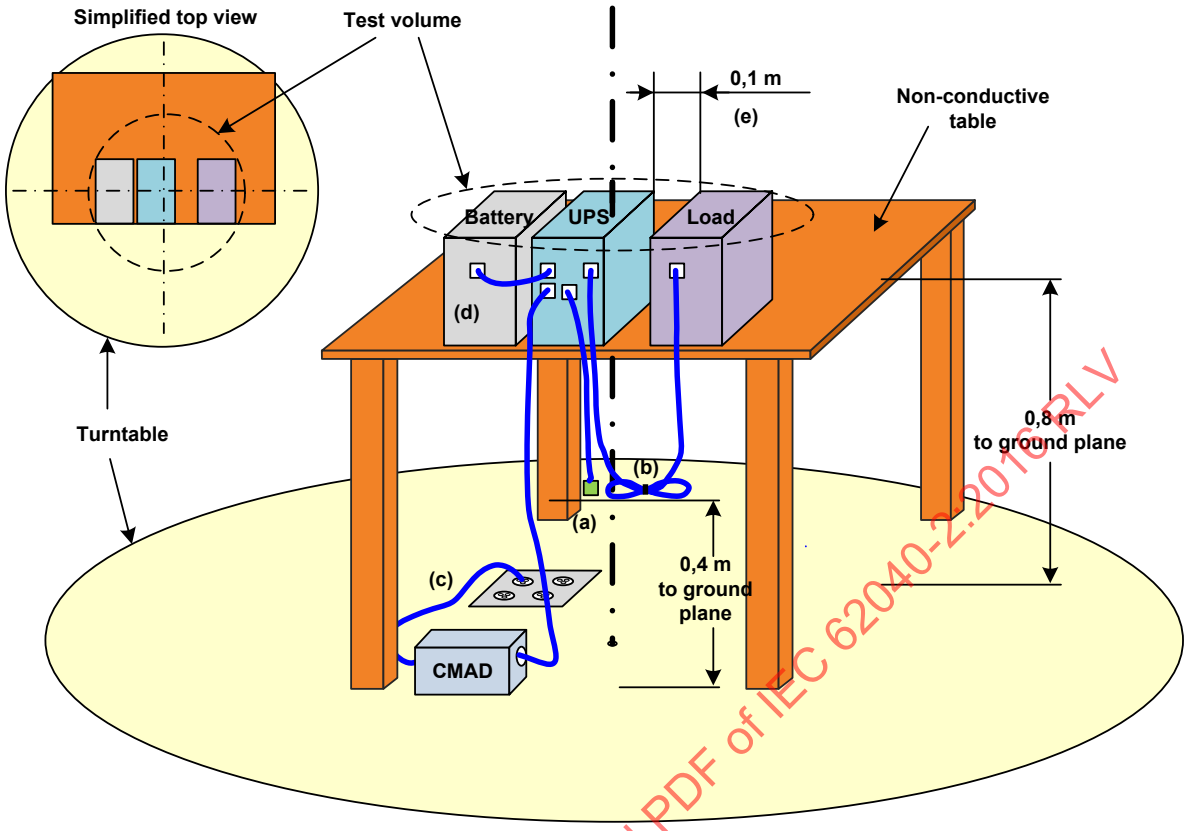
~~NOTE The end of the I/O cables which are not connected to a peripheral may be terminated if required for proper operation using correct terminating impedance.~~

[c] Refer to H.5 in CISPR 16-2-1:2014 for use of an AAN or alternative method. If used, the current probe ~~should~~ shall be placed at 0,1 m from the AAN. The end of the network cables not being measured shall be terminated using correct terminating impedance.

~~NOTE~~[d] The AMN ~~can~~ shall be placed on top of, or immediately beneath, the ground-plane.

~~NOTE~~[e] External battery (where applicable) ~~should~~ shall be positioned and wired as for a normal site configuration.

Figure A.10 – Test configuration for floor-standing equipment (conducted emission measurement)



NOTE[a] The ends of ~~the I/O~~ network cables ~~attached to the EUT~~ which are not connected to ~~a peripheral may~~ another unit or auxiliary equipment shall be terminated ~~if required for proper operation~~ using the correct terminating impedance.

NOTE[b] Interconnecting cables which hang closer than 0,4 m to the ground plane ~~should~~ shall be folded back and forth forming a bundle 0,3 m to 0,4 m long, hanging approximately in the middle between ground plane and table.

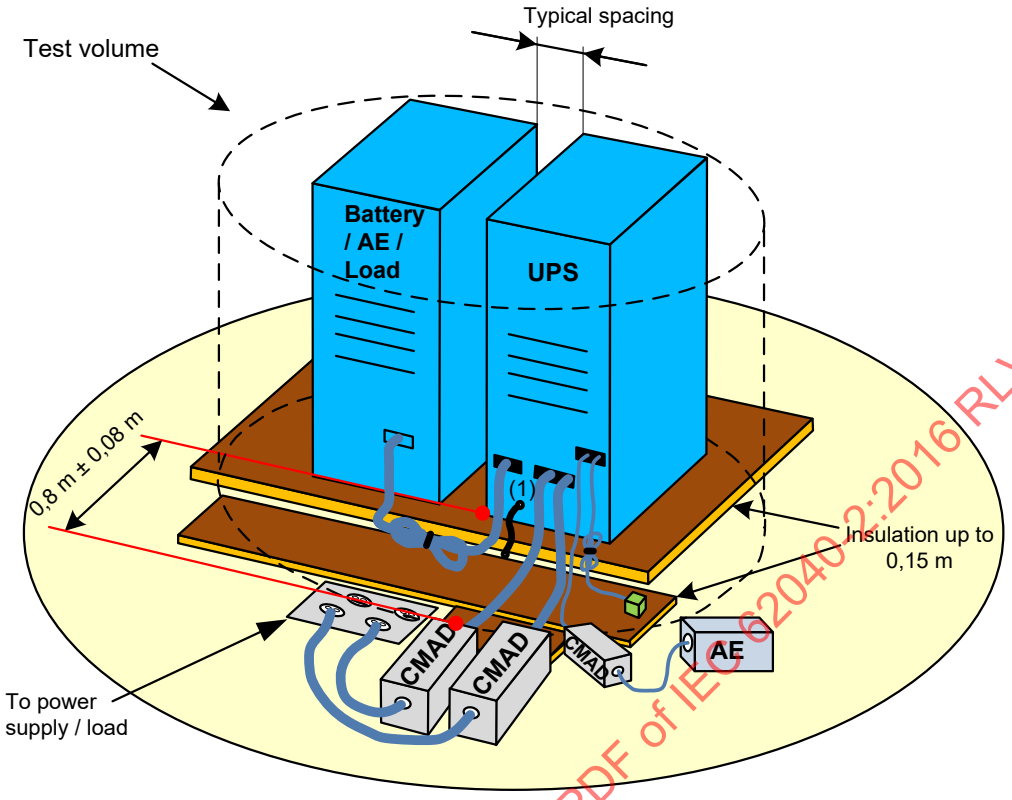
~~NOTE Peripherals should be placed at a distance of 0,1 m.~~

NOTE[c] Mains cables ~~should~~ shall drape to the floor and then be routed to the receptacle. No extension cords shall be used for the connection to mains receptacle. Mains junctions boxes ~~should~~ shall be flush with, and bonded direct to, the ground plane. If used, the AMN ~~should~~ shall be installed under the ground plane. For the purpose of restriction of radiation assessment to the cable fractions inside the test volume, CMADs may be applied at the position where the cables leave the test volume. CISPR 16-2-3 provides further guidance on the application of CMADs.

NOTE[d] External ~~battery (where applicable)~~ energy storage device(s) ~~should~~ shall be positioned and wired for normal site configuration. Any energy storage device that does not fit within the test volume may be positioned outside the test volume, including outside the test room.

[e] All units forming the system under test (including the EUT, connected peripherals and auxiliary equipment or devices) shall be arranged according to normal use. Where not defined in the normal use, a nominal 0,1 m separation distance between neighbouring units shall be defined for the test arrangement.

Figure A.11 – Test configuration for table-top equipment (radiated emission requirement)



Key

1 special earthing terminal for EMC purposes, if available

~~NOTE~~ Excess in/out cables ~~should~~ shall be bundled in the centre. If bundling is not possible, the cables ~~should~~ shall be arranged in a serpentine fashion.

~~NOTE~~ Excess mains cords ~~should~~ shall be bundled in the centre or shortened to the appropriate length.

~~NOTE~~ The end of in/out cables which are not connected to a peripheral ~~should~~ shall be bundled in the centre and may be terminated if required with the correct impedance.

~~NOTE~~ UPS and cables ~~should~~ shall be insulated (up to ~~12 mm~~ 0,15 m) from the ground plane.

~~NOTE~~ Mains junction box(es) ~~should~~ shall be flush with, and bonded direct to, the ground plane. If used, the AMN ~~should~~ shall be installed under the ground plane. For the purpose of restriction of radiation assessment to the cable fractions inside the test volume, CMADs may be applied at the position where the cables leave the test volume. CISPR 16-2-3 provides further guidance on the application of CMADs.

~~NOTE~~ Mains and signal cables ~~should~~ shall drape to the floor.

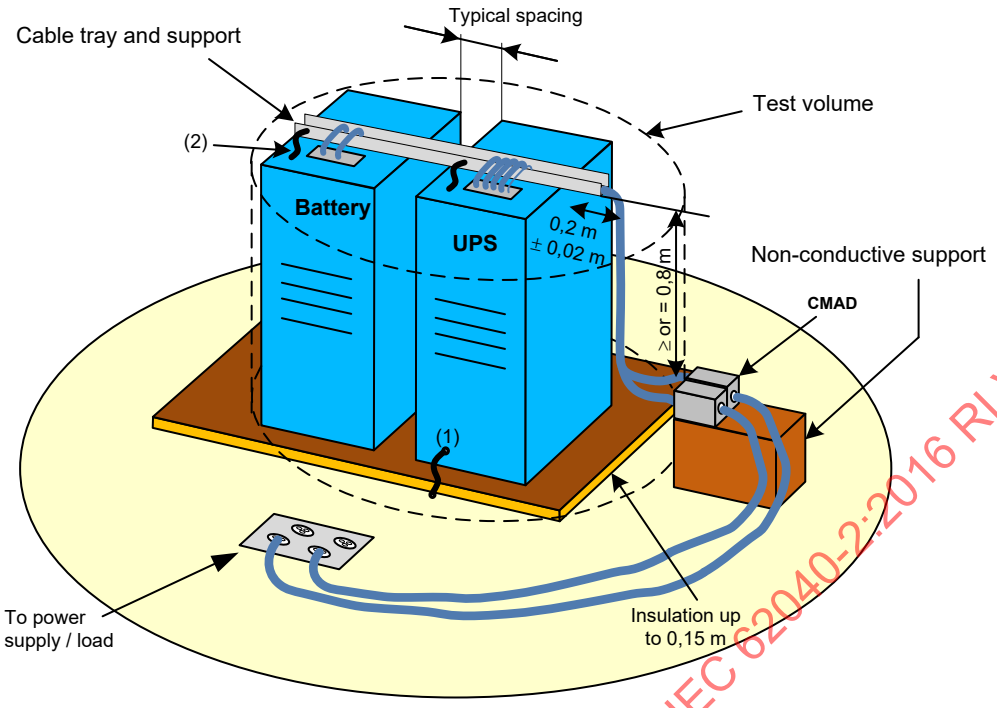
~~NOTE~~ External battery (where applicable) ~~should~~ shall be positioned and wired as for a normal installation condition.

An energy storage device that does not fit within the test volume may be positioned outside the test volume, including outside the test room. A cable length of 0,8 m ± 0,08 m shall be managed between the EUT/AE and the CMAD (when used) or between the EUT/AE and the ground plane.

When CMADs are not used, excess mains cords shall be bundled in the centre or shortened to the appropriate length.

A load that does not fit within the test volume is positioned outside the test volume, including outside the test room.

Figure A.12 – Test configuration for floor-standing equipment (radiated emission measurement)



Key

1 special earthing terminal for EMC purposes, if available

2 cable trays or conduits, if conductive, to be earthed in accordance with relevant wiring rules

Excess in/out cables shall be bundled in the centre. If bundling is not possible, the cables shall be arranged in a serpentine fashion.

Excess mains cords shall be bundled in the centre or shortened to the appropriate length.

UPS and cables shall be insulated (up to 0,15 m) from the ground plane.

Mains junction box(es) shall be flush with, and bonded direct to, the ground plane. If used, the AMN shall be installed under the ground plane. For the purpose of restriction of radiation assessment to the cable fractions inside the test volume, CMADs may be applied at the position where the cables leave the test volume. CISPR 16 2 3 provides further guidance on the application of CMADs.

Mains and signal cables shall drape to the floor.

External battery (where applicable) shall be positioned and wired as for a normal installation condition.

An energy storage device that does not fit within the test volume may be positioned outside the test volume, including outside the test room.

A length of 0,8 m ± 0,08 m cable, either vertical or horizontal, shall be visible to the antenna. The cable is to be run between the EUT/AE and the CMAD (when used) or between the EUT/AE and the ground plane. To reduce the length of cable between the EUT and CMAD, CMADs may be raised in high position, leaving at least 0,8 m of cable visible to the antenna.

The material used to support the cable shall be in accordance with the relevant wiring rules or otherwise as defined by the manufacturer's installation instructions. When CMADs are not used, excess mains cords shall be bundled in the centre or shortened to the appropriate length.

A load that does not fit within the test volume is positioned outside the test volume, including outside the test room.

The end of the in/out cables which are not connected to a peripheral shall be bundled in the centre and may be terminated if required with correct impedance.

IEC

Figure A.13 – Test configuration for top entry floor-standing equipment (radiated emission measurement)

Annex B
(informative)

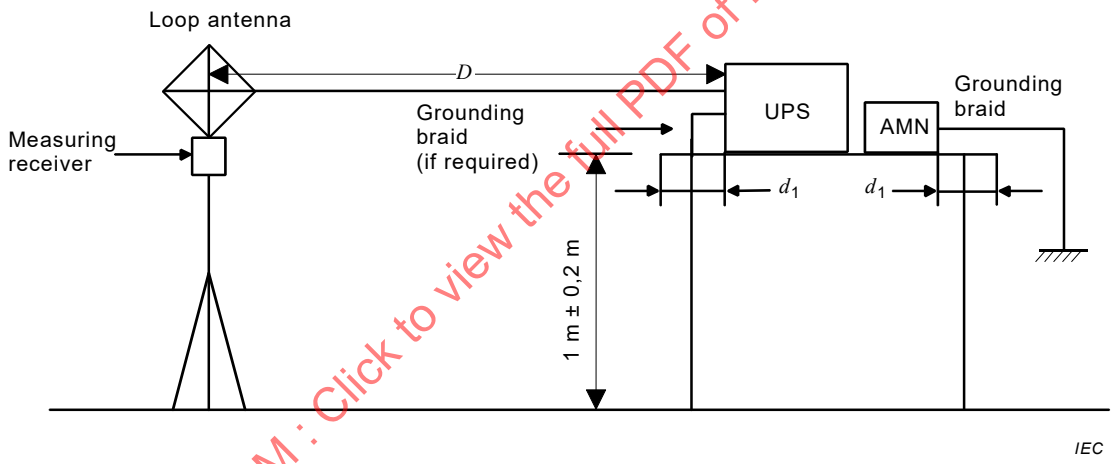
Electromagnetic emission limits and measurement methods of magnetic field – H field

The magnetic component of the field radiated by the test unit is measured from 10 kHz to 30 MHz.

If measurements are taken in a shielded enclosure, its dimensions are such that antennas are always located at least 1 m from each of the walls. The ~~device~~ equipment under test is placed on its grounded surface at 1 m ± 0,2 m from the floor. Measurements are taken at a distance D = 3 m from the most disturbance producing side of the ~~device~~ equipment under test.

The most disturbance-producing side is defined as the one emitting the highest signal in the frequency band under consideration. The choice of this side and the orientation of the measuring antenna are made simpler by using a spectrum analyser. The measurement distance is ~~counted~~ determined from the antenna's centre of phase.

Measurements are taken using a shielded loop aerial, as shown in Figure B.1. The frame is oriented in a vertical plane so that it receives the maximal magnetic field.



D = 3 m

d_1 ≥ 0,1 m

Figure B.1 – Test set-up for measuring radiated disturbances

When measured by a loop antenna, the limits given in Table B.1 and Table B.2 apply when measured at a 3 m distance in accordance with Figure B.1.

Table B.1 – UPS which has a rated output current less than or equal to 16 A

Frequency range MHz	**Quasi-peak limits** dB (μA/m)	
	Category C1 UPS	**Category C2 UPS**
0,01 to 0,15	40,0 to 16,5[a]	52,0 to 28,5[a]
0,15 to 1,0	16,5 to 0	28,5 to 12,0
1 to 30	0 to -10,5	12,0 to 1,5
[a] ~~Not mandatory up to 150 kHz.~~		
NOTE In all frequency ranges, the limit value reduces linearly with the logarithm of the frequency.		

Table B.2 – UPS which has a rated output current greater than 16 A

Frequency range MHz	**Quasi-peak limits** dB (μA/m)	
	Category C1 UPS	**Category C2/C3 UPS**
0,01 to 0,15	52,0 to 28,5[a]	64,0 to 40,5[a]
0,15 to 1,0	28,5 to 12,0	40,5 to 24,0
1 to 30	12,0 to 1,5	24,0 to 13,5
[a] ~~Not mandatory up to 150 kHz.~~		
NOTE In all frequency ranges, the limit value reduces linearly with the logarithm of the frequency.		

Annex C
(~~informative~~ normative)

Electromagnetic emission – Limits of ~~signal~~ network ports

~~The following limits apply only if the cable length exceeds 10 m, in which case the manufacturer should specify the signal cable.~~

The current limits in Tables C.1, C.2 and C.3 are alternative to the voltage limits in Tables 1 and 2.

Table C.1 – Limits of ~~signal~~ network ports for category C1 UPS

~~Port~~	Frequency range	Limits	Basic standard
~~Signal, control~~	0,15 MHz to 0,5 MHz Limit decreasing linearly with logarithm frequency	40 dB(μA) to 30 dB(μA) quasi-peak 30 dB(μA) to 20 dB(μA) average	CISPR 22 Class B
	0,5 MHz to 30 MHz	30 dB(μA) quasi-peak 20 dB(μA) average	

Table C.2 – Limits of network ports for category C2 UPS

Frequency range	Limits	Basic standard
0,15 MHz to 0,5 MHz	53 dB(μA) to 43 dB(μA) quasi-peak	CISPR 22 Class A
Limit decreasing linearly with logarithm frequency	40 dB(μA) to 30 dB(μA) average	
0,5 MHz to 30 MHz	43 dB(μA) quasi-peak	
	30 dB(μA) average	

Table C.3 – Limits of network ports for category C3 UPS

Frequency range	Limits	Basic standard
0,15 MHz to 0,5 MHz	66 dB(μA) to 56 dB(μA) quasi-peak	Extrapolation from Table 2 and CISPR 16-1-2
Limit decreasing linearly with logarithm frequency	50 dB(μA) to 40 dB(μA) average	
0,5 MHz to 30 MHz	56 dB(μA) quasi-peak	
	40 dB(μA) average	

Annex D
(normative)

Electromagnetic immunity – Test methods

D.1 General

D.1.1 Object

The purpose of these tests is to measure the degree of immunity of UPS systems to electromagnetic disturbances.

Due to the range of physical size and power ratings, the manufacturer may choose the most appropriate test site and configuration that is best to physically accommodate the UPS and, where necessary, within the current rating of the test equipment for currents in excess of 100 A.

D.1.2 Test environment

It is preferable to carry out the immunity tests in a laboratory environment, in which all tests shall be performed on a metallic ground plane projecting at least 0,5 m beyond the UPS on all sides; however, with a minimal size of 1 m × 1 m.

Floor-standing UPS shall be placed on a ~~dry wooden pallet 0,1 m high~~ non-conductive support 0,05 m to 0,15 m above the supporting plane.

UPS intended for table-top use shall be placed on a wooden table of 0,8 m height.

The equipment under test is referred to below as UPS.

D.2 Electrostatic discharge (ESD)

The immunity to electrostatic discharges shall be tested according to IEC 61000-4-2. The ESD test shall be applied only to such points and surfaces of the UPS which are accessible to personnel during normal usage, as well as to a horizontal and a vertical coupling plane of 0,5 m × 0,5 m.

D.3 Immunity to radiated electromagnetic (EM) fields

D.3.1 General

The immunity test to radiated electromagnetic fields shall be performed according to IEC 61000-4-3. The test equipment, test facility, calibration, test set-up and procedure shall be in accordance with the relevant clauses of IEC 61000-4-3.

D.3.2 Arrangement of wiring

The test shall be carried out in accordance with the requirements in 7.3 of IEC 61000-4-3:2006.

D.4 Immunity to fast transients

D.4.1 The immunity test for repetitive fast transients is required on all cables that can be connected to the UPS, unless they are declared by the manufacturer to be shorter than 3 m.

D.4.2 The equipment shall be tested according to IEC 61000-4-4.

D.4.3 A capacitive coupling clamp, according to 6.4 of IEC 61000-4-4:2012, shall be placed not more than 1 m from the UPS on any incoming or outgoing cable.

D.5 Immunity to surges

The test shall be carried out in accordance with IEC 61000-4-5.

D.6 Immunity to low-frequency signals

D.6.1 Power line harmonics and inter-harmonics

D.6.1.1 General

The operating UPS shall withstand the low-frequency conducted disturbances in the mains, as specified in IEC 61000-2-2. Compliance is checked by simulating the conditions below, and the UPS shall continue to operate without degradation of the specified performances.

D.6.1.2 Single-phase equipment

The test as a minimum shall be performed with a single sinusoidal disturbing voltage of 10 V, at a frequency which is slowly varied from 140 Hz to 360 Hz. Use can be made of a series injection circuit where the mains supplies power at 50 Hz to 60 Hz, and the amplifier delivers only the harmonics.

The 10 V disturbing voltage applies when the AC input voltage is rated 230 V and above. For AC input voltage rated lower than 230 V, a proportionally lower disturbing voltage applies.

D.6.1.3 Three-phase equipment

The test set-up and voltage level for each phase is identical to the set-up for single-phase equipment; however, a three-phase variable frequency generator is used (static or rotating). The frequency is slowly varied from 140 Hz to 360 Hz.

The test shall be performed for both rotating sequences of the disturbing three-phase signal.

If the equipment has a neutral terminal, it shall be connected and tested as in the single-phase test, but only at a frequency close to three times the line frequency.

The 10 V disturbing voltage applies when the AC input voltages are rated 230 V/400 V and above. For AC input voltages rated lower than 230 V/400 V, a proportionally lower disturbing voltage applies.

D.6.2 Power line unbalance (three-phase UPS systems only)

Three-phase systems shall be tested for amplitude and phase unbalance on the power line input.

An unbalance signal can be made with a single-phase transformer or by equivalent means. The unbalance tests are performed on one line only.

The amplitude unbalance test is made with a 230:5 transformer typically connected for a 230 V application as in Figure D.1. The test shall be performed both with the shown connection and with the reversed connection of the primary side of the transformer.

The ratio of the transformer represents a 400 V/230 V distribution system. The ratio depends on the voltage of the distribution system to which the UPS is connected.

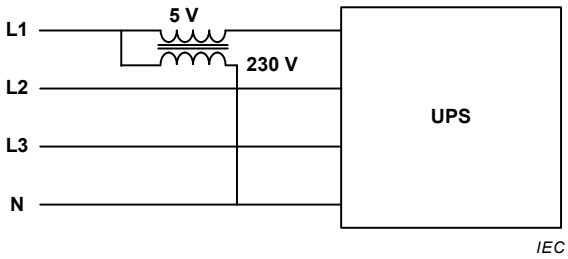


Figure D.1 – Amplitude unbalance

The phase unbalance test is made with a 400:5 transformer, typically connected for a 400 V application as in Figure D.2. The test shall be performed both with the shown connection and the reversed connection of the primary side of the transformer.

The ratio of the transformer represents a 400 V/230 V distribution system. The ratio depends on the voltage of the distribution system to which the UPS is connected.

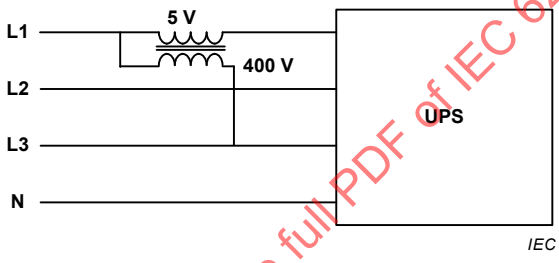


Figure D.2 – Phase unbalance

Annex E
(informative)

User installation testing

Measurements at the user's installation are generally necessary for category C4 and might sometimes apply also for other categories (C2 and C3).

For general guidance, the following should be considered:

a) Conducted emission

The mains terminal voltage may be measured by use of a voltage probe, in accordance with Clause 5 of CISPR 16-1-2:2014, and as shown in Figure A.1.

b) Radiated emission

Measurements ~~shall~~ should be made preferably at the boundary of the user's premises; if this boundary is less than 30 m from the test unit, the measurements ~~shall~~ should be made at a distance of 30 m from the test unit. The number of measurements made in azimuth shall be as great as reasonably practical, but there shall be at least four measurements in orthogonal directions, and measurements made in the direction towards any existing equipment which may be adversely affected.

NOTE Measurements made in azimuth consist of measuring radiated emission at different angles in the horizontal plane around the EUT.

This form of compliance verification is specific to the installation site, since the site characteristics affect the measurement. Additional type-tested and compliant UPS may be added to the test unit without invalidating the compliance status of the measurement.

In any case the measurements should be performed in accordance with the applicable agreement between the supplier and the customer.

Bibliography

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

IEC 61000-4 (all parts), *Electromagnetic compatibility (EMC)*

IEC 61204 (all parts), *Low-voltage power supplies, d.c. output*

CISPR 15:2013, *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*
CISPR 15:2013/AMD1:2015

IEC 62040-2

Edition 3.0 2016-11

INTERNATIONAL STANDARD

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Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements

Alimentations sans interruption (ASI) – Partie 2: Exigences pour la compatibilité électromagnétique (CEM)

IEC 62040-2:2016-11(en-fr)

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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IEC 62040-2

Edition 3.0 2016-11

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 2: Electromagnetic compatibility (EMC) requirements

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by subcommittee 22H: Uninterruptible power systems (UPS), of IEC technical committee 22: Power electronic systems and equipment.

The text of this interpretation sheet is based on the following documents:

FDIS	Report on voting
22H/232/FDIS	22H/236/RVD

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

_____

Interpretation of 5.3.2.4, Limits at the network ports

Introduction

Sub-clause 5.3.2.4 states that the **network port** limits applicable to **UPS** of **category C1, C2** and **C3** are located in Table 1, Table 2 and Annex C.

It was not clear whether 5.3.2.4 applies to **network ports** that originate and terminate within the **enclosure port** of the **UPS** (i.e. to **network ports** connected exclusively to circuits or devices forming an integral part of the **UPS**).

Interpretation

The **network port** limits in Table 1, Table 2 and Annex C apply only to **network ports** for which connection to circuits or devices external to the **enclosure port** of the **UPS** is allowed. This includes, without limitation, connection to PSTN, ISDN, xDSL and Ethernet networks. The limits in Table 1, Table 2 and Annex C do not apply to **network ports** that originate and terminate within the **enclosure port** of the **UPS** (i.e. to **network ports** connected exclusively to circuits or devices forming an integral part of the **UPS**).

IEC 62040-2:2016-11/ISH1:2018-06(en-fr)

ICS 17.220; 29.200; 33.100.10

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 2: Electromagnetic compatibility (EMC) requirements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62040-2 has been prepared by subcommittee 22H: Uninterruptible power systems (UPS), of IEC technical committee 22: Power electronic systems and equipment.

This third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision.

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

a) the inclusion of **network port** limits in Table 1, Table 2 and Annex C for the sake of consistency with other standards;
b) a change of quasi-peak limit for **category C3 UPS** in Table 2 for the sake of consistency with other standards;
c) a clarification in Table 4 about the performance criteria for immunity tests;
d) a revision of some test configurations in Annex A.

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

FDIS	Report on voting
22H/210/FDIS	22H/212/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.

In this document, the following print types are used:

– requirements proper and normative annexes: in roman type;
– compliance statements and test specifications: *in italic type*;
– notes and other informative matter: in smaller roman type;
– normative conditions within tables: in smaller roman type;
– terms that are defined in Clause 3: **bold**.

A list of all parts in the IEC 62040 series, published under the general title *Uninterruptible power systems (UPS)*, 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.

The contents of the Interpretation sheet of June 2018 have been included in this copy.

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.

UNINTERRUPTIBLE POWER SYSTEMS (UPS) –

Part 2: Electromagnetic compatibility (EMC) requirements

1 Scope

This part of IEC 62040 is a type test product standard for electromagnetic compatibility (EMC) and applies to movable, stationary, fixed or built-in, pluggable and permanently connected UPS for use in low-voltage distribution systems with an environment being either residential, commercial, light industrial or industrial, which deliver output voltage with **port** voltages not exceeding 1 500 V DC or 1 000 V AC and which include an energy storage device.

Subject to installing, operating and maintaining the UPS in the manner prescribed by the manufacturer, this standard defines emission limits, immunity levels, test methods and performance criteria for a complete UPS to comply with the essential EMC requirements necessary to avoid the UPS interfering with other apparatus, e.g. radio receivers, and to avoid the UPS being affected by external phenomena.

This standard does not address EMC phenomena produced by loads connected to the UPS or situations created by any apparatus external to the UPS other than as described in the immunity requirements.

This standard is harmonized with applicable IEC standards for electromagnetic emission limits and immunity levels. It contains additional requirements applicable to UPS.

This standard does not cover:

a) low-voltage DC power supply devices covered by IEC 61204 standards;

b) systems wherein the output voltage is derived from a rotating machine.

NOTE 1 UPS generally connect to their energy storage device through a DC link. A chemical battery is an example of an energy storage device. Alternative devices can be suitable, and as such, where “battery” appears in the text of this standard, this can be understood as “energy storage device”.

NOTE 2 This type test-based product standard allows EMC conformity assessment of UPS included in one of categories C1, C2 and C3 before placing them on the market. It also provides guidance for conformity assessment of UPS included in category C4 (see Clause 4).

NOTE 3 The differing test conditions necessary to encompass the range of physical sizes and power ratings of a complete UPS are taken into account. A complete UPS can consist of one or more interconnected units. For UPS configuration details refer to IEC 62040-3:2011, Annex A.

NOTE 4 The requirements have been selected so as to permit an adequate level of EMC for UPS installed in residential, commercial, light industrial and industrial locations. The requirements are not always sufficient to cover situations with low probability of occurrence including UPS faults.

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 61000-2-2:2002, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-12:2011, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 62040-3:2011, *Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements*

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

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

CISPR 16-2-3:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*
CISPR 16-2-3:2010/AMD1:2010
CISPR 16-2-3:2010/AMD2:2014

CISPR 22:2008, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62040-3:2011 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
particular interface of the UPS with the external electromagnetic environment as shown in Figure 1

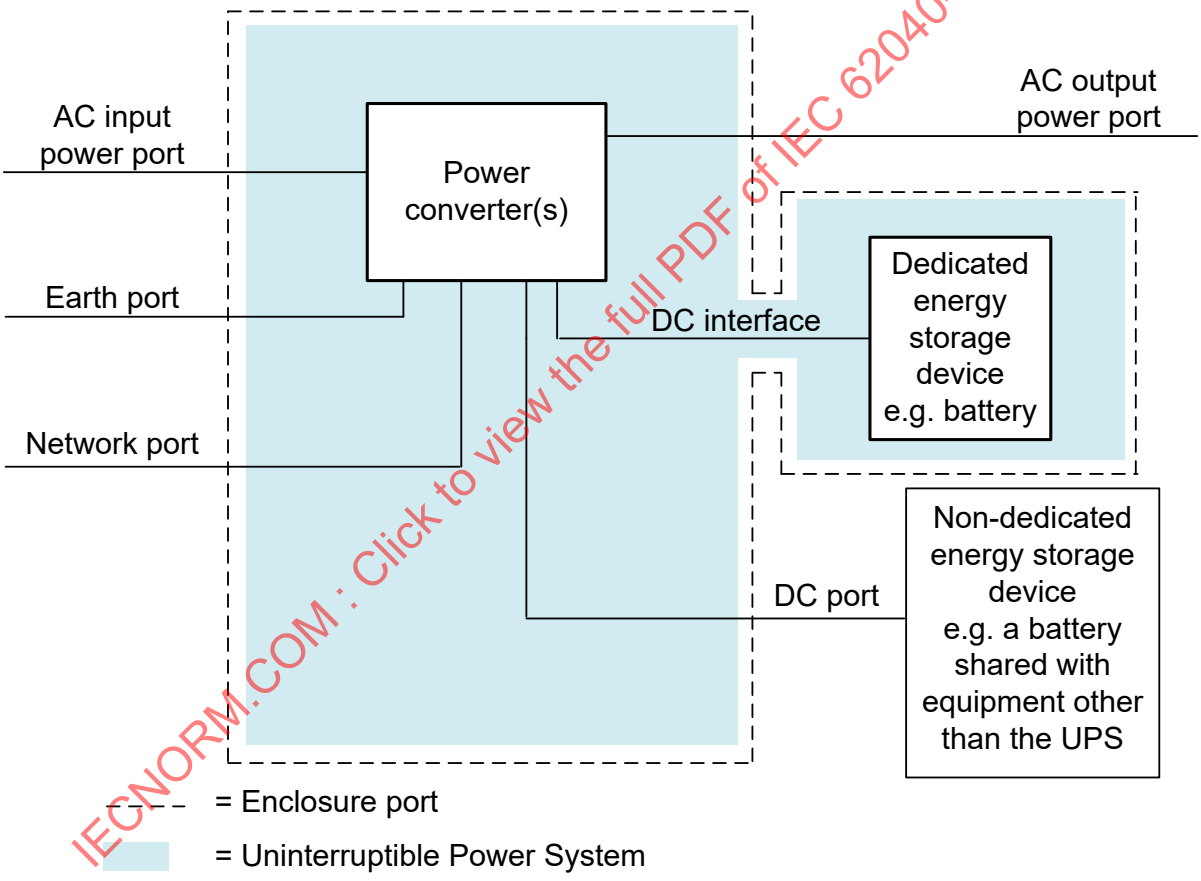


Figure 1 – UPS ports

3.1.2
DC interface
dedicated connection between the power converter and an energy storage device that is exclusively used by the UPS

Note 1 to entry: The interface to an energy storage device intended for exclusive use of the UPS is not a **port** because this device is included in the UPS. The dedicated energy storage device shown in Figure 1 is connected through a **DC interface**.

3.1.3
DC port
connection from the power converter to an energy storage device that is not exclusively used by the UPS

Note 1 to entry: The non-dedicated energy storage device is connected through a **DC port**.

3.1.4
enclosure port
physical boundary of the equipment under test (EUT) which electromagnetic fields can radiate through or impinge on

Note 1 to entry: In Figure 1, the **enclosure port** represented by the dotted line around the power converter(s) and the dedicated energy storage device does not imply the existence of any shielding.

3.1.5
network port
signal, control or communication **ports** intended for the interconnection of components of an uninterruptible power system (UPS), or between a UPS and local associated equipment and used in accordance with relevant functional specifications for the purpose of control and/or monitoring of the UPS system and/or control of the associated equipment in accordance with the instruction manual

Note 1 to entry: The maximum length of cable connected to the **network port** is an example of relevant functional specifications.

3.1.6
first environment
environment that includes residential, commercial and light industrial premises directly connected, without intermediate transformers, to a public low-voltage mains supply

3.1.7
second environment
environment that includes all commercial, light industry and industrial locations other than those included in the **first environment**

Note 1 to entry: A building, or part of it, when supplied from a dedicated transformer or generator is an example of **second environment**.

3.1.8
category C1 UPS
UPS intended for use without any restriction in the **first environment**

Note 1 to entry: Such UPS are suitable for use in residential locations.

3.1.9
category C2 UPS
UPS intended for use without any restriction in the **second environment**

Note 1 to entry: Such UPS can also be used in the **first environment** under certain conditions.

3.1.10
category C3 UPS
UPS with an output current exceeding 16 A and intended for use in the **second environment** with certain restrictions

3.1.11
category C4 UPS
UPS that cannot be classified within any of the C1, C2 or C3 categories and intended for use in environments subject to particular requirements

3.2 Abbreviated terms

AAN asymmetric artificial network

NOTE 1 The terms impedance stabilization network (ISN) and AAN are used interchangeably.

AE auxiliary equipment

AMN artificial mains network

NOTE 2 The terms line impedance stabilization network (LISN) and AMN are used interchangeably.

CMAD common mode absorption device

EUT equipment under test

RF radio frequency

4 UPS categories

4.1 Category C1 UPS

This category includes UPS intended for use without any restriction in the **first environment**.

Category C1 UPS shall comply with category C1 requirements for emission limits (see Clause 5) and for immunity (see Clause 6).

4.2 Category C2 UPS

This category includes UPS intended for use without any restriction in the **second environment**. Such UPS may also be used in the **first environment** when the effect of the warning notice below is considered.

Category C2 UPS shall comply with category C2 requirements for emission limits (see Clause 5) and for immunity (see Clause 6).

The following warning shall be included in the user manual.

WARNING: This is a **category C2 UPS** product. In a residential environment, this product may cause radio interference, in which case the user may be required to take additional measures.

NOTE Such additional measures can require the services of a person or organization skilled with respect to EMC aspects.

4.3 Category C3 UPS

This category includes UPS with an output current exceeding 16 A and intended for use in the **second environment** with the following restrictions:

a) the UPS shall be installed and commissioned by a professional person or organization that is skilled with respect to EMC aspects;

b) the UPS location shall be physically separated from other buildings classified as **first environment** by a distance greater than 30 m or by a structure which acts as a barrier to radiated phenomena providing equivalent attenuation; and

c) the installation shall be supplied through a dedicated transformer or generator or through a device providing equivalent attenuation.

Category C3 UPS shall comply with category C3 requirements for emission limits (see Clause 5) and for immunity (see Clause 6).

The following warning shall be included in the user manual.

WARNING: This is a product for commercial and industrial application in the **second environment** – installation restrictions or additional measures may be needed to prevent disturbances.

4.4 Category C4 UPS

This category includes UPS that cannot be classified within any of the C1, C2 or C3 categories and intended for use in environments subject to particular requirements.

Such UPS shall meet the specific emission and immunity levels applicable for the installation.

A **category C4 UPS** is not limited by current ratings.

NOTE Conformity assessment of a C4 UPS generally consists of a technical evaluation of the effect of combining complying UPS variants and subassemblies, and of a final site test to verify compliance with requirements that cannot be readily verified by technical evaluation. For details regarding site testing refer to Annex E.

4.5 Categories and environment

If the environment has been determined as the **first environment**, a **category C1** or **C2 UPS** should be used.

If the environment has been determined as the **second environment**, a **category C2** or **C3 UPS** should be used.

If the environment is not covered exclusively either by the **first** or **second environment**, a **category C4 UPS** should be used.

From the emission point of view, a UPS with a lower emission category, such as C1, can always be used instead of one with a higher emission category, such as C3.

Emission categories are independent of immunity. For example, a statement that a UPS has emission category C1 does not imply that the immunity is only suitable for the **first environment**.

4.6 Documentation

For EMC purposes, the following shall be included in the user documentation:

a) any special measures to be taken to achieve compliance, for example, the segregation of cables, the use of shielded or special cables and any restriction on the length of cables connected to the AC output and/or to the energy storage device;

b) upon request, a list of EMC-compatible UPS accessories;

c) warning notice for **category C1 UPS** as described in 6.3.2;

d) warning notice for **category C2** and **category C3 UPS** as applicable and as described in 4.2 and 4.3.

5 Emission

5.1 General

The applicable emission limits for each UPS category are specified in 5.3.

Emissions in the frequency range up to 1,0 GHz are covered.

The emission requirements have been selected so as to ensure that disturbances generated by UPS operating normally do not reach a level which could prevent other apparatus from operating as intended.

NOTE 1 There is a possibility that the limits in this standard do not fully provide protection against interference to radio and television reception when the UPS is used closer than 10 m to the receiving antenna for **category C1** or **C2 UPS** and 30 m for **category C3 UPS**.

NOTE 2 In special cases, for instance when highly susceptible apparatus is being used in proximity, additional mitigation measures can be employed to reduce the electromagnetic emission further below the specified levels.

5.2 General test requirements

The UPS emission tests shall be performed under the following conditions:

a) rated input voltage;

b) normal mode(s) and stored energy mode of operation;

c) resistive load that results in the highest disturbance level.

Test requirements are specified for each **port** considered. Refer to Annex A for test methodology.

5.3 Measurement requirements

5.3.1 General

The emission of all **ports** shall be verified as follows.

If the UPS can be connected to auxiliary accessories, then the UPS shall be tested while connected to the minimum configuration including auxiliary and communication accessories necessary to exercise all such **ports**, or connected to an equivalent terminating impedance.

The configuration and mode of operation during measurement shall be precisely noted in the test report. Refer to Annex A for test set-up and measurement criteria. For *in situ* or user installation testing, see Annex E.

5.3.2 Conducted emission

5.3.2.1 Ports and limits

For UPS with additional mains terminals (**ports**) for the connection of separate supplies for static by-pass and/or maintenance bypass circuits, these terminals (**ports**) may be temporarily interconnected to the normal AC input **port** supply permitting the conducted emission tests to be performed at the resulting (common) AC input **port**.

Measuring one of several identical **ports** is sufficient for conducted emission purposes.

NOTE Conducted emission in the frequency range from 2 kHz to 150 kHz is under consideration.

Where referred to in 5.3.2, the 0,15 MHz to 30 MHz conducted emission limits are listed in Tables 1 and 2.

Table 1 – Limits of mains terminal and network port disturbance voltage for category C1 and category C2 UPS in the frequency range 0,15 MHz to 30 MHz

Frequency range MHz	Limits dB (μV)							
	Category C1 UPS				Category C2 UPS			
	Mains terminal		Network port		Mains terminal		Network port	
	Quasi-peak	Average	Quasi-peak	Average	Quasi-peak	Average	Quasi-peak	Average
0,15 to 0,50[b]	66 to 56[a]	56 to 46[a]	84 to 74[a]	74 to 64[a]	79	66	97 to 87[a]	84 to 74[a]
0,50 to 5[b]	56	46	74	64	73	60	87	74
5 to 30	60	50			73	60		

[a] The limit decreases linearly with the logarithm of the frequency.

[b] The lower limit shall apply at the transition frequency.

Table 2 – Limits of mains terminal and network port disturbance voltage for category C3 UPS in the frequency range 0,15 MHz to 30 MHz

UPS rated output current A	Frequency range MHz	Limits dB (μV)			
		Mains terminal		Network port	
		Quasi-peak	Average	Quasi-peak	Average
> 16 to 100	0,15 to 0,50[b]	100	90	110 to 100[a]	94 to 84[a]
	0,50 to 5,0[b]	86	76	100	84
	5,0 to 30,0	90 to 73[a]	80 to 60[a]		
> 100	0,15 to 0,50[b]	130	120	110 to 100[a]	94 to 84[a]
	0,50 to 5,0[b]	125	115	100	84
	5,0 to 30,0	115	105		

[a] The limits decrease linearly with the logarithm of the frequency.

[b] The lower limit shall apply at the transition frequency.

5.3.2.2 Limits at the AC input port (mains)

The UPS shall not exceed the limits of either Table 1 or Table 2 according to the category and the rated output current of the UPS under test.

The UPS shall meet both the average and quasi-peak limit when using, respectively, an average detector receiver and a quasi-peak detector receiver, and measured in accordance with the methods described in A.6.

If the average limit is met when using a quasi-peak detector receiver, the test unit shall be deemed to meet both limits, and measurement with the average detector receiver is unnecessary.

If the reading on the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the highest reading shall be recorded, with the exception of any brief isolated high reading, which shall be ignored.

5.3.2.3 Limits at the AC output port

The mains terminal limits in Table 1 and Table 2 apply.

An allowance of +14 dB is permitted for conducted emission at the output of the UPS as specified in Table 1 and Table 2, except for C3 greater than 100 A where no allowance is permitted.

No limits apply to UPS where the output cable, as declared by the manufacturer in the user manual, does not exceed 10 m in length. When the manufacturer does not declare the maximum cable length, the limits apply.

The values shall be measured in accordance with A.7.

5.3.2.4 Limits at the network ports

The **network port** limits in Table 1 and Table 2 apply.

No limits apply to UPS where the network cable, as declared by the manufacturer in the user manual, does not exceed 10 m in length. When the manufacturer does not declare the maximum cable length, the limits apply.

As an alternative to compliance with voltage limits, Annex C provides current limits that may be applied.

5.3.2.5 Limits for DC interface and DC port

No conducted emission test is required at the **DC interface** (see Figure 1).

NOTE The effect of conducted emission on the **DC interface** can however cause radiated emission, but no conducted emission tests apply as the UPS is required to comply with the radiated emission limits described in 5.3.3.

The **DC port** limits are currently under consideration and their values pending determination in a future edition of CISPR 11.

5.3.2.6 Low-frequency emission – Input current harmonics

If the rated input current and voltage are within the scope of IEC 61000-3-2 or IEC 61000-3-12, the limits and test methodology therein shall apply.

5.3.3 Radiated emission

5.3.3.1 Electromagnetic field

The UPS shall meet the limits of Table 3. If the reading on the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the highest reading shall be recorded, with the exception of any brief isolated high reading, which shall be ignored.

No limits apply for radiated emission below 30 MHz.

Table 3 – Limits of radiated emission in the frequency range 30 MHz to 1 000 MHz

Frequency range	Quasi-peak limits dB (μV/m)		
MHz	Category C1 UPS	Category C2 UPS	Category C3 UPS
30 to 230[a]	30	40	50
230 to 1 000	37	47	60

[a] The lower limit shall apply at the transition frequency.

NOTE 1 The test distance is 10 m. If the emission measurement at 10 m cannot be made because of high ambient noise levels or for other reasons, measurements are made at a closer distance, for example 3 m. An inverse proportionality factor of 20 dB per decade is used to normalize the measured data to the specified distance for determining compliance.

NOTE 2 Where interference occurs additional provisions can be necessary.

5.3.3.2 Magnetic field

No limits apply for magnetic emissions. Annex B provides guidance for measurement methods and informative levels.

6 Immunity

6.1 General

Immunity requirements in the frequency range 0 Hz to 1 GHz only are covered.

These test requirements represent essential electromagnetic compatibility immunity requirements. Test requirements are specified for each **port** considered.

The levels given in Clause 6 do not cover extreme cases, which may occur in any location but with an extremely low probability of occurrence. For such cases, higher levels may be required.

NOTE In special cases, situations can arise where the level of disturbances exceed the levels specified in this standard, for example, where a hand-held transmitter is used in proximity of a UPS. In these instances, there is a possibility that special mitigation measures become necessary.

6.2 General requirements and performance criteria

The equipment shall, as a minimum, comply with the immunity levels of 6.3. The performance criteria adequate for UPS are given in Table 4.

Table 4 – Performance criteria for immunity tests

	Criterion A	Criterion B
External and internal indications and metering	Change only during test	Change only during test
Control signals to external devices	No change	Change only temporarily in consistency with the actual UPS mode of operation
Mode of operation[a]	No change	Change only temporarily
[a] At all times, the UPS shall remain within the performance classification as declared by the UPS manufacturer (see IEC 62040-3:2011).		

The tests shall be made with the UPS in the following conditions:

a) rated input voltage;

b) normal mode(s) of operation;

c) linear load at rated active output power or at light load according to IEC 62040-3:2011.

The UPS shall be specified with the proper level in case of different levels of performance criteria.

Refer to Annex D for test methodology.

6.3 Basic immunity requirements

6.3.1 General

Compliance is checked by testing against the immunity requirements listed in Table 5 and Table 6. The UPS shall continue to operate without degradation and in accordance with the applicable performance criterion. The performance criteria are detailed in Table 4.

6.3.2 Category C1 UPS

The levels in Table 5 shall be applied to **category C1 UPS**. If a UPS is designed to have immunity according to Table 5, it shall include a written warning in the user manual or on the equipment which indicates that it is not intended to be used in an industrial environment.

Table 5 – Minimum immunity requirements for category C1 UPS

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance) criterion
Enclosure port	ESD	IEC 61000-4-2	4 kV CD or 8 kV AD if CD impossible	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80 MHz to 1 000 MHz 3 V/m 80 % AM (1 kHz)	A
	Immunity to power-frequency magnetic field	IEC 61000-4-8	3 A/m	A
AC input power **ports**	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz[a]	B
	Surge[b] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
	Immunity to low-frequency signals	See D.6 and IEC 61000-2-2	10 V/ 140 Hz to 360 Hz	A
AC output power **ports** and **DC port**	Fast transient-burst	IEC 61000-4-4	1 kV/5 kHz[a]	B
	Surge[b,e] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A
DC interface	Fast transient-burst[e]	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
Network ports	Fast transient-burst[e]	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 3 V 80 % AM (1 kHz)	A

CD = contact discharge
AD = air discharge
AM = amplitude modulation
ESD = electrostatic discharge

[a] Power **ports** with current rating < 100 A: direct coupling using the coupling and decoupling network. Power **ports** with current rating ≥ 100 A: direct coupling or capacitive clamp without decoupling network. If the capacitive clamp is used, the test level shall be 2 kV/5 kHz.

[b] Light-load test condition is acceptable for power **ports** rated for current > 63 A.

[c] Coupling line to line.

[d] Coupling line to earth.

[e] Applicable only to **ports** or interfaces with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

6.3.3 Category C2 and C3 UPS

The levels in Table 6 shall be applied to UPS which are intended to be used in the **second environment**.

Table 6 – Minimum immunity requirements for category C2 and C3 UPS

Port	Phenomenon	Basic standard for test method	Level	Performance (acceptance) criterion
Enclosure port	ESD	IEC 61000-4-2	4 kV CD or 8 kV AD	B
	Radio-frequency electromagnetic field, amplitude modulated	IEC 61000-4-3	80 MHz to 1 000 MHz 10 V/m 80 % AM (1 kHz)	A
	Immunity to power-frequency magnetic field	IEC 61000-4-8	30 A/m	A
AC input power **ports**	Fast transient-burst	IEC 61000-4-4	2 kV/5 kHz[a]	B
	Surge[b] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A
	Immunity to low-frequency signals	See D.6 and IEC 61000-2-2	10 V/ 140 Hz to 360 Hz	A
AC output power **ports** and **DC port**	Fast transient-burst	IEC 61000-4-4	2 kV/5 kHz[a]	B
	Surge[b,e] 1,2/50 µs 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A
DC interface	Fast transient-burst[e]	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
Network ports	Fast transient-burst[e]	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
	Surge[b, f] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV	B
	Conducted radio-frequency common mode[e]	IEC 61000-4-6	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A

CD = contact discharge
AD = air discharge
AM = amplitude modulation
ESD = electrostatic discharge

[a] Power **ports** with current rating < 100 A: direct coupling using the coupling and decoupling network. Power **ports** with current rating ≥ 100 A: direct coupling or capacitive clamp without decoupling network. If the capacitive clamp is used, test level shall be 4 kV/5 kHz.

[b] Light-load test condition is applicable for power **ports** rated for current > 63 A.

[c] Coupling line to line.

[d] Coupling line to earth.

[e] Applicable only to **ports** or interfaces with cables whose total length according to the manufacturer's functional specification may exceed 3 m.

[f] Applicable only to **ports** with cables whose total length according to the manufacturer's functional specification may exceed 30 m. In the case of shielded cable, a direct coupling to the shield is applied. This immunity requirement does not apply to field bus or other signal interfaces where the use of surge protection devices is not practical for technical reasons. The test is not required where normal functioning cannot be achieved because of the impact of the coupling/decoupling network on the EUT.

6.4 Immunity to voltage dips, short interruptions and voltage variations

Immunity to voltage dips, short interruptions and voltage variations characterize intrinsic UPS performance, and no specific EMC tests are required.

NOTE Refer to IEC 62040-3:2011 for the related performance tests.

Annex A
(normative)

Electromagnetic emission – Test methods

A.1 General

The purpose of these tests is to measure the levels of electromagnetic emission produced by the UPS and propagated by conduction and radiation.

Annex A mainly concerns continuous electromagnetic emissions.

Due to the range of physical size and power ratings, the manufacturer may choose the most appropriate test site and configuration that is best to physically accommodate the UPS.

In some cases, for example for UPS consisting of two or more UPS units, the only solution will be a site-installed evaluation. Therefore, the following test set-ups and methods provide, as far as possible, the general criteria to cater for most UPS.

The tests shall be carried out within the specific operating environment specified for the UPS and as specified in Annex A.

A.2 Measuring equipment

A.2.1 Measuring instruments

Receivers with quasi-peak detectors and with average detectors shall be in accordance with CISPR 16-1-1:2015.

A.2.2 Artificial mains network (AMN)

Measurement of the mains terminal disturbance voltage shall be made using an AMN consisting of 50 Ω/50 μH network as specified in Clause 4 of CISPR 16-1-2:2014.

The AMN is required to provide a defined impedance at radio frequency across the mains supply at the point of measurement and also to provide for isolation of the equipment under test from ambient noise on the power lines.

A.2.3 Voltage probe

The voltage probe, in accordance with the requirements of Clause 5 of CISPR 16-1-2:2014, and shown in Figure A.1, shall be used where specified for UPS outputs, and when the AMN cannot be used due to the current rating of the input of the UPS. The probe is connected sequentially between each line and the reference ground plane.

The probe mainly consists of a blocking capacitor and a resistor so that the total resistance between the line and earth is at least 1 500 Ω. The effect on the accuracy of measurement of the capacitor or any other device which may be used to protect the measuring receiver against dangerous currents shall be either less than 1 dB or allowed for in calibration.

The loop formed by the ground lead connected to the probe, the mains conductor tested and reference ground should be minimized to reduce the effects of any strong magnetic fields.

An extension ground braid may be used in this purpose when the measurement is performed at a terminal not reachable with the normal probe only.

A.2.4 Antennas

The antenna shall comply with the requirements of CISPR 16-1-4:2010/AMD1:2012, Clause 4.

A.2.5 Common mode absorption device (CMAD)

Common mode absorption devices (CMADs) are applied on cables leaving the test volume during a radiated emission measurement. CMADs are used in radiated emission measurements to reduce variations in the measurement results between different test sites (see Clause 9 of CISPR 16-1-4:2010 for further information).

A.2.6 Asymmetric artificial network

Asymmetric artificial networks (AAN) are used to measure (or inject) asymmetric (common mode) voltages on unshielded symmetric signal (e.g. telecommunication) lines while rejecting the symmetric (differential mode) signal. (see Clause 7 of CISPR 16-1-2:2014 for further information).

A.3 Test unit configuration

A.3.1 Where not specified herein, the UPS shall be configured, installed, arranged and operated in a manner consistent with typical applications. Interface cables/loads/devices shall be connected to at least one of each type of interface **port** of the UPS, and, where practical, each cable shall be terminated in a device typical of actual usage.

Where there are multiple interface **ports** of the same type, additional interconnecting cables/loads/devices may have to be added to the UPS, depending upon the results of preliminary tests.

The number of additional cables should be limited to the condition in which the addition of another cable does not affect the emission level by more than 2 dB. The rationale for the selection of the configuration and loading of **ports** shall be included in the test report.

A.3.2 Interconnecting cables should be of the type and length specified in the individual equipment requirements. If the length can be varied, the length shall be selected to produce maximum emission.

A.3.3 If shielded or special cables are used during the tests to achieve compliance, then a note shall be included in the user manual advising of the need to use such cables.

A.3.4 Excess lengths of cables shall be bundled at the approximate centre of the cable, with the bundles 0,3 m to 0,4 m in length. If it is impractical to do so because of cable bulk or stiffness or because the testing is being made at a user installation, the disposition of the excess cable shall be precisely noted in the test report.

A.3.5 Any set of results shall be accompanied by a complete description of the cable and equipment orientation so that results can be repeated. If there are conditions of use, those conditions shall be specified and documented, for example, cable length, cable type, shielding and grounding. These conditions shall be included in the user manual.

A.3.6 When equipment which interacts with other equipment to form a system is being evaluated, then the evaluation may be carried out using either additional equipment to represent the total system or with the use of simulators. Using either method, care shall be taken to ensure that the equipment under test is evaluated with the effects of the rest of the system, or simulators satisfying the ambient noise conditions specified in A.6.5. Any simulator used in lieu of an actual device shall properly represent the electrical and, in some cases, the mechanical characteristics of the interface, especially with respect to RF signals and impedances as well as cable configuration and types.

NOTE This procedure serves to enable the evaluation of equipment which will be combined with other equipment from different manufacturers to form a system.

A.3.7 Where a UPS is provided with terminals for the connection of an external DC source, these terminals shall be included in the test set-up. For table-top UPS, the battery and its enclosure shall be installed in a position permitted by the user manual. For floor-standing UPS, the external DC source and its enclosure shall be positioned in close proximity to the UPS and otherwise wired in accordance with the manufacturer's instructions. For large UPS, where the DC source is installed at a distance from the UPS, the **port** shall be wired in accordance with the manufacturer's instructions, and a test battery or power supply shall be fitted to the DC source end of the cables to enable measurement in stored energy mode.

Where this is not possible, or the battery including its housing is supplied by others, then this shall be noted in the test report.

A.3.8 AC outputs shall be loaded with resistive devices which can be adjusted to obtain the required levels of active power loading for the UPS under test.

A.3.9 The test unit situation relative to the ground plane shall be equivalent to that occurring in use, i.e. a floor-standing UPS is placed on a ground plane or on an isolating floor (for example, wood) close to a ground plane, and a table-top UPS is placed on a non-metallic table. The power and signal cables shall be oriented with respect to the ground plane in a manner equivalent to actual use. The ground plane may be of metal.

NOTE Specific ground plane requirements are given in A.6.3 for terminal voltage measurements and in A.9.1 for field strength measurements.

A.4 Determination of maximum emission configurations

Initial testing shall identify the frequency that has the highest emission relative to the limit while operating the UPS in typical modes of operation and cable positions in a test set-up which is representative of typical system configurations.

The identification of the frequency of the highest emission with respect to the limit shall be found by investigating emissions at a number of significant frequencies as detailed, to give confidence that the probable frequency of maximum emission has been found, and that the associated cable, UPS configurations and mode of operation are identified.

For initial testing, the UPS shall be set up in accordance with Figures A.3 to A.10. The distances between the UPS and peripherals are set according to the figures, and only the cables are to be manipulated in order to find the maximum.

For table-top systems during this process, cables should be manipulated within the range of typical configurations. For floor-standing equipment, the cables should be located in the same manner as the user would install them and no further manipulation has to be made. If the manner of cable installation is not known, or if it changes with each installation, cables for floor-standing equipment shall be manipulated to the extent practical to produce the maximum level of emissions.

Final measurements shall be conducted as in A.6, A.7 and A.8 for terminal disturbance voltage and disturbance field strength measurements, respectively.

A.5 Operation of the equipment under test

The UPS shall be operated at the rated (nominal) operating voltage and typical load conditions for which it is designed. Loads may be actual or simulated. The test programme or other means of exercising UPS should ensure that various parts of the system are exercised

in a manner that permits detection of all system emissions, in any mode of operation of the UPS.

A.6 Method of measurement of mains terminal disturbance voltage

A.6.1 Measuring receivers

Measurements shall be carried out using the quasi-peak and average detector receivers described in A.2.1.

A.6.2 Artificial mains network (AMN)

A.6.2.1 General

An AMN as described in A.2.2 shall be used.

Connection of the test unit to the AMN is required, and the test unit is located so that the distance between the boundary of the test unit and the closest surface of the AMN is 0,8 m.

Where a mains flexible cord is provided by the manufacturer, this shall be 1 m long or if in excess of 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0,4 m in length.

Where a mains cable is specified in the manufacturer's instructions, a 1 m length of the type specified shall be connected between the test unit and the AMN.

The test unit shall be arranged and connected with cables terminated in accordance with the manufacturer's instructions.

Earth connections, where required for safety purposes, shall be connected to the reference earth point of the network, and where not otherwise provided or specified by the manufacturer, shall be 1 m long and run parallel to the mains connection at a distance of not more than 0,1 m.

Other earth connections (for example for EMC purposes), either specified or supplied by the manufacturer for connection to the same ultimate terminal as the safety earth connection, shall also be connected to the reference earth of the network.

If because of the ambient noise it is not possible to measure the disturbances at some frequencies, a suitable additional radio-frequency filter may be inserted between the AMN and the mains supply, or measurements may be performed in a shielded enclosure. The components forming the additional radio-frequency filter should be enclosed in a metallic screen directly connected to the reference earth of the measuring system. The requirements for the impedance of the AMN shall be satisfied, at the frequency of the measurement, with the additional radio-frequency filter connected.

A.6.2.2 Exception

For UPS whose rated power is beyond the normal ratings of AMNs, the mains terminal voltage may be measured by use of a voltage probe, in accordance with CISPR 16, and as shown in Figure A.1.

Where this is done, the mains supply current rating shall be at least the same rating as will be the mains supply of the installed UPS, in order to match as well as possible the site mains source impedance.

A.6.3 Ground plane

The test unit, if unearthed and non-floor-standing, shall be placed 0,4 m from a reference ground plane consisting of a horizontal or vertical metal surface of at least 2 m × 2 m and shall be kept at least 0,8 m from any other metal surface or other ground plane which is not part of the test unit. If the measurement is made in a screened enclosure, the distance of 0,4 m may be with respect to one of the walls of the enclosure.

Floor-standing test units are subject to the same provisions, with the exception that they shall be placed on a floor, the point(s) of contact being consistent with normal use. The floor may be of metal but shall not make metallic contact with the floor supports of the test unit. A metal floor may replace the reference ground plane. The reference ground plane shall extend at least 0,5 m beyond the boundaries of the test unit and have minimum dimensions of 2 m × 2 m.

The reference earth point of the AMN shall be connected to the reference ground plane with a conductor as short as possible, having a length to width ratio of less than 3:1, or be bolted to the reference ground plane.

A.6.4 Equipment set-up for conducted emission measurements

The UPS shall be configured and operated in accordance with the requirements of A.3 and set up in accordance with Figures A.3 to A.8 for table-top equipment and floor-standing equipment.

Table-top UPS shall be placed upon a non-metallic table 0,8 m above the horizontal ground plane (see A.6.3), and 0,4 m from a vertical ground plane which is connected to the horizontal ground plane.

Equipment designed for both table-top and floor operation shall be tested only in the table-top configuration, unless the typical installation is floor-standing, in which case the respective configuration is used.

Equipment designed for wall-mounted operation shall be tested as table-top UPS. The orientation of the equipment shall be consistent with that of normal operation.

A mains **port** is connected, via its mains cord, to an AMN, unless being tested in accordance with the exception of A.6.2 at a test site or *in situ*. An AC output **port** is connected to a load bank. A **network port** is connected, via its network cable, to an asymmetric artificial network (AAN) when intended for connection to an external network line.

A.6.5 Conducted emission measurement

As described in A.4, the one UPS configuration, the cable configuration and the mode of operation which produce the highest emission relative to the limit are found.

This configuration shall be used to measure and record data. Of those emissions no greater than 20 dB below the limit, at least the six highest emission frequencies shall be recorded relative to the limit from the current-carrying mains **ports** and **network ports** of the UPS. The specific conductor for each emission shall be identified.

The emission from a **network port** shall, when so specified, be measured as current instead of voltage by means of a current probe, in accordance with Clause 5 of CISPR 16-1-2:2014.

A.7 Method of measurement at AC output ports (where applicable)

The AC output **port** shall be connected to a resistive load bank, and the AC output active power shall be increased slowly from zero to the maximum rated value to determine worst-case disturbance voltage.

The load should be purely resistive to avoid errors of measurement with non-sinusoidal waveforms.

The output voltage for which the disturbance is maximum shall be measured by a voltage probe with a characteristic outlined in the CISPR 16 series and shown in Figure A.1.

The disturbance voltage shall not exceed the limits of 5.3.2.3 when measured at the UPS output terminals to the load equipment.

The effect of accuracy of measurement of the voltage probe capacitor or other device which may be used to protect the measuring receiver against dangerous currents shall be either < 1 dB or that allowed for in calibration.

The typical connection method is shown in Figure A.7 for connection of the voltage probe. The connection length shall be limited, where practicable, to 2 m in length or additional loss adjustment shall be taken into account.

The probe shall measure each output terminal to the reference ground plane, and the results shall be recorded.

Where practical, the load shall be positioned 0,8 m from floor-standing UPS or 0,1 m from table-top UPS under test with a load cable length of 1 m.

If the UPS mains input is connected via an AMN, this shall remain in circuit in order to maintain the defined impedance of the supply.

As an alternative to using the voltage probe as described above, an AMN may be used in the same principle as for AC input **port** measurement.

Attention may be required with respect to possible resonance.

A.8 Method of measurement of radiated emission

A.8.1 General

Measurements shall be conducted with a quasi-peak detector receiver in the frequency range of 30 MHz to 1 000 MHz.

Measurements of the radiated field shall be made at a distance measured from the boundary of the test unit. The boundary is defined by an imaginary straight line periphery describing a simple geometric configuration encompassing the test unit. All UPS inter-system cables and the UPS shall be included within this boundary.

The specific measurement distances for **category C2 UPS** and **category C1 UPS** are given in 5.3.3.1.

A.8.2 Measuring receivers

The measuring receivers shall be in accordance with the requirements of CISPR 16-1-1.

A.8.3 Antennas

The test shall be carried out in accordance with Clause 7 of CISPR 16-2-3:2010, CISPR 16-2-3:2010/AMD1:2010 and CISPR 16-2-3:2010/AMD2:2014.

A.9 Measurement site

A.9.1 Test site

The test shall be carried out in accordance with the requirements of CISPR 16-2-3.

A.9.2 Alternative test sites

In some cases, it may be necessary to conduct tests at sites that do not have all the characteristics described in A.9.1. Evidence shall be obtained that the errors due to such alternative sites do not invalidate the results obtained. Figure A.2 is an example of an alternative site. A ground plane not satisfying all the requirements of A.9.1 is another example.

A.10 Equipment set-up for radiated emission tests

A.10.1 General

The UPS shall be configured and operated in accordance with the requirements of A.6.4, and set up for table-top equipment in accordance with Figure A.11, and for floor-standing equipment in accordance with Figure A.12 or Figure A.13.

Table-top UPS shall be placed upon a non-metallic table 0,8 m above the horizontal ground plane of the radiated emission test site.

Floor-standing UPS shall be placed directly on the ground plane, the point(s) of contact being consistent with normal use, but separated from metallic contact with the ground plane by insulation of a thickness not exceeding 0,15 m.

Equipment designed for both table-top and floor-standing operation shall be tested only in the table-top configuration unless the typical installation is floor-standing, in which case the respective configuration is used.

Equipment designed for wall-mounted operation shall be tested as table-top UPS. The orientation of the equipment shall be consistent with that of normal operation.

Ferrite clamp type CMADs are used to reduce the influence of cables outside the test volume on radiated disturbance measurement results. If CMADs are used (optional), the cable leaving the test volume shall enter the CMAD at the point where it reaches the ground plane. The part of the cable between the exit point of the CMAD and the exit point of the turntable shall be kept as short as possible. Each cable shall be treated with a separate CMAD. Cables with diameters larger than the cable openings of commercially available CMADs do not have to be treated with CMADs.

NOTE The manufacturer needs to be aware about the magnitude of the common mode current within the unit under test so the proper CMAD can be selected.

For EUTs with up to three cables leaving the test volume, each cable shall be treated with a CMAD during radiated disturbance measurements. This requirement applies to any type of cable (e.g. power, **network ports**). For a test set-up with more than three cables leaving the test volume, only the three cables from which the highest emission is expected need to be equipped with CMADs. The cables on which the CMADs have been applied shall be documented in the test report.

The addition of CMADs is recommended for the sake of reproducibility of the test results.

When the test configuration uses long cables, it is advisable to limit the length visible to the antenna. The distance between the EUT and the CMAD should be 0,8 m.

A.10.2 Radiated emission measurement

As described in A.4, the UPS configuration, the cable configuration and the mode of operation which produce the highest emission relative to the limit shall be found. This configuration shall be used to measure and record data.

Variations in aerial heights, aerial polarization and UPS azimuth shall be explored while the frequency spectrum is monitored to produce the highest emission relative to the limit.

Of those emissions less than 20 dB below the limit, at least the six highest emission frequencies relative to the limit shall be recorded. The antenna polarization shall be recorded for each reported emission.

A.10.3 Measurement in the presence of high ambient signals

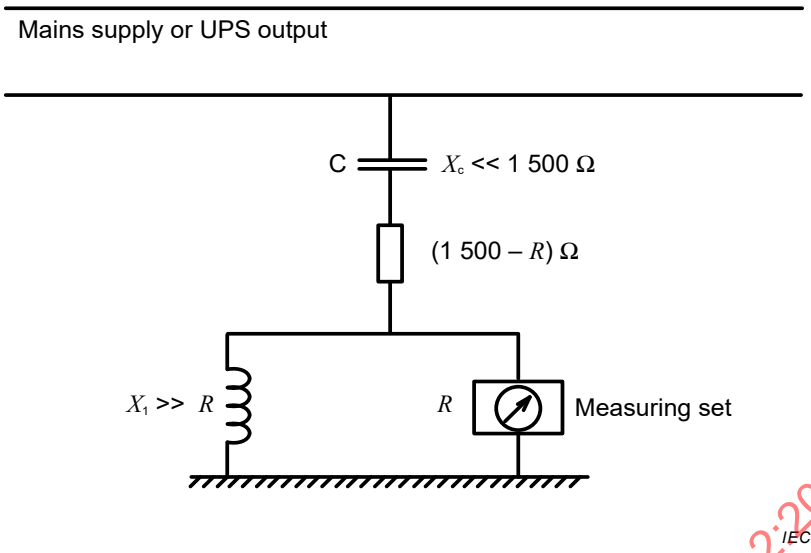
The test shall be carried out in accordance with the requirements of 7.2 and Annex C of CISPR 11:2015.

A.11 Measurement of radiated magnetic disturbances

Refer to Annex B.

A.12 Measurement of network port disturbances

The test shall be carried out in accordance with H.5 in CISPR 16-2-1:2014.



NOTE $V = \frac{1500}{R} U$

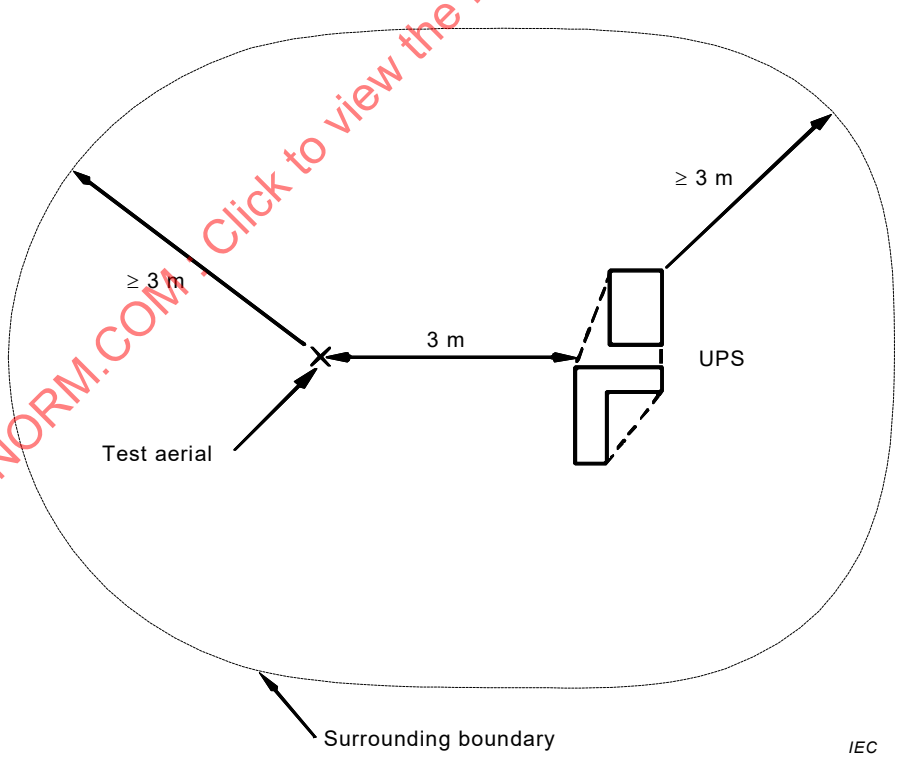
where

V is the disturbing voltage,

U is the voltage at the input of the measuring apparatus,

provided that X_c << 1 500 Ω and X_1 >> R at the frequency measured.

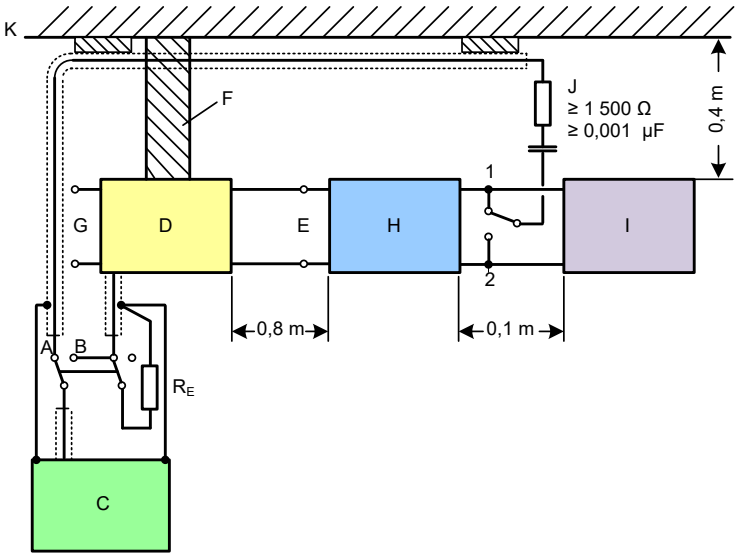
Figure A.1 – Circuit for disturbance voltage measurements on mains supply or UPS output



There shall be no reflecting object inside the volume defined on the ground by the line corresponding to the "surrounding boundary" and defined in height by a horizontal plane ≥ 3 m above the highest element of either aerial or equipment under test.

See A.9.2 for applicability of the alternative test site.

Figure A.2 – Minimum alternative test site



Key

A load measuring switch position
B mains measuring switch position
C RFI measuring receiver
D AMN
E AMN to UPS power connection
F grounding strap (length/width ratio 3:1 max.)
G input power connections
H UPS
I load
J voltage probe
K reference ground
R_E terminating resistor (50 Ω)

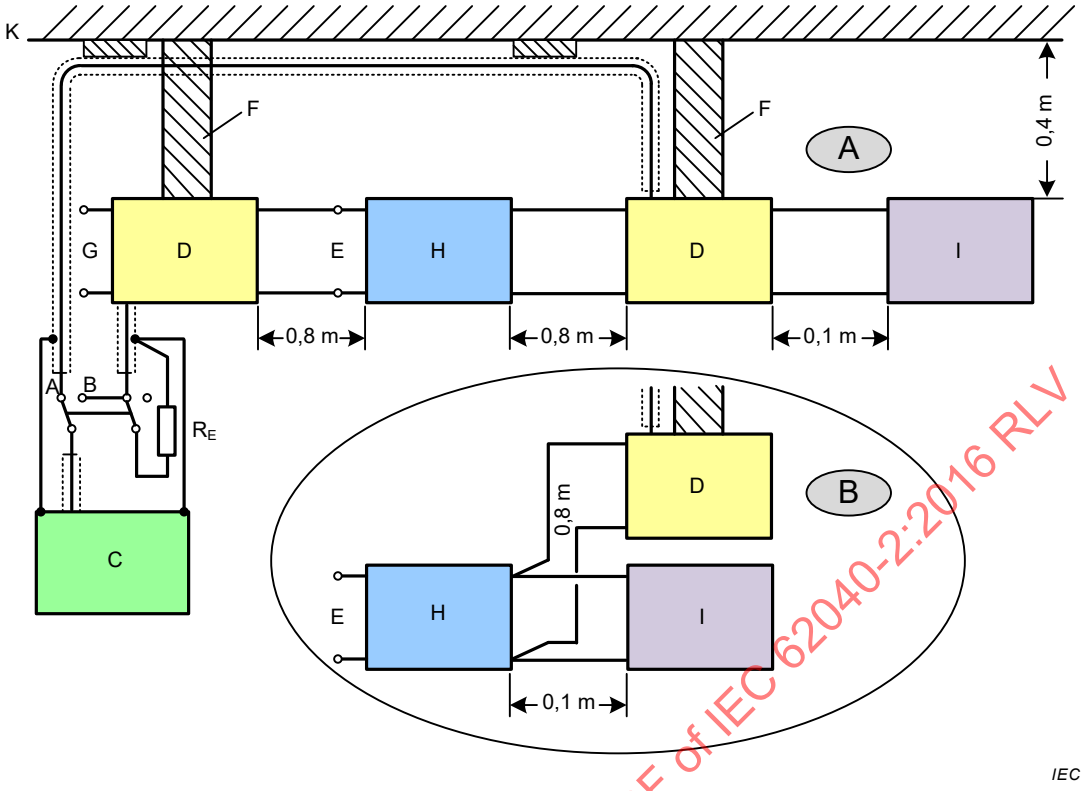
The distance between the output terminals 1 and 2 of the UPS and the load should be 0,1 m. The connecting lines between them shall not exceed 1 m.

The test ground of the RFI measurement shall be securely fastened to the AMN ground.

When the switch is in position A, the measuring set terminal on the AMN shall be terminated with the appropriate terminating resistor, R_E.

For UPS and/or loads of protection class 1, the ground safety conductor shall be connected to the ground of the AMN.

Figure A.3 – Set-up for measurement of conducted emission for table-top units using voltage probe



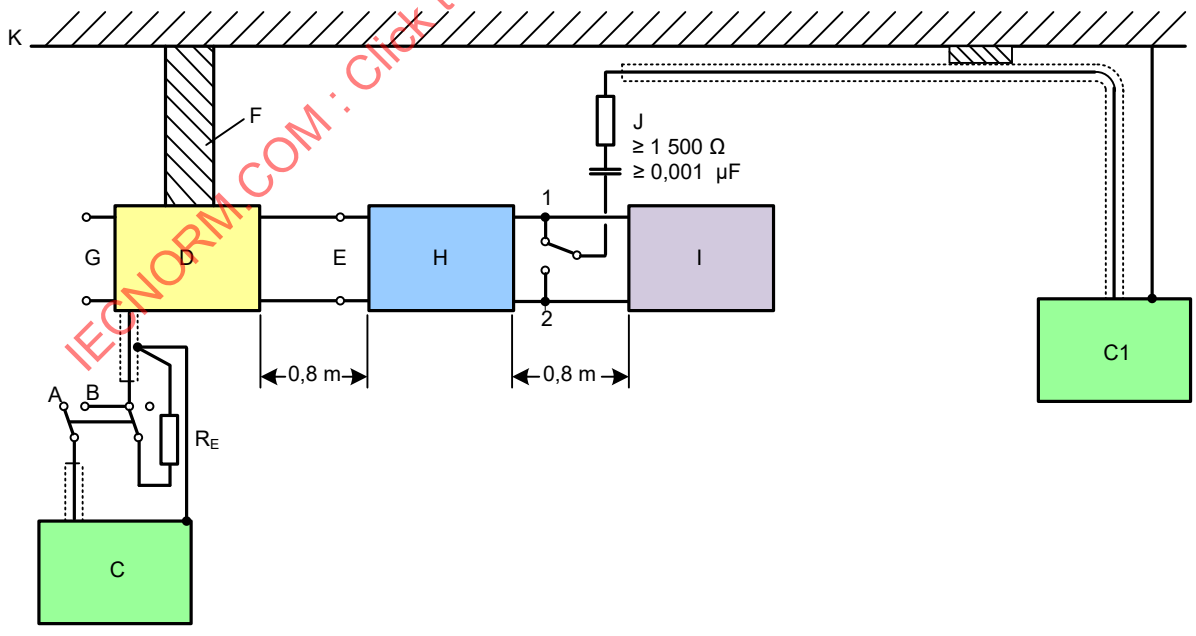
Key

See Figure A.3

Configuration A: In case the current flowing to the load is lower than or equal to the rated current of the AMN.

Configuration B: In case the current flowing to the load is higher than the rated current of the AMN, the load may be connected directly to the UPS output, the AMN consequently being used as a probe only.

Figure A.4 – Set-up for measurement of conducted emission for table-top units using AMN (alternative method)

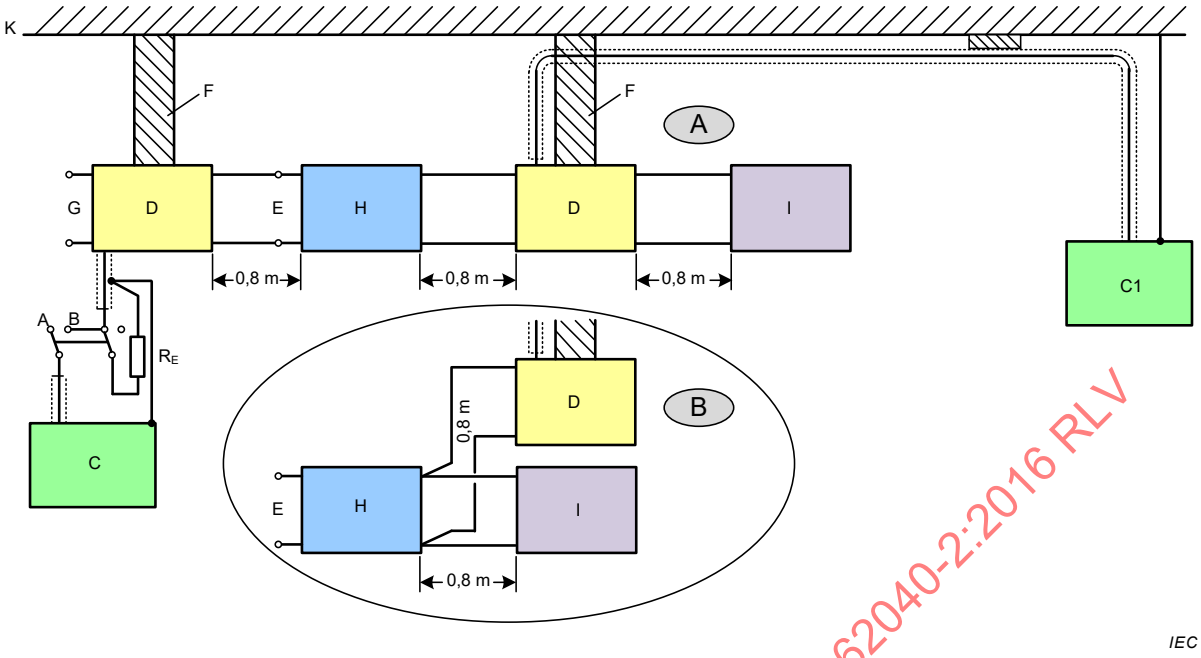


Key

See Figure A.3

C1 Alternative receiver position

Figure A.5 – Test set-up for floor-standing units



Key

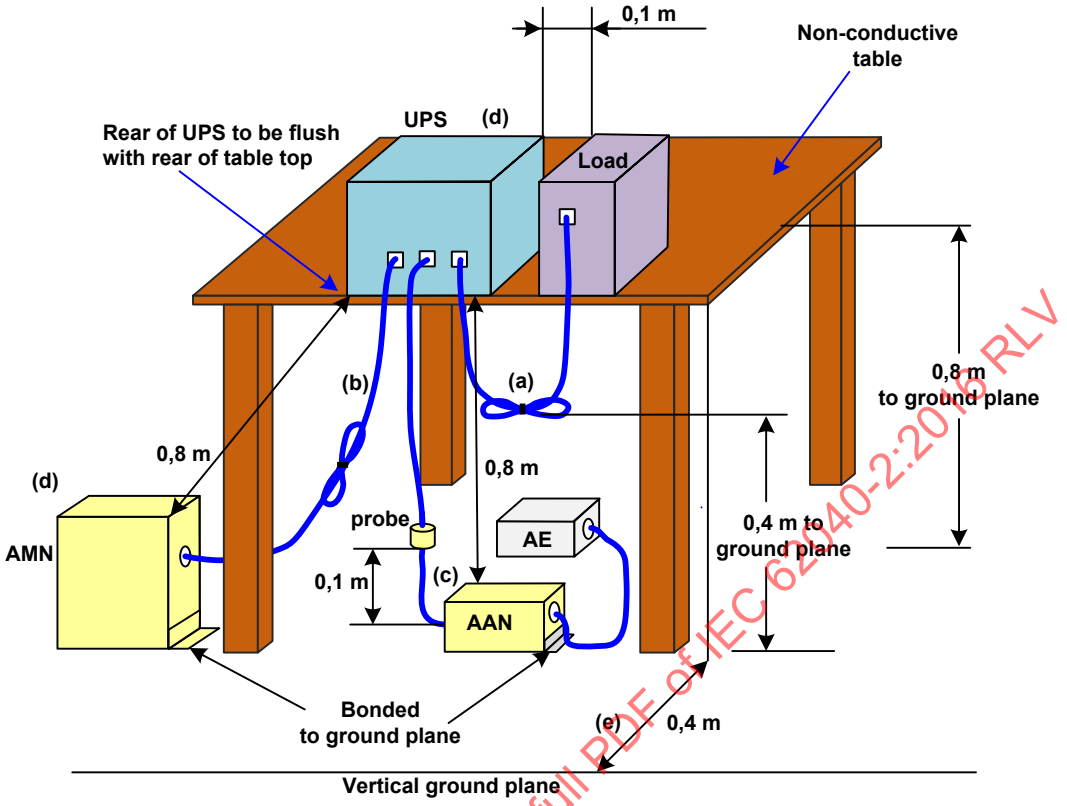
See Figure A.3

C1 Alternative receiver position

Configuration A: In case the current flowing to the load is lower than or equal to the rated current of the AMN.

Configuration B: In case the current flowing to the load is higher than the rated current of the AMN, the load may be connected directly to the UPS output, the AMN consequently being used as a probe only.

Figure A.6 – Test set-up for floor-standing units using AMN (alternative method)



Key

AE auxiliary equipment

AAN asymmetric artificial network

AMN artificial mains network

[a] Interconnecting cables which hang closer than 0,4 m to the ground-plane shall be folded back and forth forming a bundle 0,3 m to 0,4 m long, hanging approximately in the middle between ground plane and table.

[b] Excess mains cord shall be bundled in the centre or shortened to approximate length.

[c] Refer to H.5 in CISPR 16-2-1:2014 for use of an AAN or alternative method. If used, the current probe shall be placed at 0,1 m from the AAN. The end of the network cables not being measured shall be terminated using correct terminating impedance.

[d] The AMN shall be placed on top of, or immediately beneath, the ground-plane.

[e] Mains and network cables shall be positioned for their entire lengths, as far as possible, at 0,4 m from the vertical ground plane.

Figure A.7 – Test configuration for table-top equipment (conducted emission measurement)

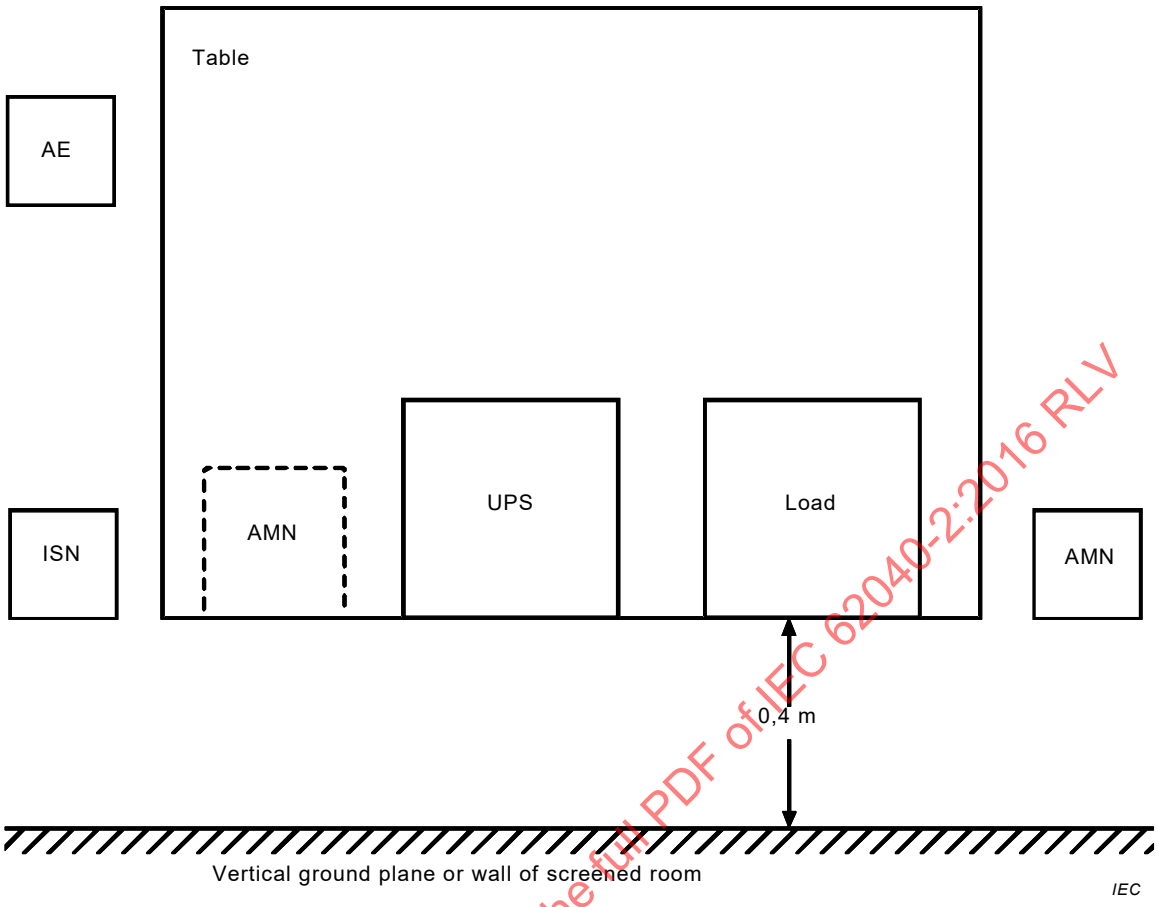


Figure A.8 – Test configuration for table-top equipment (conducted emission measurement) – Plan view

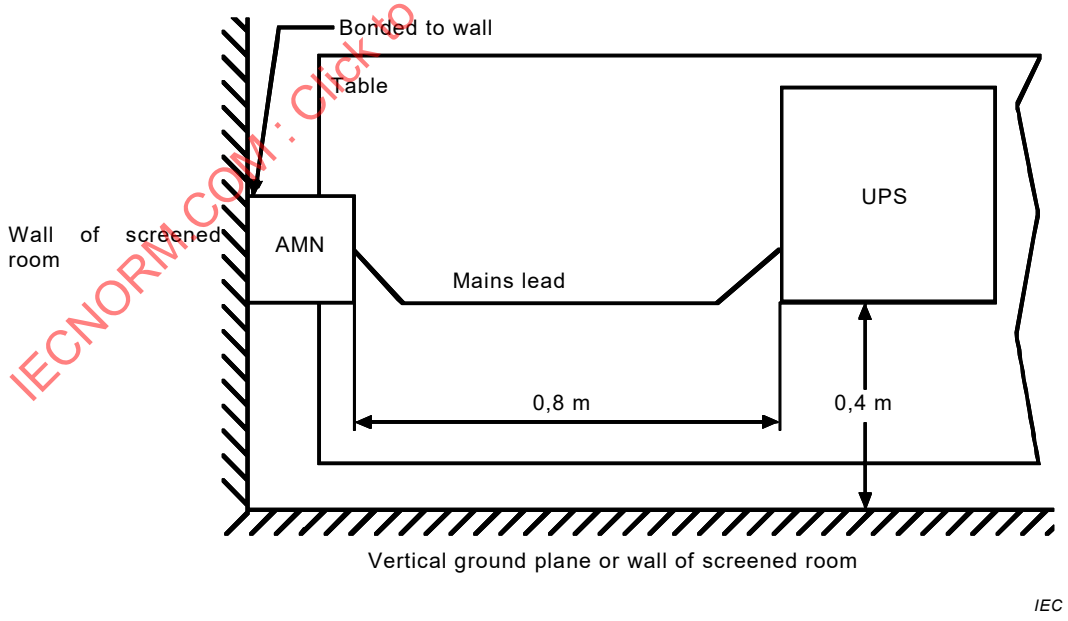
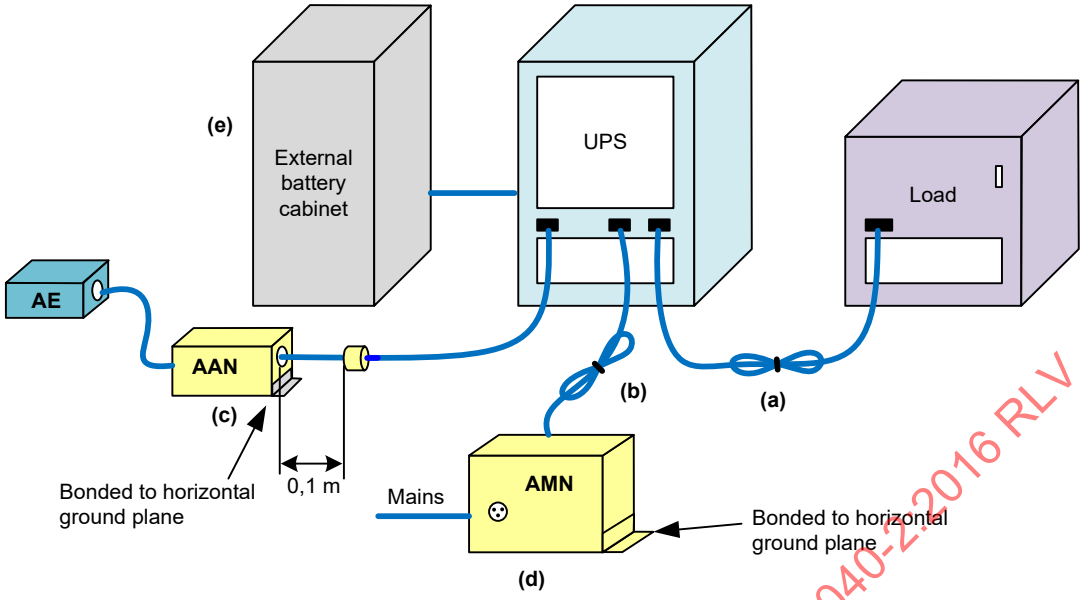


Figure A.9 – Alternative test configuration for table-top equipment (conducted emission measurement) – Plan view



[a] UPS and cables shall be insulated (up to 0,15 m) from horizontal ground-plane. Excess cables shall be bundled in the centre. If bundling is not possible, the cables shall be arranged in a serpentine fashion.

[b] Excess mains cord shall be bundled in the centre or shortened to approximate length.

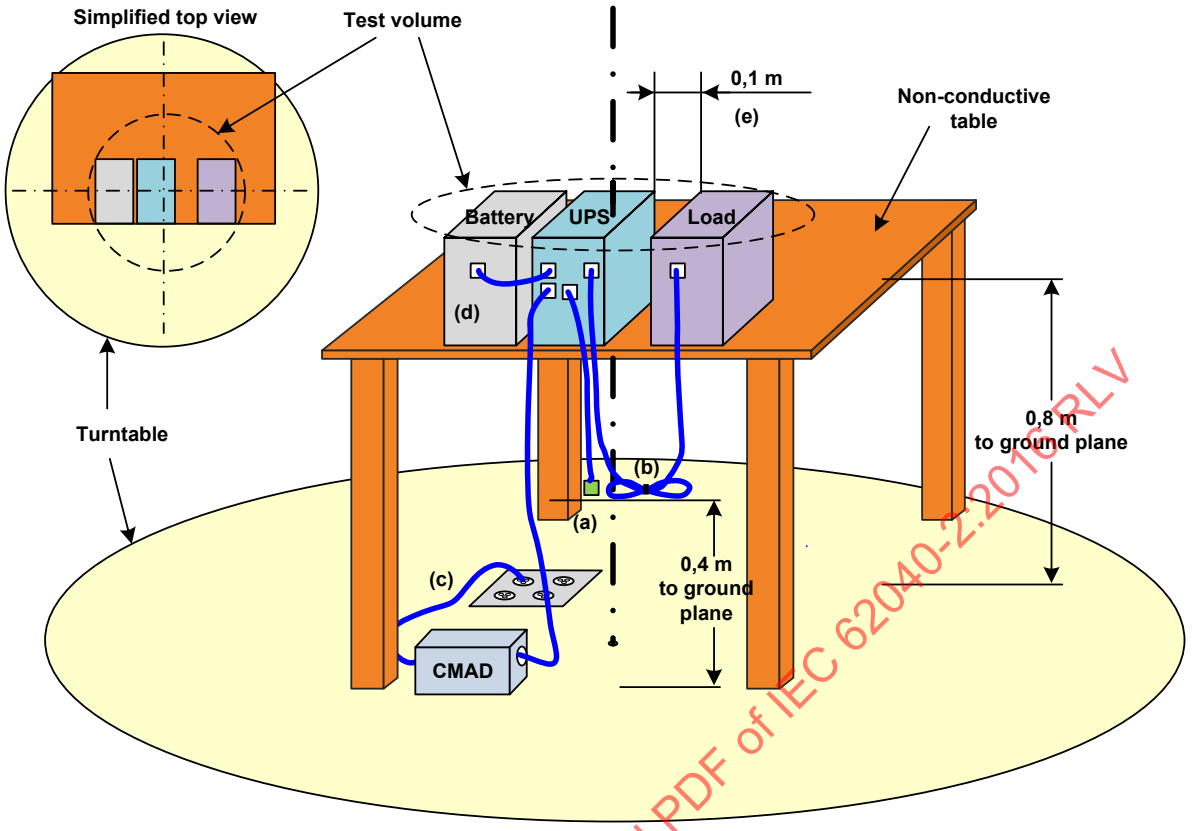
[c] Refer to H.5 in CISPR 16-2-1:2014 for use of an AAN or alternative method. If used, the current probe shall be placed at 0,1 m from the AAN. The end of the network cables not being measured shall be terminated using correct terminating impedance.

[d] The AMN shall be placed on top of, or immediately beneath, the ground-plane.

[e] External battery (where applicable) shall be positioned and wired as for a normal site configuration.

IEC

Figure A.10 – Test configuration for floor-standing equipment (conducted emission measurement)



[a] The ends of network cables attached to the EUT that are not connected to another unit or auxiliary equipment shall be terminated using the correct terminating impedance.

[b] Interconnecting cables which hang closer than 0,4 m to the ground plane shall be folded back and forth forming a bundle 0,3 m to 0,4 m long, hanging approximately in the middle between ground plane and table.

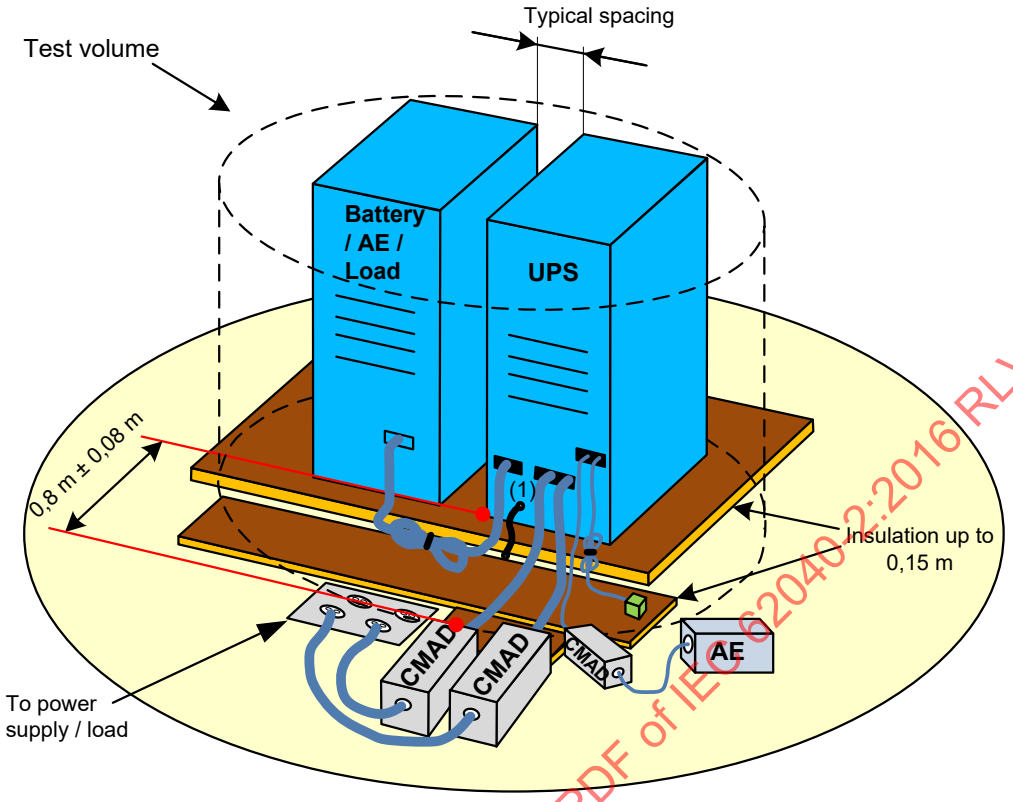
[c] Mains cables shall drape to the floor and then be routed to the receptacle. No extension cords shall be used for the connection to mains receptacle. Mains junctions boxes shall be flush with, and bonded direct to, the ground plane. If used, the AMN shall be installed under the ground plane. For the purpose of restriction of radiation assessment to the cable fractions inside the test volume, CMADs may be applied at the position where the cables leave the test volume. CISPR 16-2-3 provides further guidance on the application of CMADs.

[d] External energy storage device(s) shall be positioned and wired for normal site configuration. Any energy storage device that does not fit within the test volume may be positioned outside the test volume, including outside the test room.

[e] All units forming the system under test (including the EUT, connected peripherals and auxiliary equipment or devices) shall be arranged according to normal use. Where not defined in the normal use, a nominal 0,1 m separation distance between neighbouring units shall be defined for the test arrangement.

IEC

Figure A.11 – Test configuration for table-top equipment (radiated emission requirement)



Key

1 special earthing terminal for EMC purposes, if available

Excess in/out cables shall be bundled in the centre. If bundling is not possible, the cables shall be arranged in a serpentine fashion.

Excess mains cords shall be bundled in the centre or shortened to the appropriate length.

UPS and cables shall be insulated (up to 0,15 m) from the ground plane.

Mains junction box(es) shall be flush with, and bonded direct to, the ground plane. If used, the AMN shall be installed under the ground plane. For the purpose of restriction of radiation assessment to the cable fractions inside the test volume, CMADs may be applied at the position where the cables leave the test volume. CISPR 16-2-3 provides further guidance on the application of CMADs.

Mains and signal cables shall drape to the floor.

External battery (where applicable) shall be positioned and wired as for a normal installation condition.

An energy storage device that does not fit within the test volume may be positioned outside the test volume, including outside the test room. A cable length of 0,8 m ± 0,08 m shall be managed between the EUT/AE and the CMAD (when used) or between the EUT/AE and the ground plane.

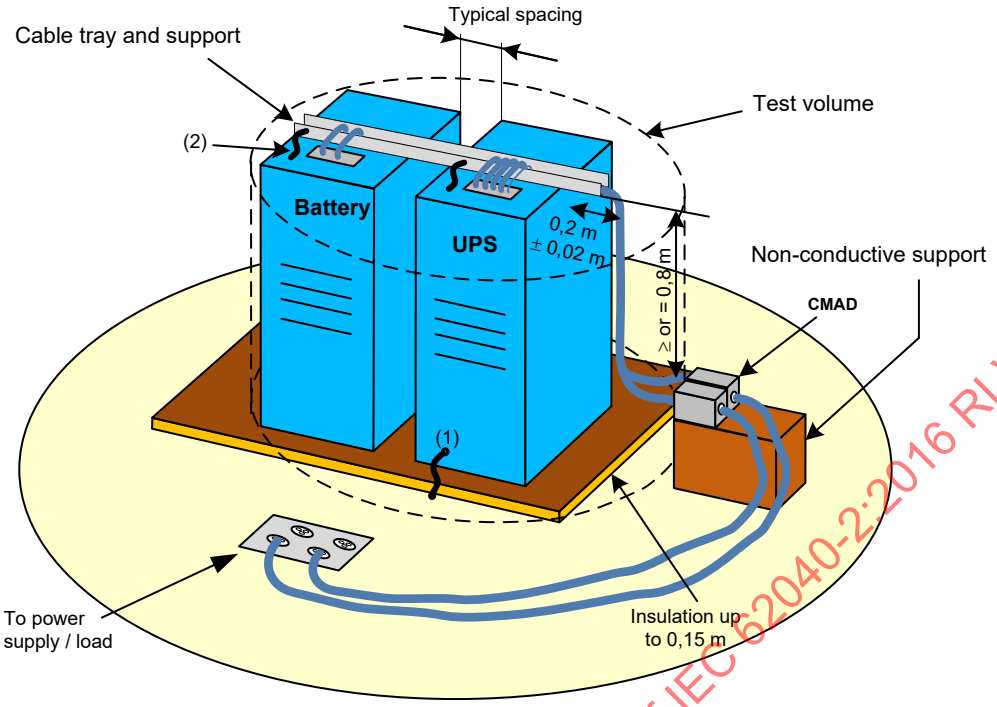
When CMADs are not used, excess mains cords shall be bundled in the centre or shortened to the appropriate length.

A load that does not fit within the test volume is positioned outside the test volume, including outside the test room.

The ends of in/out cables which are not connected to a peripheral shall be bundled in the centre and may be terminated if required with the correct impedance.

IEC

Figure A.12 – Test configuration for floor-standing equipment (radiated emission measurement)



Key

1 special earthing terminal for EMC purposes, if available

2 cable trays or conduits, if conductive, to be earthed in accordance with relevant wiring rules

Excess in/out cables shall be bundled in the centre. If bundling is not possible, the cables shall be arranged in a serpentine fashion.

Excess mains cords shall be bundled in the centre or shortened to the appropriate length.

UPS and cables shall be insulated (up to 0,15 m) from the ground plane.

Mains junction box(es) shall be flush with, and bonded direct to, the ground plane. If used, the AMN shall be installed under the ground plane. For the purpose of restriction of radiation assessment to the cable fractions inside the test volume, CMADs may be applied at the position where the cables leave the test volume. CISPR 16 2 3 provides further guidance on the application of CMADs.

Mains and signal cables shall drape to the floor.

External battery (where applicable) shall be positioned and wired as for a normal installation condition.

An energy storage device that does not fit within the test volume may be positioned outside the test volume, including outside the test room.

A length of 0,8 m ± 0,08 m cable, either vertical or horizontal, shall be visible to the antenna. The cable is to be run between the EUT/AE and the CMAD (when used) or between the EUT/AE and the ground plane. To reduce the length of cable between the EUT and CMAD, CMADs may be raised in high position, leaving at least 0,8 m of cable visible to the antenna.

The material used to support the cable shall be in accordance with the relevant wiring rules or otherwise as defined by the manufacturer's installation instructions. When CMADs are not used, excess mains cords shall be bundled in the centre or shortened to the appropriate length.

A load that does not fit within the test volume is positioned outside the test volume, including outside the test room.

The end of the in/out cables which are not connected to a peripheral shall be bundled in the centre and may be terminated if required with correct impedance.

IEC

Figure A.13 – Test configuration for top entry floor-standing equipment (radiated emission measurement)

Annex B
(informative)

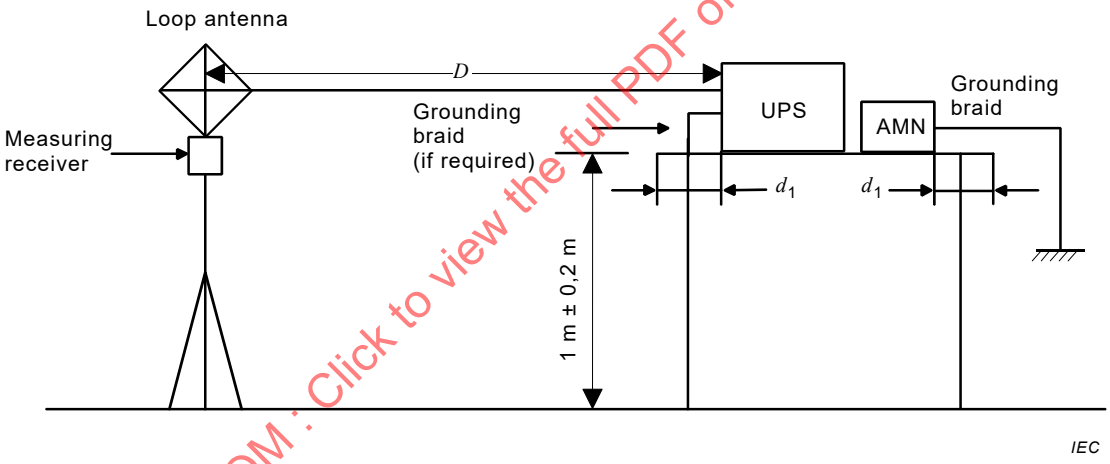
Electromagnetic emission limits and measurement methods of magnetic field – H field

The magnetic component of the field radiated by the test unit is measured from 10 kHz to 30 MHz.

If measurements are taken in a shielded enclosure, its dimensions are such that antennas are always located at least 1 m from each of the walls. The equipment under test is placed on its grounded surface at 1 m ± 0,2 m from the floor. Measurements are taken at a distance D = 3 m from the most disturbance producing side of the equipment under test.

The most disturbance-producing side is defined as the one emitting the highest signal in the frequency band under consideration. The choice of this side and the orientation of the measuring antenna are made simpler by using a spectrum analyser. The measurement distance is determined from the antenna's centre of phase.

Measurements are taken using a shielded loop aerial, as shown in Figure B.1. The frame is oriented in a vertical plane so that it receives the maximal magnetic field.



D = 3 m

d_1 ≥ 0,1 m

Figure B.1 – Test set-up for measuring radiated disturbances

When measured by a loop antenna, the limits given in Table B.1 and Table B.2 apply when measured at a 3 m distance in accordance with Figure B.1.

Table B.1 – UPS which has a rated output current less than or equal to 16 A

Frequency range MHz	Quasi-peak limits dB (μA/m)	
	Category C1 UPS	Category C2 UPS
0,01 to 0,15	40,0 to 16,5	52,0 to 28,5
0,15 to 1,0	16,5 to 0	28,5 to 12,0
1 to 30	0 to -10,5	12,0 to 1,5
NOTE In all frequency ranges, the limit value reduces linearly with the logarithm of the frequency.		

Table B.2 – UPS which has a rated output current greater than 16 A

Frequency range MHz	**Quasi-peak limits** dB (μA/m)	
	Category C1 UPS	**Category C2/C3 UPS**
0,01 to 0,15	52,0 to 28,5	64,0 to 40,5
0,15 to 1,0	28,5 to 12,0	40,5 to 24,0
1 to 30	12,0 to 1,5	24,0 to 13,5
NOTE In all frequency ranges, the limit value reduces linearly with the logarithm of the frequency.		

Annex C
(normative)

Electromagnetic emission – Limits of network ports

The current limits in Tables C.1, C.2 and C.3 are alternative to the voltage limits in Tables 1 and 2.

Table C.1 – Limits of network ports for category C1 UPS

Frequency range	Limits	Basic standard
0,15 MHz to 0,5 MHz Limit decreasing linearly with logarithm frequency	40 dB(μA) to 30 dB(μA) quasi-peak 30 dB(μA) to 20 dB(μA) average	CISPR 22 Class B
0,5 MHz to 30 MHz	30 dB(μA) quasi-peak 20 dB(μA) average	

Table C.2 – Limits of network ports for category C2 UPS

Frequency range	Limits	Basic standard
0,15 MHz to 0,5 MHz Limit decreasing linearly with logarithm frequency	53 dB(μA) to 43 dB(μA) quasi-peak 40 dB(μA) to 30 dB(μA) average	CISPR 22 Class A
0,5 MHz to 30 MHz	43 dB(μA) quasi-peak 30 dB(μA) average	

Table C.3 – Limits of network ports for category C3 UPS

Frequency range	Limits	Basic standard
0,15 MHz to 0,5 MHz Limit decreasing linearly with logarithm frequency	66 dB(μA) to 56 dB(μA) quasi-peak 50 dB(μA) to 40 dB(μA) average	Extrapolation from Table 2 and CISPR 16-1-2
0,5 MHz to 30 MHz	56 dB(μA) quasi-peak 40 dB(μA) average	

Annex D
(normative)

Electromagnetic immunity – Test methods

D.1 General

D.1.1 Object

The purpose of these tests is to measure the degree of immunity of UPS systems to electromagnetic disturbances.

Due to the range of physical size and power ratings, the manufacturer may choose the most appropriate test site and configuration that is best to physically accommodate the UPS and, where necessary, within the current rating of the test equipment for currents in excess of 100 A.

D.1.2 Test environment

It is preferable to carry out the immunity tests in a laboratory environment, in which all tests shall be performed on a metallic ground plane projecting at least 0,5 m beyond the UPS on all sides; however, with a minimal size of 1 m × 1 m.

Floor-standing UPS shall be placed on a non-conductive support 0,05 m to 0,15 m above the supporting plane.

UPS intended for table-top use shall be placed on a wooden table of 0,8 m height.

The equipment under test is referred to below as UPS.

D.2 Electrostatic discharge (ESD)

The immunity to electrostatic discharges shall be tested according to IEC 61000-4-2. The ESD test shall be applied only to such points and surfaces of the UPS which are accessible to personnel during normal usage, as well as to a horizontal and a vertical coupling plane of 0,5 m × 0,5 m.

D.3 Immunity to radiated electromagnetic (EM) fields

D.3.1 General

The immunity test to radiated electromagnetic fields shall be performed according to IEC 61000-4-3. The test equipment, test facility, calibration, test set-up and procedure shall be in accordance with the relevant clauses of IEC 61000-4-3.

D.3.2 Arrangement of wiring

The test shall be carried out in accordance with the requirements in 7.3 of IEC 61000-4-3:2006.

D.4 Immunity to fast transients

D.4.1 The immunity test for repetitive fast transients is required on all cables that can be connected to the UPS, unless they are declared by the manufacturer to be shorter than 3 m.

D.4.2 The equipment shall be tested according to IEC 61000-4-4.

D.4.3 A capacitive coupling clamp, according to 6.4 of IEC 61000-4-4:2012, shall be placed not more than 1 m from the UPS on any incoming or outgoing cable.

D.5 Immunity to surges

The test shall be carried out in accordance with IEC 61000-4-5.

D.6 Immunity to low-frequency signals

D.6.1 Power line harmonics and inter-harmonics

D.6.1.1 General

The operating UPS shall withstand the low-frequency conducted disturbances in the mains, as specified in IEC 61000-2-2. Compliance is checked by simulating the conditions below, and the UPS shall continue to operate without degradation of the specified performances.

D.6.1.2 Single-phase equipment

The test as a minimum shall be performed with a single sinusoidal disturbing voltage of 10 V, at a frequency which is slowly varied from 140 Hz to 360 Hz. Use can be made of a series injection circuit where the mains supplies power at 50 Hz to 60 Hz, and the amplifier delivers only the harmonics.

The 10 V disturbing voltage applies when the AC input voltage is rated 230 V and above. For AC input voltage rated lower than 230 V, a proportionally lower disturbing voltage applies.

D.6.1.3 Three-phase equipment

The test set-up and voltage level for each phase is identical to the set-up for single-phase equipment; however, a three-phase variable frequency generator is used (static or rotating). The frequency is slowly varied from 140 Hz to 360 Hz.

The test shall be performed for both rotating sequences of the disturbing three-phase signal.

If the equipment has a neutral terminal, it shall be connected and tested as in the single-phase test, but only at a frequency close to three times the line frequency.

The 10 V disturbing voltage applies when the AC input voltages are rated 230 V/400 V and above. For AC input voltages rated lower than 230 V/400 V, a proportionally lower disturbing voltage applies.

D.6.2 Power line unbalance (three-phase UPS systems only)

Three-phase systems shall be tested for amplitude and phase unbalance on the power line input.

An unbalance signal can be made with a single-phase transformer or by equivalent means. The unbalance tests are performed on one line only.

The amplitude unbalance test is made with a 230:5 transformer typically connected for a 230 V application as in Figure D.1. The test shall be performed both with the shown connection and with the reversed connection of the primary side of the transformer.

The ratio of the transformer represents a 400 V/230 V distribution system. The ratio depends on the voltage of the distribution system to which the UPS is connected.

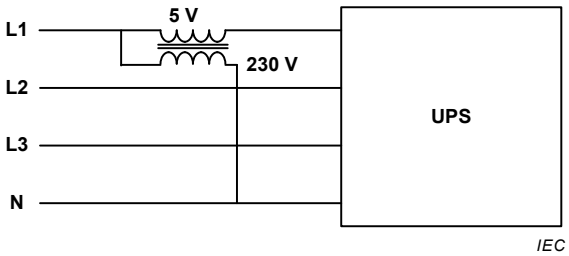


Figure D.1 – Amplitude unbalance

The phase unbalance test is made with a 400:5 transformer, typically connected for a 400 V application as in Figure D.2. The test shall be performed both with the shown connection and the reversed connection of the primary side of the transformer.

The ratio of the transformer represents a 400 V/230 V distribution system. The ratio depends on the voltage of the distribution system to which the UPS is connected.

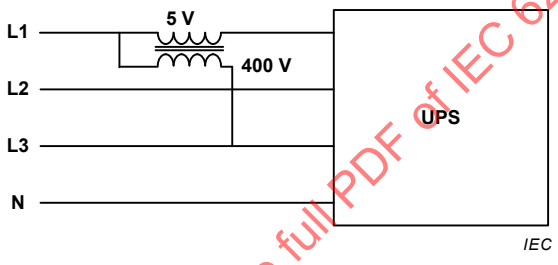


Figure D.2 – Phase unbalance

Annex E
(informative)

User installation testing

Measurements at the user's installation are generally necessary for category C4 and might sometimes apply also for other categories (C2 and C3).

For general guidance, the following should be considered:

a) Conducted emission

The mains terminal voltage may be measured by use of a voltage probe, in accordance with Clause 5 of CISPR 16-1-2:2014, and as shown in Figure A.1.

b) Radiated emission

Measurements should be made preferably at the boundary of the user's premises; if this boundary is less than 30 m from the test unit, the measurements should be made at a distance of 30 m from the test unit. The number of measurements made in azimuth shall be as great as reasonably practical, but there shall be at least four measurements in orthogonal directions, and measurements made in the direction towards any existing equipment which may be adversely affected.

NOTE Measurements made in azimuth consist of measuring radiated emission at different angles in the horizontal plane around the EUT.

This form of compliance verification is specific to the installation site, since the site characteristics affect the measurement. Additional type-tested and compliant UPS may be added to the test unit without invalidating the compliance status of the measurement.

In any case the measurements should be performed in accordance with the applicable agreement between the supplier and the customer.

Bibliography

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

IEC 61000-4 (all parts), *Electromagnetic compatibility (EMC)*

IEC 61204 (all parts), *Low-voltage power supplies, d.c. output*

CISPR 15:2013, *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*
CISPR 15:2013/AMD1:2015

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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IEC 62040-2
Edition 3.0 2016-11

ALIMENTATIONS SANS INTERRUPTION (ASI) –

Partie 2: Exigences pour la compatibilité électromagnétique (CEM)

FEUILLE D'INTERPRÉTATION 1

Cette feuille d'interprétation a été établie par le sous-comité 22H: Alimentations sans interruption (ASI), du comité d'études 22 de l'IEC: Systèmes et équipements électroniques de puissance.

Le texte de cette feuille d'interprétation est issu des documents suivants:

FDIS	Rapport de vote
22H/232/FDIS	22H/236/RVD

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

_____

Interprétation du 5.3.2.4, Limites aux accès réseau de télécommunication

Introduction

Le paragraphe 5.3.2.4 stipule que les limites des **accès réseau de télécommunication** applicable aux **ASI** de **catégorie C1, C2** et **C3** se trouvent dans le Tableau 1, le Tableau 2 et l'Annexe C.

Il n'était pas clair si 5.3.2.4 s'appliquait aux **accès réseau de télécommunication** qui débutent et se terminent dans l'**accès par l'enveloppe** de l'**ASI** (c'est-à-dire aux **accès réseau de télécommunication** connectés exclusivement aux circuits ou dispositifs faisant partie intégrante de l'**ASI**).

Interprétation

Les limites de l'**accès réseau de télécommunication** du Tableau 1, du Tableau 2 et de l'Annexe C s'appliquent uniquement aux **accès réseau de télécommunication** pour lesquels la connexion à des circuits ou dispositifs externes à l'**accès par l'enveloppe** de l'**ASI** est autorisée. Cela inclut, sans restriction, la connexion aux réseaux RTC, RNIS, xDSL et Ethernet. Les limites du Tableau 1, du Tableau 2 et de l'Annexe C ne s'appliquent pas aux

accès réseau de télécommunication qui débutent et se terminent dans l'**accès par l'enveloppe** de l'**ASI** (c'est-à-dire aux **accès réseau de télécommunication** connectés exclusivement aux circuits ou dispositifs faisant partie intégrante de l'**ASI**).

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ALIMENTATIONS SANS INTERRUPTION (ASI) –

Partie 2: Exigences pour la compatibilité électromagnétique (CEM)

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Cette troisième édition annule et remplace la deuxième édition parue en 2005. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) l'intégration des limites pour les **accès réseau de télécommunication** dans le Tableau 1, le Tableau 2 et l'Annexe C, à des fins de cohérence avec d'autres normes;
b) une modification des limites quasi-crête pour les **ASI de catégorie C3** dans le Tableau 2, à des fins de cohérence avec d'autres normes;

c) une clarification des critères de performance destinés aux essais d'immunité dans le Tableau 4;

d) une révision de certaines configurations d'essai dans l'Annexe A.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
22H/210/FDIS	22H/212/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.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Dans le présent document, les caractères d'imprimerie suivants sont employés:

– exigences proprement dites et annexes normatives: caractères romains;
– déclarations de conformité et modalités d'essai: *caractères italiques*;
– notes et commentaires: petits caractères romains;
– conditions normatives au sein des tableaux: petits caractères romains;
– termes définis à l'Article 3: **gras**.

Une liste de toutes les parties de la série IEC 62040, publiées sous le titre général *Alimentations sans interruption (ASI)*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives à la publication recherchée. A cette date, la publication sera

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- amendée.

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ALIMENTATIONS SANS INTERRUPTION (ASI) –

Partie 2: Exigences pour la compatibilité électromagnétique (CEM)

1 Domaine d'application

La présente partie de l'IEC 62040 est une norme de produit pour les essais de type en matière de compatibilité électromagnétique (CEM). Elle s'applique aux ASI mobiles, stationnaires, installées à poste fixe ou intégrées, enfichables et connectées en permanence, destinées à une utilisation dans les réseaux de distribution basse tension d'un environnement résidentiel, commercial, d'industrie légère ou industriel, qui fournissent une tension de sortie ne dépassant pas 1 000 V en courant alternatif ou 1 500 V en courant continu au niveau de l'**accès**, et qui incluent un dispositif de stockage d'énergie.

Sous réserve que l'installation, l'exploitation et la maintenance de l'ASI soient réalisées de la manière prescrite par le fabricant, la présente norme définit les limites d'émission, les niveaux d'immunité, les méthodes d'essai et les critères de performances permettant à une ASI complète de respecter les exigences de CEM essentielles nécessaires pour éviter les interférences entre l'ASI et d'autres appareils, par exemple des récepteurs radio, et pour empêcher que l'ASI soit affectée par des phénomènes extérieurs.

La présente norme ne traite pas des phénomènes de CEM produits par des charges connectées à l'ASI ni des situations créées par tout appareil externe à l'ASI autre que ceux décrits dans les exigences d'immunité.

La présente norme est harmonisée avec les normes IEC applicables relatives aux limites d'émissions électromagnétiques et aux niveaux d'immunité. Elle contient des exigences supplémentaires applicables aux ASI.

La présente norme ne couvre pas:

a) les dispositifs d'alimentation à basse tension en courant continu couverts par les normes IEC 61204;

b) les systèmes dont la tension de sortie est dérivée d'une machine tournante.

NOTE 1 Les ASI sont généralement raccordées à leur dispositif de stockage d'énergie via une liaison continue. Une batterie chimique est un exemple de dispositif de stockage d'énergie. D'autres dispositifs peuvent être appropriés; par conséquent, lorsque le mot "batterie" apparaît dans le texte de la présente norme, il peut être compris dans le sens de "dispositif de stockage d'énergie".

NOTE 2 La présente norme de produit pour les essais de type permet d'évaluer la conformité CEM des ASI comprises dans l'une des catégories C1, C2 et C3 avant leur mise sur le marché. Elle propose également des préconisations destinées à évaluer la conformité des ASI comprises dans la catégorie C4 (voir Article 4).

NOTE 3 Les différentes conditions d'essai nécessaires à couvrir toute la plage de tailles et de caractéristiques assignées de puissance d'une ASI complète sont prises en considération. Une ASI complète peut consister en une ou plusieurs unités interconnectées. Pour plus d'informations sur la configuration d'une ASI, voir l'IEC 62040-3:2011, Annexe A.

NOTE 4 Les exigences ont été choisies de manière à permettre un niveau adéquat de CEM pour les ASI installées dans un environnement résidentiel, commercial, d'industrie légère ou industriel. Les exigences ne suffisent pas systématiquement à couvrir les situations peu susceptibles de se produire, y compris les défaillances de l'ASI.

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 61000-2-2:2002, *Compatibilité électromagnétique (CEM) – Partie 2-2: Environnement – Niveaux de compatibilité pour les perturbations conduites à basse fréquence et la transmission des signaux sur les réseaux publics d'alimentation basse tension*

IEC 61000-3-2:2014, *Compatibilité électromagnétique (CEM) – Partie 3-2: Limites – Limites pour les émissions de courant harmonique (courant appelé par les appareils ≤ 16 A par phase)*

IEC 61000-3-12:2011, *Compatibilité électromagnétique (CEM) – Partie 3-12: Limites – Limites pour les courants harmoniques produits par les appareils connectés aux réseaux publics basse tension ayant un courant appelé > 16 A et ≤ 75 A par phase*

IEC 61000-4-2:2008, *Compatibilité électromagnétique (CEM) – Partie 4-2: Techniques d'essai et de mesure – Essai d'immunité aux décharges électrostatiques*

IEC 61000-4-3:2006, *Compatibilité électromagnétique (CEM) – Partie 4-3: Techniques d'essai et de mesure – Essai d'immunité aux champs électromagnétiques rayonnés aux fréquences radioélectriques*

IEC 61000-4-4:2012, *Compatibilité électromagnétique (CEM) – Partie 4-4: Techniques d'essai et de mesure – Essai d'immunité aux transitoires électriques rapides en salves*

IEC 61000-4-5:2014, *Compatibilité électromagnétique (CEM) – Partie 4-5: Techniques d'essai et de mesure – Essai d'immunité aux ondes de choc*

IEC 61000-4-6:2013, *Compatibilité électromagnétique (CEM) – Partie 4-6: Techniques d'essai et de mesure – Immunité aux perturbations conduites, induites par les champs radioélectriques*

IEC 61000-4-8:2009, *Compatibilité électromagnétique (CEM) – Partie 4-8: Techniques d'essai et de mesure – Essai d'immunité au champ magnétique à la fréquence du réseau*

IEC 62040-3:2011, *Alimentations sans interruption (ASI) – Partie 3: Méthode de spécification des performances et exigences d'essais*

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

CISPR 16-1-1:2015, *Spécification 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 16-2-1:2014, *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 16-2-3:2010, *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 – Mesures des perturbations rayonnées*
CISPR 16-2-3:2010/AMD1:2010
CISPR 16-2-3:2010/AMD2:2014

CISPR 22:2008, *Appareils de traitement de l'information – Caractéristiques des perturbations radioélectriques – Limites et méthodes de mesure*

3 Termes, définitions et abréviations

3.1 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 62040-3:2011 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 particulière entre l'ASI et l'environnement électromagnétique externe (voir Figure 1)

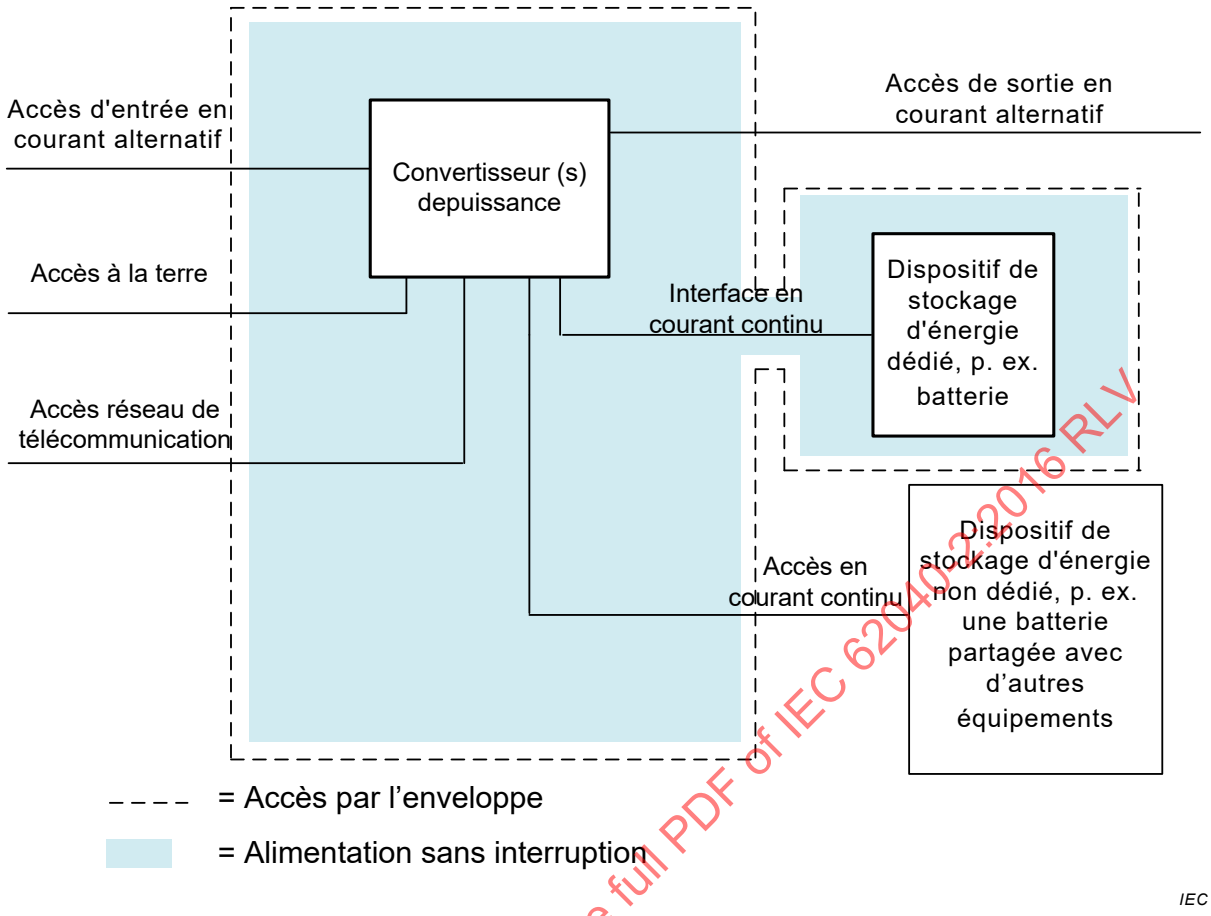

Figure 1 – Accès d'une ASI

3.1.2
interface en courant continu
connexion dédiée située entre le convertisseur de puissance et un dispositif de stockage d'énergie exclusivement utilisé par l'ASI

Note 1 à l'article: L'interface vers un dispositif de stockage d'énergie prévu pour être utilisé exclusivement par l'ASI n'est pas un **accès**, car ce dispositif est inclus dans l'ASI. Le dispositif de stockage d'énergie dédié présenté à la Figure 1 est connecté via une **interface en courant continu**.

3.1.3
accès en courant continu
connexion entre le convertisseur de puissance et un dispositif de stockage d'énergie qui n'est pas exclusivement utilisé par l'ASI

Note 1 à l'article: Un dispositif de stockage d'énergie non dédié est connecté via un **accès en courant continu**.

3.1.4
accès par l'enveloppe
frontière physique de l'appareil en essai (EUT), à travers laquelle des champs électromagnétiques peuvent rayonner ou qu'ils peuvent affecter

Note 1 à l'article: Sur la Figure 1, **l'accès par l'enveloppe** représenté par la ligne en pointillés qui entoure le ou les convertisseurs de puissance et le dispositif de stockage d'énergie dédié n'implique pas l'existence d'un quelconque blindage.

3.1.5
accès réseau de télécommunication
accès de signal, de commande ou de communication prévus pour l'interconnexion entre des composants d'une alimentation sans interruption (ASI), ou entre une ASI et un matériel local associé et utilisé conformément aux spécifications fonctionnelles pertinentes aux fins de

commande et/ou de surveillance de l'ASI et/ou de commande du matériel associé conformément au manuel d'utilisation

Note 1 à l'article: La longueur maximale du câble raccordé à **l'accès réseau de télécommunication** est un exemple de spécification fonctionnelle pertinente.

3.1.6
premier environnement
environnement qui inclut des locaux d'habitation, commerciaux et pour l'industrie légère directement connectés, sans transformateurs intermédiaires, à un réseau public d'alimentation basse tension

3.1.7
deuxième environnement
environnement qui inclut tous les établissements commerciaux, pour l'industrie légère et industriels qui ne sont pas inclus dans le **premier environnement**

Note 1 à l'article: Un bâtiment ou une partie d'un bâtiment, lorsqu'un transformateur ou un générateur dédié leur fournit de l'énergie, sont des exemples de **deuxième environnement**.

3.1.8
ASI de catégorie C1
ASI destinée à être utilisée sans aucune restriction dans le **premier environnement**

Note 1 à l'article: De telles ASI sont adaptées à une utilisation dans des locaux d'habitation.

3.1.9
ASI de catégorie C2
ASI destinée à être utilisée sans aucune restriction dans le **deuxième environnement**

Note 1 à l'article: De telles ASI peuvent également être utilisées dans le **premier environnement**, dans certaines conditions.

3.1.10
ASI de catégorie C3
ASI dont le courant de sortie dépasse 16 A, destinée à être utilisée dans le **deuxième environnement** sous certaines restrictions

3.1.11
ASI de catégorie C4
ASI qui ne peut pas être classée dans les catégories C1, C2 ou C3, destinée à être utilisée dans des environnements soumis à des exigences particulières

3.2 Abréviations

AAN réseau fictif asymétrique (*Asymmetric Artificial Network*)

NOTE 1 Les termes "réseau de stabilisation d'impédance" (ISN, *Impedance Stabilization Network*) et "AAN" sont interchangeables.

EA équipement auxiliaire

AMN réseau fictif d'alimentation (*Artificial Mains Network*)

NOTE 2 Les termes "réseau de stabilisation d'impédance de ligne" (RSIL) et "AMN" sont interchangeables.

CMAD dispositif d'absorption en mode commun (*Common Mode Absorption Device*)

EUT appareil en essai (*Equipment Under Test*)

RF fréquence radioélectrique *(Radio Frequency)*

4 Classification des ASI

4.1 ASI de catégorie C1

Cette catégorie comprend les ASI destinées à être utilisées sans aucune restriction dans le **premier environnement**.

Les **ASI de catégorie C1** doivent être conformes aux exigences de catégorie C1 relatives aux limites d'émission (voir Article 5) et d'immunité (voir Article 6).

4.2 ASI de catégorie C2

Cette catégorie comprend les ASI destinées à être utilisées sans aucune restriction dans le **deuxième environnement**. De telles ASI peuvent également être utilisées dans le **premier environnement**, à condition de tenir compte des effets de la note d'avertissement ci-dessous.

Les **ASI de catégorie C2** doivent être conformes aux exigences de catégorie C2 relatives aux limites d'émission (voir Article 5) et d'immunité (voir Article 6).

L'avertissement suivant doit être inclus dans le manuel d'utilisation.

AVERTISSEMENT: Ce produit est une **ASI de catégorie C2**. Dans un environnement résidentiel, ce produit peut être la source de perturbations radioélectriques, auquel cas il peut être demandé à l'utilisateur de prendre des mesures supplémentaires.

NOTE Ces mesures supplémentaires peuvent exiger les services d'une personne ou d'une organisation qualifiée en matière de CEM.

4.3 ASI de catégorie C3

Cette catégorie comprend les ASI dont le courant de sortie dépasse 16 A et destinées à être utilisées dans le **deuxième environnement**, sous les restrictions suivantes:

a) l'ASI doit être installée et mise en service par un professionnel ou une organisation qualifié(e) en matière de CEM;

b) l'emplacement de l'ASI doit être physiquement séparé d'autres bâtiments classés dans la catégorie "**premier environnement**" d'une distance supérieure à 30 m ou par une structure qui fasse barrage aux phénomènes de rayonnement et produise une atténuation équivalente; et

c) l'installation doit être alimentée par un transformateur ou un générateur dédié, ou un dispositif fournissant une atténuation équivalente.

Les **ASI de catégorie C3** doivent être conformes aux exigences de catégorie C3 relatives aux limites d'émission (voir Article 5) et d'immunité (voir Article 6).

L'avertissement suivant doit être inclus dans le manuel d'utilisation.

AVERTISSEMENT: Ce produit est destiné à une application commerciale et industrielle dans le **deuxième environnement**; des restrictions d'installation ou des mesures supplémentaires peuvent être nécessaires pour empêcher les perturbations.

4.4 ASI de catégorie C4

Cette catégorie comprend les ASI qui ne peuvent pas être classées dans les catégories C1, C2 ou C3, et sont destinées à être utilisées dans des environnements soumis à des exigences particulières.

De telles ASI doivent respecter les niveaux d'émission et d'immunité spécifiques applicables pour l'installation.

Les **ASI de catégorie C4** ne sont pas limitées par les courants assignés.

NOTE L'évaluation de la conformité d'une **ASI de catégorie C4** consiste généralement en une évaluation technique des effets d'une combinaison de variantes et de sous-ensembles d'ASI, et en un essai final sur site destiné à vérifier la conformité aux exigences qui ne peuvent pas être vérifiées de manière satisfaisante par une évaluation technique. Pour plus d'informations concernant les essais sur site, voir l'Annexe E.

4.5 Catégories et environnement

Si l'environnement a été déterminé comme **premier environnement**, il convient qu'une **ASI de catégorie C1** ou **C2** soit utilisée.

Si l'environnement a été déterminé comme **deuxième environnement**, il convient qu'une **ASI de catégorie C2** ou **C3** soit utilisée.

Si l'environnement n'est pas couvert exclusivement soit par le **premier environnement**, soit par le **deuxième environnement**, il convient qu'une **ASI de catégorie C4** soit utilisée.

Du point de vue du niveau d'émission, une ASI d'une catégorie faible, par exemple C1, peut toujours être utilisée à la place d'une ASI d'une catégorie plus élevée, par exemple C3.

Les catégories d'émission sont indépendantes des niveaux d'immunité. Par exemple, l'indication selon laquelle une ASI correspond à la catégorie d'émission C1 n'implique pas que son niveau d'immunité soit uniquement approprié pour le **premier environnement**.

4.6 Documentation

Aux fins de la CEM, ce qui suit doit être inclus dans la documentation destinée à l'utilisateur:

a) toutes mesures spéciales à prendre pour satisfaire aux exigences de conformité, par exemple la ségrégation des câbles, l'utilisation de câbles blindés ou spéciaux, et toute restriction portant sur la longueur des câbles raccordés à la sortie en courant alternatif et/ou au dispositif de stockage d'énergie;

b) sur demande, une liste des accessoires d'ASI compatibles avec la CEM;

c) une notice d'avertissement pour les **ASI de catégorie C1** décrites en 6.3.2;

d) une notice d'avertissement pour les **ASI de catégories C2** et **C3** décrites en 4.2 et 4.3, en fonction du cas.

5 Emission

5.1 Généralités

Les limites d'émission applicables pour chaque catégorie d'ASI sont spécifiées en 5.3.

Les émissions comprises dans la plage de fréquences jusqu'à 1,0 GHz sont couvertes.

Les exigences en termes d'émission ont été choisies de manière à assurer que les perturbations engendrées par l'ASI en fonctionnement normal n'atteignent pas un niveau qui pourrait empêcher d'autres appareils de fonctionner comme prévu normalement.

NOTE 1 Il est possible que les limites données dans la présente norme ne fournissent pas une protection totale contre la perturbation de la réception des émissions radio ou de télévision lorsque l'ASI est utilisée à moins de 10 m des antennes réceptrices pour les **ASI de catégorie C1** ou **C2**, et à moins de 30 m pour les **ASI de catégorie C3**.

NOTE 2 Dans certains cas particuliers, par exemple lorsqu'un appareil très sensible est utilisé à proximité, des mesures d'atténuation supplémentaires peuvent être prises pour réduire les émissions électromagnétiques en deçà des niveaux spécifiés.

5.2 Exigences d'essai générales

Les essais d'émission pour une ASI doivent être réalisés dans les conditions suivantes:

a) tension d'entrée assignée;

b) mode(s) de fonctionnement normal et en autonomie;

c) charge résistive qui se traduit par le niveau le plus élevé de perturbations.

Les exigences d'essai sont spécifiées pour chaque **accès** examiné. Voir Annexe A pour les méthodes d'essais.

5.3 Exigences de mesure

5.3.1 Généralités

Les émissions de tous les **accès** doivent être vérifiées comme suit.

Si l'ASI peut être connectée à des accessoires auxiliaires, elle doit être soumise à l'essai en étant connectée à la configuration minimale incluant les accessoires auxiliaires et de communication nécessaires pour faire appel à l'ensemble de ces **accès**, ou doit être connectée à une impédance de terminaison équivalente.

La configuration et le mode de fonctionnement au cours de la mesure doivent être notés précisément dans le rapport d'essai. Voir Annexe A pour les montages d'essai et les critères de mesure. Pour les essais *in situ* ou les essais d'installation par l'utilisateur, voir Annexe E.

5.3.2 Emissions conduites

5.3.2.1 Accès et limites

Lorsque les ASI comportent des bornes d'alimentation additionnelles (**accès**) destinées à la connexion de sources d'alimentation séparées pour les circuits de bypass statique et/ou pour les circuits de bypass de maintenance, ces bornes (**accès**) peuvent être temporairement interconnectées avec l'**accès** d'entrée en courant alternatif afin de permettre la réalisation des essais d'émissions conduites sur l'**accès** d'entrée en courant alternatif (commun) correspondant.

La mesure sur l'un des multiples **accès** identiques est suffisante aux fins de l'essai d'émissions conduites.

NOTE Les émissions conduites dans la plage de fréquences de 2 kHz à 150 kHz sont à l'étude.

En 5.3.2, les limites d'émissions conduites dans la plage de 0,15 MHz à 30 MHz sont données dans les Tableaux 1 et 2.

Tableau 1 – Limites de tension perturbatrice sur les bornes d'alimentation et les accès réseau de télécommunication pour les ASI de catégories C1 et C2 dans la plage de fréquences comprise entre 0,15 MHz et 30 MHz

Plage de fréquences MHz	Limites dB (µV)							
	ASI de catégorie C1				ASI de catégorie C2			
	Bornes d'alimentation		Accès réseau de télécommunication		Bornes d'alimentation		Accès réseau de télécommunication	
	Quasi-crête	Valeur moyenne	Quasi-crête	Valeur moyenne	Quasi-crête	Valeur moyenne	Quasi-crête	Valeur moyenne
0,15 à 0,50[b]	66 à 56[a]	56 à 46[a]	84 à 74 [a]	74 à 64 [a]	79	66	97 à 87[a]	84 à 74[a]
0,50 à 5[b]	56	46	74	64	73	60	87	74
5 à 30	60	50			73	60		

[a] La limite décroît linéairement avec le logarithme de la fréquence.

[b] La limite inférieure doit s'appliquer à la fréquence de transition.

Tableau 2 – Limites de tension perturbatrice sur les bornes d'alimentation et les accès réseau de télécommunication pour les ASI de catégorie C3 dans la plage de fréquences comprise entre 0,15 MHz et 30 MHz

Courant de sortie assigné de l'ASI A	Plage de fréquences MHz	Limites dB (µV)			
		Bornes d'alimentation		Accès réseau de télécommunication	
		Quasi-crête	Valeur moyenne	Quasi-crête	Valeur moyenne
> 16 à 100	0,15 à 0,50[b]	100	90	110 à 100[a]	94 à 84[a]
	0,50 à 5,0[b]	86	76	100	84
	5,0 à 30,0	90 à 73[a]	80 à 60[a]		
> 100	0,15 à 0,50[b]	130	120	110 à 100[a]	94 à 84[a]
	0,50 à 5,0[b]	125	115	100	84
	5,0 à 30,0	115	105		

[a] La limite décroît linéairement avec le logarithme de la fréquence.

[b] La limite inférieure doit s'appliquer à la fréquence de transition.

5.3.2.2 Limites à l'accès d'entrée en courant alternatif (alimentation)

L'ASI ne doit pas dépasser les limites indiquées soit par le Tableau 1, soit par le Tableau 2, en fonction de la catégorie et du courant de sortie assigné de l'ASI soumise à l'essai.

L'ASI doit respecter aussi bien la limite moyenne que la limite quasi-crête lors de l'utilisation, respectivement, d'un récepteur de valeur moyenne et d'un récepteur de valeur quasi-crête, la mesure étant effectuée dans les deux cas conformément aux méthodes décrites en A.6.

Si la limite moyenne n'est pas dépassée lorsqu'un récepteur de valeur quasi-crête est utilisé, les deux limites doivent être considérées comme respectées et la mesure avec le récepteur de valeur moyenne n'est pas nécessaire.

Si la lecture sur le récepteur de mesure met en évidence des fluctuations au voisinage de la limite, cette lecture doit être poursuivie pendant au moins 15 s à chaque fréquence de

mesure; c'est la lecture la plus élevée qui doit être notée, à l'exception de tout pic isolé bref, qui doit être négligé.

5.3.2.3 Limites à l'accès de sortie en courant alternatif

Les limites du Tableau 1 et du Tableau 2 pour les bornes du réseau d'alimentation s'appliquent.

Une majoration de + 14 dB est admise pour les émissions conduites à la sortie de l'ASI spécifiées dans le Tableau 1 et le Tableau 2, excepté pour les **ASI de catégorie C3** dont le courant dépasse 100 A, pour lesquelles aucune majoration n'est admise.

Aucune limite ne s'applique aux ASI pour lesquelles la longueur du câble de sortie décrit par le fabricant dans son manuel d'utilisation est inférieure à 10 m. Lorsque le fabricant ne déclare pas de longueur de câble maximale, les limites s'appliquent.

Les valeurs doivent être mesurées conformément à A.7.

5.3.2.4 Limites aux accès réseau de télécommunication

Les limites du Tableau 1 et du Tableau 2 pour les **accès réseau de télécommunication** s'appliquent.

Aucune limite ne s'applique aux ASI pour lesquelles la longueur du câble réseau décrit par le fabricant dans son manuel d'utilisation est inférieure à 10 m. Lorsque le fabricant ne déclare pas de longueur de câble maximale, les limites s'appliquent.

L'Annexe C fournit des limites de courants qui peuvent être appliquées comme alternative aux limites de tension.

5.3.2.5 Limites pour les interfaces en courant continu et les accès en courant continu

Aucun essai d'émissions conduites n'est exigé sur l'**interface en courant continu** (voir Figure 1).

NOTE L'effet des émissions conduites sur l'**interface en courant continu** peut cependant provoquer des émissions rayonnées, mais aucun essai d'émissions conduites ne s'applique dans la mesure où il est exigé que l'ASI respecte les limites d'émissions rayonnées décrites en 5.3.3.

Les limites des **accès en courant continu** sont actuellement à l'étude et leurs valeurs sont en attente de détermination dans une future édition de la CISPR 11.

5.3.2.6 Emissions basse fréquence – Harmoniques du courant d'entrée

Si le courant d'entrée et la tension assignés sont dans le domaine d'application de l'IEC 61000-3-2 ou de l'IEC 61000-3-12, les limites et les méthodes d'essais qu'elles contiennent doivent s'appliquer.

5.3.3 Emissions rayonnées

5.3.3.1 Champ électromagnétique

L'ASI doit respecter les limites données au Tableau 3. Si la lecture sur le récepteur de mesure met en évidence des fluctuations au voisinage de la limite, cette lecture doit être poursuivie pendant au moins 15 s à chaque fréquence de mesure; c'est la lecture la plus élevée qui doit être notée, à l'exception de tout pic isolé bref, qui doit être négligé.

Aucune limite ne s'applique pour les émissions rayonnées au-dessous de 30 MHz.

Tableau 3 – Limites des émissions rayonnées dans la plage de fréquences comprise entre 30 MHz et 1 000 MHz

Plage de fréquences	Limites quasi-crête dB (µV/m)		
MHz	ASI de catégorie C1	ASI de catégorie C2	ASI de catégorie C3
30 à 230[a]	30	40	50
230 à 1 000	37	47	60
[a] La limite inférieure doit s'appliquer à la fréquence de transition.			

NOTE 1 La distance d'essai est de 10 m. Si la mesure d'émission à 10 m ne peut pas être effectuée à cause de niveaux de bruit de fond importants, ou pour toute autre raison, la mesure est effectuée à une distance inférieure, par exemple 3 m. Un facteur de proportionnalité inverse de 20 dB par décade est utilisé pour normaliser les données mesurées à la distance spécifiée afin de déterminer la conformité.

NOTE 2 Pour les cas où des perturbations se produisent, des dispositions supplémentaires peuvent être nécessaires.

5.3.3.2 Champ magnétique

Aucune limite ne s'applique pour les émissions magnétiques. L'Annexe B fournit préconisations relatives aux méthodes de mesure et aux niveaux informatifs.

6 Immunité

6.1 Généralités

Les exigences d'immunité traitées dans le présent document concernent uniquement la plage de fréquences comprise entre 0 Hz et 1 GHz.

Les présentes exigences d'essai constituent les exigences essentielles d'immunité dans le domaine de la compatibilité électromagnétique. Les exigences d'essai sont spécifiées pour chaque **accès** examiné.

Les niveaux indiqués dans l'Article 6 ne tiennent pas compte de certains cas extrêmes qui peuvent être rencontrés dans n'importe quel lieu mais avec une faible probabilité. Dans de tels cas, il peut y avoir lieu de spécifier des niveaux supérieurs.

NOTE Il peut arriver, dans certains cas particuliers, que les niveaux de perturbation dépassent ceux indiqués dans la présente norme, par exemple lorsqu'un émetteur portable est utilisé à proximité d'une ASI. Dans ces cas, il est possible que des mesures particulières adaptées soient nécessaires.

6.2 Exigences générales et critères de performance

Le matériel doit au moins respecter les niveaux d'immunité indiqués en 6.3. Les critères de performance des ASI sont donnés dans le Tableau 4.

Tableau 4 – Critères de performance pour les essais d'immunité

	Critère A	Critère B
Indications externes et internes et dispositif de mesure	Variation seulement pendant l'essai	Variation seulement pendant l'essai
Signaux de commande vers les dispositifs externes	Aucune variation	Variation temporaire seulement en cohérence avec le mode de fonctionnement réel des ASI
Mode de fonctionnement[a]	Aucune variation	Variation temporaire seulement
[a] A tout moment, l'ASI doit respecter la catégorie de performance déclarée par le fabricant (voir l'IEC 62040-3:2011).		

Les essais doivent être effectués avec l'ASI dans les conditions suivantes:

a) tension d'entrée assignée;

b) mode(s) de fonctionnement normal;

c) charge linéaire à la puissance active de sortie assignée ou à charge réduite, conformément à l'IEC 62040-3:2011.

L'ASI doit être spécifiée avec le niveau adapté lorsqu'il existe différents niveaux de critères de performance.

Voir l'Annexe D pour les méthodes d'essais.

6.3 Exigences d'immunité de base

6.3.1 Généralités

La conformité est vérifiée par des essais correspondant aux exigences d'immunité répertoriées dans le Tableau 5 et le Tableau 6. L'ASI doit continuer à fonctionner sans dégradation et conformément au critère de performance applicable. Les critères de performance sont décrits dans le Tableau 4.

6.3.2 ASI de catégorie C1

Les niveaux du Tableau 5 doivent être appliqués aux **ASI de catégorie C1**. Si une ASI est conçue pour avoir une immunité conforme au Tableau 5, elle doit comprendre un avertissement écrit dans le manuel d'utilisation ou sur l'appareil, qui indique qu'elle n'est pas destinée à être utilisée dans un environnement industriel.

Tableau 5 – Exigences d'immunité minimales pour les ASI de catégorie C1

Accès	Phénomène	Norme fondamentale pour la méthode d'essai	Niveau	Critère de performance (d'acceptation)
Accès par l'enveloppe	DES	IEC 61000-4-2	4 kV CD ou 8 kV AD si CD impossible	B
	Champ électromagnétique à radiofréquence, modulation d'amplitude	IEC 61000-4-3	80 MHz à 1 000 MHz 3 V/m 80 % AM (1 kHz)	A
	Immunité au champ magnétique à la fréquence du réseau d'alimentation	IEC 61000-4-8	3 A/m	A
Accès d'entrée en courant alternatif	Transitoires rapides en salves	IEC 61000-4-4	1 kV/5 kHz[a]	B
	Surtensions[b] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Radiofréquence conduite en mode commun[e]	IEC 61000-4-6	0,15 MHz à 80 MHz 3 V 80 % AM (1 kHz)	A
	Immunité aux signaux basses fréquences	Voir D.6 et IEC 61000-2-2	10 V/ 140 Hz à 360 Hz	A
Accès de sortie en courant alternatif et **accès en courant continu**	Transitoires rapides en salves	IEC 61000-4-4	1 kV/5 kHz[a]	B
	Surtensions[b,e] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Radiofréquence conduite en mode commun[e]	IEC 61000-4-6	0,15 MHz à 80 MHz 3 V 80 % AM (1 kHz)	A
Interface en courant continu	Transitoires rapides en salves[e]	IEC 61000-4-4	1 kV/5 kHz Pince capacitive	B
Accès réseau de télécom-munication	Transitoires rapides en salves[e]	IEC 61000-4-4	1 kV/5 kHz Pince capacitive	B
	Radiofréquence conduite en mode commun[e]	IEC 61000-4-6	0,15 MHz à 80 MHz 3 V 80 % AM (1 kHz)	A

CD = décharge au contact *(contact discharge)*

AD = décharge dans l'air *(air discharge)*

AM = modulation d'amplitude *(amplitude modulation)*

DES = décharge électrostatique

[a] **Accès** réseau d'alimentation à courant assigné < 100 A: couplage direct en utilisant le réseau de couplage et de découplage. **Accès** réseau d'alimentation à courant assigné ≥ 100 A: couplage direct ou pince capacitive sans réseau de découplage. Si la pince capacitive est utilisée, le niveau d'essai doit être de 2 kV/5 kHz.

[b] La condition d'essai de charge réduite est acceptable pour des connexions d'alimentation avec un courant assigné > 63 A.

[c] Couplage entre lignes.

[d] Couplage entre ligne et terre.

[e] Applicable seulement aux connexions ou interfaces destinées à des câbles dont la longueur totale, conformément aux spécifications fonctionnelles données par le fabricant, peut dépasser 3 m.

6.3.3 ASI de catégorie C2 et C3

Les niveaux du Tableau 6 doivent être appliqués aux ASI destinées à être utilisées dans le **deuxième environnement**.

Tableau 6 – Exigences d'immunité minimales pour les ASI de catégories C2 et C3

Accès	Phénomène	Norme fondamentale pour la méthode d'essai	Niveau	Critère de performance (d'acceptation)
Accès par l'enveloppe	DES	IEC 61000-4-2	4 kV CD ou 8 kV AD	B
	Champ électromagnétique à radiofréquence, modulation d'amplitude	IEC 61000-4-3	80 MHz à 1 000 MHz 10 V/m 80 % AM (1 kHz)	A
	Immunité au champ magnétique à la fréquence du réseau d'alimentation	IEC 61000-4-8	30 A/m	A
Accès d'entrée en courant alternatif	Transitoires rapides en salves	IEC 61000-4-4	2 kV/5 kHz[a]	B
	Surtensions[b] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Radiofréquence conduite en mode commun[e]	IEC 61000-4-6	0,15 MHz à 80 MHz 10 V 80 % AM (1 kHz)	A
	Immunité aux signaux basses fréquences	Voir D.6 et l'IEC 61000-2-2	10 V/ 140 Hz à 360 Hz	A
Accès de sortie en courant alternatif et **accès en courant continu**	Transitoires rapides en salves	IEC 61000-4-4	2 kV/5 kHz[a]	B
	Surtensions[b,e] 1,2/50 µs 8/20 µs	IEC 61000-4-5	1 kV[c] 2 kV[d]	B
	Radiofréquence conduite en mode commun[e]	IEC 61000-4-6	0,15 MHz à 80 MHz 10 V 80 % AM (1 kHz)	A
Interface en courant continu	Transitoires rapides en salves[e]	IEC 61000-4-4	2 kV/5 kHz Pince capacitive	B
Accès réseau de télécom-munication	Transitoires rapides en salves[e]	IEC 61000-4-4	2 kV/5 kHz Pince capacitive	B
	Surtensions[b, f] 1,2/50 µs, 8/20 µs	IEC 61000-4-5	1 kV	B
	Radiofréquence conduite en mode commun[e]	IEC 61000-4-6	0,15 MHz à 80 MHz 10 V 80 % AM (1 kHz)	A

CD = décharge au contact
AD = décharge dans l'air
AM = modulation d'amplitude
DES = décharge électrostatique

[a] **Accès** réseau d'alimentation à courant assigné < 100 A: couplage direct en utilisant le réseau de couplage et de découplage. **Accès** réseau d'alimentation à courant assigné ≥ 100 A: couplage direct ou pince capacitive sans réseau de découplage. Si la pince capacitive est utilisée, le niveau d'essai doit être de 4 kV/5 kHz.

[b] La condition d'essai de charge réduite est applicable pour des connexions d'alimentation avec un courant assigné > 63 A.

[c] Couplage entre lignes.

[d] Couplage entre ligne et terre.

[e] Applicable seulement aux connexions ou interfaces destinées à des câbles dont la longueur totale, conformément aux spécifications fonctionnelles données par le fabricant, peut dépasser 3 m.

[f] Applicable seulement aux connexions destinées à des câbles dont la longueur totale, conformément aux spécifications fonctionnelles données par le fabricant, peut dépasser 30 m. Dans le cas d'un câble blindé, un couplage direct au blindage est appliqué. Cette exigence d'immunité ne s'applique pas aux bus dédiés ou autres interfaces de signaux pour lesquelles l'utilisation de dispositifs de protection contre les surtensions n'est pas pratique pour des raisons techniques. L'essai n'est pas requis lorsqu'un fonctionnement normal ne peut pas être atteint en raison de l'impact du réseau de couplage et de découplage sur l'appareil en essai (EUT).