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Edition 7.0 2020-09

INTERNATIONAL STANDARD

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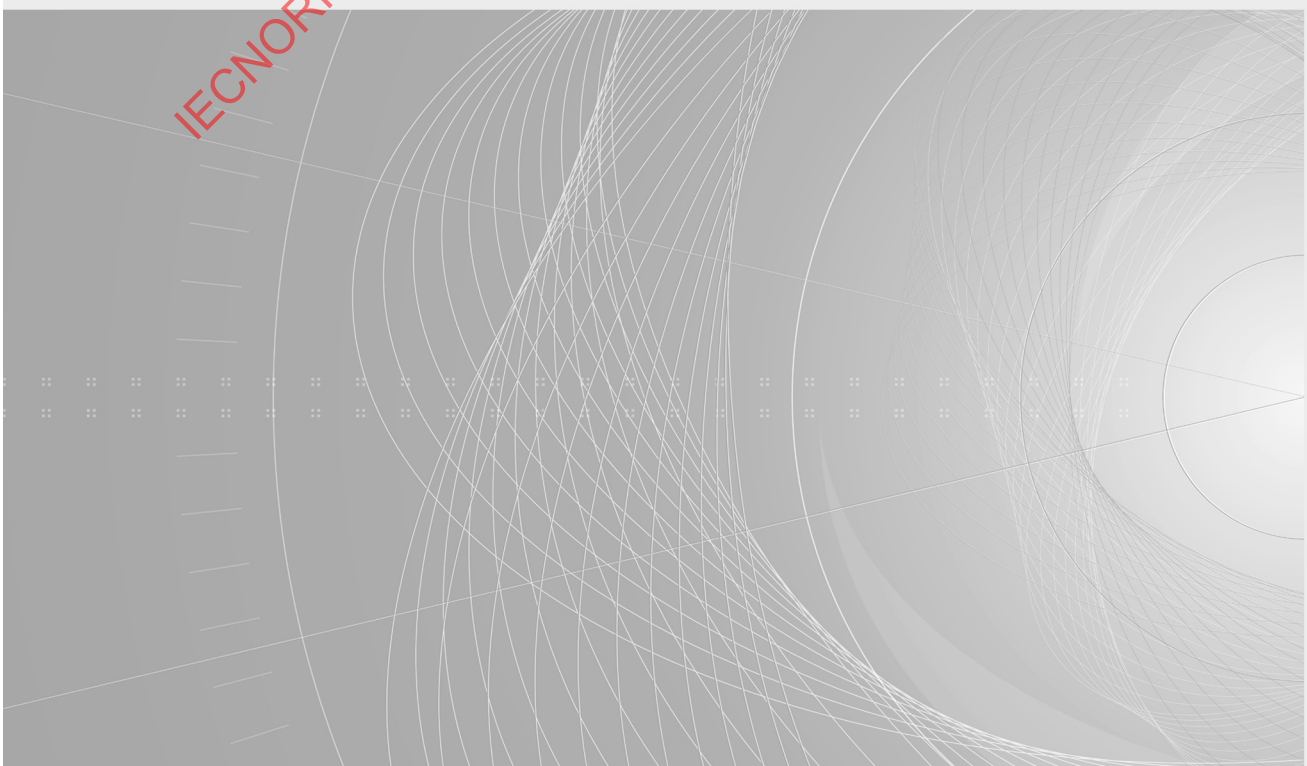
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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



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INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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ELECTROMAGNETIC COMPATIBILITY – REQUIREMENTS FOR HOUSEHOLD APPLIANCES, ELECTRIC TOOLS AND SIMILAR APPARATUS –

Part 1: Emission

FOREWORD

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The International Standard CISPR 14-1 has been prepared by subcommittee CISPR/F: Interference related to household appliances tools, lighting equipment and similar apparatus, of IEC technical committee CISPR.

This seventh edition cancels and replaces the sixth edition published in 2016. This edition constitutes a technical revision.

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

– extension of the frequency range for radiated measurements above 1 GHz;
– revision of general test conditions and addition of new specific test conditions (e.g. for robotic equipment);
– introduction of additional requirements for equipment making use of inductive power transfer technology;

– remove from the normative text any compliance requirement based on statistical evaluation;
– revision of clicks analysis, with particular relevance to the determination of the observation time and the application of the upper quartile method for different types of click analysers.

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

FDIS	Report on voting
CIS/F/796/FDIS	CIS/F/799/RVD

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

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

A list of all parts in the CISPR 14 series can be found on the IEC website under the general title *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus*.

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

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

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.

ELECTROMAGNETIC COMPATIBILITY – REQUIREMENTS FOR HOUSEHOLD APPLIANCES, ELECTRIC TOOLS AND SIMILAR APPARATUS –

Part 1: Emission

1 Scope

This part of CISPR 14 specifies the requirements that apply to the emission of radio-frequency disturbances in the frequency range 9 kHz to 400 GHz from appliances, electric tools and similar apparatus as defined below, whether powered by AC or DC (including a battery).

This document is applicable to the following equipment:

- household appliances or similar equipment;

NOTE 1 Examples are equipment used:

- for typical housekeeping functions in the household environment, which includes the dwelling and its associated buildings, the garden, etc.;
- for typical housekeeping functions in shops, offices, commercial and other similar working environments;
- on farms;
- by clients in hotels and other residential type environments;
- for induction cooking or air-conditioning, either in residential or commercial environments.

- electric tools;

NOTE 2 Examples of electric tools include electric motor-operated or electromagnetically driven hand-held tools, transportable tools, lawn and garden machinery.

- similar apparatus.

NOTE 3 Examples are:

- external power controllers using semiconductor devices;
- motor-driven electro-medical equipment;
- electric/electronic toys;
- personal care and beauty care appliances;
- automatic goods-dispensing machines;
- entertainment machines;
- cine or slide projectors;
- battery chargers and external power supplies for use with products under the scope of this document;
- electric fence energisers.

Also included in the scope of this document are separate parts of the above mentioned equipment such as motors and switching devices (e.g. power or protective relays). However, no emission requirements apply to such separate parts, unless otherwise stated in this document.

Products which incorporate radio transmit/receive functions are included in the scope of this document.

Equipment under the scope of this document making use of IPT is also in the scope.

Excluded from the scope of this document are:

– equipment for which all emission requirements in the radio-frequency range are explicitly formulated in other CISPR standards;

NOTE 4 Examples are:

- luminaires, including portable luminaires for children, discharge lamps and other lighting devices under the scope of CISPR 15;
- information technology equipment, e.g. home computers, personal computers, electronic copying machines under the scope of CISPR 32;
- audio/video equipment and electronic music instruments other than toys under the scope of CISPR 32;
- mains communication devices, as well as baby surveillance systems;
- equipment which is under the scope of CISPR 11 (e.g. microwave ovens) but be aware of 6.5 on multifunction equipment (e.g. for another function requiring click measurements)
- radio controls, walkie-talkies and other types of radio-transmitters;
- arc welding equipment.

– equipment intended to be used only on a vehicle, ship or aircraft;

– equipment used only in industrial environment

– the effects of electromagnetic phenomena relating to the safety of the equipment.

Multifunction equipment may be required to comply with clauses in this and other standards. The details are given in 6.5.

The emission requirements in this document are not intended to be applicable to the intentional transmissions from a radio transmitter as defined by the ITU including their spurious emissions.

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.

CISPR 16-1-1:2015[1], *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 16-1-2:2014/AMD1:2017

CISPR 16-1-3:2004, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-3: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Disturbance power*
CISPR 16-1-3:2004/AMD1:2016
CISPR 16-1-3:2004/AMD2:2020

CISPR 16-1-4:2019, *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*

[1] 4th edition (2015). This 4th edition has been replaced in 2019 by a 5th Edition CISPR 16-1-1:2019, Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus.

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*
CISPR 16-2-1:2014/AMD1:2017

CISPR 16-2-2:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-2: Methods of measurement of disturbances and immunity – Measurement of disturbance power*

CISPR 16-2-3:2016, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*
CISPR 16-2-3:2016/AMD1:2019

CISPR 16-4-2:2011, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty*
CISPR 16-4-2:2011/AMD1:2014
CISPR 16-4-2:2011/AMD2:2018

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

IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Part 161: Electromagnetic compatibility*
IEC 60050-161:1990/AMD1:1997
IEC 60050-161:1990/AMD2:1998
IEC 60050-161:1990/AMD3:2014
IEC 60050-161:1990/AMD4:2014
IEC 60050-161:1990/AMD5:2015
IEC 60050-161:1990/AMD6:2016
IEC 60050-161:1990/AMD7:2017
IEC 60050-161:1990/AMD8:2018
IEC 60050-161:1990/AMD9:2019

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

IEC 61000-4-22:2010, *Electromagnetic compatibility (EMC) – Part 4-22: Testing and measurement techniques – Radiated emission and immunity measurements in fully anechoic rooms (FARs)*

3 Terms, definitions and abbreviated terms

3.1 General

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

NOTE Within this document wherever the term “equipment” is used it includes the more specific terms “appliance”, “household or similar appliances”, “electric tool”, “toys” and “apparatus”.

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

3.2 General terms and definitions

3.2.1
equipment under test
EUT
equipment being evaluated according to the requirements of this document

3.2.2
system under test
EUT and auxiliary equipment which are tested together in accordance with the requirements of this document

Note 1 to entry: The system under test can be made by one or more EUTs, and can also include auxiliary equipment (see 3.5.5). See Figure 2 for examples of systems under test as part of the test configuration.

3.2.3
reference ground
reference potential connecting point

Note 1 to entry: There can only be one reference ground in a conducted disturbance measurement system.

[SOURCE: CISPR 16-2-1:2014/AMD1:2017, 3.1.24]

3.2.4
reference ground plane
RGP
flat, conductive surface that is at the same electric potential as reference ground, which is used as a common reference, and which contributes to a reproducible parasitic capacitance with the surroundings of the EUT

Note 1 to entry: A reference ground plane is needed for the measurements of conducted disturbances, and serves as reference for the measurement of unsymmetrical and asymmetric disturbance voltages.

Note 2 to entry: In some regions, the term 'reference earth' is used in place of 'reference ground'.

[SOURCE: CISPR 16-2-1:2014/AMD1:2017, 3.1.25]

3.2.5
common mode absorption device
CMAD
device applied on cables leaving the test volume in radiated emission measurements to reduce the compliance uncertainty

[SOURCE: CISPR 16-1-4:2019, 3.1.7, modified – "Radiated disturbance" replaced with "radiated emission".]

3.2.6
radio frequency
RF
frequency of the electromagnetic spectrum that is between the audio-frequency portion and the infrared portion

Note 1 to entry: The RF spectrum is generally accepted to be from 9 kHz to 3 000 GHz.

3.2.7
weighting
pulse-repetition-frequency (PRF) dependent conversion (mostly reduction) of a peak-detected impulse voltage level to an indication that corresponds to the interference effect on radio reception

[SOURCE: CISPR 16-2-1:2014, 3.1.29, modified – Notes omitted.]

3.3 Terms and definitions related to click analysis

3.3.1
switching operation
operation of opening or closing a switch or contact

Note 1 to entry: Switches can be mechanical (including electro-mechanical relays) or electronic (thyristors, transistors).

Note 2 to entry: Switching operations are used to control/enable the operation of a device/load (e.g. a motor or a heating element) and have the potential of generating discontinuous disturbances.

Note 3 to entry: Switching operations occur at a random rate (e.g. for the purpose of temperature control) or pre-determined rate (e.g. as part of automatic program controls).

Note 4 to entry: The occurrence of switching operations is not necessarily associated with the generation of disturbances classified as clicks (see 3.3.3 definition)

3.3.2
discontinuous disturbance
impulsive disturbance that appears as an abrupt and transitory increase of the disturbance level caused by switching operations

Note 1 to entry: The spectral density of discontinuous disturbances is broadband. Their subjective effect varies with repetition rate, duration and amplitude. These parameters are captured with suitable time domain instrumentation (e.g. click analyser).

Note 2 to entry: Other impulsive disturbances appear as broadband (e.g. those generated by commutation in brush motors) but the repetition rate is higher than that typical of switching operations.

3.3.3
click
discontinuous disturbance, having an amplitude exceeding the quasi-peak limit for continuous disturbance, the duration of which is not longer than 200 ms and which is separated from a preceding or subsequent disturbance by at least 200 ms, where the durations are determined from the signal which exceeds the i.f. reference level of the measuring receiver or from the instantaneous peak signal which exceeds the quasi-peak limit for continuous disturbance

Note 1 to entry: A click can comprise one or more pulses, see 4.4.1.

Note 2 to entry: Examples of discontinuous disturbances, which can be classified as clicks are shown in Figure 3. Examples of discontinuous disturbances, which cannot be classified as clicks, are shown in Figure 4.

Note 3 to entry: Under certain conditions, some kinds of disturbances are considered as clicks even if they do not meet this definition (see 5.4.3).

3.3.4
i.f. reference level
corresponding value on the intermediate frequency output of the measuring receiver of an unmodulated sinusoidal signal which produces a quasi-peak indication equal to the limit for continuous disturbance

3.3.5
click observation time
T
time used for the calculation of the click rate

Note 1 to entry: Information about the required minimum observation time for the statistical interpretation of the disturbance caused by clicks or switching operations is given in 5.4.2.2.

Note 2 to entry: The observation time T can be further distinguished as T_C, observation time for the measurement of clicks, or T_S, observation time for the counting of switching operations.

3.3.6
click rate
N
number of clicks or switching operations per minute

Note 1 to entry: The click rate N can be further distinguished as N_C, number of clicks per minute, or N_S, number of switching operations per minute.

3.3.7
click limit
***L*q**
variable limit for discontinuous disturbances, which depends on the click rate N

Note 1 to entry: The click limit can be seen as a relaxation of the relevant quasi-peak limit for continuous disturbances and it is used for the assessment of discontinuous disturbances classified as clicks.

3.3.8
upper quartile method
statistical evaluation method for clicks

3.4 Terms and definitions related to types of ports

3.4.1
port
physical interface of the system under test through which electromagnetic energy propagates

3.4.2
public mains network
electricity lines to which all categories of consumers have access and which are operated by a supply or distribution undertaking for the purpose of supplying electrical energy

3.4.3
AC mains port
port used for connection to an AC public mains network

3.4.4
auxiliary port
port used for connection to an auxiliary equipment

Note 1 to entry: Wired network ports are not included in this definition.

3.4.5
wired network port
point of connection for voice, data and signalling transfers intended to interconnect widely dispersed systems by direct connection to a single-user or multi-user communication network

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

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

[SOURCE: CISPR 32:2015, 3.1.32, modified – Note 2 to entry modified]

3.4.6
fence port
output port of an electric fence energizer (high voltage)

3.4.7
enclosure port
physical boundary of the system under test through which electromagnetic fields may radiate

[SOURCE: CISPR 32:2015, 3.1.13, modified – The definition was rephrased.]

3.5 Terms and definitions related to parts and devices connected to the EUT

3.5.1
terminal
conductive part that allows electrical connection at a port

Note 1 to entry: Terminals are fitted at the end of a cable (e.g. a plug, a connector) or directly at the enclosure of the EUT (a connector).

3.5.2
non-extendable wiring
arrangement whereby the length of electrical wire connected to a port cannot be easily increased by the user

EXAMPLE Non-extendable wiring are cables and leads that are:

– permanently attached to equipment or devices at both ends,
– attached using special tools,
– connected using couplers that are not generally available to members of the public,
– fitted with connectors specifically designed for use only with a particular model of equipment/apparatus,
– wiring whose length is established only after installation, e.g. air conditioning units.

3.5.3
ancillary equipment
transducer or other equipment connected to a measuring receiver or (test) signal generator and used in the disturbance signal transfer between the EUT and the measuring or test equipment

EXAMPLE Current probes, voltage probes, antennas, coaxial cables, filters, attenuators and artificial mains networks.

[SOURCE: CISPR 16-2-3:2016/AMD1:2019, 3.1.2, modified – Addition of "or other equipment" in the definition and example added.]

3.5.4
associated equipment
AE
equipment that is not part of the system under test but needed to exercise and/or monitor the EUT

[SOURCE: CISPR 16-2-3:2016, 3.1.5, modified – Addition of "and/or monitor".]

3.5.5
auxiliary equipment
AuxEq
peripheral equipment that is part of the system under test

EXAMPLE A detachable motorised power nozzle of a vacuum cleaner, a wired remote control, an external battery, an external power supply, or a laptop providing a compatible USB power port.

[SOURCE: CISPR 16-2-3:2016, 3.1.6, modified – Note added.]

3.5.6
external power controller
device or equipment which allows the user to directly control the power delivered to a load external to the EUT

EXAMPLE Controllers used to regulate the speed of motors or the movement of mechanical parts. The required settings are generally achieved by rotating knobs and/or pressing buttons. Regulation can be provided by a number of fixed or continuously adjustable settings.

3.5.7
external power supply
EPS
device having its own physical enclosure that converts power supplied by the AC mains into power at a different voltage

Note 1 to entry: The output voltage of the EPS can be either AC or DC.

3.5.8
representative load
load which is not provided (sold) with the equipment but it is used to exercise the EUT as specified in the relevant test conditions

Note 1 to entry: Examples are a resistive load or a battery used to load a battery charger at its output terminals, a resistive load connected to a secondary coil to exercise an IPTS or a real IPTC. It is common that a representative load is an apparatus commercially available or specified by the manufacturer in the instructions for use.

3.5.9
representative source
apparatus which is not provided (sold) with the equipment but it is used to power the EUT at its rated voltage in order to obtain the relevant test conditions

Note 1 to entry: Examples are an EPS or an inductive power source (IPTS).

Note 2 to entry: This is generally an apparatus commercially available or specified by the manufacturer in the instructions for use.

3.6 Terms and definitions related to operating conditions

3.6.1
mains operated equipment
equipment which is not battery operated equipment

3.6.2
battery operated equipment
equipment which is operated only from batteries and cannot perform its intended function when connected to the AC mains supply, either directly or via an external power supply (EPS) unit

3.6.3
mains operation
condition where the equipment is powered from the AC mains supply either directly or via a dedicated external power supply to perform its intended function(s)

Note 1 to entry: Charging batteries from the AC mains supply is mains operation.

3.6.4
battery operation
condition where the equipment is powered only from batteries and there is no provision for the equipment to perform its intended function(s) when connected to the AC mains supply, either directly or via an external power supply (EPS) unit

3.6.5
operating mode
condition in which the equipment performs one or more of its intended function(s), as specified in the instructions for use

Note 1 to entry: The number of operating modes can increase if an auxiliary equipment can be used to expand the functionality of the equipment.

Note 2 to entry: A number of user selectable settings could be available within an operating mode (e.g. control of power or speed).

3.6.6
table-top EUT
equipment intended to be located on the top of a table or on a surface other than the floor

EXAMPLE Wall and ceilings are examples of surfaces other than the floor.

3.6.7
floor standing EUT
equipment that, according to its design and/or weight, usually stands on the floor while in use

3.6.8
DC powered equipment
equipment which can perform its intended functions when supplied with direct current

Note 1 to entry: DC powered equipment are typically powered from DC supplies as energy storage (batteries), AC/DC power converters or DC distribution networks.

Note 2 to entry: Examples of intended functions are the operation of motors and charging of internal batteries.

3.7 Terms and definitions related to toys

3.7.1
toy
equipment designed for, or clearly intended for use in play by children under 14 years old

Note 1 to entry: Toys can incorporate motors, heating elements, electronic circuits and their combination.

Note 2 to entry: The supply voltage of a toy can be provided by a battery or by means of an adapter or a transformer connected to the AC mains supply.

3.7.2
battery toy
toy which contains or uses one or more batteries as the only source of electrical energy

3.7.3
transformer toy
toy which is connected to the supply mains through a transformer for toys and using the supply mains as the only source of electrical energy

3.7.4
dual supply toy
toy which can be operated simultaneously or alternatively as a battery toy and a transformer toy

3.7.5
battery box
compartment which is separate from the toy or equipment and in which the batteries are placed

3.7.6
video toy
toy consisting of a screen and activating means by which the child can play and interact with the picture shown on the screen

Note 1 to entry: All parts necessary for the operation of the video toy, such as control box, joy stick, keyboard, monitor and connections, are considered to be part of the toy.

3.7.7
normal operation of toys
condition under which the toy, connected to the recommended power supply, is played with as intended or in a foreseeable way, bearing in mind the normal behaviour of children

3.7.8
experimental kit
collection of electric or electronic components intended to be assembled in various combinations

Note 1 to entry: The main aim of an experimental set is to facilitate the acquiring of knowledge by experiment and research. It is not intended to create a toy or equipment for practical use.

3.8 Terms and definitions related to IPT

3.8.1
inductive power transfer
IPT
transfer of electrical energy solely by using inductive coupling from an IPTS to an IPTC, when these are placed in physical contact or in close proximity to each other, but are not electrically connected

Note 1 to entry: Examples of functions that can make use of IPT are cooking, heating and charging. See Figure 1 for a visual description of IPT terms.

3.8.2
IPT source
IPTS
apparatus that makes electric energy available to an IPTC using IPT

Note 1 to entry: Examples are induction powering equipment and induction cooking appliances.

Note 2 to entry: An IPTS can be made by one or more parts (e.g. when using an external power supply as first energy conversion stage).

3.8.3
inductive powering equipment
IPTS used for the purpose of powering or charging an IPTC

Note 1 to entry: The energy could be stored in the IPTC (e.g. charging a battery) or used immediately.

3.8.4
induction cooking appliance
IPTS used for the purpose of cooking or heating food contained in a suitable IPTC

3.8.5
IPT client
IPTC
apparatus or device which receives electric energy through IPT

Note 1 to entry: The energy might be used to power directly the intended functions of the client, stored in a battery or both.

Note 2 to entry: Examples are appliances that contain a battery and those that in the absence of a battery rely on simultaneous inductive power transfer, including simple passive devices (e.g. vessels on an induction cooking appliance).

3.8.6
IPT equipment
IPTE
equipment made by the combination of a specific IPTS and one or more specific IPTCs

Note 1 to entry: Examples of IPTE are a shaver provided with a dedicated charging cradle or an induction cooking appliance intended for use with dedicated vessels.

3.9 Other terms and definitions

3.9.1
clock frequency
fundamental frequency of any signal used in the EUT excluding those which are solely used inside integrated circuits (IC) and those used in radio transmitters or radio receivers

Note 1 to entry: High frequency signals are often generated inside integrated circuits (IC) by phase-locked-loop (PLL) circuits from lower clock oscillator frequencies outside the IC.

3.9.2
active electronic circuit
electronic circuit containing electronic components switching at a variable or fixed rate (switching/clock frequency)

Note 1 to entry: Active electronic circuits comprise components such as transistors, thyristors, digital ICs, microprocessors, and oscillators. An LED display circuit connected to a battery is not an active electronic circuit if the current is limited only by a resistor or by a transistor operating linearly, but it is an active electronic circuit if the current is pulsed.

Note 2 to entry: According to the switching rate and to the measurement bandwidth, the spectral distribution of the disturbance generated by active electronic circuits appears as either broadband or narrowband.

Note 3 to entry: Active electronic circuits are used to control switching operations as defined in 3.3.1 (e.g. by a microcontroller) but the two switching rates are fundamentally different.

3.9.3
robotic equipment
equipment capable of performing its intended use by changing its position or the position of its parts without human intervention

Note 1 to entry: The movements can be within a limited space, a pre-programmed space, or a space self-controlled by the equipment.

3.9.4
robotic cleaner
robotic equipment capable of performing the functions of a cleaner

EXAMPLE Robotic cleaners used to vacuum dust and dirt or to wash floors and windows.

Note 1 to entry: Robotic cleaners typically consist of two parts:

– a battery powered mobile part that performs the cleaning function (cleaning unit), and
– a stationary docking station which could, for example, provide battery charging, data processing and dust removal from the mobile cleaner.

3.9.5
radio transmitter
device producing radio-frequency energy intended to be radiated by an antenna, normally for the purpose of radiocommunication

[SOURCE: IEC 60050-713:1998, 713-08-01, modified – "Apparatus" replaced by "device".]

3.9.6
radio receiver
device with associated antenna or including an antenna, used to select the desired radio-frequency signals from incident radio-frequency radiation, to amplify them, demodulate them and if necessary convert the recovered signals into a usable form by equipment in the scope of this document

3.10 Abbreviated terms

AC	Alternating current
AE	Associated equipment
AMN	Artificial Mains Network
AuxEq	Auxiliary Equipment
DC	Direct current
EMI	ElectroMagnetic Interference
EPS	External Power Supply
EUT	Equipment Under Test
FAR	Fully Anechoic Room
FSOATS	Free Space Open Area Test Site
i.f.	intermediate frequency
IPT	Inductive Power Transfer
IPTS	Inductive Power Transfer Source
IPTC	Inductive Power Transfer Client
IPTE	Inductive Power Transfer Equipment
OATS	Open Area Test Site
SAC	Semi Anechoic Chamber
RBW	Resolution Band Width
RGP	Reference Ground Plane
RF	Radio Frequency
VBW	Video Band Width

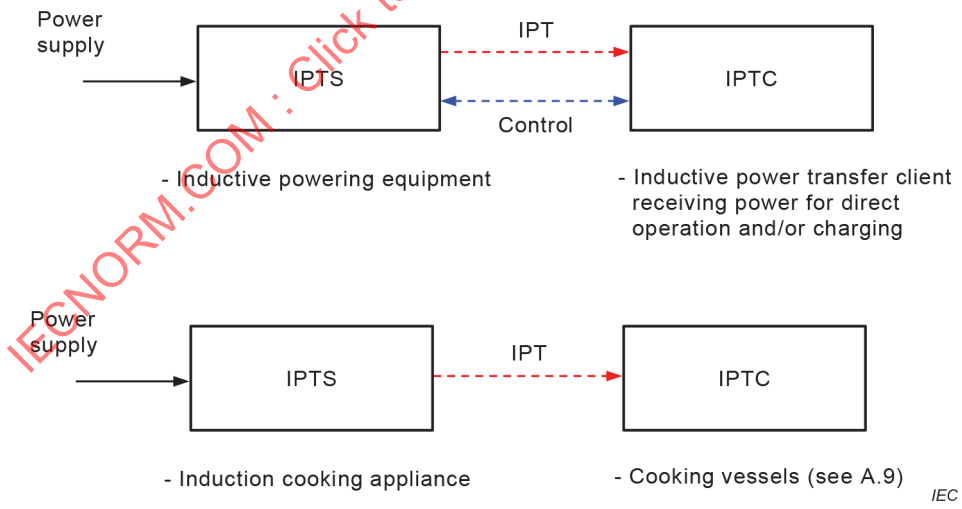


Figure 1 – IPT terms

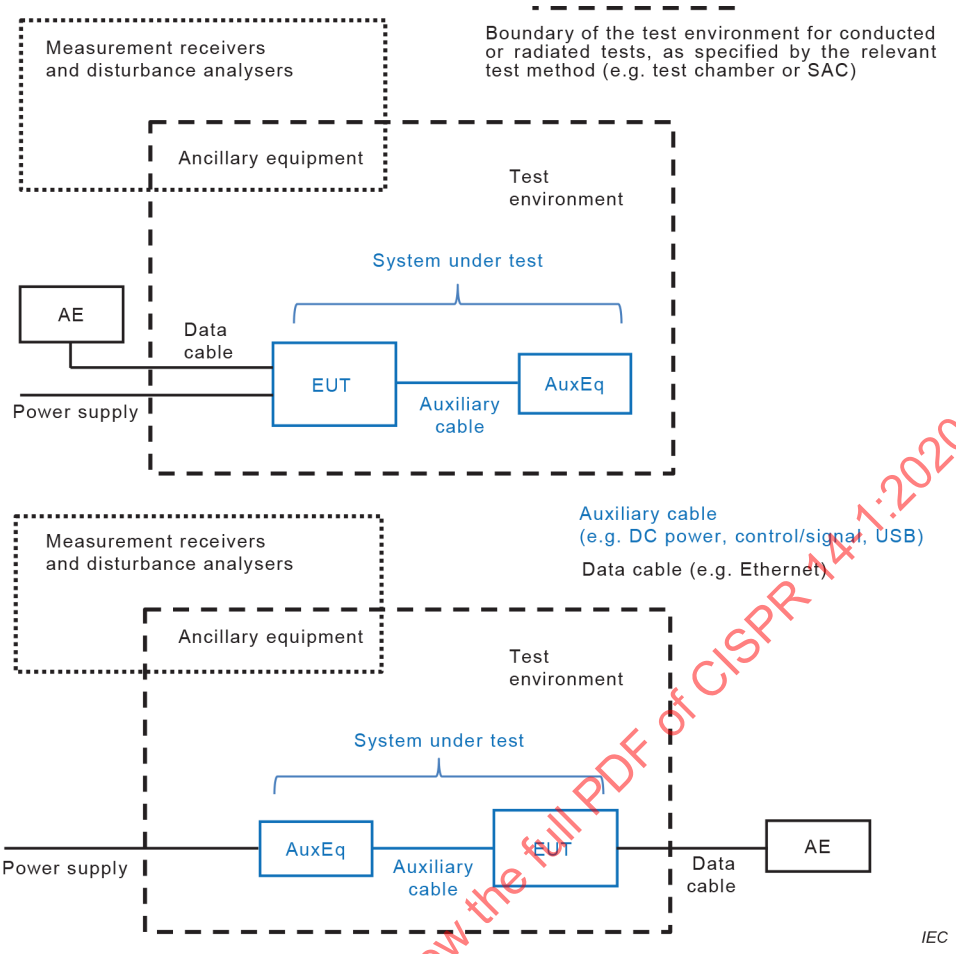


Figure 2 – Examples of test configuration

4 Limits of disturbances

4.1 General

Radio disturbance limits are given in the frequency range 150 kHz to 6 000 MHz, with an extension down to 9 kHz for specific types of equipment.

If it is evident from the construction, electrical characteristics and intended use of the equipment that a certain measurement is not necessary, the equipment is deemed to comply with the relevant requirements without testing. The test report shall include the engineering justification to support these exclusions from testing.

NOTE Examples are equipment that do not contain sources of RF disturbance (e.g. sources such as commutator motors and active electronic circuits, see 3.8.2) or equipment for which the emission characteristics do not require a certain test to be performed (e.g. the equipment is not deemed to be source of significant magnetic field).

No measurements need be performed at frequencies where no limits are specified.

4.2 Application of limits

The following Table 1 gives a reference to the limits applicable to the different types of equipment under the scope of this document.

The table provides only a quick reference. The requirements detailed in the referenced clauses and other relevant clauses shall be applied.

Table 1 – Application of limits

	Disturbance voltage/current			Dist. voltage	Disturbance		Radiated disturbances		
	Continuous [a, f]			Clicks [b]	Power [c]		Electric field	Magnetic field	
Subclause	(4.3.2)	(4.3.3)		(4.4.2)	(4.3.4)		(4.3.4, 4.3.5)	(4.3.2)	
Limits	Table 2	Table 5	Table 6	Text	Table 7	Table 8	Table 9	Table 3	Table 4
All equipment not listed below		•		•	•	•	•		
Tools			•	•	•	•	•		
Equipment using IPT	•			•	•	•	•	•	•
Electric fence energisers [d]		•		•	•	•	•		
Toys [e]		•		•	•	•	•		

[a] The limits of Table 5 and Table 6 could be applicable to discontinuous disturbances (see 4.4.2.2).

[b] For exemption and exceptions, see 4.4.1 and 5.4.3.

[c] For mains operated equipment, if certain conditions are met, the disturbance power test may be applied in alternative to the radiated disturbance test (see 4.3.4.2 and Figure 5).

[d] For electric fence energisers the disturbance voltage test is applied according to 4.3.3.5.

[e] Certain toys are deemed to comply with the requirements of this document without testing (see A.7.1).

[f] For wired network ports, see 4.3.3.7.

4.3 Continuous disturbances

4.3.1 General

Continuous disturbances shall be assessed in accordance with the methods and limits of this subclause using the test equipment specified in 5.1.

NOTE Continuous disturbances can be either: broadband, caused by switching devices such as mechanical switches, commutators and semiconductor regulators; or narrowband, caused by electronic control devices such as microprocessors.

4.3.2 Frequency range 9 kHz to 30 MHz

The requirements and the tables contained in this subclause shall apply only to equipment and apparatus with active IPT functions, when tested in the operating conditions specified in 6.7.

The measurement of disturbance voltage on the mains port shall be made in accordance with Clause 5 and the corresponding limits are specified in Table 2. Measurements of conducted emissions on other ports shall be made according to 4.3.3.

Equipment that can be fully encompassed by an imaginary sphere having a diameter less than or equal to 1,6 m, shall be tested by using either the test method and limits specified in Table 4, or the test method and limits specified in Table 3.

Equipment that cannot be fully encompassed by an imaginary sphere having a diameter less than or equal to 1,6 m, the test method and the limits specified in Table 3 shall be used.

EXAMPLE For an EUT in the form of a cube, the maximum length of the cube side would be (1,6 m)/√3 = 0,92 m.

Table 2 – Disturbance voltage limits for the AC mains port of equipment with active IPT functions

Frequency range	Appliances which are 100 V rated and without an earth connection		All other appliances	
MHz	dBμV Quasi-peak	dBμV Average	dBμV Quasi-peak	dBμV Average
0,009 to 0,050	122	–	110	–
0,050 to 0,150	Decreasing linearly with logarithm of frequency from 102 to 92	–	Decreasing linearly with logarithm of frequency from 90 to 80	–
0,150 to 0,5	Decreasing linearly with logarithm of frequency from 72 to 62	62 to 52	66 to 56	56 to 46
0,5 to 5	56	46	56	46
5 to 30	60	50	60	50
The lower limit applies at the transition frequencies.				

If the quasi-peak measurements meet the average limit, the EUT shall be deemed to meet both limits and the measurements using the average detector need not be carried out.

Table 3 – Magnetic field strength limits

Frequency range MHz	Limits at 3 m distance [a, b] Quasi-peak dBμA/m
0,009 to 0,070	69
0,070 to 0,150	Decreasing linearly with logarithm of frequency from 69 to 39
0,150 to 4,0	Decreasing linearly with logarithm of frequency from 39 to 3
4,0 to 30	3

[a] The measurements are performed at 3 m distance with a small loop antenna (e.g. 60 cm) as described in 4.3.2 of CISPR 16-1-4:2019.

[b] The antenna shall be installed vertically, with the lower edge of the loop at 1 m height above the floor.

Table 4 – Limits for the magnetic field induced current

Frequency range MHz	Horizontal component [a, b] Quasi-peak dBμA	Vertical component [a, c] Quasi-peak dBμA
0,009 to 0,070	88	106
0,070 to 0,150	Decreasing linearly with logarithm of frequency from	
	88 to 58	106 to 76
0,150 to 30	Decreasing linearly with logarithm of frequency from	
	58 to 22	76 to 40

[a] The measurements shall be performed using the 2 m large loop antenna system (LLAS) as described in 4.7 and Annex C of CISPR 16-1-4:2019.

[b] Current induced by the horizontal component of the magnetic field, which is measured with the two vertically-oriented LLAs of the LLAS.

[c] Current induced by the vertical component of the magnetic field, which is measured with the horizontally-oriented LLA of the LLAS.

The test report shall state which method was used and which limits were applied.

4.3.3 Frequency range 150 kHz to 30 MHz

4.3.3.1 General

Disturbance voltages shall be measured in accordance with Clause 5 at each applicable port with respect to the reference ground. Disturbance currents shall be measured in accordance with Clause 5 on the relevant leads.

4.3.3.2 Mains port

The limits in columns 2 and 3 of Table 5 shall be met on the phase(s) and the neutral of the mains port of all equipment except for electric tools. For electric tools, see 4.3.3.4.

However, the limits in Table 5 for the mains port shall not apply if the mains port limits given in 4.3.2 are applicable to the EUT.

4.3.3.3 Auxiliary ports

On auxiliary ports, either the disturbance voltage or the disturbance current measurement method may be selected for testing, the corresponding limits given in columns 4 to 7 of Table 5.

However, these limits do not apply to:

a) ports of equipment or auxiliary equipment that do not contain active electronic circuits or brush motors

b) ports which connect to non-extendable wiring shorter than 2 m;

c) ports connected to leads integrated in the suction hose of vacuum cleaners, even if the length exceeds 2 m;

d) ports internal to the EUT (e.g. built-in batteries);

e) ports which are not necessary for the intended functions of the EUT and which are not in operation during normal use (e.g. programming ports);

f) ports which connect to leads having a shield whose both ends are connected to a ground layer, a metal plate or metal enclosure; the connections of the shield should offer low impedance to high frequency currents (e.g. a short wire or a suitable capacitor).

If a port can be configured to be either an AC mains port or another type of port, then the limits of Table 5 applicable to the type of port being tested shall be met.

4.3.3.4 Tools

For motor operated electric tools the limits for the mains port are given in Table 6. However, the limits in Table 6 shall not apply if the mains port limits given in 4.3.2 are applicable to the EUT.

The power ratings given in columns 2 to 7 of Table 6 relate only to the rated power P of the motor. The power taken by resistive loads of the EUT (for instance the power used by the heating elements in an electric blower for plastic welding) is disregarded for the purpose of selecting the limits.

For ports other than the mains port, 4.3.3.3 shall apply.

4.3.3.5 Electric fence energisers

The battery port and the fence port of electric fence energisers shall be considered as auxiliary ports and the relevant limits applied.

The instructions for use of electric fence energizers should instruct the users to avoid discharge points such as touching vegetation or broken fence wires.

NOTE 1 High-voltage discharges from electric fence wires to the surrounding can act as source of disturbances, in particular to radio and telecommunication networks.

NOTE 2 An example of instruction is: “Caution: Arcing on the fence will cause radio interferences. Vegetation and other causes of arcing must be removed and maintained.”

4.3.3.6 Limits

The general conducted emission limits of Table 5 and Table 6 shall apply, unless otherwise stated in this document.

Table 5 – General limits

Frequency range	Mains ports		Auxiliary ports			
	Disturbance voltage		Disturbance voltage		Disturbance current	
1	2	3	4	5	6	7
MHz	Quasi-peak dBµV	Average dBµV	Quasi-peak dBµV	Average dBµV	Quasi-peak dBµA	Average dBµA
0,15 to 0,50	Decreasing linearly with the logarithm of the frequency from:		80	70	Decreasing linearly with the logarithm of the frequency from:	
	66 to 56	59 to 46			40 to 30	30 to 20
0,50 to 5	56	46	74	64	30	20
5 to 30	60	50	74	64		
The lower limit applies at the transition frequencies. The test report shall state which test method was used and which limits were applied.						

Table 6 – Limits for the mains port of motor operated tools

Frequency range	$P \leq 700$ W		700 W < $P \leq 1\,000$ W		$P > 1\,000$ W	
1	2	3	4	5	6	7
MHz	Quasi-peak dBμV	Average dBμV	Quasi-peak dBμV	Average dBμV	Quasi-peak dBμV	Average dBμV
0,15 to 0,35	Decreasing linearly with the logarithm of the frequency from:					
	66 to 59	59 to 49	70 to 63	63 to 53	76 to 69	69 to 59
0,35 to 5	59	49	63	53	69	59
5 to 30	64	54	68	58	74	64
The lower limit applies at the transition frequencies. **Key** P = rated power of the motor only.						

If the quasi-peak measurements meet the average limit, the EUT shall be deemed to meet both limits and the measurements using the average detector need not be carried out.

4.3.3.7 Wired network ports

Wired network ports shall meet the requirements of CISPR 32:2015 and the applicable disturbance limits for class B equipment in the frequency range 150 kHz to 30 MHz.

4.3.4 Frequency range 30 MHz to 1 000 MHz

4.3.4.1 General

EUT and auxiliary equipment that do not contain active electronic circuits or brush motors are deemed to comply with the requirements of this document in the frequency range 30 MHz to 1 000 MHz without testing. See also 4.1.

For mains operation, the assessment procedure of 4.3.4.2 shall be applied.

For battery operation, the assessment procedure of 4.3.4.3 shall be applied.

Equipment which is capable of both mains and battery operation shall be assessed in the mains operation mode only if all intended functions can be performed in this mode.

4.3.4.2 Mains operation

The EUT shall be assessed for emissions in the frequency range from 30 MHz to 1 000 MHz by testing in accordance with either method a) or b), see also Figure 5.

a) The disturbance power limits in columns 2 and 3 of Table 7 for the frequency range from 30 MHz to 300 MHz shall be met by all equipment except for electric tools.

   For electric tools the limits given in columns 4 to 9 of Table 7 apply. The power ratings given in columns 4 to 9 of Table 7 relate only to the rated power P of the motor. The power taken by resistive loads of the EUT (for instance the power used by the heating elements in an electric blower for plastic welding) is disregarded for the purpose of selecting the limits.

   The EUT shall be also deemed to comply with the requirement of this document in the frequency range from 300 MHz to 1 000 MHz without further testing if both conditions 1) and 2) below are fulfilled:

   1) the disturbance power emission from the EUT is lower than the limits of Table 7 reduced by the values of Table 8;

2) the maximum clock frequency is less than 30 MHz;

If either of the conditions 1) or 2) is not fulfilled, radiated measurements in the frequency range from 300 MHz to 1 000 MHz shall be performed and the limits of Table 9 for that range applied. In any case, the limits of Table 7 in the frequency range 30 MHz to 300 MHz shall be met.

b) The limits for radiated disturbances in Table 9 for the selected test method shall be met.

NOTE The advantage of method b) is that the assessment in the frequency range 30 MHz to 1 000 MHz of equipment having leads in addition to the mains lead is done in one measurement only, whilst with method a) the leads, where applicable, have to be tested separately.

4.3.4.3 Battery operation

The EUT shall comply with the limits in Table 9 for the frequency range from 30 MHz to 1 000 MHz (see also Figure 6).

4.3.4.4 Disturbance power limits

The disturbance power limits in Table 7, and where relevant, in Table 8 shall be applied.

Table 7 – Disturbance power limits – 30 MHz to 300 MHz

Frequency range	General		Tools					
			$P \leq 700$ W		700 W < $P \leq 1\,000$ W		$P > 1\,000$ W	
1	2	3	4	5	6	7	8	9
MHz	Quasi-peak dBpW	Average dBpW	Quasi-peak dBpW	Average dBpW	Quasi-peak dBpW	Average dBpW	Quasi-peak dBpW	Average dBpW
30 to 300	Increasing linearly with the frequency from:							
	45 to 55	35 to 45	45 to 55	35 to 45	49 to 59	39 to 49	55 to 65	45 to 55
Key P = rated power of the motor only.								

If the quasi-peak measurements meet the average limit, the EUT shall be deemed to meet both limits and the measurements using the average detector need not be carried out.

Table 8 – Reduction applicable to Table 7 limits

Frequency range	General		Tools					
			$P \leq 700$ W		700 W < $P \leq 1\,000$ W		$P > 1\,000$ W	
1	2	3	4	5	6	7	8	9
MHz	Quasi-peak dBpW	Average dBpW	Quasi-peak dBpW	Average dBpW	Quasi-peak dBpW	Average dBpW	Quasi-peak dBpW	Average dBpW
200 to 300	Increasing linearly with the frequency from:							
	0 to 10	0	0 to 10	0	0 to 10	0	0 to 10	0
NOTE This table only applies if method a) specified in 4.3.4.2 is followed.								

4.3.4.5 Radiated disturbance limits – 30 MHz to 1 000 MHz

The radiated disturbances limits, as specified in Table 9, shall be applied according to the selected test method.

Table 9 – Radiated disturbance limits and testing methods – 30 MHz to 1 000 MHz

Testing method	Basic standard	Frequency range MHz	Limit [a] Quasi-peak dBμV/m	Remarks
OATS or SAC [b]	CISPR 16-2-3:2016/AMD1:2019	30 to 230 230 to 1 000	30 37	Measurement distance 10 m
FAR [c]	CISPR 16-2-3:2016/AMD1:2019	30 to 230 230 to 1 000	42 to 35 [d] 42	Measurement distance 3 m
FAR [c]	IEC 61000-4-22:2010	30 to 230 230 to 1 000	42 to 35 [d] 42	Measurement distance 3 m
TEM-Waveguide [e]	IEC 61000-4-20:2010	30 to 230 230 to 1 000	30 37	–

[a] The lower limit is applies at the transition frequency.

[b] Measurements may be made at closer distance, down to 3 m. An inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining the limit. In this case the recommendations of the CISPR basic standards shall be considered when testing large EUT at frequency approaching 30 MHz, due to near field effects.

[c] All equipment shall be measured within the test volume as described in 5.3.4.3 and shown in Figure 12 to Figure 19.

[d] Decreasing linearly with the logarithm of the frequency.

[e] The TEM waveguide method shall be limited to battery operated EUT without cables attached and with a maximum size according to 6.2 of IEC 61000-4-20:2010 (the largest dimension of the enclosure is equal to the wavelength at the maximum measurement frequency, 300 mm at 1 GHz).

The test report shall state which test method was used and which limits were applied.

Any of the measurement methods mentioned in Table 9 may be selected to assess the EUT (see Figure 5, Figure 6 and Clause 7).

4.3.5 Frequency range 1 GHz to 6 GHz

4.3.5.1 General

EUTs and auxiliary equipment that contain active electronic circuits shall be evaluated in the frequency range from 1 GHz to 6 GHz up to the frequency specified in Table 10 based on the highest clock frequency used in the EUT.

Table 10 – Required highest frequency for radiated electric field strength measurements

Highest clock frequency (F_x)	Highest measurement frequency
$F_x \leq 108$ MHz	1 GHz
108 MHz < $F_x \leq 500$ MHz	2 GHz
500 MHz < $F_x \leq 1$ GHz	5 GHz
$F_x > 1$ GHz	5 × F_x up to a maximum of 6 GHz

Where the user of the standard decides not to perform measurements up to 6 GHz, the test report shall state in which frequency range of Table 10 (first column) F_x belongs to.

4.3.5.2 Limits

The limits in the frequency range 1 GHz to 6 GHz are based on radiated electric field measurements as specified in Table 11.

Table 11 – Radiated electric field disturbance limits and test methods – 1 GHz to 6 GHz

Test methods	Site validation	Frequency range MHz	Limit [a] dB(μV/m)	Detector / RBW	Measurement distance m
FSOATS [b] FAR	CISPR 16-1-4:2019	1 000 to 3 000	50	Average 1 MHz	3
		3 000 to 6 000	54		
		1 000 to 3 000	70	Peak 1 MHz	
		3 000 to 6 000	74		

[a] The limits are applied across the frequency range from 1 000 MHz to the required highest frequency of measurement derived from Table 10.

[b] A FSOATS may be a SAC/OATS with RF absorbers on the RGP.

When using a spectrum analyser the VBW shall be 1 MHz or higher. The recommended VBW is 3 MHz.

4.4 Discontinuous disturbances

4.4.1 General

Discontinuous disturbances on the mains port shall be evaluated using the limits in 4.4.2, taking into account general exclusions (see 4.1) and the exceptions (see 5.4.3).

NOTE Examples of exclusions in accordance with 4.1 (second paragraph) is equipment that:

– switch a resistive load at zero crossing of the mains voltage, thus causing discontinuous disturbances that do not exceed the limit for continuous disturbances;

– make use of inverters or Variable Speed Drives (VSD) for a smooth control of an inductive load;

– stop automatically and have not produced any click during a complete program; for such equipment there is no value in continuing the test as it would not produce clicks.

The test equipment shall be as specified in 5.1, with particular reference to 5.1.7. See Annex C for further guidance.

4.4.2 Limits

4.4.2.1 The limits for discontinuous disturbances identified as clicks are based on quasi-peak disturbance voltage measurements on the mains port. These limits only apply in the frequency range 150 kHz to 30 MHz.

NOTE The level of disturbances below 30 MHz is interpreted as an indication for the level above 30 MHz.

The limits for discontinuous disturbance depend on the disturbance characteristics and on the click rate N, as given in detail in 4.4.2.2 and 4.4.2.3.

4.4.2.2 The limits of Table 5 or Table 6 apply to:

– discontinuous disturbances other than those classified as clicks, or
– clicks with a click rate *N* equal to or greater than 30.

NOTE Examples of discontinuous disturbances other than clicks for which the limits for continuous disturbance apply are shown in 4.

4.4.2.3 The click limit L_q is calculated by increasing the relevant quasi-peak limit L for continuous disturbances (as given in Table 5 column 2 or in Table 6 columns 2, 4 and 6) by:

44 dB	for N < 0,2, or
20 lg (30/*N*) dB	for 0,2 ≤ N < 30

The click rate N shall be calculated in accordance with 5.4.2.3.

Table B.1 contains a list of equipment for which the click rate N may be derived from counting the number of switching operations.

5 Test equipment and methods of measurement

5.1 Test equipment

5.1.1 General

The instruments and devices specified in 5.1 shall be used in accordance with the methods of measurement specified in 5.2 and 5.3.

5.1.2 Measuring receivers

Receivers with quasi-peak detectors shall be in accordance with Clause 4 of CISPR 16-1-1:2015; receivers with average detectors shall be in accordance with Clause 6 of CISPR 16-1-1:2015.

NOTE 1 Both detectors are generally incorporated in a single receiver.

NOTE 2 Some measuring receivers contain, beside the average detector according to the specification in CISPR 16-1-1, a linear average detector which can give a different indicated result.

5.1.3 Artificial Mains Network (AMN)

Where this document specifies the use of an AMN, the artificial mains V-network 50 Ω/50 µH (or 50 Ω/50 µH + 5 Ω) as defined in Clause 4 of CISPR 16-1-2:2014/AMD1:2017 shall be used.

The connection between the AMN and the measuring receiver shall be made by means of a coaxial cable with a characteristic impedance of 50 Ω.

The AMN shall be bonded to the applicable ground plane according to 5.2.1.1 by a low RF impedance connection. This connection shall be according to 5.3 of CISPR 16-2-1:2014/AMD1:2017.

During all measurements of disturbance voltage and disturbance current (on the mains port or on auxiliary ports) the mains port of the EUT shall be connected to the EUT port of an AMN in order to provide a defined termination.

5.1.4 Voltage probe

Where this document specifies the use of a voltage probe, the device shall be as defined in 5.2 of CISPR 16-1-2:2014. If the impedance of the probe is too low, thus affecting the operation of the EUT, more suitable values of its components shall be chosen (for example 15 kΩ in series with 500 pF).

The readings shall be corrected according to the voltage division factor between the probe and the measuring instrument set. For this correction factor, only the resistive parts of the impedances shall be taken into account.

5.1.5 Current probe

The current probe shall be in accordance with 5.1 of CISPR 16-1-2:2014.

5.1.6 Artificial hand

The artificial hand is used to simulate the influence of the user's hand on the radio disturbance emitted by the EUT. The artificial hand shall be applied only during the disturbance voltage and disturbance current measurements, as specified in 5.2.

The artificial hand consists of metal foil connected to the reference ground through a RC element consisting of a capacitor of (220 ± 44) pF in series with a resistor of (510 ± 51) Ω (see Figure 12 and Clause 8 of CISPR 16-1-2:2014 for constructive details). The RC element of the artificial hand may be incorporated in the housing of the AMN.

5.1.7 Click analyser for discontinuous disturbance

The measuring equipment for discontinuous disturbances shall comply with Clause 9 of CISPR 16-1-1:2015. Alternative instrumentation may be used as long the test system fulfills the verification procedure according to Clause 9 of CISPR 16-1-1:2015.

For the measurement of the duration of the disturbance, an alternative method using an oscilloscope may be applied if the measurement accuracy is in accordance with CISPR 16-1-1:2015. In particular, the cut-off frequency of the oscilloscope shall not be lower than the intermediate frequency of the measuring receiver.

See also Annex C for further information.

5.1.8 Absorbing clamp

The absorbing clamp shall be in accordance with Clause 4 of CISPR 16-1-3:2004/AMD1:2016.

The transducer factor used for measurements with the absorbing clamp shall result from a calibration according to CISPR 16-1-3:2004/AMD1:2016, B.2.1 (original method).

5.1.9 Radiated emission test sites

The measurement instrumentation, including antennas and test sites shall be compliant with the relevant requirements for the test method selected according to 4.3.2, 4.3.4.5 and 4.3.5, as applicable. The test sites shall be validated in accordance with CISPR 16-1-4:2019, where such requirements exist, for the measurement distance between the EUT and the antenna selected for measurement.

Common mode absorption devices (CMAD) shall be constructed and validated according to CISPR 16-1-4:2019.

5.2 Conducted disturbances set-up and measurements

5.2.1 Arrangement of the EUT

5.2.1.1 EUT operated without an earth connection and not held by the hand

The EUT shall be placed, with respect to the floor, in an orientation typical of intended use, unless special conditions are given in Annex A.

Table-top EUT shall be:

– placed at a distance of (0,4 ± 0,05) m from a RGP of at least 2 m × 2 m in size;
– placed at a distance of (0,8 ± 0,05) m from the AMN;
– kept at least 0,8 m from any other earthed conducting surface;
– placed in a manner to ensure that the RGP extends at least 0,5 m beyond the projection of its boundaries.

The RGP shall be either horizontal or vertical (see Figure 23 and Figure 24).

The AMN shall be bonded to the RGP. However, if the RGP is vertical and it is bonded to a horizontal ground plane (e.g. a shielded room), the AMN may be bonded to the horizontal ground plane.

Floor standing EUT (see Figure 25) shall be:

– placed at a height of (0,12 ± 0,04) m above a horizontal RGP of at least 2 m × 2 m in size;
– placed at a distance of (0,8 ± 0,05) m from the AMN;
– kept at least 0,8 m from any other earthed conducting surface;
– placed in a manner to ensure that the RGP extends at least 0,5 m beyond the projection of its boundaries.

NOTE A specific height and associated tolerance (0,12 ± 0,04) ensure better repeatability.

Objects supporting the EUT and its parts at the required height shall be made of non-conductive material.

5.2.1.2 EUT without an earth connection and held by hand during operation

5.2.1.2.1 The EUT shall be arranged in accordance with 5.2.1.1, with the addition of the artificial hand described in 5.1.6 and according to the requirements provided in 5.2.1.2.

The artificial hand shall not be applied to the EUT in cases where it is necessary for a person to hold the EUT by hand during testing.

5.2.1.2.2 The artificial hand shall be applied only on handles, grips and those parts of the EUT specified as such by the instructions for use. Where no information is provided by the instructions for use the application of the artificial hand shall follow the general principle that the foil shall be wrapped around all handles, both fixed and detachable, supplied with the EUT. The terminal M of the RC element (see 10) shall be connected to any exposed non-rotating metalwork as specified in 5.2.1.2.3 to 5.2.1.2.7.

5.2.1.2.3 Metalwork that is covered with paint or lacquer is considered as exposed metalwork and shall be directly connected to the terminal M.

5.2.1.2.4 When the enclosure of the EUT is entirely made of metal, no metal foil is required and the terminal M shall be connected directly to the metal enclosure.

5.2.1.2.5 When the enclosure of the EUT is of insulating material, the metal foil shall be wrapped round the handles, e.g. in Figure 11, around handle B, and also round the second handle D, if present. Also metal foil 60 mm wide shall be wrapped round the body C at that point where the iron core of the motor stator is located, or around the gearbox if this gives a higher disturbance level. All these pieces of metal foil, and the ring or bushing A, if present, shall be connected together and to the terminal M of the RC element.

5.2.1.2.6 When the enclosure of the EUT is partly metal and partly insulating material, and has insulating handles, metal foil shall be wrapped round the handles, as handles B and D in Figure 11. If the case is non-metallic at the location of the motor, a metal foil 60 mm wide shall be wrapped round the body C at that point where the iron core of the motor stator is located, or alternatively around the gearbox, if this is of insulating material and a higher disturbance level is obtained. The metal part of the body, the point A, the metal foil round the handles B and D and the metal foil on the body C shall be connected together and to the terminal M of the RC element.

5.2.1.2.7 When a class II EUT has two handles of insulating material A and B and a case of metal C, for example an electric saw (Figure 12), metal foil shall be wrapped round the handles A and B. The metal foil at A and B and the metal body C shall be connected together and to the terminal M of the RC element.

NOTE Classes 0, I, II and III are according to IEC 61140.

5.2.1.3 EUT with an earth connection

EUT shall be arranged in accordance with 5.2.1.1

5.2.2 Arrangement of the leads at the ports of the EUT

5.2.2.1 Mains port

The disturbance voltage measurements at the mains port are normally made at the plug end of the mains lead.

If the mains lead is longer than the distance between the mains port and the AMN, and can form random loops on the ground, the length in excess shall be folded back and forth parallel to the lead so as to form a bundle with a length between 0,3 m and 0,4 m (see 3). In doubt, the mains lead shall be replaced by a lead of similar type having (1,0 ± 0,1) m length or, if 1,1 m is too short, having the minimum length necessary to connect the mains port of the EUT to the AMN.

If the mains lead is shorter than the required distance between the EUT and the AMN, it shall be extended, or replaced, by a cable of similar type having the same number of wires and of the necessary overall length.

If the mains lead of the EUT includes an earth conductor (protective or functional earth), the plug end of the earth conductor shall be connected to the AMN reference ground.

Where an earth conductor is required, but it is not included in the lead, the connection of the earth terminal of the equipment to the AMN reference ground shall be made by a lead not longer than necessary to be connected to the AMN and running parallel to the mains lead at a distance of not more than 0,1 m from it.

If the equipment is not supplied with a lead, it is to be connected to the AMN by a lead not longer than 1 m (also in case of plug or socket-outlet).

The mains lead shall be led downward along the EUT to the level of the non-conductive support and then straight to the AMN.

The following requirements apply to equipment where the mains plug is either provided with, or is specified to be used with, passive EMI suppression components (e.g. capacitors, inductors).

– If the mains plug of the EUT, as supplied for testing, is already fitted with the EMI suppression components, the equipment is tested as supplied, i.e. the mains plug shall be connected directly to the EUT port of the AMN.

– If the mains plug of the EUT, as supplied for testing, is not already fitted with EMI suppression components then these shall be mounted and connected in accordance with the instructions for use. These instructions, together with the type and ratings of components specified for use, shall be noted in the test report. Once the EMI suppression components have been incorporated into the mains plug, this shall be connected directly to the EUT port of the AMN.
– In either of the above cases, the mains lead shall take the most direct path between its connection point to the EUT and the AMN's EUT port.

For equipment supplied with a plug or connector fitted with EMI suppression components the user manual shall contain the following information (or similar):

Caution: Only replace the mains plug or supply cord with the type as specified for this equipment.

5.2.2.2 Auxiliary port

Leads attached to auxiliary ports (auxiliary leads) shall be treated in accordance with 5.2.3.2, except where otherwise stated in this document.

5.2.2.3 Wired network port

CISPR 32:2015 provides the measuring procedure and arrangement for cables connected to wired network ports.

5.2.3 Arrangement of auxiliary equipment

5.2.3.1 General

Unless otherwise stated, 5.2.3 applies to auxiliary equipment attached by cables to the EUT.

When the auxiliary equipment is not essential to the operation of the EUT and has a separate test procedure specified elsewhere in this document, this subclause shall not apply to it. The auxiliary equipment shall be arranged and tested as specified in this separate test procedure.

5.2.3.2 Measuring arrangement

The EUT shall be arranged in accordance with 5.2.1 and 5.2.2.1 with the following additional requirements:

a) auxiliary equipment shall be placed at a distance from the RGP following the same principles used for the EUT (i.e. depending whether the auxiliary equipment is floor standing or table top equipment).
b) for auxiliary leads delivered to the end user together with the EUT, the measurements shall be performed with the original lead;

   If an auxiliary lead is not delivered to the end user together with the EUT but the instructions for use specify for it a length shorter than 10 m, the measurements shall be performed with a lead having the maximum specified length;

   If the instructions for use give no information about the length of the auxiliary lead to be used or if the instructions for use specify that the length of the auxiliary lead may be longer than 10 m, the measurements shall be performed with a lead having a length of at least 10 m;

   From the point of connection to the EUT the auxiliary lead goes vertically down to the required height, horizontally to the auxiliary equipment and vertically to the point of connection at the auxiliary equipment;

   Where bundling is required, the lead shall be folded back and forth for a length of 0,3 m to 0,4 m, as shown in Figure 13.

   The auxiliary lead should be routed in the opposite direction to the mains lead.

The arrangement and operation of an auxiliary equipment shall not unduly affect the disturbance level of the EUT.

c) if the artificial hand is required for the EUT (see 5.2.1.2), the artificial hand shall be applied to the EUT and not to the auxiliary equipment;

d) the artificial hand shall be applied to the auxiliary equipment only if this is not earthed and has to be held in hand when used.

When the disturbance current method is used, the probe shall clamp together the leads connected to the same port, in order to cancel out the effect of differential mode currents. Where the leads cannot fit in the current probe, they may be separated, but still aiming to clamp both the send and return currents. Each group of leads, as relevant, shall be identified in order to be tested separately according to the measurement procedure described in 5.2.3.3.

For voltage probe measurements, the auxiliary equipment shall be placed at a distance of (0,8 ± 0,05) m from the EUT. If an auxiliary lead is shorter than 0,8 m, the auxiliary equipment shall be placed at the furthest possible distance from the EUT.

For current probe measurements, the current probe shall be placed at a distance of (0,3 ± 0,03) m from the port to be tested. In this case the auxiliary equipment shall be placed at a distance of (0,8 ± 0,05) m from the current clamp (see Figure 24).

NOTE When using the current clamp the distance is approximately 1,1 m between EUT and AE.

If no disturbance voltage or disturbance current measurements are required on the auxiliary port or cable, the distance between the auxiliary equipment and EUT shall be (0,8 ± 0,05) m (see Figure 23 and Figure 25).

5.2.3.3 Measuring procedure

Unless specified elsewhere in this document, in addition to the measurement on the mains port, measurements are made on each auxiliary port to be connected to leads (e.g. control and load lines) using a probe selected between those described in 5.1.4 (see Figure 14) and 5.1.5.

The auxiliary equipment is connected to allow measurements to be made under all provided operating conditions and during interactions between the EUT and the auxiliary equipment.

When using the voltage probe the above measurements are performed both on the ports of the EUT and on those of the auxiliary equipment. If using the current probe measurement is used the measurement shall be done on the EUT port only.

The measurement of the disturbance voltage or disturbance current on non-extendable leads longer than 2 m shall be started at a frequency according to the following formula, but without going below 150 kHz:

$$f_{\text{start}} = \frac{60}{L}$$

where

f_{start} is the start frequency in MHz for the measurement;

L is the length in m of the connecting lead between the EUT and the auxiliary equipment.

NOTE This calculation is based on the assumption that a lead is not an efficient emitter at frequencies whose wavelength is longer than five times its length.

If no specific information about the length of the connecting leads is provided in the instructions for use of the EUT, the measurements shall start at 150 kHz.

5.3 Radiated disturbances set-up and measurements

5.3.1 General

Subclause 5.3 describes the general requirements for the measurements of radiated disturbances.

5.3.2 Magnetic field strength – 9 kHz to 30 MHz

The measurement of radiated disturbances in the frequency range 9 kHz to 30 MHz shall be made in accordance with CISPR 16-2-3:2016/AMD1:2019.

NOTE CISPR 16-2-3 covers both the measurement of the magnetic field with a small loop antenna (e.g. 60 cm) and the measurement of the magnetic dipole with a Large Loop Antenna System.

5.3.3 Disturbance power – 30 MHz to 300 MHz

5.3.3.1 General

The disturbance power is measured on the cables attached to the ports of the EUT according to Clause 7 of CISPR 16-2-2:2010 and the methods described in this document.

It is generally considered that for frequencies above 30 MHz radio interference energy is propagated by radiation. Experience has shown that the disturbing energy is mostly radiated by the part of the mains leads and other leads near the EUT. It is therefore agreed to define the disturbing capability of an EUT as the RF power it could supply to its leads. This power is nearly equal to that transferred by the EUT to a suitable absorbing device (absorbing clamp) placed around these leads at the position where the absorbed power is at its maximum.

5.3.3.2 Measurement procedure for the mains port

5.3.3.2.1 The distance between the clamp test set-up (the EUT, the mains lead and the absorbing clamp) and any other conductive objects (including persons, walls and ceiling, but excluding the floor) shall be at least 0,8 m. The EUT shall be placed on a non-metallic support parallel to the floor.

The height of the support (e.g. pallet) shall be (0,12 ± 0,04) m for floor standing EUT and (0,8 ± 0,05) m for table-top EUT.

The lead under test shall be placed in a straight line at a height of (0,8 ± 0,05) m from the floor for a length specified in 5.3.3.2.2.

5.3.3.2.2 The straight portion of the lead under test should be about 6 m long, this being equal to ($\lambda_{max}/2 + 1$) m in order to allow at any time the positioning of the absorbing clamp and a possible second clamp for additional isolation.

NOTE λ_{max} is the wavelength corresponding to the lowest frequency at which measurements are to be made, for instance 10 m at 30 MHz.

Mains leads that are shorter than the necessary length shall be extended. Any plug or socket that, due to their size, does not allow for the positioning of the absorbing clamp along the full length of the lead to be tested shall be removed. Alternatively, the lead may be replaced with one of similar type and having the necessary length.

If the mains plug contains passive EMI filter components (e.g. capacitors, inductors) the test shall be performed both:

– on the mains side of the plug using a lead of required length and suitable type, and
– on the lead at the EUT side of the plug, with the clamp pointing towards the EUT.

5.3.3.2.3 The absorbing clamp shall be clamped around the lead under test and, at each test frequency, moved along the lead in order to find the position that gives the maximum indication. The maximum value is found between a position adjacent to the EUT and a distance of about a half-wavelength from it.

NOTE The maximum can occur at a distance close to the equipment.

5.3.3.2.4 If the RF isolation between mains supply and the input of the absorbing clamp on the side of the EUT appears to be insufficient, a fixed ferrite clamp should be placed along the lead at a distance of about 6 m from the EUT. This improves the stability of the loading impedance and further reduces extraneous noise coming from the mains supply. For more information see Clause 4 of CISPR 16-1-3:2004/AMD1:2016.

5.3.3.3 Measurement procedure for ports other than the mains port

5.3.3.3.1 Test set-up

The EUT, the lead under test and the absorbing clamp shall be arranged following the principles described in 5.3.3.2.

Leads normally extendable by the user shall be extended to a length of about 6 m in accordance with the procedure in 5.3.3.2.2 for the mains lead.

NOTE 1 Examples of leads normally extendable by the user are those with a loose end or fitted with an easily replaceable plug or socket on one or both ends (see also 3.5.2 for definition of non-extendable wiring).

If the lead connected to the port is non-extendable and:

– shorter than or equal to 0,25 m, measurement need not be made on it;

– is longer than 0,25 m but shorter than twice the length of the absorbing clamp, it shall be extended to twice the length of the absorbing clamp and measurements shall be made on it;

– is longer than twice the length of the absorbing clamp, measurements shall be made on it.

For leads that can be stretched when the equipment is in operation, their overall length shall be considered when applying the above requirements.

NOTE 2 Some leads return to a pre-set arrangement (e.g. coil) when the auxiliary equipment at the end of it is not held in hand.

Where plugs, sockets or other construction features do not allow for the positioning of the absorbing clamp along the full length of the lead to be tested, the lead may be replaced with one of similar type and having the necessary length.

When the auxiliary equipment connected at the end of the lead is not essential for the operation of the EUT and a separate test procedure is specified for it elsewhere in this document, only the lead, but not the auxiliary equipment, shall be connected. However, all measurements on the EUT in accordance with 5.3.3.3.2 shall be made.

5.3.3.3.2 Measurement procedure

Measurement of the disturbance power shall be made firstly on the mains lead (if applicable) of the EUT using the absorbing clamp in accordance with 5.3.3.2. Any lead connecting the EUT to an auxiliary equipment is disconnected, if this does not affect the operation of the EUT; otherwise, it is isolated by means of ferrite rings (e.g. an additional absorbing clamp or a CMAD) placed close to the EUT.

Secondly, a similar measurement shall be made on each lead which is or may be connected to an auxiliary equipment, whether or not it is essential for the operation of the EUT; the current transformer of the clamp pointing towards the EUT. Isolation or disconnection of the mains lead and other leads is made in accordance with the above paragraph.

NOTE For permanently connected short leads the movement of the clamp (as described in 5.3.3.2.2) is limited by the length of the lead.

In addition, measurements shall be made as above but with the current transformer of the clamp pointing towards any auxiliary equipment, unless this device is not essential for the operation of the EUT and a separate test procedure for it is specified elsewhere in this document (no disconnection or RF isolation of other leads is of course necessary in this case).

5.3.4 Radiated emission – 30 MHz to 1 000 MHz and 1 GHz to 6 GHz

5.3.4.1 General

Except for the setup requirements specified in 5.3.4.3, the measurement methods used for measuring radiated emissions from the enclosure port of equipment shall be in conformity with the relevant requirements of one of the basic standards listed below:

– CISPR 16-2-3:2016/AMD1:2019, if the test is made using an open area test site (OATS), a semi anechoic absorber-lined shielded enclosure (SAC), a fully anechoic absorber-lined shielded enclosure (FAR) or free space open area test site (FSOATS), all validated according to CISPR 16-1-4:2019;

– IEC 61000-4-20:2010, if the test is made using a Transverse Electromagnetic (TEM)-Waveguide;

– IEC 61000-4-22:2010, if the test is made in a FAR according to IEC 61000-4-22.

5.3.4.2 Measurement instrumentation

The measurement instrumentation, including antennas and test sites shall be compliant with the relevant requirements for the different methods as described in CISPR 16-1-1:2015, CISPR 16-1-4:2019, IEC 61000-4-20:2010 or IEC 61000-4-22:2010, as applicable. Common mode absorption devices (CMADs) shall be constructed and validated according to CISPR 16-1-4:2019.

5.3.4.3 Test set-up for radiated emission measurements

5.3.4.3.1 General

The boundary of the EUT is defined by an imaginary circle encompassing the EUT. The centre of this imaginary circle shall be at the same position as the centre of the turntable (see Figure 15).

The distance from the receive antenna reference point to the boundary of the EUT shall be the measurement distance as required by the limits used (see 4.3.4.5).

If ancillary equipment is needed to operate the EUT, this ancillary equipment is not part of the EUT and its radiated emissions shall not influence the test results e.g. by placing it outside the screened room.

Table-top EUT shall be placed at (0,8 ± 0,05) m above the reference plane of the test site selected for measurement (see Figure 16 and Figure 17).

Floor standing EUT shall be placed at (0,12 ± 0,04) m above the reference plane of the test site selected for measurement (see Figure 19).

The objects supporting the EUT and its parts at the required height shall not affect significantly the results, in particular when taking measurements above 1 GHz.

NOTE For example tables made of unpainted expanded polystyrene. CISPR 16-1-4:2019 describes a measurement to help ensure that the dielectric properties of the material used for construction of the supporting objects are appropriate.

Where the EUT comprises multiple parts, these shall be arranged to minimise, as far as it is reasonably practical, the test volume. A minimum distance of 0,1 m shall be maintained between these parts (see Figure 20 and Figure 21).

Where the test set-up of particular equipment is not fully covered by this document, the set-up shall be determined by referring to the basic standard relevant to the test method selected for measurement.

5.3.4.3.2 Cables

All cables, both signal and power, are covered in this subclause.

Retractable cables on reel cords or in cable compartments shall be fully extracted and bundled as appropriate.

For cables leaving the test volume:

– Mains cables shall be routed directly from the EUT vertically to the floor (see Figure 16, Figure 17, Figure 19, Figure 20 and Figure 21 as examples).
– If more than one cable is connected to the EUT and leaves the test volume, then all other cables shall be routed together with the nearest mains cable to the floor. These cables shall be routed first down to the supporting surface and then around the periphery of the EUT using the shortest possible path to the nearest mains cable (see Figure 18 as an example).
– At the point where each cable reaches the ground plane (or leaves the test volume in the FAR) it shall be taken through a CMAD. Each cable shall be routed through a single CMAD separately (see Figure 16 to Figure 21 as example). If more than three cables are leaving the test volume only the mains cable(s) shall be routed through CMADs.
– When measuring in a FAR, at least 0,8 m of cables leaving the test volume shall be visible from the antenna reference point (see Figure 22).

For cables terminating within the test volume:

– Interconnecting cables shall be routed between EUT units in the shortest possible way. Any excess length of each cable shall be separately bundled in a serpentine fashion at the approximate centre of the cable with the bundle 0,3 m to 0,4 m in length (see Figure 20 and Figure 21 as example).

5.4 Measurement procedures and interpretation of results

5.4.1 Continuous disturbance

5.4.1.1 If the disturbance level is fluctuating, the reading shall be observed for about 15 s for each measurement and the highest readings recorded, except that any isolated spike shall be ignored. If the disturbance level is stable, it is not necessary to measure for 15 s.

5.4.1.2 If the level of the disturbance is not steady, but shows a continuing rise or fall of more than 2 dB in the 15 s period, then the disturbance measurement shall be performed in accordance with the conditions of normal use of the equipment, as follows:

a) If in normal use the equipment may be switched on or off frequently, for instance an electric drill or a sewing-machine, then when performing tests, at each frequency of measurement the EUT shall be switched on just before each measurement, and switched off just after each measurement; the maximum level obtained during the first minute at each frequency of measurement shall be recorded;

b) if in normal use the equipment runs for longer periods, for instance a hair-dryer, then it shall remain switched on for the entire test period, and at each frequency the level of disturbance shall be recorded only after a steady reading (subject to the provision of 5.4.1.1) has been obtained. For such equipment the starting phase, generally lasting few seconds, shall be ignored.

5.4.1.3 The disturbance voltages or disturbance currents shall be assessed throughout the frequency range for which limits are specified.

An initial survey or scanning of the complete frequency range shall be made.

If the peak envelope is measured, the quasi-peak and average values shall be given for the significant maxima of the measured peak envelope (i.e. near the limit).

5.4.1.4 Where disturbance power is assessed, measurements shall be made throughout the frequency range 30 MHz to 300 MHz.

The same principles as 5.4.1.3 shall be used; however, the measurement procedure of the absorbing clamp method shall also be applied.

5.4.1.5 The radiated emission is assessed for the frequency range 30 MHz to 1 000 MHz. If certain conditions are in accordance with 4.3.4.2, disturbance power measurements may be made throughout the frequency range 30 MHz to 300 MHz and electric field strength measurements made throughout the frequency range 300 MHz to 1 000 MHz.

For the range 1 GHz to 6 GHz, if the measurement is necessary, 4.3.5 shall be followed.

The measurement of the radiated magnetic field or magnetic field induced current, if applicable, shall be made throughout the frequency range 9 kHz to 30 MHz.

The measurement procedure of the selected radiated measurement method shall also be applied.

5.4.1.6 When the equipment contains only commutator motors as source of disturbance, average detector measurements does not need to be carried out.

5.4.2 Discontinuous disturbance

5.4.2.1 General

The evaluation of clicks shall be carried out at the following four frequencies: 150 kHz, 500 kHz, 1,4 MHz and 30 MHz.

The receiver input attenuation shall be set such that an input signal equal in amplitude to the limit L for continuous disturbance is within the dynamic range of the receiver.

If the click evaluation is to be done in one measurement run, input signals equal in amplitude to the limit L for continuous disturbance as well as to the limit L_q for the upper quartile shall be within the dynamic range of the receiver.

5.4.2.2 Observation time

The observation time T shall be determined only at 150 kHz and 500 kHz under the operating conditions specified in this document.

The following procedure shall be used for determining the minimum observation time:

a) If the equipment does not operate according to a programme, the minimum observation time is the shorter of:
   – the time in minutes to count 40 clicks at one of the two frequencies, or
   – 120 min;
b) If the EUT does operate according to a programme, the minimum observation time is the duration of a complete programme if the click rate obtained from the complete programme is less than or equal to 0,5 and the programme duration is more than 20 min. Otherwise it is either:
   – the sum of the durations of the minimum number of complete programmes necessary to count 40 clicks at one of the two frequencies, or
   – the sum of the durations of the minimum number of complete programmes that exceeds 120 min, if 120 min after the beginning of the test 40 clicks have not been recorded,

NOTE 1 Explanations for the additional conditions $N \leq 0{,}5$ and $T > 20$ min provided in b) and examples for determining the minimum observation time are given in Annex C.

The same procedure shall be applied when, instead of counting the clicks, the click rate is determined by counting the switching operations.

When case b) applies, the interval between the end of one programme and the manual start of the next programme shall be excluded from the minimum observation time.

However, it is permitted to extend the observation time beyond the minimum and use that value as T.

NOTE 2 For practical reasons it might not be possible or convenient to stop the clicks evaluation at the minimum observation time. However, making the observation time longer and recording more clicks can give benefits in terms of test reproducibility.

When counting 40 clicks (or switching operations) with a 4-channel-analyser, the minimum observation time is the shorter observation time to reach 40 clicks at either 150 kHz or at 500 kHz. This observation time T shall be applied to the evaluation at all 4 frequencies

With a 1-channel analyser the observation time T at 150 kHz and 500 kHz could be different. In this case for the frequencies 1,4 MHz and 30 MHz the shorter observation time shall be used.

Measurements with a 1-channel analyser shall start at 150 kHz. If at 500 kHz a shorter observation time has been determined, the clicks at 150 kHz may be re-evaluated with this observation time and the results used in place of the original measurements at 150 kHz.

NOTE 3 Re-evaluating means either re-measuring the clicks or re-calculating the results from the stored data.

The test report shall clearly state the used observation time for each frequency.

5.4.2.3 Click rate

The click rates shall be calculated separately for each of the four frequencies specified in 5.4.2.1 using the observation time(s) determined according to 5.4.2.2. See Figure 8 for the test procedure based on counting clicks.

The click rate N_C is the number of clicks per minute determined from the formula $N_C = n_C/T_C$, where n_C is the number of clicks during the observation time T_C (in minutes).

For equipment listed in Table B.1, the click rate N may be alternatively determined from the formula $N_S = n_S \times f/T_S$, where n_S is the number of switching operations during the observation time T_S and f is a factor depending on the particular equipment, as given in Table B.1.

The factor f shall only be applied when the method of counting switching operations is used. See also Figure 9 for the test procedure based on counting switching operations.

For equipment for which it is permitted to determine the click rate from either counting the number of switching operations or measuring the clicks, the user of this document may choose between the two methods (see also Clause 9).

5.4.2.4 Upper quartile method

The upper quartile method shall be applied at each of the four frequencies specified in 5.4.2.1 using the same observation time obtained when determining the corresponding click rates.

At each frequency, the number of clicks exceeding L_q shall be compared with the total number of clicks counted at the same frequency.

If the click rate N is determined from measuring the number of clicks, the EUT shall be deemed to comply if not more than a quarter of the number of clicks counted during the observation time T exceeds the click limit L_q.

If the click rate N is determined from counting the number of switching operations, the EUT shall be deemed to comply if not more than a quarter of the number of switching operations counted during the observation time T produce clicks exceeding the click limit L_q.

NOTE See Annex C for guidance on the measurement of discontinuous disturbances and the use of the upper quartile method.

5.4.3 Exceptions

5.4.3.1 General

Some types of discontinuous disturbance are allowed specific exceptions under certain conditions, in accordance with 5.4.3.2 through 5.4.3.7.

The measurement procedure shall be able to verify these occurrences.

Figure 8 and Figure 9 show how to consider these conditions, also when further measurements are needed in order to apply the upper quartile method.

5.4.3.2 Individual switching operations

Within the meaning of 5.4.3, an individual switching operation is considered to result from the infrequent operation of a switch that is part of the equipment, either by direct or remote activation.

NOTE These switching operations have the potential to cause discontinuous disturbances but are disregarded because they are infrequent.

Examples of individual switching operations are those for:

a) the purpose of mains connection or disconnection only (including foot activated);
b) the purpose of programme selection only;
c) the control of energy or speed by switching between a limited number of fixed positions;
d) changing the manual setting of continuously adjustable controls;
e) the manual switching of heat and airflow controls in equipment such as fan heaters and hair dryers;
f) indirectly operated switches in a cupboard, wardrobe or refrigerator;

g) sensor-operated switches (e.g. user presence activation, environmental conditions sensing other than temperature)

Any disturbance caused by individual switching operations shall be disregarded.

In addition, the disturbance caused by the operation of any switching device or control, which is included in an equipment for the purpose of mains disconnection for safety, only, shall also be disregarded.

The exclusions of this Subclause 5.4.3.2 shall not be applied to disturbances caused by switches which are intended to be repeatedly operated (e.g. for sewing machines and soldering equipment).

5.4.3.3 Combination of disturbances in a time frame less than 600 ms

A series of discontinuous disturbances within a time frame less than 600 ms, having amplitudes that exceed the limits for continuous disturbances and which do not meet the definition of click, may be considered as one click. This exception may be applied:

– once per program cycle, for program controlled equipment, or
– once per observation time, for all other equipment.

The same exception may also be applied to thermostatically controlled three-phase switches, causing three disturbances sequentially in each of the three phases and the neutral.

5.4.3.4 Instantaneous switching

Equipment is deemed to comply with the click requirements, regardless of the amplitude of the clicks, if all of the following conditions are fulfilled:

– the click rate is not more than 5;
– none of the caused clicks has a duration longer than 20 ms;
– 90 % of the caused clicks have a duration less than or equal to 10 ms.

A determination of whether the above conditions are met may be made at only one frequency, either 150 kHz or 500 kHz, where the higher click rate occurs.

If any of these conditions is not satisfied, then the general assessment in accordance with 5.4.2 applies.

5.4.3.5 Separation less than 200 ms

For equipment which have a click rate less than 5, any two disturbances, each having a maximum duration of 200 ms, shall be evaluated as two clicks even when the separation between the disturbances is less than 200 ms. After using this exemption, the click rate shall remain less than 5. In this case, for instance observed with some refrigerators, the second example shown in Figure 4, would be evaluated as two clicks and not as continuous disturbance.

5.4.3.6 Thermostatically controlled three-phase switches

For thermostatically controlled three-phase switches, the three disturbances caused sequentially in each of the three phases and the neutral shall, independent of their spacing, be evaluated as three clicks and not as continuous disturbance if the following conditions are met:

a) the switch does not operate more than once in any 15 min period;
b) the duration of the disturbance caused by the opening or closing of any one of the contacts shall be 20 ms or less;

c) not more than a quarter of the number of the clicks caused by switching operations registered during the observation time exceed the level of 44 dB above the relevant limit L for continuous disturbance.

5.4.3.7 Superposition of clicks with continuous disturbance

If the clicks have to be measured under the superposition of continuous disturbance, the reference level for the duration and spacing measurements may be increased to a value just above the signals produced by the continuous disturbance.

This is allowed only if the continuous disturbance level at the QP output is at least 2 dB lower than the QP limit.

6 Operating conditions

6.1 General

The EUT shall be tested when operated from the intended power supply sources according to 6.2 and/or 6.3 as appropriate.

The EUT shall be tested in accordance with the operating modes and load conditions given in Annex A in order to assess the emission from all relevant functions. If no operating modes or load conditions are given in Annex A, the EUT shall be tested in all relevant operating modes and load conditions expected for intended use.

Testing may be carried out by measuring the EUT's emissions when operating its functions simultaneously, individually in turn, or any combination thereof, unless to do so is likely to reduce the emission caused by any of those functions.

See 6.5 for equipment having functions within the scope of different standards.

NOTE 1 Operating modes can be made by the combination of different functions operated simultaneously (e.g. for a vacuum cleaner the nozzle to beat a carpet can be operated in addition to the suction function).

NOTE 2 Certain functions can be operated only simultaneously (e.g. the heating function of certain heating appliances can be active only when associated with a ventilation function that maintains the heating elements within the appropriate temperature range).

Equipment that is normally operated continuously with a load made by consumable material (e.g. glue, water) could run out of such material before the test is completed. In this case, unless otherwise specified in Annex A, the test shall be paused when the material runs out and re-started after the initial quantity of material has been reinstated.

When the EUT cannot operate normally in the conditions specified above (e.g. because sensing a non-real environment) a special control mode (e.g. “EMC testing mode”) may be included in the software by the manufacturer.

Where there is a conflict between Annex A and the instructions for use (e.g. the equipment cannot be set in the operating conditions specified in Annex A), the instructions for use shall take precedence.

The duration of operation is not restricted unless the instructions for use specifies limitations for the operating time of the EUT. In this case, the limitations shall be complied with.

No running-in time to be specified but, prior to testing, the EUT shall be operated for a sufficient period to ensure that the conditions of operation will be typical of those during normal life of the equipment. Running-in of motors shall be carried out by the manufacturer.

The ambient temperature shall lie within the range 15 °C to 35 °C.

6.2 Mains operation

6.2.1 Voltage at the AC mains port

During the tests, the EUT shall be operated at the rated voltage specified for the equipment.

For single-phase equipment with a rated voltage range in the range between:

- 100 V to 127 V, testing shall be done at one nominal voltage within this range; the recommended test voltage is 120 V;
- 200 V to 240 V, testing shall be done at one nominal voltage within this range; the recommended test voltage is 230 V;
- 100 V to 240 V, testing shall be done at one nominal voltage within the range 100 V to 127 V, or at one nominal voltage within the range 200 V to 240 V. However, the user of this document may test the equipment twice; once at one nominal voltage within the range 100 V to 127 V and once within the range 200 V to 240 V. This decision shall be recorded in the test report.

Where applicable, the same applies to the AC mains port of the EPS.

Multi-phase equipment shall be tested applying the same principles set-out above.

For three-phase equipment with a rated voltage range in the range between:

- 200 V to 240 V, testing shall be done at one nominal voltage within this range; the recommended test voltage is 220 V;
- 380 V to 450 V, testing shall be done at one nominal voltage within this range; the recommended test voltage is 400 V.

6.2.2 Frequency at the AC mains port

During the tests the EUT shall be operated at the rated frequency specified for the equipment.

If the equipment has more than one rated frequency (e.g. 50 Hz to 60 Hz), then the EUT shall be tested at one of these frequencies only.

If the equipment has a rated frequency range (e.g. 50 Hz to 60 Hz), then the EUT shall be tested at one frequency within this range.

6.3 DC operation

6.3.1 Battery operation

When testing an EUT for battery operation, the type of batteries used and their connection shall be as specified in the instructions for use. If the instructions provide for different ratings of batteries to be used, the batteries with the highest capacity (e.g. in Ah) should be used.

Fully charged batteries shall be used when starting each test. During the test, the battery condition shall be adequate to maintain normal operating conditions.

If the battery is charged from the AC mains supply, the equipment shall be treated in this operation mode as mains operated equipment.

6.3.2 Operation from a DC supply other than a battery

During the tests, the EUT shall be operated at the rated voltage specified for the DC powered equipment using a representative source.

DC powered equipment which operate from a dedicated DC supply unit (e.g. EPS) shall be tested using the DC supply unit supplied, specified or recommended in the instructions for use. Where the DC supply unit is not specified nor recommended in the instructions for use, or not made available at the time of testing, a representative source providing the rated voltage and current specified for the equipment shall be used. The representative source chosen shall be adequate to meet the specifications of the EUT and shall meet the limits of this document when operated standalone (see A.8.8 or A.8.9).

The representative source used shall be documented in the test report.

6.4 Speed controls

Unless specific requirements for a particular product are given elsewhere in this document, speed controls shall be adjusted to approximately maximum speed and mid-range speed, and the highest disturbance level shall be recorded.

Once the setting of controls, which are not intended for frequent adjustment in normal use, has been pre-set by the manufacturer, it shall not be further adjusted during the test.

6.5 Multifunction equipment

Unless otherwise stated in this document, multifunction equipment may be required to comply with clauses in this document and clauses in other standards. In this case, the functions subjected to clauses of this document shall be operated in isolation from the functions subjected to clauses of the other standards, if this can be achieved without modifying the EUT internally. Where it is not practical to isolate a particular function, or where doing so would result in the EUT being unable to fulfil its functions, then the EUT shall be tested with the minimum number of functions operative, consistent with the equipment's intended use.

NOTE 1 An example of a multifunction appliance required to be tested to the relevant clauses of this document and another standard is an appliance with an Ethernet interface. In this case, the appliance would need to comply with the various requirements in this document and the Ethernet interface (communications function) would need to comply with the provisions of CISPR 32 (e.g. see 4.3.3.7).

Equipment tested as above shall be considered compliant when each of the functions subjected to this document has been found to be compliant with the requirements in this document.

NOTE 2 For multifunction equipment having all its functions subjected to this document, see 6.1 and Annex A.

6.6 Equipment with built-in luminaires

Equipment with a lighting function shall be tested with the lighting function switched on at the highest setting during the operating conditions specified in Annex A, unless otherwise stated in this document. If all requirements of this document are met, 6.5 shall not be applied for the lighting function.

Alternatively, if the lighting function of such equipment can be tested separately, then the lighting function may be tested according to the requirements in CISPR 15 with the remaining equipment being tested according to this standard with the lighting function not activated.

The lighting function need not be tested if it is not intended to be continuously switched on during normal operation.

NOTE A range hood is an example of a product where the lighting function is intended to be continuously switched on during normal operation. A refrigerator is an example of a product where the lighting function is not intended to be continuously switched on during normal operation, since the light is turned off when the door is closed.

6.7 Equipment incorporating IPT functions

The provisions specified in A.10 shall be applied to the operating modes during which the IPT is active. When doing so, functions that are not powered by energy obtained through IPT may be switched off and tested separately.

NOTE 1 For example, a display on an IPT charging cradle can be powered from energy obtained directly from the mains and not through the IPT power circuit.

NOTE 2 Examples of functions that can be tested separately are a display on an IPT charging cradle that can be turned off by the user or switched off automatically by the equipment, or an accessory that can be removed by the user.

The normal provisions other than those specified in A.10 shall be applied, as relevant, to operating modes during which the IPT is not active.

NOTE 3 For example, a massage apparatus can be charged using a dedicated IPT charging cradle (operating mode 1, case 3 in A.10) and used when the IPT charging has stopped (operating mode 2, A.1.5).

7 Compliance with this document

Where this document gives options for evaluating particular EMC characteristics with a choice of test methods and associated limits, any one of these options may be used.

The equipment complies with the requirements of this document with respect to the addressed EMC characteristics when one of the test methods results a test result compliant with the applicable requirements. In any situation where it is necessary to verify the original compliance assessment result, the option originally chosen shall be used to avoid excessive uncertainties induced by applying different test methods.

An EUT which fulfils the applicable requirements specified in this document is deemed to fulfil the requirements in the entire frequency range from 9 kHz to 400 GHz.

8 Measurement uncertainty

Where guidance for the calculation of the instrumentation uncertainty of a measurement is specified in CISPR 16-4-2:2011/AMD1:2014, this shall be followed. For these measurements the determination of compliance with the limits in this document shall take into consideration the measurement instrumentation uncertainty in accordance with CISPR 16-4-2:2011/AMD1:2014. Calculations to determine the measurement result and any adjustment of the test result required when the test laboratory uncertainty is larger than the value for U_{CISPR} given in CISPR 16-4-2:2011/AMD1:2014 shall be included in the test report.

9 Test report

Sufficient details shall be provided to facilitate reproducibility of the measurements. Accordingly, the test report shall include:

- a description of the EUT;
- information about the auxiliary equipment and associated equipment used and their coupling to the EUT;
- which modes of operation has been subjected to testing during each type of measurement and which settings have been applied (e.g. control set to position 3);
- which ports have been tested and how these ports were exercised, if applicable;
- any special measure taken to ensure compliance (e.g. the use of a shielded cable);
- photographs of measurement setups;

- information about the components of the measurement system and their position, where relevant (e.g. antenna distance, distance of the EUT to the reference ground plane);
- the assessed EMC characteristic, used measurement method and applied limits;
- the measurements values obtained according to the procedures detailed in 5.4;
- the frequency F_x of the highest clock frequency within the EUT (see 3.8.1);

In addition the test report may include:

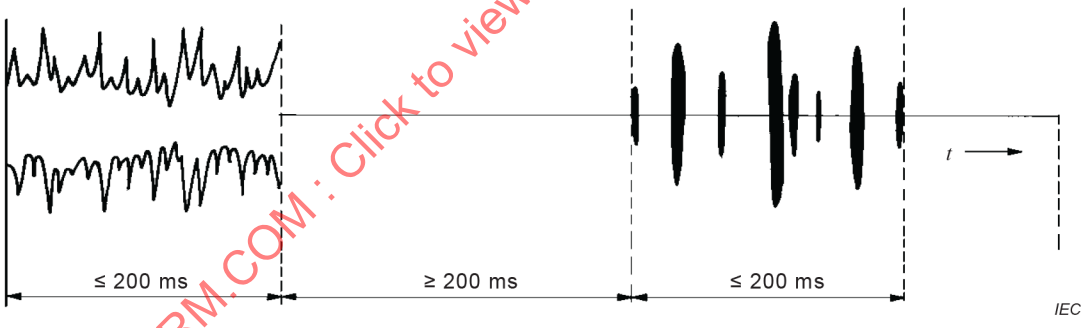
- the margin of each value from the limit;
- information about the laboratory measurement uncertainty and how this has been taken into consideration (see Clause 8).

One click

Disturbance consisting of a continuous series of impulses having duration not longer than 200 ms

One click

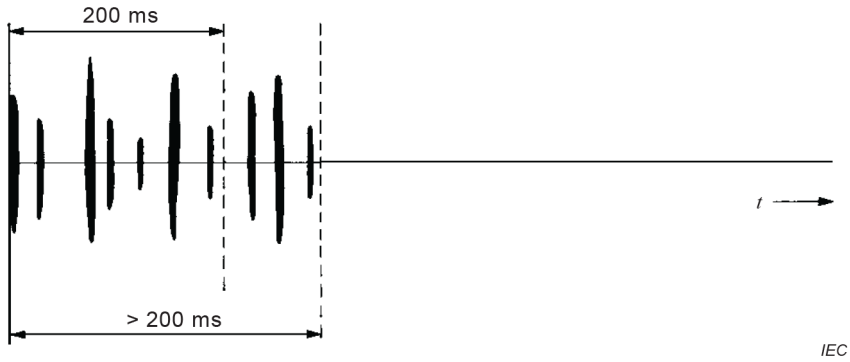
Sequence of short individual impulses having total duration not longer than 200 ms.



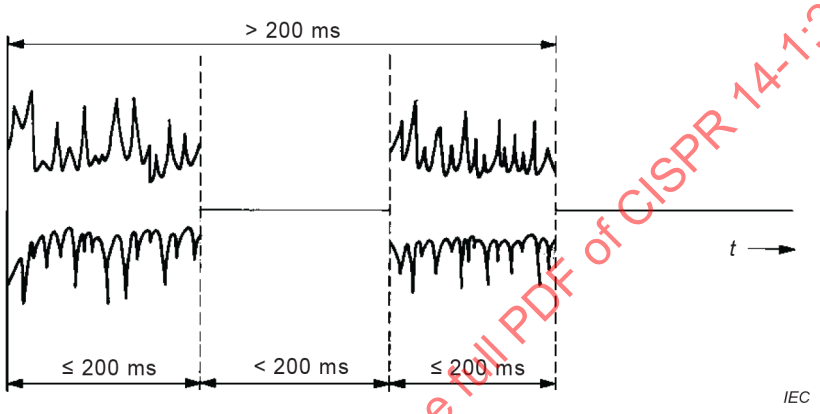
Two clicks

Two disturbances neither exceeding 200 ms, separated by at least 200 ms

Figure 3 – Examples of discontinuous disturbances whose duration and separation meet the definition of clicks (see 3.3.3)



Sequence of short individual impulses having duration shorter than 200 ms, separated by less than 200 ms and continuing for more than 200 ms



Two disturbances having duration not longer than 200 ms, separated by less than 200 ms and having a total duration of more than 200 ms

Figure 4 – Examples of discontinuous disturbance whose duration or separation do not meet the definition of click

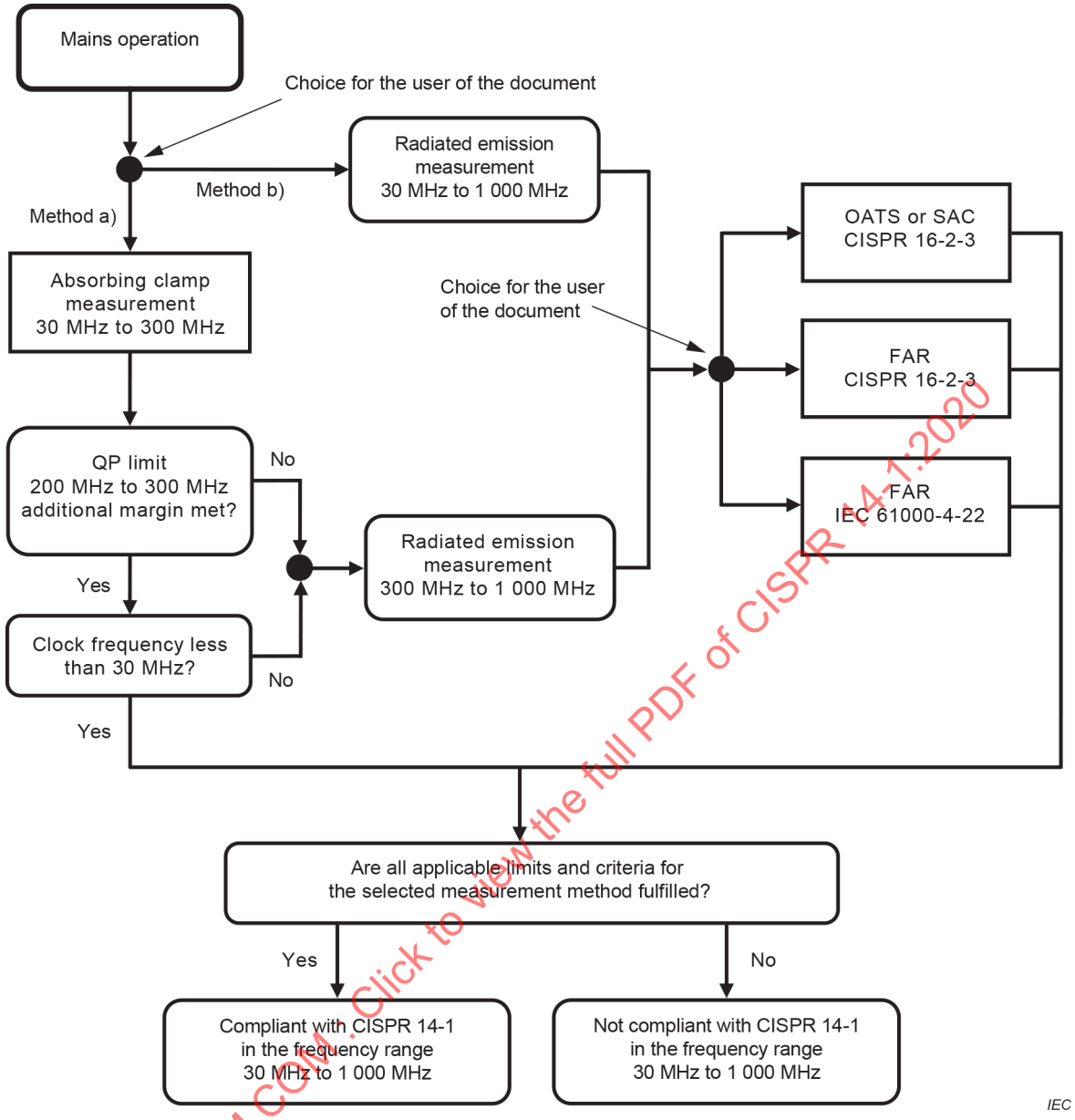


Figure 5 – Flow chart for emission measurements of mains operated equipment in the frequency range from 30 MHz to 1 000 MHz

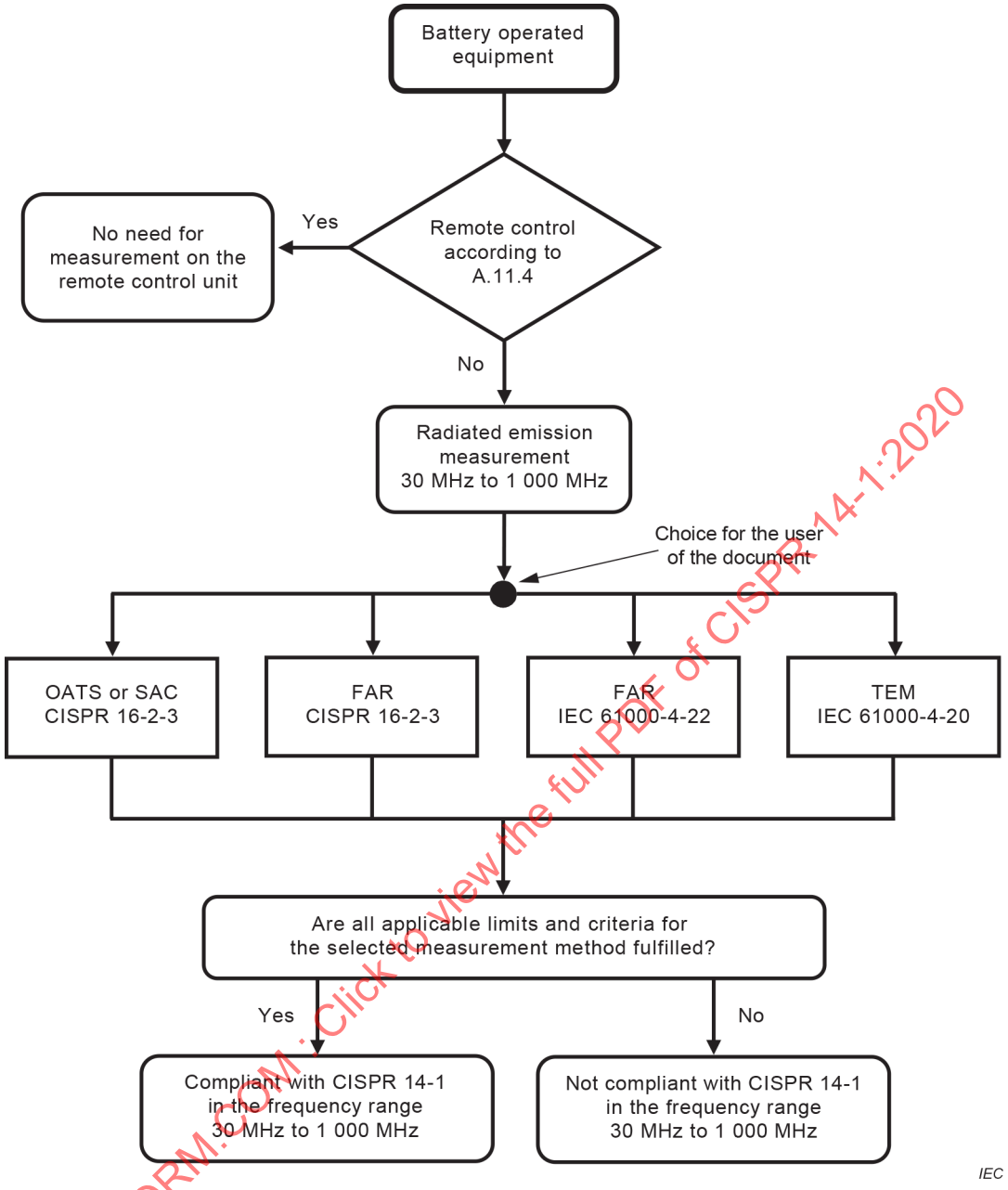


Figure 6 – Flow chart for emission testing of battery operated equipment in the frequency range from 30 MHz to 1 000 MHz

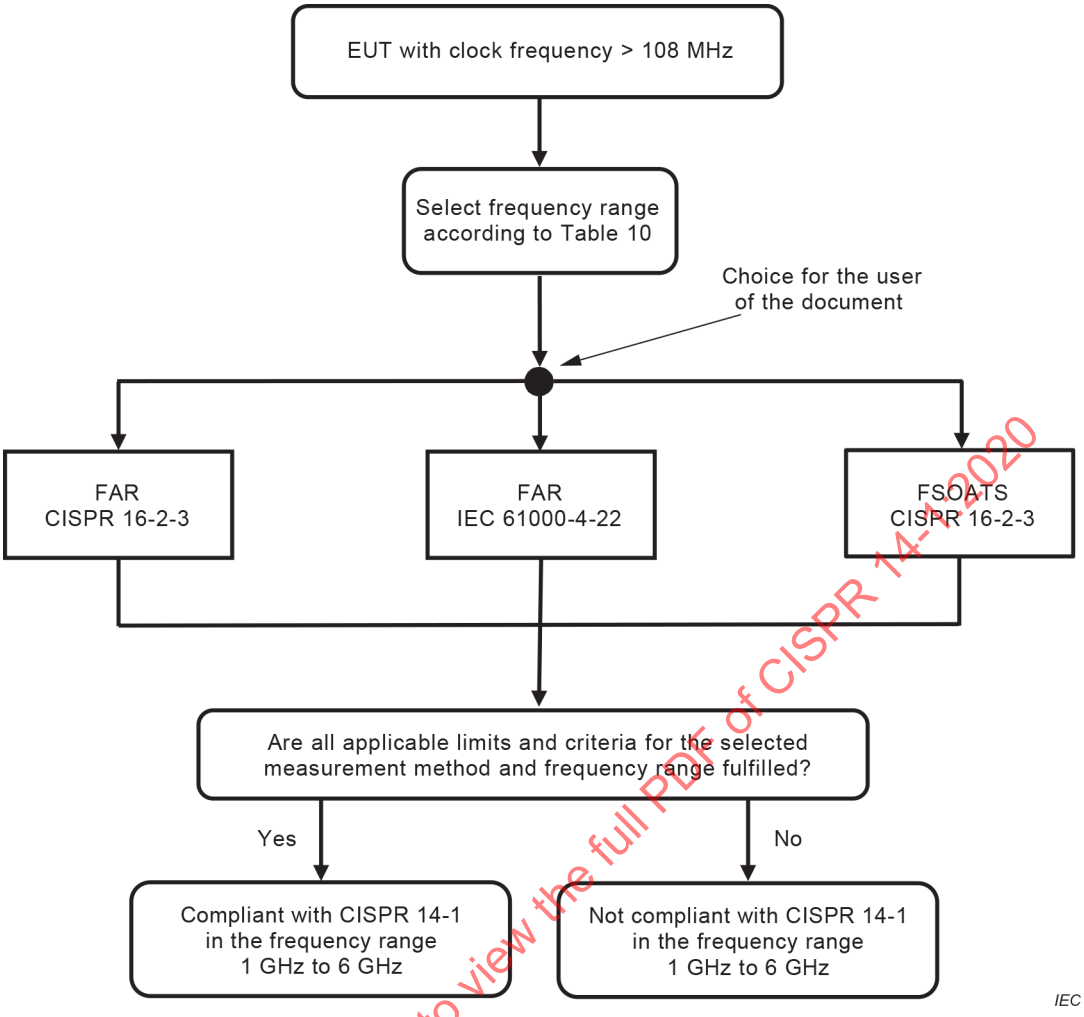


Figure 7 – Flow chart for emission measurements in the frequency range from 1 GHz to 6 GHz

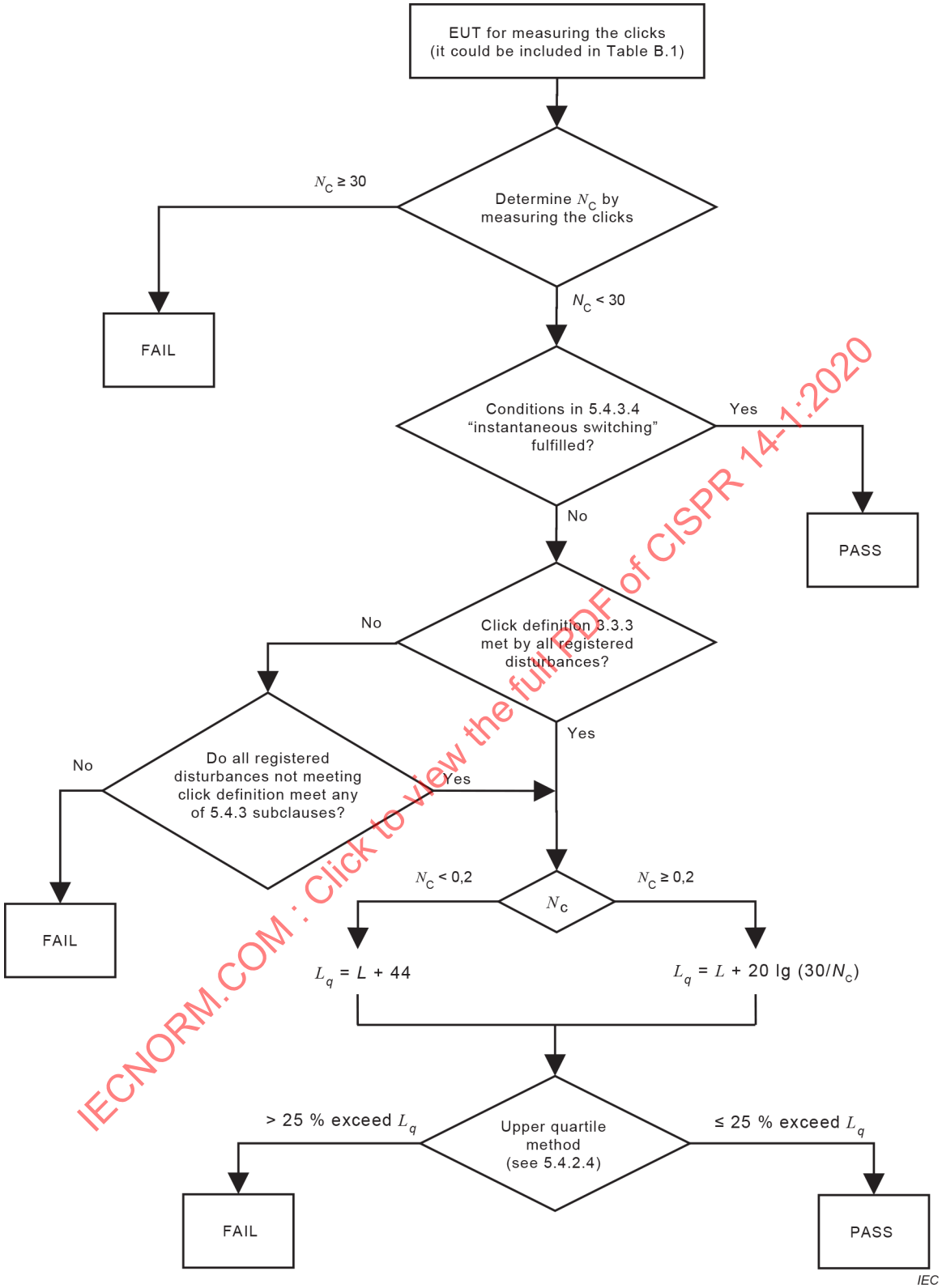


Figure 8 – Flow diagram for the evaluation of discontinuous disturbance, based on measuring the clicks

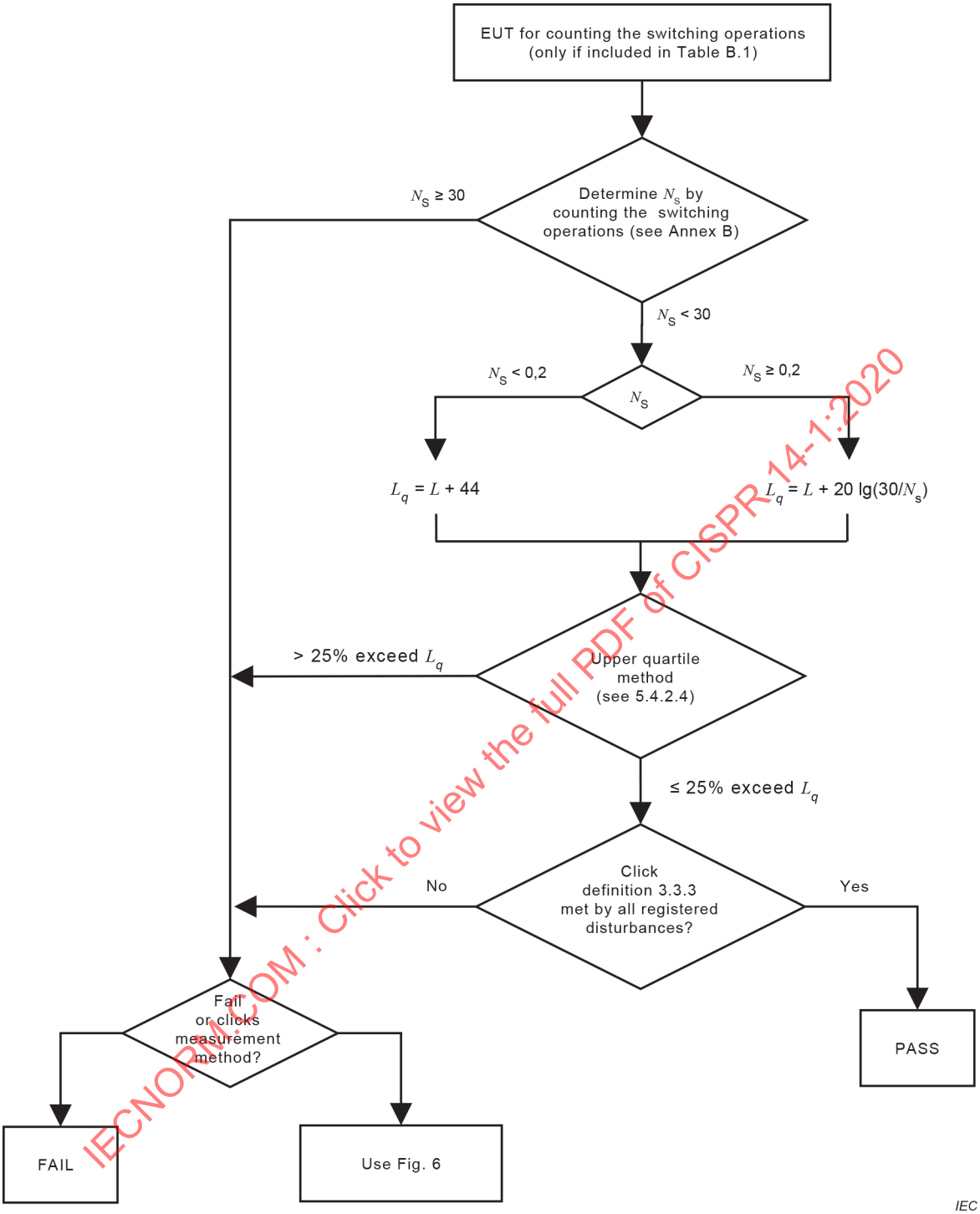
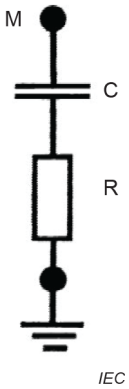


Figure 9 – Flow diagram for the evaluation of discontinuous disturbance, based on counting the switching operations

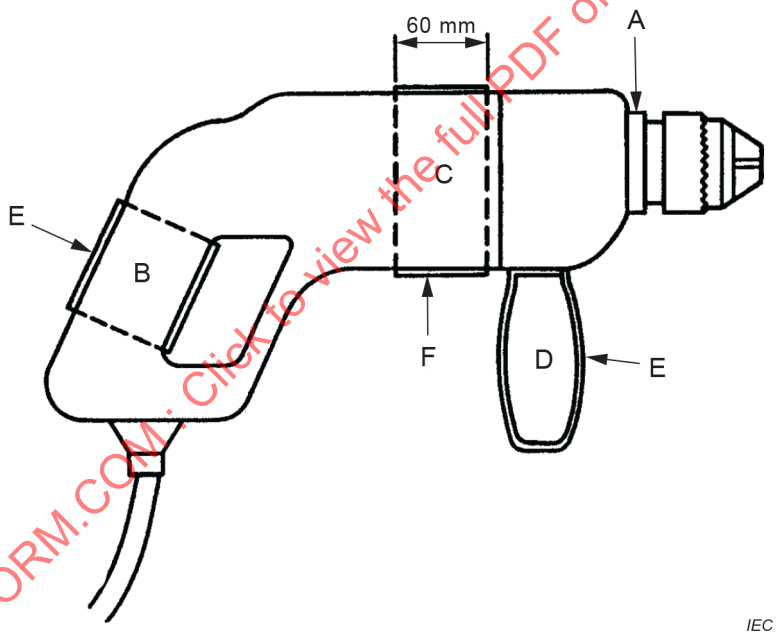


C 220 ± 44 pF

M RC element terminal

R 510 ± 51 Ω

Figure 10 – Artificial hand – RC element



A Ring or bushing

B Handle

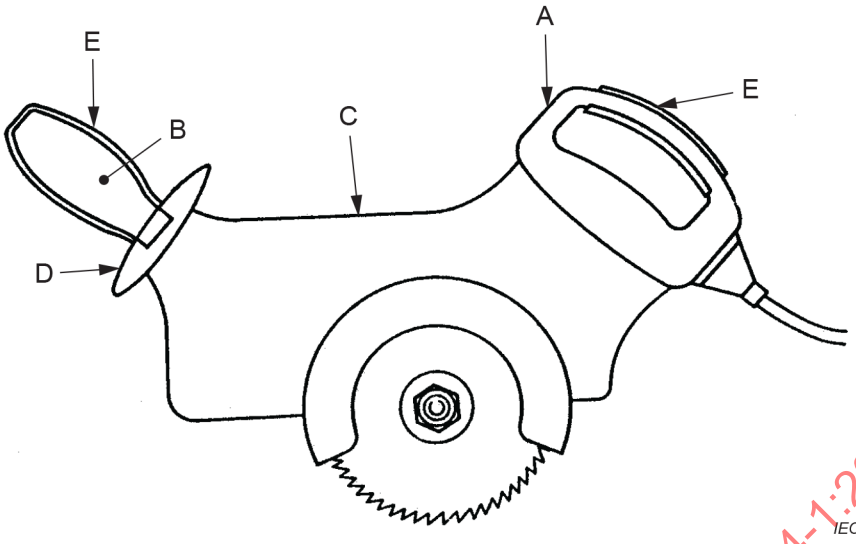
C Body

D Second handle (if fitted)

E Metal foil wrapped round the handle

F Metal foil wrapped around case in correspondence of the motor stator or gearbox

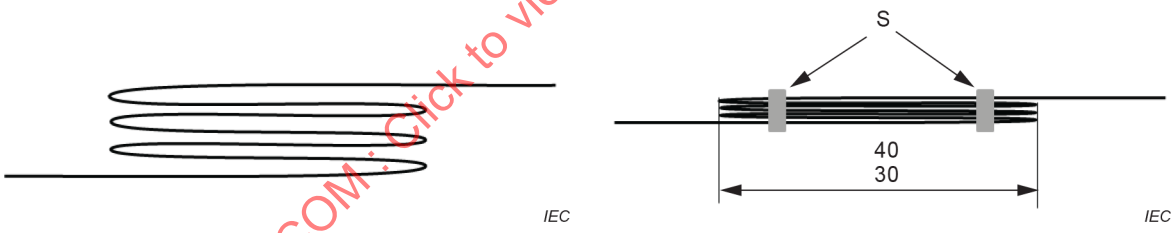
Figure 11 – Application of the artificial hand – Portable electric drill



A Insulated handle
B Insulated handle
C Metal body
D Guard (if fitted)
E Metal foil wrapped round handle

Figure 12 – Application of the artificial hand – Portable electric saw

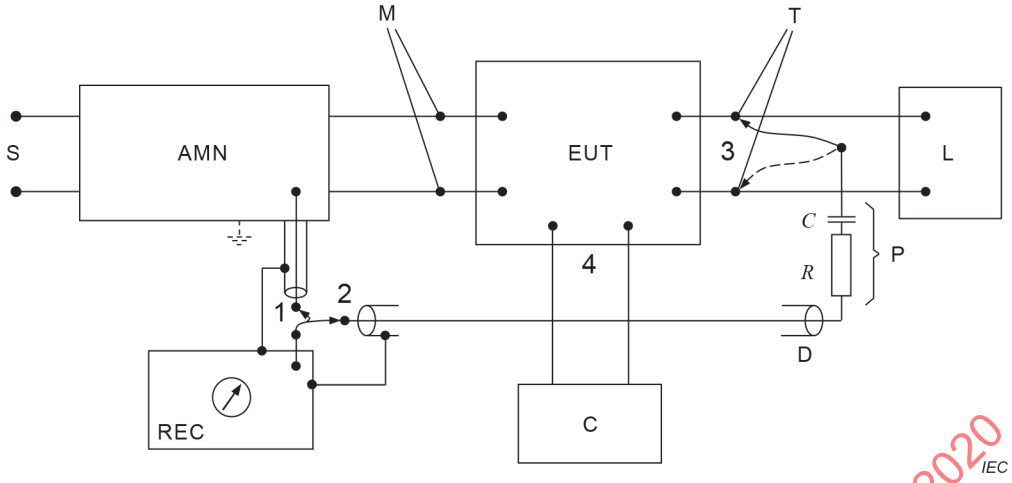
Dimensions in centimetres



a) Cable arrangement before final bundling **b) Bundled cable**

S Non-conductive fixing (e.g. cable ties or tape)

Figure 13 – Cable bundling



1 Switch position for mains port measurements. The input of the CISPR measuring receiver is connected to the output of the AMN.

2 Switch position for auxiliary ports measurements. When the switch is in this position, the output of the AMN shall be terminated by an impedance equivalent to that of the CISPR measuring receiver.

3 Connections for measurements to auxiliary port

4 Connections for measurements to auxiliary port. Measurement done identical as on 3.

C Auxiliary equipment (e.g. remote control)

D Coaxial cable; the length of the coaxial cable of the probe shall not exceed 2 m

L Auxiliary equipment (e.g. load)

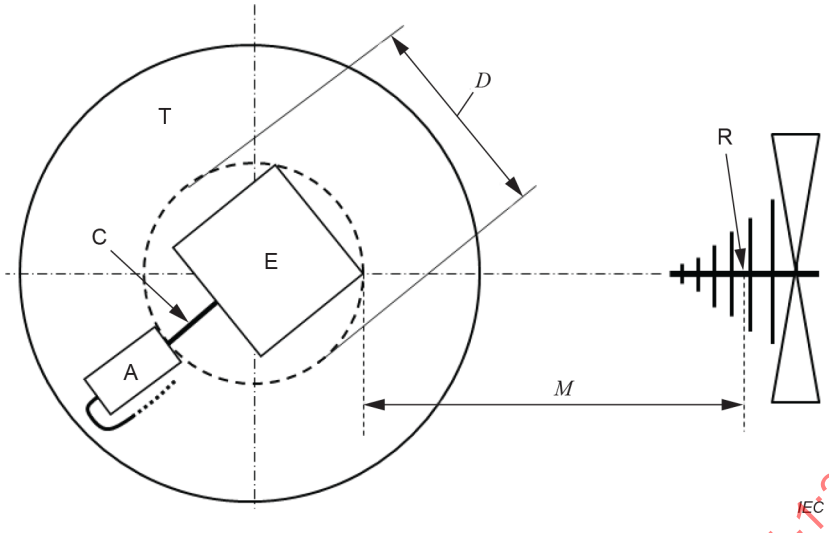
M Mains terminals

P Probe: $C \geq 0{,}005\ \mu F$, $R \geq 1\ 500\ \Omega$

S Supply voltage

T Load terminals

Figure 14 – Voltage probe measurement for mains powered EUT



A Common mode absorption device

C Cable(s) leaving the EUT and within the test volume of diameter D

D Diameter of the circle enclosing the EUT including the cables

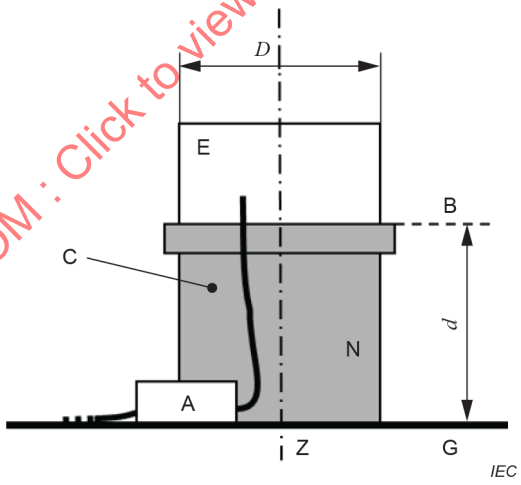
E EUT

M Measuring distance

R Antenna reference point

T Turntable

Figure 15 – Radiated emission – Location of the EUT on the turntable and measuring distance



A Common mode absorption device

B Bottom plane of test volume of FAR

C Cable(s) leaving the EUT and within the test volume of diameter D

D Diameter of the circle enclosing the EUT including the cables

d In SAC and OATS d is (0,8 ± 0,05) m; In FAR d is the distance between bottom plane of the test volume and floor

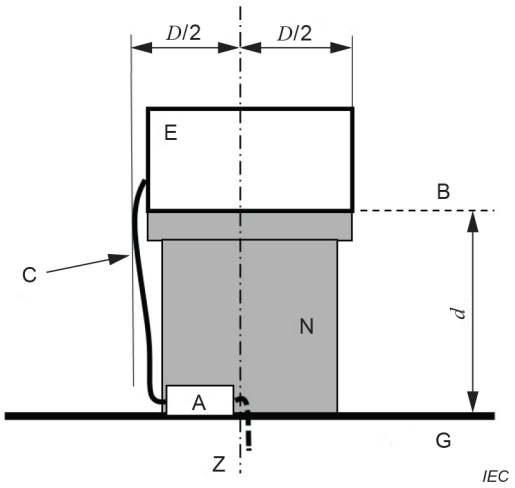
E EUT

G Ground plane of SAC and OATS (or floor of FAR)

N Non-conductive support

Z Centre of turntable

Figure 16 – Radiated emission – Example of test set-up for table-top EUT



A Common mode absorption device

B Bottom plane of test volume of FAR

C Cable(s) leaving the EUT and within the test volume of diameter D

D Diameter of the circle enclosing the EUT including the cables

d In SAC and OATS d is (0,8 ± 0,05) m; in FAR d is the distance between bottom plane of the test volume and floor

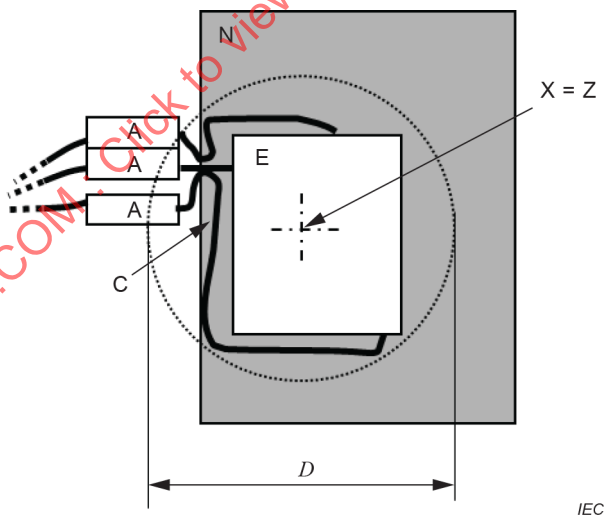
E EUT

G Ground plane of SAC and OATS (or floor of FAR)

N Non-conductive support

Z Centre of turntable

Figure 17 – Radiated emission – Example of test set-up for table-top EUT



A Common mode absorption device

C Cable(s) leaving the EUT and within the test volume of diameter D

D Diameter of the circle enclosing the EUT including the cables

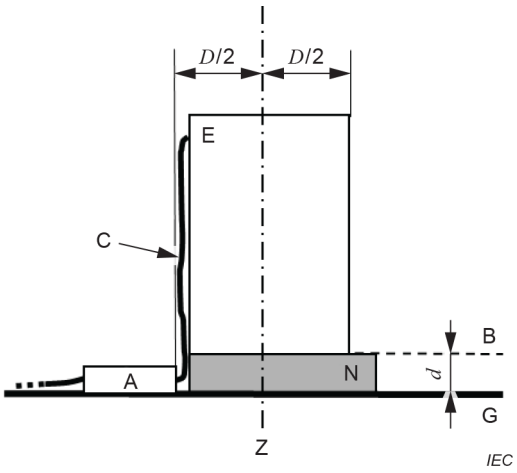
E EUT

N Non-conductive support

X Centre of circle enclosing the EUT and the cables

Z Center of turntable

Figure 18 – Radiated emission – Example of test set-up for table-top EUT (top view)



A Common mode absorption device

B Bottom plane of test volume of FAR

C Cable(s) leaving the EUT and within the test volume of diameter D

D Diameter of the circle enclosing the EUT including the cables

d In SAC and OATS d is (0,12 ± 0,04) m; in FAR d is the distance between bottom plane of the test volume and floor

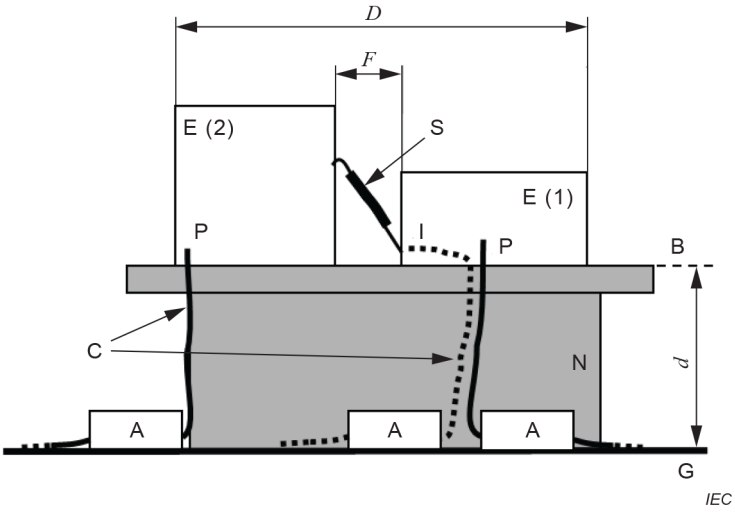
E EUT

G Ground plane of SAC and OATS (or floor of FAR)

N Non-conductive support

Z Centre of turntable

Figure 19 – Radiated emission – Example of test set-up for floor standing EUT



A Common mode absorption device

B Bottom plane of test volume of FAR

C Cable(s) leaving the EUT and within the test volume of diameter D

D Diameter of the circle enclosing the EUT including the cables

d In SAC and OATS d is (0,8 ± 0,05) m; in FAR d is the distance between bottom plane of the test volume and floor

E(1) EUT part 1

E(2) EUT part 2

F Distance between EUT(s) ≥ 0,1 m

G Ground plane of SAC and OATS (or floor of FAR)

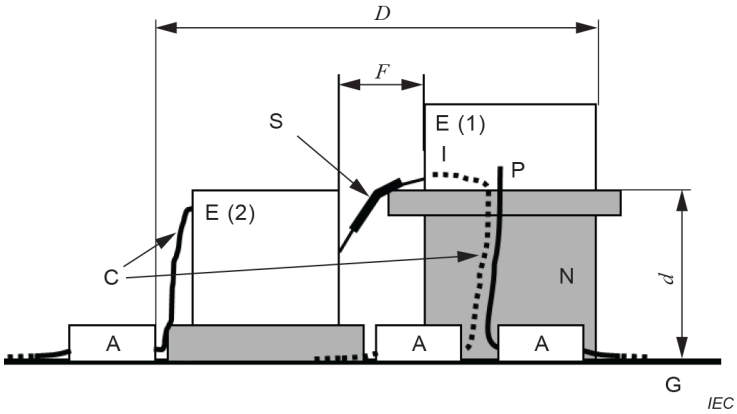
I Data cable

N Non-conductive support

P Mains cable

S Bundled inter-connecting cable

Figure 20 – Radiated emission – Example of the test set-up for an EUT made of multiple table-top parts



A Common mode absorption device

C Cable(s) leaving the EUT and within the test volume of diameter D

D Diameter of the circle enclosing the EUT including the cables

d In SAC and OATS d is (0,8 ± 0,05) m; in FAR d is the distance between bottom plane of the test volume and floor

E(1) EUT part 1

E(2) EUT part 2

F Distance between EUT(s) ≥ 0,1 m

G Ground plane of SAC and OATS (or floor of FAR)

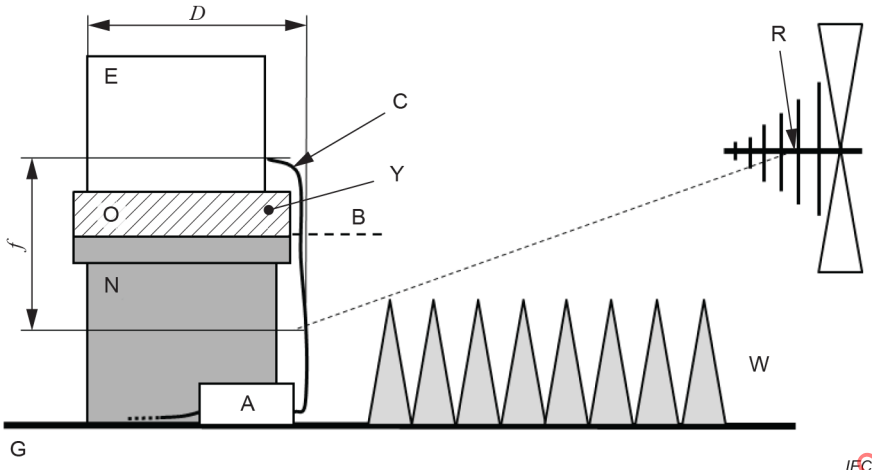
I Data cable

N Non-conductive support

P Mains cable

S Bundled inter-connecting cable

Figure 21 – Radiated emission – Example of the test set-up for an EUT in SAC or OATS, made of a combination of table-top and floor standing parts



A Common mode absorption device

B Bottom plane of test volume of FAR

C Cable(s) leaving the EUT and within the test volume of diameter D

D Diameter of the circle enclosing the EUT including the cables

E EUT

f At least 0,8 m

G Floor of FAR

N Non-conductive support

O Optional non-conductive support (see also Y)

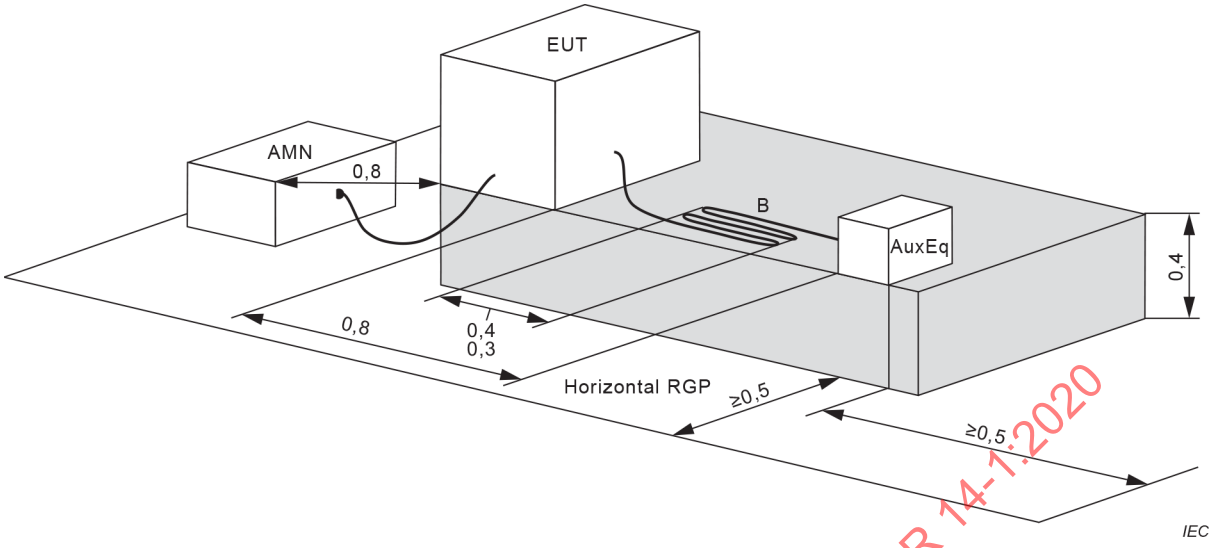
R Antenna reference point

W Floor absorbers

Y If necessary in the FAR the EUT has to be raised (using e.g. a non-conductive support) in order that at least 0,8 m of the cables leaving the test volume are visible from the antenna reference point

Figure 22 – Radiated emission – Height of the EUT in the FAR

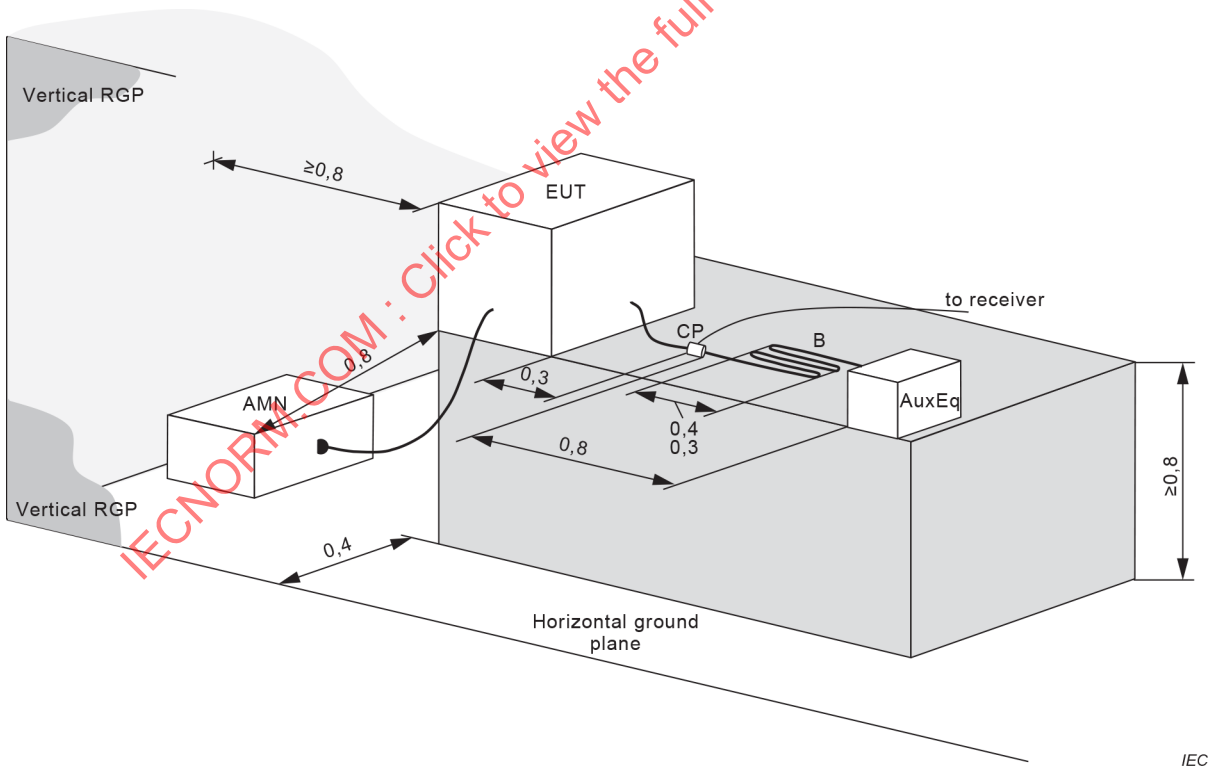
Dimensions in meters



B Auxiliary cable bundled

Figure 23 – Example of test setup for disturbance voltage measurements on table-top EUT (horizontal RGP)

Dimensions in meters

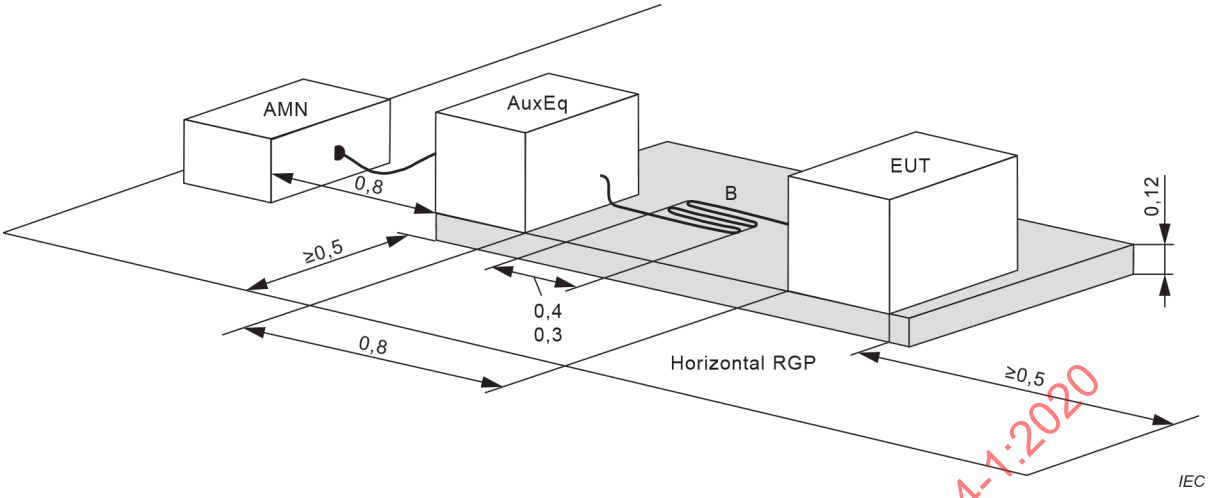


B Auxiliary cable bundled

CP Current Probe

Figure 24 – Example of alternative test setup (vertical RGP) for measurements on table-top EUT (disturbance voltage on mains port and disturbance current on auxiliary port)

Dimensions in meters



B Auxiliary cable bundled

Figure 25 – Example of disturbance voltage measurement arrangement for floor standing EUT(s)

Annex A
(normative)

Standard operating conditions and normal loads for specific equipment

A.1 Motor operated equipment for household and similar purposes

A.1.1 Vacuum cleaners

A.1.1.1 Vacuum cleaners shall be tested while operating continuously without accessories and with an empty dust container in place. Vacuum cleaners with a mains lead retracted by a cord reel shall be tested with the mains lead pulled out completely, and arranged in accordance with 5.2.2.1.

A.1.1.2 Disturbance voltage and disturbance current measurements are not applicable to leads integrated in the suction hose (see 4.3.3.3).

A.1.1.3 Where applicable, in addition to the measurement on the mains lead, the measurement of disturbance power shall be performed on leads integrated in the suction hose if the plug or socket of the leads is easily replaceable by the user. The measurement shall be performed by replacing the suction hose and its integrated lead with a cable of the necessary length, connected to the terminals on the main unit and having the same number of wires as provided in the originally submitted suction hose.

A.1.1.4 Power nozzles of vacuum cleaners shall be operated continuously without mechanical load on the brushes. The cooling, if necessary, shall be provided without unduly affecting the test results. The required cooling airflow shall be achieved without metallic fixtures in proximity of the nozzles.

If the power nozzle is connected by a non-extendable supply lead having a total length shorter than 0,4 m or if connected directly by plug and socket to the vacuum cleaner they shall be measured together. In all other cases, the EUT shall be measured separately.

A.1.1.5 When making radiated emission measurements, vacuum cleaners shall be assessed in accordance with the following arrangement:

– The vacuum cleaner shall be placed at a height according to the position for intended use and to the provisions of 5.3.4; i.e. if the part containing the motor (main body) will be used on the floor, then it shall be positioned as floor standing EUT, otherwise, as in the case of portable hand-held equipment, as table-top EUT. Electric nozzles shall be rotating in free air.
– Where the suction hose and/or associated non-flexible tube, if any, contain electrical parts, they shall be extended to the maximum length. The nozzle shall be positioned at a distance of (0,5 ± 0,1) m from the main body. The non-flexible part of the tube shall be positioned with an inclination of (30 ± 10)° between the tube and the vertical (See Figure A.3). The flexible part of the hose shall be arranged as in the first drawing in Figure A.3, with the hose coiled. The diameter of the coil shall be as large as possible, to allow the minimum number of turns, without touching the pallet. If the flexible part of the hose is too short to be coiled, then the arrangement in the second drawing of Figure A.3 may be used,
– Objects supporting the parts at the specified height/position shall be made of non-metallic material.

The mains lead shall be routed according to 5.3.4.3.2.

A.1.1.6 Robotic vacuum cleaners shall be tested according to the general requirements for robotic cleaners given in A.8.11. The general operating conditions of vacuum cleaners shall be applied and the suction inlet shall not be obstructed.

A.1.2 Floor polishers

Floor polishers shall be operated continuously without any mechanical load on the polishing brushes.

A.1.3 Coffee grinders and coffee makers

A.1.3.1 Coffee grinders

Coffee grinders shall be operated without load.

If it is not possible to operate the grinder without load, the grinder shall be operated after the hopper has been filled with the maximum quantity of roasted coffee beans stated in the instructions.

The coffee grinder shall be operated continuously for a time sufficient to complete the required measurements. However, when discontinuous disturbance measurements are applicable, coffee grinders with a timer shall be operated for the maximum duration allowed by the timer and this time shall be used as the programme time.

A.1.3.2 Coffee makers with integrated grinder

The grinder function shall be tested according to A.1.3.1.

The coffee brewing function may be tested with the coffee grinder or separately.

A.1.3.3 Automatic coffee makers

The different functions of automatic coffee makers shall be tested sequentially so that all possible disturbance sources are covered.

The test conditions shall reflect the normal operation of the equipment, as stated in the instructions for use. Where these are not specified, the following separate modes of operation shall be tested:

- keep warm mode;
- pre-heating for espresso coffee makers;
- 1 cup of coffee (approximately 125 ml) per minute;
- 200 ml hot water, followed by 30 s pause;
- 20 s steam consumption per minute.

A.1.4 Kitchen machines

Food mixers, liquid-mixers, blenders and liquidizers shall be operated continuously without load. For speed controls, see 6.4.

A.1.5 Personal care appliances with a motor

Motor operated personal care appliances (e.g. massage apparatus, epilators, dead skin removers) shall be operated continuously without load.

A.1.6 Fans

Ventilation fans shall be operated continuously with maximum airflow. If an electronic control of the airflow is used, 6.4 shall apply.

A.1.7 Extractors and range hoods

Extractor and range hoods shall be operated continuously with maximum airflow. If an electronic control of the airflow is used, 6.4 shall apply.

If the equipment includes lighting devices, 6.6 applies in addition.

A.1.8 Hair-dryers, fan heaters

Hair-dryers, fan heaters and similar equipment, shall be tested, where applicable, with any user selectable heating function turned on and off. The airflow shall be set at maximum unless an electronic control is provided, in which case 6.4 is applied. Any additional function (e.g. ionizer) shall be in operation during the test.

For the measurement of clicks, where applicable, 5.4.2 and 5.4.3 shall be followed.

A.1.9 Refrigerators and freezers

Refrigerators and freezers shall be operated continuously with the door closed. The thermostat shall be adjusted to the middle of the adjustment range. The cabinet shall be empty and not heated. The measurement shall be made after the steady state has been reached.

The light inside the cabinet shall be switched off during the measurement, unless it can be switched on by the user while the door is closed or it is continuously switched on during normal operation.

NOTE 1 The light in a wine cooler with glass door is an example for continuously switched on light.

If the clicks are not measured, the click rate N is determined from half the number of switching operations.

NOTE 2 Due to ice deposition on the cooling element, the number of switching operations in normal use is about half that compared with the refrigerator being empty.

A.1.10 Washing machines

Washing machines shall be operated with water but without textiles, the temperature of the incoming water shall be in accordance with the instruction for use.

Continuous disturbances are evaluated only during the normal washing-mode for cotton and the final spinning-mode with max speed.

For the evaluation of continuous disturbances, infrequent short term events are disregarded if they do not last more than a few seconds, e.g. during the start of a spin cycle.

For the evaluation of discontinuous disturbances a complete program cotton 60 °C without prewash, if available, is measured, otherwise the regular wash program without prewash is used.

NOTE For machines where the drying function forms a part of the programme, see A.1.12 or A.1.13.

Aqua-stop valves are not considered an auxiliary equipment within the meaning of this document and measurements need not be made on the lead to these valves.

During the measurement of disturbance power on the mains lead, the aqua-stop hose shall be connected to the water tap and located parallel to the mains lead on a length of (0,4 ± 0,05) m with a maximum distance of 0,1 m. Afterwards the measurements on the mains lead are carried out as described in 5.3.3.2.

A.1.11 Dishwashers

Dishwashers shall be operated with water but without dishes. The temperature of the incoming water shall be in accordance with the instruction for use. If there is no instruction for use or a choice is given between cold-fill and hot-fill then the cold-fill shall be used.

For the evaluation of discontinuous disturbances a complete program for heavily soiled dishes with the highest available temperature, without pre-wash, is used.

Aqua-stop valves are evaluated following the principles in A.1.10.

A.1.12 Tumble dryers

Tumble-dryers shall be operated with textile material in form of pre-washed, double-hemmed cotton sheets having dimensions of approximately 0,7 m × 0,7 m and a mass between 140 g/m^2 and 175 g/m^2 in dry condition.

Control devices are set to either the lowest or the highest position. The position that gives the highest click rate N shall be taken.

Separate tumble dryers are operated with half the maximum dry weight of cotton textile material recommended in the instruction for use. The material shall be soaked with water having a temperature of (25 ± 5) °C and a mass of 60 % of that of the textile material.

Tumble dryers combined with washing machines where the washing, spinning and drying operations are performed sequentially in the same container, are operated with half the maximum dry weight of cotton textile material recommended for the tumble dryer sequence operation in the instruction for use. The water content at the start of the dryer operation shall be that obtained at the end of the spinning operation after the previous washing operation.

A.1.13 Centrifugal dryers

Centrifugal dryers shall be operated continuously without load.

A.1.14 Razors and clippers

Razors and hair clippers shall be operated continuously without load, according to general operating conditions (see Clause 6).

A.1.15 Sewing machines

Sewing machines shall be operated so that their motors operate continuously at their maximum speed. The sewing gear shall be operational during the test but without a load (i.e. not sewing any material). See also A.11.1.2 or 6.4, where applicable.

A.1.16 Electro-mechanical office machines

A.1.16.1 Electric typewriters

Electric typewriters shall be operated continuously.

A.1.16.2 Paper shredders

The device shall be tested for continuous disturbances while the device is fed continuously with paper, resulting in continuous operation of the drive (if possible)

The device shall be tested for discontinuous disturbances while the device is fed with one single sheet at the time, allowing the motor to switch off between each sheet.

This process shall be repeated as quickly as possible.

The paper shall be suitable for typewriter or copying machine, and shall have a length between 278 mm and 310 mm independent of the dimensions for which the shredder is designed. The weight category shall be 80 g/m^2.

A.1.17 Projectors

A.1.17.1 Cine projectors

Cine projectors shall be operated continuously with a film, the lamp being switched on.

A.1.17.2 Slide projectors

Slide projectors shall be operated continuously without slides, the lamp being switched on.

To determine the click rate N, the picture change device shall be operated with the lamp switched on and with four picture-changes per minute without slides.

A.1.18 Milking machines

Milking machines shall be operated continuously without vacuum.

A.1.19 Lawn mowers

Lawn mowers shall be operated continuously without load.

A.1.20 Air conditioning equipment

A.1.20.1 If the air temperature is controlled by changing the time interval of operation of the compressor motor used in the equipment, or the equipment has heating device(s) controlled by thermostat(s), measurements shall be made according to the same operating condition as in A.4.14.

A.1.20.2 If the equipment is a variable capacity type which has inverter circuit(s) that control(s) the revolution of the fan or compressor motor, measurements shall be made with the temperature controller setting at the lowest position when in cooling mode, and at the highest position when in heating mode.

A.1.20.3 The ambient temperature for testing the equipment by A.1.20.1 and A.1.20.2 shall be (15 ± 5) °C when the equipment is operating in heating mode, and (30 ± 5) °C when it is operating in cooling mode. If it is impractical to keep the ambient temperature within this range, another temperature is also permissible, provided that the equipment operates in a stable manner.

The ambient temperature is defined at the temperature of the air flow to the indoor unit.

A.1.20.4 If the equipment consists of indoor and outdoor units (split type) the length of connecting refrigerant pipe shall be (5 ± 0,3) m and the pipe shall be coiled, where possible, to approximate a circular shape having a diameter of approximately (1 ± 0,3) m. If the pipe length cannot be adjusted, it shall be longer than 4 m, but not longer than 8 m.

For the measurement of disturbance power on the connecting leads between the two units, the leads shall be separated from the refrigerant pipe and extended to accommodate the clamp. For all other measurements of disturbance power and disturbance voltage the connecting leads between the two units shall be routed along the refrigerant pipe. Where an earthing conductor is required, but not included in the mains lead, the earthing terminal of the outdoor unit shall be connected to the reference ground (see 5.2.1, 5.2.2 and 5.2.3).

For disturbance voltage measurement the AMN shall be situated at a distance of 0,8 m from the unit (either the indoor or outdoor unit) which is connected to the AC mains network.

Alternatively, for the measurement of disturbance voltages or disturbance power, the test set-up in A.1.20.5 may be used.

In order to determine the starting frequency of the disturbance voltage or disturbance current test on ports other than the AC mains, if no specific information about the length of the connecting leads is given in the instructions for use, it shall be assumed that their length is always greater than 2 m but less than 30 m.

NOTE The length of the connection leads is expected to be always less than 30 m due to constraints imposed by the refrigerant pipe reach.

When the disturbance current probe method is selected to measure the disturbance from leads other than the mains routed along the refrigerant pipe, all leads and all refrigerant pipes should be clamped together. If this is impossible because of the overall size, only the leads and not the pipes may be clamped.

A.1.20.5 Radiated disturbance measurements shall be performed according to the following set-up.

Each unit shall be located as follows:

– Floor-standing units shall be placed on a non-metallic support of height between (0,12 ± 0,04) m from the ground plane;
– Units other than floor standing units shall be mounted at a height that is at least 0,8 m from the ground plane.

NOTE Examples of units not standing on the floor are units fixed to the ceiling (suspended or concealed), units for cassette, duct connected and wall mounted.

In all cases the units shall be supported by a structure made from a non-metallic material.

Interconnecting cables between units shall be routed along the refrigerant pipe and also shall be insulated from the ground plane by a non-conductive material such that they are between (0,12 ± 0,04) m above the ground plane.

It is permitted to use metal mountings for the installation of the EUT, if these are specified in the instructions for use.

A.2 Electric tools

A.2.1 General

A.2.1.1 For motor operated tools with two rotating directions, measurements shall be made for each direction after operating periods of 15 min for each direction, the highest of the two disturbance levels shall comply with the limit.

A.2.1.2 Electric tools that incorporate vibrating or swinging masses shall be tested with these masses disengaged. If it is not possible to disengage any mass, testing may be performed with the electric tool operated with the masses that cannot be disengaged.

NOTE These masses are typically disengaged by a clutch, a mechanical device or electrically disconnected by a switch.

A.2.1.3 Tools that operate from the AC mains via an EPS shall be tested according to the following procedure:

a) Conducted disturbances
   - the disturbance voltage shall be assessed by measurements made on the AC mains port of the EPS supplied, specified or recommended in the instructions for use;
   - where an EPS is not supplied, specified or recommended for use, or made available at the time of testing, the tool shall be supplied at its rated voltage (see 6.3.2) and the disturbance voltage or disturbance current shall be measured at the tool's power input port, in accordance with the requirements for auxiliary ports;

b) Radiated disturbances
   - the disturbance power shall be assessed by measurements made on the tool's power input cable;
   - if applicable, the radiated fields shall be measured according to the general measuring procedure;
   - where an EPS is not supplied, specified or recommended for use, or made available at the time of testing, the measurements shall be made with the tool supplied at its rated voltage (see 6.3.2) using a supply cable of suitable type.

A.2.2 Handheld (portable) motor-operated tools

Drills, impact drills, screwdrivers, impact wrenches, thread-cutting machines, grinders, disc-type and other sanders and polishers, knives and shears, planing machines and hammers, saws and other similar portable motor-operated tools shall be operated continuously without load.

A.2.3 Transportable (semi-stationary) motor-operated tools

Transportable (semi-stationary) motor-operated tools shall be operated continuously without load.

A.2.4 Soldering equipment, soldering guns, soldering irons and similar

Soldering equipment, soldering guns, soldering irons and similar equipment having a thermostatically or electronically controlled switch for setting the functional temperature shall be operated with these switches operating at their highest possible duty-cycle.

If there is a control device for the temperature, the click rate N, if any, shall be determined for a duty cycle of (50 ± 10) % of this control device.

For equipment repeatedly operated with a switch (e.g. soldering guns operated by a push button), where the only source of discontinuous disturbance is due to the operation of this switch, the duty cycle and the cycle duration specified in the instructions for use shall be used to determine the highest possible number of switching operation per minute.

A.2.5 Glue guns

Glue guns shall be operated continuously with a glue stick in working position; if clicks occur, the click rate N shall be assessed under steady-state conditions with the gun in stand-by position on the table.

A.2.6 Heat guns

Heat guns (blower for removal of paint, blower for plastic welding etc.) shall be operated as described in A.1.6.

A.2.7 Power staplers

The staples/nails compartment of power staplers and nail guns shall not be loaded, if the equipment can be operated in such condition. If the equipment cannot operate with no load, the longest staples/nails specified in the instructions for use shall be used while working on soft wood (e.g. pinewood).

When testing for continuous emission power staplers and nail guns shall be ready to operate but no strokes shall be applied.

For mains operated power staplers and nail guns, when measuring the discontinuous emission the click rate N, if any, shall be determined while operating the tool at 6 strokes per minute (i.e. successive strokes are separated by approximately 10 s), regardless of the product information or instruction for use.

A.2.8 Spray guns

Spray guns shall be operated continuously with the container empty and without accessories.

A.2.9 Internal vibrators

Internal vibrators shall be operated continuously in the centre of a round steel-plate container filled with water, the volume of the water being 50 times the volume of the vibrator.

A.3 Motor-operated electro-medical apparatus

A.3.1 General

Motor-operated electro-medical and similar equipment shall be operated continuously at their maximum speed and at no load condition.

A.3.2 Dental drills

For testing continuous disturbance of the dental drills, the motor shall be operated continuously at its maximum speed with the drilling apparatus operating, but not drilling a material.

For testing disturbance from switches or semiconductor controls, see A.11.1 or A.11.2.

A.3.3 Saws and knives

Saws and knives shall be operated continuously without load.

A.3.4 Electrocardiograms and similar recorders

Electrocardiograms and similar recorders shall be operated continuously with a tape or paper.

A.3.5 Pumps

Pumps shall be operated continuously with a liquid specified for intended use.

A.4 Electrical heating equipment

A.4.1 General

Before starting measurements the equipment shall reach steady-state conditions. The click rate N, if any, shall be determined for a duty-cycle of (50 ± 10) % of the control device, unless otherwise specified. If the duty-cycle of (50 ± 10) % cannot be reached, the highest possible duty-cycle shall be applied instead.

Temperature controlled heating equipment shall be set, for the determination of the click rate N, to the middle of their temperature range.

A.4.2 Hobs and hotplates

For equipment with multiple cooking zones the relevant measurements (e.g. clicks) shall be performed on each individual cooking zone in turn, i.e. during each measurement only one cooking zone is active.

Cooking zones shall be operated in the middle of the available setting range. A suitable pan or pot filled with water shall be placed on the element.

NOTE The induction cooking function, if any, is covered in A.9.

A.4.3 Cooking pans, table-type roasters, deep-fat fryers

Cooking pans, table-type roasters, deep-fat fryers shall be operated as in normal use. Unless a minimum oil level is specified the quantity of oil above the highest point of the heating surface shall be:

– about 30 mm for cooking pans;
– about 10 mm table-type roasters;
– about 10 mm for deep-fat fryers.

A.4.4 Feed boilers, water boilers, kettles and similar boilers

Feed boilers, water boilers, kettles, coffee makers with no grinder, coffee heaters, milk boilers, feeding-bottle heaters, glue pots, sterilizers, wash boilers, shall be operated half-filled with water and without lid. Immersion heaters shall be operated fully submerged. The click rate N, if any, shall be determined with a medium setting (60 °C) of a variable control device having a range between 20 °C and 100 °C or with the fixed setting of a fixed control device.

A.4.5 Instantaneous water heaters

Instantaneous water heaters shall be operated in usual position of use with the water flow set at half of the maximum flow rate. The click rate N shall be determined with the highest setting of any control device fitted.

A.4.6 Storage heaters

Thermal and non-thermal storage water heaters shall be operated in usual position of use, filled with typical quantity of water; no water to be drawn off during test. The click rate N shall be determined with the highest setting of any control device fitted.

A.4.7 Warming plates, boiling tables, heating drawers, heating cabinets

Warming plates, boiling tables, heating drawers and heating cabinets shall be operated with no load in the heating compartment or on the heating surface.

A.4.8 Cooking ovens, grills, waffle irons, waffle grills

Cooking ovens, grills, waffle irons and waffle grills shall be operated with no load in the heating compartment or on the heating surface (i.e. no food). Ovens doors shall be kept closed.

NOTE The microwave function, if any, is covered by CISPR 11.

A.4.9 Toasters

A.4.9.1 General

No discontinuous disturbance limits apply to toasters that generate only disturbances described in 5.4.3.4 (instantaneous switching).

Toasters shall be tested using as normal load slices of white bread about 24 h old (dimensions approximately 100 mm × 90 mm × 10 mm) to produce golden-brown toasts.

Discontinuous disturbances shall be tested according to A.4.9.2 or A.4.9.3.

A.4.9.2 Simple toasters

Simple toasters are toasters which:

– incorporate a manually operated switch for switching on the heating element at the start of the toasting cycle and which will switch off the heating element automatically at the end of a predetermined period, and

– incorporate no automatic control device to regulate the heating element during the toasting operation.

The click rate N, if any, shall be determined using the normal load, with the manual control set to give the required result (golden brown toasts). With the equipment in a warm condition, the average "on" time (t_1 seconds) of the heating element shall be determined from three toasting operations. A rest period of 30 seconds shall be allowed after each "on" time. The average time for a complete toasting cycle is (t_1 + 30) s, thus the click rate is:

$$N = \frac{2}{\frac{t_1}{60} + 0{,}5}$$

The toaster shall be operated for 20 cycles without load. Each cycle shall comprise an operating period and a rest period, the latter having sufficient duration to ensure that the equipment is cooled to approximately room temperature at the beginning of the next cycle. Forced air cooling may be used.

A.4.9.3 Other toasters

These toasters shall be operated using the normal load. Each cycle shall consist of an operating period and a rest period, the latter having a duration of 30 s. The click rate N shall be determined at a setting at which the bread becomes golden-brown.

A.4.10 Ironing machines

Ironing machines are ironing machines for table use, rotating ironing machines and ironing presses.

The click rate N_1, if any, of the heating function shall be determined with the heating surface being in the open position and the control at high temperature setting.

The click rate N_2, if any, of the motor shall be determined ironing two damp hand-towels, ironed per minute. The size of the towels is approximately 1 m × 0,5 m.

The click limit L_q is calculated by using the sum of the two click rates $N = N_1 + N_2$. This limit shall be applied to both the heating function and the motor function.

A.4.11 Clothes irons

Irons shall be operated with the soleplate cooled using air, water or oil cooling. The heating control shall be at a high temperature setting for a duty-cycle of (50 ± 10) %. The click rate N may be determined by counting the number of switching operations (f = 0,66 in Table B.1).

Clothes irons without production of steam shall be operated while placed on a 3-pointed metallic support that has a height of at least 100 mm, for the soleplate to rest in a horizontal position and cooled using fan-cooled air. The heating control shall be set to the middle of the highest temperature range available on the iron.

NOTE See IEC 60335-2-3:2012, 11.2 for an example of metallic support.

Clothes irons providing a steam function shall be set on the same support specified above for irons with no steam function. The additional cooling is not necessary.

The steam function shall be active. In particular:

- for irons that can provide continuous steam, the steam control shall be set to continuous steaming;
- for irons that can provide steam shots, the steam control shall be set to continuous steaming if possible or operate by shots at a cadence of 3 shots per minutes.

The test report shall specify the settings selected for testing.

Clothes irons may use Annex B for the clicks evaluation.

A.4.12 Vacuum packagers

Vacuum packagers shall be operated with empty bags once per minute or according to the instruction for use.

A.4.13 Flexible electrical heating equipment

Flexible electrical heating equipment (warming pads, electric blankets, bed warmers, heating mattresses) shall be spread between two flexible covers (e.g. non-conducting mats), extending beyond the heating surface by at least 0,1 m. The thickness and the heat conductivity shall be selected in such a way that the click rate N can be determined for a duty-cycle of (50 ± 10) % of the control device.

A.4.14 Air convection room heaters

Room heaters (convectors, fluid-filled heaters as well as oil and gas burners and similar equipment operating by air convection) shall be operated as in normal use.

The click rate N, if any, shall be determined for a duty-cycle of (50 ± 10) % of the control device or the maximum operating rate stated by the instructions for use.

The amplitude and duration of the disturbance shall be measured for the lowest position of the power range switch, if any.

For equipment having their thermostats and acceleration resistor connected to the mains, the same measurements shall be performed in addition with the switch in zero position.

When, in practice, the thermostat may be used together with inductive loads (e.g. relay, contactor) all measurements shall be performed using such a device, having the highest coil inductance used in practice.

In order to obtain a satisfactory measurement, it is essential that the contacts shall be operated for a sufficient number of times with a suitable load to ensure that the levels of disturbance are representative of those encountered in normal operation.

NOTE See also A.5 for room heating equipment intended to be used stationary.

A.4.15 Rice cookers

Rice cookers shall be tested with the rated capacity of tap water and with the lid closed. If there is no indication of the rated capacity, the cooker shall be filled with 80 % water of the maximum capacity of the inner pot.

In case of the rice cooker operating in induction heating function, measurement shall be made under the condition of maximum input power and the same conditions as specified in A.9.

If the cooker automatically enters a “keep warm”-mode at the end of the cooking process, the cooking mode should be ended manually and the click measurement shall be started at the time of the first operation of the thermostat, which controls the “keep warm” temperature.

A.5 Thermostats

A.5.1 General

Thermostats used for the control of specific equipment (e.g. electric room heaters, water heaters, oil and gas burners) are tested in accordance with the instructions for use at maximum load.

NOTE 1 This kind of thermostats could be integrated in equipment which they do not control.

When the thermostat is contained in the equipment to be controlled, the requirements of A.4 shall be applied.

For electro-mechanical thermostats, measurements of continuous disturbances shall not be made, only discontinuous disturbances shall be measured.

Thermostats for equipment intended for stationary use shall be allocated with a click rate N which is five times the click rate determined for a single, portable or removable room heater.

The click rate N shall be determined for the maximum operating rate stated by the manufacturer or – if sold for or together with a heater or burner – for a duty-cycle of (50 ± 10) % of this heater or burner.

The amplitude and duration of the disturbance shall be measured for the lowest rated current of the thermostat. For thermostats which have an acceleration resistor incorporated, the same measurements shall be performed in addition, without any separate heater connected.

NOTE 2 An acceleration resistor is an additional heating element that increases the switching rate of the thermostat in order to have a better temperature control.

When, in practice, the thermostat may be used together with inductive loads (e.g. relay, contactor) all measurements shall be performed using such a device, having the highest coil inductance used in practice.

In order to obtain a satisfactory measurement, the contacts shall be operated for a sufficient number of times with a suitable load to ensure that the levels of disturbance are representative of those encountered in normal operation.

A.5.2 Thermostatically controlled three-phase switches

Thermostatically controlled three-phase switches shall be treated as thermostats (see A.5.3.2). Where no specification is given, a click rate N = 10 shall be used.

A.5.3 Thermostats – Alternative procedure to that specified in A.5.1

A.5.3.1 General

For thermostats following this alternative procedure, 5.4.3.2, 5.4.3.4 and the flow diagram of Figure 6 are not applicable.

A.5.3.2 Thermostats for fixed room heating equipment

For thermostats, separate or incorporated in a control box, e.g. with timer, intended to be integrated in a fixed room heating installation, the manufacturer shall specify the maximum operating switching rate. The click rate N shall be derived from this specification. Failing that, a click rate N = 10 shall be used for the determination of L_q.

The thermostat shall be caused to operate for 40 contact operations (20 opening and 20 closing), either manually by actuating of the temperature setting means, or automatically by e.g. a hot/cold blower.

The amplitude and duration of the disturbance shall be measured for the lowest rated current of the thermostat. In the absence of a marked or a declared minimum rated current, a current equal to 10 % of the maximum rated current is used. The amplitude of no more than 25 % of the disturbances shall exceed the L_q level. For thermostats which have an acceleration resistor incorporated, the same measurements shall be performed in addition without any separate load connected.

When, in practice, the thermostat can be used together with inductive loads (e.g. relay, contactor) all measurements shall be performed using such a device, having the highest coil inductance allowed for by the manufacturer's specification.

Prior to test, it is essential that the contacts shall be operated for a hundred times with the rated load.

NOTE This is to ensure that the levels of disturbance are representative of those encountered in normal operations.

A.5.3.3 Thermostats for portable and movable room heating equipment

For portable and movable room heating equipment the manufacturer shall specify the maximum operating switching rate. The click rate N shall be derived from this specification and the procedure in A.5.3.2 shall be followed.

Where no specification is given, a click rate N = 10 shall be used, following the procedure in A.5.3.2, or the click rate N shall be determined for a duty-cycle of (50 ± 10) % of the control device. The procedure of Figure 6 shall be followed.

The power range switch, if any, shall be in the lowest position.

Prior to test, the contacts shall be operated for a hundred times with the rated load.

NOTE This is to ensure that the levels of disturbance are representative of those encountered in normal operations.

A.6 Automatic goods-dispensing machines, entertainment machines and similar equipment

A.6.1 General

For measurement of continuous disturbances, no special operating conditions are applicable. The EUT shall be operated according to the instruction for use.

In case of automatic machines, where individual switching processes are (directly or indirectly) manually operated, and whereby no more than two clicks per vending operation, dispensing or similar processes are produced, 5.4.3 is applicable.

A.6.2 Automatic dispensing machines

Three dispensing operations are to be carried out, each subsequent operation being initiated once the EUT has returned to a standby rest state. If the number of clicks produced by each of the dispensing operations is the same then the click rate N is numerically equal to one-sixth of the number of clicks produced in a single dispensing operation. If the number of clicks varies from operation to operation, a further seven dispensing operations are to be carried out and the click rate N shall be determined from at least 40 clicks on the assumption that the rest period between each dispensing operation was such that the 10 operations were uniformly distributed over a period of one hour. The rest period is to be included in the minimum observation time.

A.6.3 Juke boxes

An operating cycle is carried out by inserting the largest number of coins with the minimum value necessary to start the EUT, followed by the selection and playing of the corresponding number of pieces of music. This operating cycle is to be repeated as often as necessary to produce a minimum of 40 clicks. The click rate N is determined as being half the number of clicks per minute.

NOTE Due to the normal frequency of use and combination of coins, the number of clicks is taken as half that during the test observed.

A.6.4 Automatic entertainment machines incorporating a winnings-payout mechanism

Electromechanical devices incorporated in the EUT for storing and paying out winnings are to be disconnected where possible from the operating system to allow the entertainment function to be operated independently.

The entertainment cycle is initiated by inserting the largest number of coins with the minimum value necessary to start the EUT. The entertainment cycle is to be repeated as often as necessary to produce a minimum of 40 clicks. The click rate $N1$ is determined as being half the number of clicks per minute.

NOTE Due to the normal frequency of use and combination of coins, the number of clicks is taken as half that during the test observed.

The average frequency and value of the winnings-payout is to be supplied by the manufacturer. The click rate, $N2$, of the devices for storing and paying-out winnings are assessed by simulation of a win of the average value supplied by the manufacturer rounded off to nearest payout value. The simulation of this win is to be repeated as often as necessary to produce a minimum of 40 clicks. The winnings-payout mechanism click rate, $N2$, is thus determined.

To allow for the frequency of paying-out, the number of entertainment cycles used to determine $N1$ is multiplied by the average frequency of paying-out. This number of paying-outs per entertainment cycle is multiplied by $N2$ to produce an effective winnings paying-out mechanism click rate, $N3$.

The click rate for the machine is the sum of the two click rates, i.e. $N1 + N3$.

A.6.5 Automatic entertainment machines with no winnings-payout mechanism

A.6.5.1 Pinball machines

The pinball machine shall be operated by a reasonable player (one with at least 30 min experience of operating this or similar machines). The largest number of coins with the minimum value necessary to start the machine are used. The operating cycle is to be repeated as often as necessary to produce a minimum of 40 clicks.

A.6.5.2 Video machines and all other similar equipment

Video machines and other similar equipment shall be operated in accordance with the instruction for use. The operating cycle shall be the programme obtained after inserting the largest number of coins with the minimum value necessary to start the EUT. Where it is possible to select several programmes, the programme giving the maximum click rate shall be selected. Should the duration of the programme be less than 1 min, the following programme is not to be started within one minute off the start of the previous programme so as to reflect normal use. This rest period is to be included in the observation time. The programme shall be repeated as often as necessary to produce a minimum of 40 clicks.

A.7 Electric and electronic toys

A.7.1 General

Toys that do not contain active electronic circuits or brush motors are deemed to comply with the requirements of this document without testing (see also 4.1).

NOTE Examples are electric torches for children.

All other toys shall be tested in accordance with the operating conditions and test procedures specified in A.7.2.

A.7.2 Operating conditions

A.7.2.1 General

During the tests, toys shall be operated in normal conditions and according to intended use. Transformer toys shall be tested with an EPS selected according to A.11.3.

Dual supply toys shall be tested when supplied by the EPS and with the batteries inserted.

Auxiliary equipment (e.g. video toy cartridges) that is separately sold and intended for use with different toys, shall be tested with at least one appropriate representative hosting toy, selected according to the instructions for use, The hosting toy is to be representative of series produced equipment and shall be typical.

A.7.2.2 Electric toys running on tracks

Electric toys sold as a complete package shall be tested together, e.g. with the moving element running on the tracks provided and operated via any control device provided in the package.

For the test, the toy shall be assembled in accordance with the instructions accompanying it. The layout of the track shall be that having the largest area. Other components shall be arranged as shown in Figure A.2.

Each moving element shall be tested separately while running on the track. All moving elements which are in the package shall be tested and the toy shall also be tested with all moving elements operating simultaneously. All self-propelled vehicles contained in the toy shall operate simultaneously but the other vehicles shall not be on the track. The toy is tested in the most unfavourable configuration, these conditions being assessed for each test.

If toys running on tracks have identical moving components, control devices and track and differ only by the numbers of moving elements, the tests are only carried out on the toy which contains the greatest number of moving elements in one package. If this toy complies with the requirements, the other toys are considered as complying with the requirements without being further tested.

Individual components of a toy which have been found to comply with the requirements as part of a toy, do not require further testing even when sold separately.

Individual moving elements, not already approved as part of a toy, shall be tested on an oval track having dimensions 2 m × 1 m. The track, cords and control device shall be selected from those specified in the instructions for use of the individual moving element. If such accessories are not supplied, the tests shall be carried out with accessories considered as appropriate by the testing organisation.

A.7.2.3 Experimental kits

A few set-ups of the experiments specified by the manufacturer for the normal intended use are subjected to EMC tests. The selection is made by the manufacturer, but from those with the highest interference potential.

A.8 Miscellaneous equipment

A.8.1 Time switches not incorporated in equipment

The switch is adjusted to maximize the number of switching operation n_2. The load current shall be (10 ± 1) % of the maximum rated value. Unless otherwise specified by the manufacturer, the load shall be resistive.

No discontinuous disturbance limits apply if only disturbances described in 5.4.3.4 (instantaneous switching) are generated.

For switches employing a manually operated "on" and automatic "off", the average "on" time (t_1 seconds) shall be determined from three successive operations while the switch is adjusted to maximize the value of n_2. A rest period of 30 s shall be allowed. The average time for a complete cycle is (t_1 + 30) s, thus the click rate is:

$$N = \frac{2}{\frac{t_1}{60} + 0{,}5}$$

A.8.2 Electric fence energizers

When measuring the disturbance voltage at the fence port of the electric fence energizer, the fence wire shall be simulated by a RC equivalent circuit comprising a 10 nF capacitor in series with a 250 Ω resistor. The capacitor shall be rated to withstand surge voltages at least equal to the no-load output voltage of the electric fence energizer. The leakage resistance of the fence wire is represented by a 500 Ω resistor placed in parallel to the fence port. The connections are as shown in Figure A.1.

NOTE 1 The characteristic impedance of the combination AMN-receiver provides the 50 Ω balance of the required 300 Ω load resistance.

For the measurements on the fence port a constant correction factor of 16 dB shall be added to the measured values from 150 kHz to 30 MHz.

NOTE 2 The real voltage division factor is affected by the AMN impedance curve and it is acceptable to use 16 dB as average value between over and under compensation.

Other tests, where applicable, shall be made using the same load at the fence port, as specified for the disturbance voltage measurements.

During the tests, the EUT shall be operated in the normal position with a maximum inclination of 15° from the vertical position.

The controls accessible without tools shall be set to the position producing the maximum emission level.

The earth terminal of the fence circuit shall be connected to the earth terminal of the AMN. If the terminals of the fence circuit are not clearly marked, they shall be earthed in turn.

NOTE 3 In order to avoid damage to the RF input of the measuring receiver by the high voltage pulses of the electric fence unit, it is good practice to insert an attenuator before the RF input of the receiver.

Electric fence energizers designed to be operated with both AC and DC supply shall be tested with both types of supply.

A.8.3 Electronic gas igniters

A.8.3.1 General

The disturbance caused by manually operated single spark on demand electronic gas igniters, which operate only when a switch included for the purpose of mains connection or disconnection operates, is to be disregarded according to 5.4.3.2 (for instance central heating boilers and gas fires are excluded, but not cooking equipment).

Other equipment incorporating electronic gas igniters shall be tested without gas being applied to the equipment as described in the next subclauses.

A.8.3.2 Single spark on demand igniters

Determine whether disturbance is continuous or discontinuous as follows:

Produce 10 single sparks with not less than 2 s between sparks. If any click exceeds 200 ms, the continuous disturbance limits of Table 5 apply. When the conditions of the click duration in 5.4.3.4 "instantaneous switching" are fulfilled, it is assumed that the click rate is not more than five and there is no limit on the amplitude of the click produced.

Otherwise, the click limit L_q shall be determined using an empirical click rate N = 2. This click rate is an assumed practical value, which gives a click limit L_q 24 dB above the continuous disturbance limit L.

The igniter shall be tested for 40 sparks with a minimum of 2 s between each spark,

A.8.3.3 Repetitive igniters

Determine whether the disturbance is continuous or discontinuous as follows:

Operate the igniter to produce 10 sparks.

If either,

a) any disturbance exceeds 200 ms, or
b) any disturbance is not separated from a subsequent disturbance or click by at least 200 ms, the continuous disturbance limit of Table 5 applies.

When measuring continuous disturbances the igniter equipment shall be switched on during the whole test. A resistive load of 2 kΩ shall be placed across the discharge path.

If all clicks are less than 10 ms, it is assumed that the click rate N is not more than five and in accordance with 5.4.3.4, there is no limit on the amplitude of the clicks produced.

If one of the 10 clicks has a duration more than 10 ms but less than 20 ms for the application of the exception in 5.4.3.4, the duration of at least 40 clicks has to be evaluated.

If the exception in 5.4.3.4 cannot be applied, the click limit L_q shall be calculated using an empirical rate N = 2. This click rate is an assumed practical value which gives a click limit L_q of 24 dB above the continuous disturbance limit L.

The igniter shall be tested for 40 sparks.

A.8.4 Insect killers

A resistive load of 2 kΩ shall be placed across the discharge path

NOTE Normally only continuous disturbance can be observed.

A.8.5 Personal care appliances without a motor

Personal care appliances that do not incorporate a motor shall be operated with the control set to maximum.

A.8.6 Air cleaners

Air cleaners shall be operated at maximum airflow (e.g. maximum speed of the fan) under normal working conditions and surrounded by a sufficient volume of air.

Any additional function (e.g. humidifier, plasma ions generator) shall also be active.

A.8.7 Steam generators and humidifiers

Steam generators for domestic use or for use in hotels and public baths, e.g. for indirect heating, shall be operated using a quantity of water as specified in the instructions for use.

If a fan is incorporated in the steam generator, it shall be active and its control shall be set to maximum.

The same operating conditions shall apply to humidifiers.

NOTE Regardless of the technology used (e.g. ultrasonic, heat exchange, evaporative) steam generators and humidifiers have similar load characteristics (e.g. a tank to be filled with water).

A.8.8 Battery chargers other than IPT chargers

Non IPT battery chargers which are not incorporated in, or supplied with, the equipment to be charged, shall be measured in a manner similar to 5.2.3 with the mains supply port connected to an AMN.

The output terminals of the charger shall be connected to a variable representative load (e.g. a variable resistor) designed to ensure that the rated charge current or voltage to be controlled can be obtained.

For each applicable test a measurement with no load and maximum specified load shall be performed.

When a fully charged battery is required for correct operation of the charger, the representative load may include a battery and this shall be connected in parallel with the variable representative load.

Non IPT battery chargers that would not operate as intended when connected to a resistive load or a fully charged battery shall be tested after being connected to a battery that is partially charged.

A.8.9 External Power Supplies (EPS)

The requirements in this subclause shall apply to EPS intended to be used with equipment in the scope of this document. These requirements may be used for testing EPS which are marketed separately from the equipment to be powered.

NOTE See A.11.3 for equipment that is operated from EPS.

Mains operated EPS shall be measured with the auxiliary port connected to a variable representative load designed to ensure that the rated current or voltage to be controlled can be obtained. Unless specified otherwise (e.g. in the instructions for use), a resistive load shall be used.

For each applicable test a measurement with no load and maximum specified load shall be performed.

For DC powered EPS the same load requirements for AC mains operated EPS shall apply. The DC input port shall be connected directly to the DC supply source and the test conditions of 6.3 shall be applied.

A.8.10 Lifting devices (electric hoists)

To be operated in intermittent action without load.

The click rate N shall be determined with 18 working cycles per hour; each cycle shall comprise:

a) on hoists having only operating speed: lift; pause; lower; pause;

b) on hoists having two operating speeds with both the following cycles, alternating:

– Cycle 1: fine lift (creep speed); lift (full speed); fine lift; pause; fine lower; lower (full speed); fine lower; pause;
– Cycle 2: fine lift; pause; fine lower; pause.

In order to reduce the duration of tests the cycles may be accelerated, but the click rate is calculated on the basis of 18 cycles per hour; care should be taken not to damage the motor by exceeding duty cycle.

For any traction drive a similar test shall be made.

Lifting and traction shall be measured and evaluated separately.

A.8.11 Robotic equipment

A.8.11.1 General

Batteries for mobile parts shall be fully charged when starting each test. During the test, the battery condition shall be adequate to maintain normal operating conditions. If the battery charge is depleted down to a level for which normal operating conditions are not maintained, in order to complete the test the battery shall be recharged or replaced with one of the same type, which is fully charged.

Where the mobile part is powered through a cable, the cable shall be of the necessary length to enable the movements of the mobile part within the test setup as provided in A.8.11.2, A.8.11.3 or A.8.11.4, as appropriate.

The TEM-waveguide measuring method shall not be used for performing radiated emission measurements on robotic equipment which is not intended for operation along the orientations used for TEM test.

A.8.11.2 Mobile parts – Horizontal operation

This type of robotic equipment is intended to move according to a pattern parallel to the ground or with an inclination less than 45°.

NOTE 1 Examples are robotic cleaners that move on the floor of a house or the benchtop of a kitchen.

During testing the mobile part of the robotic equipment shall be maintained stationary, with the electronic control (microprocessors and sensors) operating in order to fulfil its intended functions. Motors (e.g. brush motors, traction motors, suction motors) shall be operating under normal conditions. Tools and traction means (e.g. brushes, wheels or tracks) shall be operated continuously, but without mechanical load.

NOTE 2 Robotic equipment which utilise a program that gives the equipment a kind of artificial intelligence might not be able to operate the intended functions while stationary. In such case, a special software mode (e.g. “EMC testing mode”) to be included in the software by the manufacturer is generally used to achieve the above mentioned operating conditions.

The mobile part shall be placed at a height above the ground reference plane of the test site selected for measurement according to the requirements of 5.2.1.1 and 5.3.4.3.1, as applicable (i.e. floor standing or table-top configuration for conducted and radiated measurements respectively).

Where robotic equipment have sensors that stop the intended functions when not in contact with the surface they operate on (e.g. in order to prevent access to hazardous moving parts), a support can be used to achieve the above mentioned conditions (for example an idle roller, see Figure A.4).

The roller or any support used to maintain the mobile part of the robotic appliance to the required height shall be made of non-conductive material and shall be placed directly on the reference plane of the test site selected for measurement.

NOTE 3 The idle roller has no own drive, it only supports the robotic equipment and allows the wheels to turn while the appliance stays on the spot. The roller can provide an alternative or be of complement to the EMC testing mode software.

A.8.11.3 Mobile parts – Operation other than horizontal

This robotic equipment is intended to move according to a pattern not parallel to the ground, with an inclination greater than 45°, but typically vertical.

NOTE 1 Examples are robotic window cleaners that move on one or both sides of a window.

During testing, the mobile part of the robotic equipment shall be operated freely on a vertical test surface having a size (1,0 ± 0,2) m × (1,0 ± 0,2) m, unless specified differently in A.8.11.4. The electronic control (microprocessors and sensors) shall be operating in order to fulfil the intended functions. Motors (e.g. brushes, blades, traction motors, suction motors) shall be operating under normal conditions. Tools and traction means (e.g. brushes, blades, wheels or tracks) shall be operated continuously.

NOTE 2 It is expected that the robotic equipment is able to operate normally on the test surface without particular arrangements. Otherwise, a special software mode (e.g. “EMC testing mode”) to be included in the software by the manufacturer is generally used to achieve the above mentioned operating conditions.

The vertical test surface shall be placed at a height above the ground reference plane of the test site selected for measurement, according to 5.2.1.1 and 5.3.4.3.1, as applicable (for conducted and radiated measurements respectively). See Figure A.7.

The vertical test surface shall be made of non-conductive material suitable for the type of equipment to be tested and shall be sufficiently even in order to keep constant the load of the parts in contact with it.

A.8.11.4 Specific test conditions for robotic equipment

Robotic vacuum cleaners shall be tested stationary according to A.8.11.2.

Electrical robotic lawn mowers shall be tested stationary according to A.8.11.2.

Robotic window cleaners shall be tested according to A.8.11.3 using a rectangular vertical test surface made of glass. The size of the test surface shall be (1,0 ± 0,2) m × (1,0 ± 0,2) m and its thickness shall be (10 ± 2) mm. However, the thickness may be different if this is necessary to allow the movement of split-type window cleaners.

Other robotic equipment shall be tested following the requirements of either A.8.11.2 or A.8.11.3, according to the inclination of the intended operating pattern of the mobile part.

A.8.11.5 Stationary parts

The stationary parts of robotic equipment shall be placed according to the intended use.

NOTE For example, the docking station and docked robotic vacuum cleaner are placed as floor standing equipment; a docking station and robotic equipment for kitchen counter use are placed as table-top equipment.

Stationary parts of robotic equipment (e.g. a docking station) shall be tested in the following conditions:

1) Mobile part docked
   - charging the battery of the mobile part continuously; a fully discharged battery shall be used when starting the test;

– operating any other function that may be active when the mobile part is docked.

2) Mobile part not docked

– operating any function that may be active when the mobile part is not docked (e.g. border detection or mobile part detection).

A.8.12 Other robotic equipment

The requirements of A.8.11 should be used as guidance for setting the operating conditions of other types of robotic equipment.

A.8.13 Clocks

Clocks shall be operated continuously.

A.9 Induction cooking appliances

A.9.1 General

During the tests the vessel is filled with tap water to about 50 % of its maximum capacity.

Standard cooking vessels (dimension of the contact surface) are:

– 110 mm,
– 145 mm,
– 180 mm,
– 210 mm,
– 300 mm.

Measurements shall be made with enameled ferromagnetic steel vessels. If this is not possible, the vessel selected for testing shall be in accordance with those specified by in the instructions for use.

The vessel bottom shall be concave and shall not deviate from flatness by more than 0,6 % of its diameter at the ambient temperature (20 ± 5) °C.

A.9.2 Operating conditions for EUT with fixed cooking zone(s)

Cooking zones shall be operated separately in sequence.

Energy controller settings shall be selected to give the maximum input power including boost mode.

The position of the vessel shall match the hob marking on the plate. The smallest usable standard vessel shall be placed in the center of each cooking zone. For the dimension of the vessels, the manufacturer's instructions take precedence.

A single cooking zone with more than one induction coil shall be measured with all coils of the zone activated. The smallest usable standard vessel shall be used (or the smallest vessel according to the manufacturer's instructions, which take precedence) which just activates all coils of the zone.

Side by side cooking zones which can be combined and controlled together shall be measured separately.

NOTE Side by side cooking zones are cooking zones which can be combined, either manually or automatically, and controlled together.

Cooking zones which are not intended for use with even vessels (e.g. wok-zones) shall be measured with the vessel provided together with the hob, or with the vessel recommended by the manufacturer.

A.9.3 Operating conditions for EUT with many small coils

These coils are, depending on the vessel used, automatically configured to a cooking zone.

Tests are performed with the biggest standard vessel (300 mm diameter) or the largest vessel according to the manufacturer's instructions, which take precedence.

The vessel shall be placed centrically in the heating zone.

A.10 Equipment making use of IPT other than induction cooking appliances

A.10.1 General

IPTS, IPTC and IPTE shall be tested according to the relevant cases described in Table A.1 and Figure A.6.

Table A.1 – Types of EUT, operating modes and test setup

Case	EUT	Operating mode	Test setup
1 (see A.10.2)	IPTS	Powering and/or charging	Representative load docked to the EUT
2 (see A.10.3)	IPTC	Normal operation and/or charging	EUT docked to a representative IPTS
3 (see A.10.4)	IPTE	Normal operation and/or charging	IPTS and IPTC(s) docked together

Measurements shall be conducted with the inductive powering equipment in the position specified for intended use, according to the principles given in this document for table-top and floor standing equipment.

In particular:

– If the inductive powering equipment is intended to be used with the IPTS coil in one orientation only (e.g. horizontal or vertical), then the measurements shall be made with the equipment positioned to obtain that coil orientation;
– If the inductive powering equipment is intended to be used with the IPTS coil in various orientations, then the measurements shall be made twice, with the equipment positioned to obtain both a horizontal and a vertical orientation of the IPTS coil.

NOTE For induction cooking appliances, see A.9.

A.10.2 IPTS

A.10.2.1 General

This subclause shall apply when the IPTS is the EUT (case 1 from Table A.1 and Figure A.6).

The IPTS shall be operated at least at 90 % of its rated input power and the representative load shall be able to obtain such condition.