

INTERNATIONAL STANDARD



INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

PRODUCT FAMILY EMC STANDARD

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



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INTERNATIONAL STANDARD



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characteristics – Limits and methods of measurement**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

**INDUSTRIAL, SCIENTIFIC AND MEDICAL EQUIPMENT –
RADIO-FREQUENCY DISTURBANCE CHARACTERISTICS –
LIMITS AND METHODS OF MEASUREMENT**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This commented version (CMV) of the official standard CISPR 11:2024 edition 7.0 allows the user to identify the changes made to the previous CISPR 11:2015+AMD1:2016+AMD2:2019 CSV edition 6.2. Furthermore, comments from CISPR Subcommittee B experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

International Standard CISPR 11 has been prepared by CISPR Subcommittee B: Interference relating to industrial, scientific and medical radio-frequency apparatus, to other (heavy) industrial equipment, to overhead power lines, to high voltage equipment and to electric traction.

This seventh edition cancels and replaces the sixth edition published in 2015, Amendment 1:2016 and Amendment 2:2019. This edition constitutes a technical revision.

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

- a) introduction of limits for radiated disturbances in the frequency range above 1 GHz for group 1 equipment in line with the requirements given in the generic emission standards;
- b) introduction of limits for conducted disturbances on the wired network port in line with the requirements given in the generic emission standards;
- c) introduction of requirements for equipment which incorporates radio transmit/receive functions;
- d) introduction of definitions for various types of robots;
- e) consideration of some particular conditions when measuring robots, such as measurement setups and operating modes of robots.

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

Draft	Report on voting
CIS/B/831/FDIS	CIS/B/837/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This document has the status of a Product Family EMC standard in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications* (2014).

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

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

The main content of this document is based on CISPR Recommendation No. 39/2 given below:

RECOMMENDATION No. 39/2

Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment

The CISPR

CONSIDERING

- a) that ISM RF equipment is an important source of disturbance;
- b) that methods of measuring such disturbances have been prescribed by the CISPR;
- c) that certain frequencies are designated by the International Telecommunication Union (ITU) for unrestricted radiation from ISM equipment,

RECOMMENDS

that the latest edition of CISPR 11 be used for the application of limits and methods of measurement of ISM equipment.

INTRODUCTION

This CISPR publication contains, amongst common requirements for the control of RF disturbances from equipment intended for use in industrial, scientific, and medical electrical applications, specific requirements for the control of RF disturbances caused by ISM RF applications in the meaning of the definition of the International Telecommunication Union (ITU), see also Definition 3.1.18 in this document. CISPR and ITU share their responsibilities for the protection of radio services in respect of the use of ISM RF applications.

The CISPR is concerned with the control of RF disturbances from ISM RF applications by means of an assessment of these disturbances either at a standardised test site or, for an individual ISM RF application which cannot be tested at such a site, at its place of operation. Consequently, this CISPR Publication covers requirements for ~~conformity assessment of~~ both, equipment assessed by means of ~~type~~ tests at standardised test sites or of individual equipment under *in situ* conditions.

The ITU is concerned with the control of RF disturbances from ISM RF applications during normal operation and use of the respective equipment at its place of operation (see Definition 1.15 in the ITU Radio Regulations (2020)). There, use of radio-frequency energy decoupled from the ISM RF application by radiation, induction or capacitive coupling is restricted to the location of that individual application.

This CISPR publication contains, in 6.3, the essential emission requirements for an assessment of RF disturbances from ISM RF applications at standardised test sites. These requirements allow for ~~type~~ testing of ISM RF applications operated at frequencies up to 18 GHz. It further contains, in 6.4, the essential emission requirements for an *in situ* assessment of RF disturbances from individual ISM RF applications in the frequency range up to 1 GHz. All requirements were established in close collaboration with the ITU and enjoy approval of the ITU.

However, for operation and use of several types of ISM RF applications the manufacturer, installer and/or customer should be aware of additional national provisions regarding possible licensing and particular protection needs of local radio services and applications. Depending on the country concerned, such additional provisions ~~may can~~ apply to individual ISM RF applications operated at frequencies outside designated ISM bands (see Table 1). They also ~~may can~~ apply to ISM RF applications operated at frequencies above 18 GHz. ~~For the latter type of applications, local protection of radio services and appliances requires an accomplishment of the conformity assessment by application of the relevant national provisions in the frequency range above 18 GHz in accordance with vested interests of the ITU and national administrations. These additional national provisions may apply to spurious emissions, emissions appearing at harmonics of the operation frequency, and to wanted emissions at the operation frequency allocated outside a designated ISM band in the frequency range above 18 GHz.~~

Recommendations of CISPR for the protection of radio services in particular areas are found in Annex C of this document.

~~Definition 1.15 of the ITU Radio Regulations reads as follows:~~

~~**1.15 industrial, scientific and medical (ISM) applications (of radio frequency energy):**
Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications.~~

~~[ITU Radio Regulations Volume 1: 2012 – Chapter I, Definition 1.15]~~

Introduction to Amendment 1

~~This Amendment introduces the fully anechoic room (FAR) for measurements of the disturbance field strength in the range 30 MHz to 1 GHz on equipment in the scope of CISPR 11.~~

~~It contains the complete set of requirements for measurement of radiated disturbances from equipment fitting into the validated test volume of a given FAR. It specifies a separation distance of 3 m and restricts use of the FAR to measurements on table-top equipment.~~

~~At the moment the FAR can be used:~~

- ~~• for measurements on table-top equipment fitting into the validated test volume of the given FAR,~~
- ~~• for a separation distance of 3 m only, and~~
- ~~• if the FAR was validated according to CISPR 16-1-4.~~

~~The limits for class A and class B group 1 equipment in this CDV base on the limits in the generic emission standards IEC 61000-6-3:2006/AMD 1 (2010) and IEC 61000-6-4:2006/AMD 1 (2010). The limits for class A and class B group 2 equipment were derived using the same approximation formula as used when deriving the limits for the generic emission standards in mid of the years 2000 to 2010. CISPR/H/104/INF, published in 2005, gives detailed explanations how these limits for the FAR were derived.~~

~~More detailed background information is still found in CISPR/B/627/CDV.~~

~~CISPR/B-WG1 in October 2015~~

Introduction to the Amendment 2

~~This AMD 2 combines the contents of two fragments which have been circulated as CIS/B/688/CDV (f2) and CIS/B/697/CDV (f3).~~

~~Fragment 2: Requirements for semiconductor power converters (SPC)~~

~~CISPR 11 Ed. 6.1 needs to be supplemented with further information for full inclusion of type test requirements for SPCs specified hereafter. These requirements apply only to the following types of equipment:~~

- ~~a) power conversion equipment intended for assembly into photovoltaic power generating systems, such as grid-connected power converters (GCPCs) and d.c. to d.c. converters,~~
- ~~b) GCPCs intended for assembly into energy storage systems.~~

~~Fragment 3: Improvement of repeatability for measurements in the frequency range 1-18 GHz~~

~~Based on the comments from the National Committees on CIS/B/662/DC, CIS/B/WG1 decided on its meeting in Hangzhou 2016 to amend the test procedure for group 2 equipment in the frequency range 1 to 18 GHz for the following reasons:~~

- ~~a) CISPR 11 allows final measurements on group 2 equipment operating at frequencies above 400 MHz with two different weighting functions, the traditional "LogAV detector" with a video bandwidth of 10 Hz and the new APD method, where the Amplitude Probability Distribution is evaluated.~~

~~With the alignment of emission requirements for sources of fluctuating emissions with those generating CW-type emissions (Fraction 4 of the last general maintenance of CISPR 11) for most of the frequency range 1 to 18 GHz the peak detector is used mostly for preliminary~~

~~measurements, while the number of final measurements with the LogAV detector has been increased from 2 frequencies to max. 7 frequencies.~~

~~In parallel, with fraction 3, the APD detector has been introduced, but only with the traditional 2 final frequencies (one in the range 1 GHz to 2.4 GHz and one in the range 2,5 GHz to 18 GHz).~~

~~The number of final frequencies to be measured should be aligned for both weighting functions.~~

~~b) During practical measurements cases have been observed, where the critical frequency changed between preliminary and final measurement by more than 5 MHz. The range of 10 MHz for weighted measurements (± 5 MHz from highest peak emission) seems therefore not always to be sufficient.~~

~~An extension of this frequency range seems advisable and could increase the repeatability.~~

~~In the range 11,7 to 12,7 GHz, an EUT fails immediately if one peak exceeds the limit of 73 dB[μ V/m]. Observations on a big number of different microwave ovens have shown that during the final measurement (at least 2 min) such peaks may occur very seldom, and with a very short duration, and an estimated overall duration of less than 1 % of the measuring time.~~

~~A state-of-the-art digital communication service should be able to tolerate such peaks. Meanwhile, in countries where broadcasting systems, which are already standardized and widely spread and is difficult to avoid disturbance by such peaks, are under operation, additional limits could be separately introduced as necessary.~~

~~c) The repeatability of the peak measurement on microwave ovens is poor. Moreover, the sheer height of the highest peak emission, without information on its duration and repetition rate, provides very limited information on the real disturbance potential.~~

~~Measurements with both of the weighting methods have a significantly better repeatability and should, by their physical nature, give a better judgement for the disturbing potential of the EUT on digital radio services.~~

~~d) The conditions for preliminary and final measurements became ambiguous in Edition 6.0 (CISPR 11:2015), particularly regarding the required test time. Furthermore, it has been found that, in some cases, a duration of 20 s for the preliminary peak measurement may not be enough. To further increase the repeatability, WG1 decided not to divide the peak measurements anymore into preliminary and final measurements, but to require a 2-minute max hold peak measurement at every azimuth.~~

~~CISPR SC/B WG1 agreed to present the following proposals to the National Committees:~~

- ~~1) Define the same 7 final frequency ranges for the APD method as already defined for the LogAV method (detector).~~
- ~~2) Extend the frequency range for the final weighted measurement to 20 MHz.~~

~~For the APD method this would mean to measure on 5 final frequencies, the critical frequency itself, ± 5 MHz and ± 10 MHz.~~

~~For the LogAV detector, the requirement remains to perform for the final measurements at least 5 consecutive sweeps in max hold mode. The test time increases accordingly, and coverage of the fluctuations is the same as before.~~

- ~~3) Change the peak limit in Table 13 to a constant value of 70 dB[μ V/m] throughout the frequency range and replace the requirement of a final peak measurement in the range 11,7 GHz to 12,7 GHz by a requirement of an additional weighted measurement at the frequency of the highest peak emission in this range. This may lead to a maximum of 8 final weighted measurements.~~
- ~~4) Discard the distinction between preliminary and final peak measurements and make instead the peak measurements on all azimuths for 2 minutes.~~

INDUSTRIAL, SCIENTIFIC AND MEDICAL EQUIPMENT – RADIO-FREQUENCY DISTURBANCE CHARACTERISTICS – LIMITS AND METHODS OF MEASUREMENT

1 Scope

This document applies to industrial, scientific and medical electrical equipment operating in the frequency range 0 Hz to 400 GHz and to domestic and similar appliances designed to generate and/or use locally radio-frequency energy.

This document covers emission requirements related to radio-frequency (RF) disturbances in the frequency range of 9 kHz to 400 GHz. ~~Measurements need only be performed in frequency ranges where limits are specified in Clause 6.~~

For ISM RF applications in the meaning of the definition found in the ITU Radio Regulations (2020) (see Definition 3.1.18), this document covers emission requirements related to radio-frequency disturbances in the frequency range of 9 kHz to 18 GHz.

ISM equipment which incorporates radio transmit/receive functions (host equipment with radio functionality) is included in the scope of this document, see Annex F. However, 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. **1**

NOTE 1 This exclusion only applies to emissions from the intentional radio transmitter. However, combination emissions, for example emissions resulting from intermodulation between the radio and the non-radio subassemblies of the ISM equipment, are not subject to this exclusion.

NOTE 2 Emission requirements for induction cooking appliances are specified in CISPR 14-1 [1]¹.

Requirements for ISM RF lighting equipment and UV irradiators operating at frequencies within the ISM frequency bands defined by the ITU Radio Regulations are contained in this document.

Robots used for industrial, scientific and medical applications are in the scope of this document. **2**

EXAMPLE Welding robots, spraying robots, handling robots, processing robots, assembly robots, medical robots, education and experimental robots. A comprehensive list of robots in the scope of this document is given on the IEC EMC zone.

NOTE 3 Flying robots, domestic helper robots, toy robots and entertainment robots are examples of robots in the scope of other CISPR standards.

Equipment covered by other CISPR product and product family emission standards are excluded from the scope of this document.

2 Normative references

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

CISPR 16-1-1:2019, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus –*

¹ Figures in square brackets refer to the Bibliography.

Measuring apparatus~~CISPR 16-1-1:2010/AMD 1:2010~~~~CISPR 16-1-1:2010/AMD 2:2014~~

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 16-1-4:~~2010~~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*

CISPR 16-1-4:~~2010/AMD1:2012~~2019/AMD1:2020

CISPR 16-1-4:2019/AMD2:2023

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

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

CISPR 16-2-3:~~2010~~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:~~2010/AMD1:2010~~2016/AMD1:2019

CISPR 16-2-3:~~2010/AMD2:2014~~2016/AMD2:2023

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

CISPR 32:2015/AMD1:2019

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

~~IEC 60601-1-2:2014, Medical electrical equipment – Part 1-2: General requirements for basic safety and essential performance – Collateral standard: Electromagnetic disturbances – Requirements and tests~~

IEC 60601-2-2:~~2009~~2017, *Medical electrical equipment – Part 2-2: Particular requirements for the basic safety and essential performance of high frequency surgical equipment and high frequency surgical accessories*

~~IEC 60974-10:2014, Arc welding equipment – Part 10: Electromagnetic compatibility (EMC) requirements~~

IEC 61000-4-6:2023, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61307:2011 ², *Industrial microwave heating installations – Test methods for the determination of power output*

~~IEC 62135-2:2007, *Resistance welding equipment – Part 2: Electromagnetic compatibility (EMC) requirements*~~

ITU Radio Regulations (~~2012~~2020), *Radio regulations* (available at <http://www.itu.int/en/myitu/Publications/2020/09/02/14/23/Radio-Regulations-2020>)

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

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

3.1.1

AC mains power port

port used to connect to a public low voltage AC mains power distribution network or other low voltage AC mains installation

3.1.2

associated equipment

AE

apparatus that is not part of the system under test, but needed to help exercise the EUT

[SOURCE: CISPR 16-2-3:2016, 3.1.5]

3.1.3

arc welding equipment

equipment for applying current and voltage and having the required characteristics suitable for arc welding and allied processes

3.1.4

artificial mains network

AMN

network that provides a defined impedance to the EUT at radio frequencies, couples the disturbance voltage to the measuring receiver and decouples the test circuit from the supply mains

Note 1 to entry: There are two basic types of this network, the V-network (V-AMN) which couples the unsymmetrical voltages, and the Delta-network, which couples the symmetric (DM) and the asymmetric (CM) voltages separately.

Note 2 to entry: The terms line impedance stabilization network (LISN) and V-AMN are used interchangeably.

[SOURCE: CISPR 16-1-2:2014/AMD1:2017, 3.1.6, modified – added Note 2]

² This publication was withdrawn.

3.1.5**boundary of the equipment under test**

imaginary straight line periphery describing a simple geometric configuration encompassing the equipment under test

Note 1 to entry: All interconnecting cables are included within this boundary.

3.1.6**component**

product which serves a specific function or functions and which is intended for use in a higher order assembled equipment or system

3.1.7**DC artificial network****artificial DC network****DC-AN**

artificial network that provides defined termination to the EUT's DC power port under test while also providing the necessary decoupling from conducted disturbances originating from the laboratory DC power source or from the load

3.1.8**DC power port**

port used to connect to a low voltage DC power generating system or energy storage, or to another source/load

Note 1 to entry: Such a system ~~may~~ can be for example a photovoltaic or a fuel cell power generating system, or also a battery.

3.1.9**electro-discharge machining ~~(EDM)~~ equipment****EDM equipment**

all the necessary units for the spark erosion process including the machine tool, the generator, control circuits, the working fluid container and integral devices

3.1.10**electromagnetic radiation**

~~1)~~ phenomenon by which energy in the form of electromagnetic waves emanates from a source into space

~~2) energy transferred through space in the form of electromagnetic waves~~

Note 1 to entry: By extension, the term "electromagnetic radiation" sometimes also covers induction phenomena.

[SOURCE: IEC 60050-161:1990, 161-01-10]

3.1.11**equipment for resistance welding and allied processes**

all equipment associated with carrying out the processes of resistance welding or allied processes

Note 1 to entry: Such equipment consists of e.g. power source, electrodes, tooling and associated control equipment, which ~~may~~ can be a separate unit or part of a complex machine.

3.1.12**equipment with radio functionality 3**

non-radio equipment (host equipment) including one or more radio devices or radio modules that can use host control function(s) and/or power supply

Note 1 to entry: The use of the included radio equipment can be for remote control (of the host equipment by an external equipment or vice versa) or for data exchange with external equipment.

Note 2 to entry: A radio device or radio module can be plugged-in, built-in or external.

3.1.13

fully-anechoic room

FAR

shielded enclosure, the internal surfaces of which are lined with radio-frequency-energy absorbing material (i.e. RF absorber) that absorbs electromagnetic energy in the frequency range of interest

3.1.14

fundamental frequency

fundamental ISM frequency

frequency on which the ISM equipment operates

Note 1 to entry: Electromagnetic RF energy at the fundamental frequency (of an ISM equipment) can be used in, or transmitted by, or received by the equipment. This energy can be generated in the equipment but used outside the equipment (e.g. X-ray diagnostic equipment), or generated outside and used in the equipment or generated and used in the equipment (e.g. switching mode power supply, RF sterilizer, microwave oven).

Note 2 to entry: Some ISM equipment categories do not have a fundamental ISM frequency. Examples: spectrum analyser, frequency counter.

3.1.15

grid connected power converter

GCP

power converter connected to an AC mains power distribution network or other AC mains installation and used in a power generating system

3.1.16

high power electronic systems and equipment

one or more semiconductor power converters with a combined rated power greater than 75 kVA, or an equipment containing such converters

Note 1 to entry: Examples of such high power electronic equipment are semiconductor power converters for application in UPS (Uninterruptible Power Systems) and PDS (Power Drive Systems).

3.1.17

highest internal frequency

F_x

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

Note 1 to entry: This includes frequencies which are solely used within an integrated circuit.

3.1.18

industrial, scientific and medical applications

ISM applications

<of radio frequency energy> operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications

Note 1 to entry: Typical applications are the production of physical, biological, or chemical effects such as heating, ionisation of gases, mechanical vibrations, hair removal, acceleration of charged particles. A non-exhaustive list of examples is given in Annex A.

[SOURCE: ITU Radio Regulations Volume 1:20122020 – Chapter I, Definition 1.15, modified – added Note 1.]

3.1.19

ISM RF equipment and appliances

equipment or appliances designed to generate and/or use locally radio-frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field

of telecommunications and information technology and other applications covered by other CISPR publications

Note 1 to entry: The abbreviation "ISM RF" is used throughout this document for such equipment or appliances only.

3.1.20

industrial robot 4

automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or fixed to a mobile platform for use in automation applications in an industrial environment

Note 1 to entry: The industrial robot includes:

- the manipulator, including robot actuators controlled by the robot controller;
- the robot controller;
- the means by which to teach and/or program the robot, including any communications interface (hardware and software).

Note 2 to entry: Industrial robots include any auxiliary axes that are integrated into the kinematic solution.

Note 3 to entry: Industrial robots include the manipulating portion(s) of mobile robots, where a mobile robot consists of a mobile platform with an integrated manipulator or robot.

[SOURCE:ISO 8373:2021[2], 3.6]

3.1.21

low voltage

LV

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

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

3.1.22

medical robot

robot intended to be used as medical electrical equipment or medical electrical system

[SOURCE: IEC TR 60601-4-1:2017[3], 3.20]

3.1.23

open-area test site

OATS

facility used for measurements of electromagnetic fields the intention for which is to simulate a semi-free-space environment over a specified frequency range that is used for radiated emission testing of products

Note 1 to entry: An OATS typically is located outdoors in an open area and has an electrically-conducting ground plane.

3.1.24

photovoltaic power generating system

electric power generating system which uses the photovoltaic effect to convert solar power into electricity

3.1.25

power conversion equipment

electrical device converting one form of electrical power to another form of electrical power with respect to voltage, current, frequency, phase and the number of phases

[SOURCE: IEC 62920:2017/AMD1:2021[4], 3.2]

3.1.26

radio device

assembly consisting of one or more radio transmitters and/or receivers, capable to function on a stand-alone basis with or without additional accessories

Note 1 to entry: These accessories can be incorporated in the assembly or connected to it from outside. Examples of accessories are: external antenna, remote control, headsets, power supply, display, etc.

3.1.27

radio module

assembly consisting of one or more radio transmitters and/or receivers, intended to be incorporated in a host equipment

Note 1 to entry: A radio module can incorporate a power supply or any other accessories.

Note 2 to entry: A radio module can be plugged-in, built-in or external.

3.1.28

radio transmitter

device producing radio-frequency energy intended to be radiated by an antenna for the purpose of radiocommunication or radiodetermination

[SOURCE: IEC 60050-713:1998[5], 713-08-01 – modified – “apparatus” replaced with “device”, deletion of “normally”, addition of “or radiodetermination”.]

3.1.29

rated load

<for robots> maximum load that can be applied to the mechanical interface or mobile platform in normal operating conditions without degradation of any performance specification

Note 1 to entry: The rated load includes the inertial effects of the end effector, accessories and workpiece, where applicable.

[SOURCE: ISO 8373:2021[2], 7.2.1]

3.1.30

robot

programmed actuated mechanism with a degree of autonomy to perform locomotion, manipulation or positioning

Note 1 to entry: A robot includes the control system.

Note 2 to entry: Examples of mechanical structure of robots are manipulator, mobile platform and wearable robots.

[SOURCE: ISO 8373:2021[2], 3.1]

3.1.31

semi-anechoic chamber

SAC

shielded enclosure, in which five of the six internal surfaces are lined with radio-frequency energy absorbing material (i.e. RF absorber) that absorbs electromagnetic energy in the frequency range of interest, and the bottom horizontal surface is a conducting ground plane for use with OATS test set-ups

3.1.32

~~small size equipment~~

small equipment under test

small EUT

equipment under test, either positioned on a table top or standing on the floor, which, including its cables, fits in an imaginary cylindrical test volume of ~~1,2~~ 1,5 m in diameter and 1,5 m height (~~to ground plane~~ as measured from the floor)

Note 1 to entry: At an OATS or in a SAC, the radiated emission measurement distance of 3 m is applicable only to small EUTs

[SOURCE: CISPR 16-2-3:2016 and CISPR 16-2-3:2016/AMD1:2019, 3.1.35, modified – The definition was reworded and a Note to entry was added]

3.1.33

spark erosion

removal of material in a dielectric working fluid by electro-discharges, which are separated in time and randomly distributed in space, between two electrically conductive electrodes (the tool electrode and the work piece electrode), and where the energy in the discharge is controlled

~~3.19~~

~~type test~~

~~test of one or more devices made to a certain design to show that the design meets certain specifications~~

~~Note 1 to entry: Recognition of a type test as type approval may depend on national or regional regulation, see H.2 in Annex H.~~

3.1.34

wired network port **5**

port for the connection of a communication device/system intended to be interconnected to widely dispersed systems by direct connection to a single-user or multi-user network

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

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

Note 3 to entry: A port generally intended for interconnection of components of a system under test (e.g. RS-232, RS-485, field buses in the scope of IEC 61158, IEEE Standard 1284.1 [6] (parallel printer), Universal Serial Bus (USB), IEEE Standard 1394[7] ("Fire Wire"), etc.) and used in accordance with its functional specifications (e.g. for the maximum length of cable connected to it) is not considered to be a wired network port.

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

[SOURCE: IEC 61000-6-3:2020[8], 3.1.3, modified — In the definition, addition of "device/system". Deletion of Note 1 to entry. Addition of Notes 2, 3 and 4 to entry.]

3.2 Abbreviated terms

AGV	Automated guided vehicle
AMN	Artificial mains network
AN	Artificial network
APD	Amplitude probability distribution
CATV	Cable television
CDN	Coupling-decoupling network
CM	Common mode
CMAD	Common mode absorption device
CVCF	Constant voltage constant frequency
DM	Differential mode
EDM	Electro-discharge machining
EMC	Electromagnetic compatibility
EUT	Equipment under test
FAR	Fully anechoic room
FSOATS	Free space open area test site
GCPC	Grid connected power converter

ISDN	Integrated services digital network
LAN	Local area network
LV	Low voltage
OATS	Open area test site
PDS	Power drive system
PSTN	Public switched telephone network
RF	Radio frequency
SAC	Semi-anechoic chamber
UM	Unsymmetrical mode
UPS	Uninterruptible power supply
USB	Universal serial bus
VCP	Vertical coupling plane
xDSL	All digital subscriber line technologies (e.g., ADSL, SDSL, etc.)

4 Frequencies designated for ISM use

Certain frequencies are designated by the International Telecommunication Union (ITU) for use as fundamental frequencies for ISM RF applications (see also Definition 3.1.18). These frequencies are listed in Table 1.

NOTE In individual countries different or additional frequencies can be designated for use by ISM RF applications.

Table 1 – Frequencies in the radio-frequency (RF) range designated by ITU for use as fundamental ISM frequencies

Centre frequency MHz	Frequency range MHz	Maximum radiation limit ^a	Number of appropriate footnote to the table of frequency allocation of the ITU Radio Regulations ^b
6,780	6,765 to 6,795	Under consideration	5.138
13,560	13,553 to 13,567	Unrestricted	5.150
27,120	26,957 to 27,283	Unrestricted	5.150
40,680	40,66 to 40,70	Unrestricted	5.150
433,920	433,05 to 434,79	Under consideration	5.138 in Region 1, except countries mentioned in 5.280
915,000	902 to 928	Unrestricted	5.150 in Region 2 only
2 450	2 400 to 2 500	Unrestricted	5.150
5 800	5 725 to 5 875	Unrestricted	5.150
24 125	24 000 to 24 250	Unrestricted	5.150
61 250	61 000 to 61 500	Under consideration	5.138
122 500	122 000 to 123 000	Under consideration	5.138
245 000	244 000 to 246 000	Under consideration	5.138
^a The term “unrestricted” applies to the fundamental and all other frequency components falling within the designated band. Outside of ITU designated ISM bands the limits for the disturbance voltage and radiation disturbance in this document apply.			
^b Resolution No. 63 of the ITU Radio Regulations applies (see Radio Regulations (2020) , Volume 3).			

5 Classification of equipment

5.1 Separation into groups

In order to simplify identification of the relevant limits, the equipment in the scope of this document is categorized into two groups, i.e. into group 1 and group 2.

Group 1 equipment: group 1 contains all equipment in the scope of this document which is not classified as group 2 equipment.

Group 2 equipment: group 2 contains all ISM RF equipment in which radio-frequency energy in the frequency range 9 kHz to 400 GHz is intentionally generated and used or only used locally, in the form of electromagnetic radiation, inductive and/or capacitive coupling, for the treatment of material, for inspection/analysis purposes, or for transfer of electromagnetic energy.

NOTE See Annex A for examples of the separation of equipment into group 1 or 2.

5.2 Division into classes

In accordance with the intended use of equipment in the electromagnetic environment, this document defines two classes of equipment, namely class A and class B.

Class A equipment is the equipment suitable for use in all locations other than those allocated in residential environments and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Class A equipment shall meet class A limits.

An arc welding equipment which contains arc striking or stabilizing devices and stand-alone arc striking or stabilizing devices for arc welding shall be classified as class A equipment.

Class B equipment is the equipment suitable for use in locations in residential environments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Class B equipment shall meet class B limits.

5.3 Documentation for the user

The manufacturer and/or supplier of equipment shall ensure that the user is informed about the class and group of the equipment, either by labelling or by the accompanying documentation. In both cases the manufacturer/supplier shall explain the meaning of both the class and the group in the documentation accompanying the equipment.

The documentation accompanying the equipment shall contain details of any precautions to be observed by the purchaser or user to ensure that regular operation and use of the equipment in the field does not cause harmful radio frequency interference (RFI). In the framework of this document, these details concern information about:

- the possibility of radio frequency interference originating from operation of class A equipment in certain environments,
- special precautions to be observed when connecting class A equipment to a low voltage power supply network, see Footnotes to table b and c in Table 2, Footnote to table b in Table 3 and Footnote to table c in Table 8, respectively,
- measures which can be taken at installation level to reduce emissions from installed class A equipment, see Footnote to table c in Table 2 and Footnote to table a in Table 12.

For class A equipment, the instructions for use accompanying the product shall contain the following text:

Caution: This equipment is not intended for use in residential environments and ~~may~~ might not provide adequate protection to radio reception in such environments.

6 Limits of electromagnetic disturbances

6.1 General

For measurements at standardized test sites, the requirements specified hereafter constitute the requirements for ~~type~~ tests.

Class A equipment may be measured either on a test site or *in situ* as preferred by the manufacturer.

NOTE 1 Due to size, complexity or operating conditions some equipment ~~may have to~~ can be measured in situ in order to show compliance with the radiation disturbance limits specified herein.

Class B equipment shall be measured on a test site.

NOTE 2 The limits have been determined on a probabilistic basis taking into account the likelihood of interference. In cases of interference, additional provisions ~~may have to be applied~~ can apply.

The lower limit shall apply at all transition frequencies.

Measuring apparatus and methods of measurement are specified in Clause 7, Clause 8 and Clause 9.

Where this document gives options for testing particular requirements with a choice of test methods, compliance ~~can~~ may be shown against any of the test methods, using the specified limits with the restrictions provided in the relevant tables. In any situation where it is necessary to retest the equipment, the test method originally chosen should be used in order to ensure consistency of the results.

For equipment with radio functionality, the additional requirements of Annex F shall apply. **6**

6.2 Group 1 equipment measured on a test site

6.2.1 Limits for conducted disturbances

6.2.1.1 General

The equipment under test shall meet either:

- a) both the average limit specified for measurements with an average detector and the quasi-peak limit specified for measurements with a quasi-peak detector (see 7.3); or
- b) the average limit when using a quasi-peak detector (see 7.3).

The limits for the LV DC power ports specified hereafter apply only to the following types of equipment:

- 1) power conversion equipment intended for assembly into photovoltaic power generating systems;
- 2) grid connected power convertors (GCPCs) intended for assembly into energy storage systems.

6.2.1.2 Frequency range 9 kHz to 150 kHz

In the frequency range 9 kHz to 150 kHz limits are not specified.

6.2.1.3 Frequency range 150 kHz to 30 MHz

Limits for the disturbance voltage at low voltage AC mains power ports in the frequency range 150 kHz to 30 MHz for equipment measured on a test site using the 50 Ω /50 μ H CISPR artificial mains network (V-AMN) or the CISPR voltage probe (see 7.3.3 and Figure 1) are given in Table 2 and Table 4.

Limits for conducted disturbances at low voltage DC power ports in the frequency range 150 kHz to 30 MHz for equipment measured on a test site using the 150 Ω CISPR network (DC-AN) (see 7.3.2.3) and ~~Annex 1~~ or the current probe (see CISPR 16-1-2) are given in Table 3 and Table 5.

Limits for conducted disturbances at wired network ports in the frequency range 150 kHz to 30 MHz for equipment measured on a test site are given in Table 7. **7**

For measurements at LV DC power ports, the applicability criteria in accordance with Table 6 apply.

Table 2 – Disturbance voltage limits for class A group 1 equipment measured on a test site (AC mains power port)

Frequency range MHz	Rated power of ≤ 20 kVA ^a		Rated power of > 20 kVA and ≤ 75 kVA ^{b, a}		High power electronic systems and equipment, Rated power of > 75 kVA ^{c, a}	
	Quasi-peak dB(μV)	Average dB(μV)	Quasi-peak dB(μV)	Average dB(μV)	Quasi-peak dB(μV)	Average dB(μV)
0,15 to 0,50	79	66	100	90	130	120
0,50 to 5	73	60	86	76	125	115
5 to 30	73	60	90 decreasing linearly with logarithm of frequency to 73	80 60	115	105
At the transition frequency, the more stringent limit shall apply. For class A equipment intended to be connected solely to isolated neutral or high impedance earthed (IT) industrial power distribution networks (see IEC 60364-1[9]) the limits for equipment with a rated power > 75 kVA ~~may~~ can be applied, regardless of its actual rated power. NOTE A rated input or output power of 20 kVA corresponds for example to a current of approximately 29 A per phase in case of 400 V three-phase power supply networks and to a current of approximately 58 A per phase in case of 200 V three phase power supply networks. ^a The selection of the appropriate set of limits shall be based on the rated AC power stated by the product documentation. ^b These limits apply to equipment with a rated power > 20 kVA and intended to be connected to a dedicated power transformer or generator and which is not connected to low voltage (LV) overhead power lines. For equipment not intended to be connected to a user specific power transformer the limits for ≤ 20 kVA apply. ~~The manufacturer, and/or supplier shall provide information~~ Information shall be provided on installation measures that can be used to reduce emissions from the installed equipment. In particular, it shall be indicated that this equipment is intended to be connected to a dedicated power transformer or generator and not to LV overhead power lines. ^c These limits apply only to high power electronic systems and equipment with a rated power greater than 75 kVA when intended to be installed as follows: – installation is supplied from a dedicated power transformer or generator, which is not connected to Low Voltage (LV) overhead power lines, – installation is physically separated from residential environments by distance greater than 30 m or by a structure which acts as a barrier to radiated phenomena, – the ~~manufacturer and/or supplier~~ product documentation shall indicate that this equipment meets the disturbance voltage limits for high power electronic systems and equipment of rated input power >75 kVA and provide information on installation measures to be applied by the installer. In particular, it shall be indicated that this equipment is intended to be used in an installation which is powered by a dedicated power transformer or generator and not by LV overhead power lines.						

Table 3 – Limits for conducted disturbances of class A group 1 equipment measured on a test site (DC power port)

Frequency range MHz	Rated power of ≤ 20 kVA ^a		Rated power of > 20 kVA to ≤ 75 kVA ^{a, b, c}				Rated power of > 75 kVA ^{a, b, c}			
	Voltage limits		Voltage limits		Current limits		Voltage limits		Current limits	
	QP dB(μV)	AV dB(μV)	QP dB(μV)	AV dB(μV)	QP dB(μA)	AV dB(μA)	QP dB(μV)	AV dB(μV)	QP dB(μA)	AV dB(μA)
0,15 to 5	97 to 89	84 to 76	116 to 106	106 to 96	72 to 62	62 to 52	132 to 122	122 to 112	88 to 78	78 to 68
5 to 30	89 to 89	76 to 76	106 to 89	96 to 76	62 to 45	52 to 32	122 to 105	112 to 92	78 to 61	68 to 48
In certain frequency ranges, the limits in this table decrease linearly with logarithm of frequency.										
^a The selection of the appropriate set of limits shall be based on the rated AC power stated by the ~~manufacturer~~ <i>product documentation</i> . ^b These limits apply to equipment with a rated power > 20 kVA and intended to be installed in a large photovoltaic power generating system by a professional. In the manual accompanying the product, ~~the manufacturer, and/or supplier shall provide~~ <i>information shall be provided</i> on mitigation measures that can be used to reduce emissions from the installed equipment, with the goal of preventing harmful interference to radio reception in a distance of 30 m from the installation. In particular it shall be indicated that this equipment can be equipped with additional filtering and that installation is physically separated from residential environments by distance greater than 30 m. The installer is invited to check the mitigated installation against CISPR 11 <i>in situ</i> measurements as indicated in 6.4. ^c Either the voltage limits or the current limits apply.										

Table 4 – Disturbance voltage limits for class B group 1 equipment measured on a test site (AC mains power port)

Frequency range MHz	Quasi-peak dB(μV)	Average dB(μV)
0,15 to 0,50	66 Decreasing linearly with logarithm of frequency to 56	56 Decreasing linearly with logarithm of frequency to 46
0,50 to 5	56	46
5 to 30	60	50
At the transition frequency, the more stringent limit shall apply.		

For diagnostic X-ray generators operating in intermittent mode the quasi-peak limits of Table 2 or Table 4 can be relaxed by 20 dB.

Table 5 – Disturbance voltage limits for class B group 1 equipment measured on a test site (DC power port)

Frequency range MHz	Quasi-peak dB(μV)	Average dB(μV)
0,15 to 0,50	84 Decreasing linearly with logarithm of frequency to 74	74 Decreasing linearly with logarithm of frequency to 64
0,50 to 30	74	64

~~For measurements at LV d.c. power ports, the applicability criteria in accordance with Table 19 apply.~~

Table 6 – Applicability of measurements at DC power ports

Cable length L	Class B group 1 equipment	Class A group 1 equipment
$L < 3 \text{ m}$	No measurements are required	No measurement are required
$3 \text{ m} \leq L < 30 \text{ m}$	For measurements, the limits in Table 5 apply The frequency range for measurement starts at a frequency equal to: $f(\text{MHz}) = 60/L$	For measurements, the limits in Table 3 apply ^a The frequency range for measurement starts at a frequency equal to: $f(\text{MHz}) = 60/L$
$L \geq 30 \text{ m}$	For measurements, the limits in Table 5 apply	For measurements, the limits in Table 3 apply ^a
L: maximum length of a cable (in metres) connected to an LV DC power port, and provided with the product or as specified ~~by manufacturer~~ in the product documentation. Where no maximum cable length is specified, L shall be considered as longer than 30 m. This table applies unless specific conditions are given in the applicable product standard leading at least to the same level of protection of radio reception. Product standards ~~may~~ can define specific conditions according to their particular application with the purpose of avoiding radiation. ^a No limits apply if the equipment is installed using good engineering practice regarding EMC. Examples of good engineering practice are: – symmetrical DC port line configuration, – installation internal to the building, – grounded metallic cable trays, – use of shielded cables, – manage a separation distance that acts as a barrier from residential environment (e.g. greater than 30 m). If exception ^a is used, the installer ~~may~~ can refer to CISPR 11 for <i>in situ</i> measurement.		

Table 7 – Limits for conducted disturbances measured on a test site (wired network port)

Frequency range MHz	Class A				Class B			
	Voltage		Current		Voltage		Current	
	QP	AV	QP	AV	QP	AV	QP	AV
	dB(μV)	dB(μV)	dB(μA)	dB(μA)	dB(μV)	dB(μV)	dB(μA)	dB(μA)
0,15 to 0,5	97 to 87	84 to 74	53 to 43	40 to 30	84 to 74	74 to 64	40 to 30	30 to 20
0,5 to 30	87	74	43	30	74	64	30	20
In the frequency range from 0,15 MHz to 0,5 MHz, the limits in this table decrease linearly with the logarithm of frequency. Excluding measurement uncertainty, all other elements within CISPR 32 shall be applied, including but not limited to the selection of measurement procedures, test configuration, cable characteristics and ancillary equipment (current probe, capacitive voltage probe and/or artificial network). NOTE 1 The voltage and current disturbance limits are based on a common mode impedance of 150 Ω for the wired network port under test. NOTE 2 The application of the voltage and/or current disturbance limits is dependent on the port type and on the measurement procedure used; see Table C.1 of CISPR 32:2015/AMD1:2019.								

6.2.2 Limits of electromagnetic radiation disturbance

6.2.2.1 General

The equipment under test shall meet the quasi-peak limits when using a quasi-peak detector.

6.2.2.2 Frequency range 9 kHz to 150 kHz

In the frequency range 9 kHz to 150 kHz, limits are not specified.

6.2.2.3 Frequency range 150 kHz to 1 GHz

In the frequency range 150 kHz to 30 MHz, limits are not specified.

In the frequency range above 30 MHz, the limits refer to the electric field strength component of the electromagnetic radiation disturbance.

The electromagnetic radiation disturbance limits for the frequency range 30 MHz to 1 GHz for group 1, classes A and B equipment are specified in Table 8 and Table 9, respectively. Recommendations for the protection of specific safety-related radio services are given in Annex C and Table C.1.

On an open-area test site (OATS) or in a semi-anechoic chamber (SAC), class A equipment can be measured at a nominal distance of 3 m, 10 m or 30 m (see information in Table 8), and class B equipment at a nominal distance of 3 m or 10 m (see information in Table 9). A measuring distance less than 10 m is allowed only for equipment that complies with the definition for ~~small size equipment given in 3.17~~ *small EUT* (see 3.1.32).

In a fully-anechoic room (FAR) class A or class B equipment can be measured at a nominal distance of 3 m (see information in Table 8 and Table 9), provided that the EUT fits into the validated test volume of the given FAR. In conjunction with measurements according to this document, the use of the FAR is restricted to table-top equipment.

**Table 8 – Electromagnetic radiation disturbance limits
for class A group 1 equipment measured on a test site**

Frequency range MHz	OATS or SAC				FAR	
	10 m measuring distance rated power of		3 m measuring distance ^a rated power of		3 m measuring distance ^{a, b} rated power of	
	≤ 20 kVA ^c	> 20 kVA ^{a, c, d} _d	≤ 20 kVA ^c	> 20 kVA ^{a, c, d}	≤ 20 kVA ^c	> 20 kVA ^{a, c, d}
	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)
30 to 230	40	50	50	60	52 decreasing linearly with logarithm of frequency to 45	62 decreasing linearly with logarithm of frequency to 55
230 to 1 000	47	50	57	60	52	55

On an OATS or in a SAC, class A equipment can be measured at a nominal distance of 3 m, 10 m or 30 m. In case of measurements at a separation distance of 30 m, an inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance.

At the transition frequency, the more stringent limit shall apply.

In the frequency range 30 MHz to 230 MHz, the limit for measurements in the FAR decreases linearly with the logarithm of frequency.

^a The 3 m separation distance applies only to ~~small size equipment meeting the size criterion defined in 3.17~~ *small EUT* (see 3.1.32).

^b The table-top equipment shall fit into the validated test volume of the FAR.

^c The selection of the appropriate set of limits shall be based on the rated AC power stated ~~by the manufacturer in the product documentation.~~

^d These limits apply to equipment with a rated power of > 20 kVA and intended to be used at locations where there is a distance greater than 30 m between the equipment and third party sensitive radio communications. ~~The manufacturer shall indicate~~ It shall be indicated in the technical documentation that this equipment is intended to be used at locations where the separation distance to third party sensitive radio services is > 30 m. If these conditions are not met, then the limits for ≤ 20 kVA apply.

**Table 9 – Electromagnetic radiation disturbance limits
for class B group 1 equipment measured on a test site**

Frequency range MHz	OATS or SAC		FAR
	10 m measuring distance	3 m measuring distance ^a	3 m measuring distance ^{a, b}
	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)
30 to 230	30	40	42 Decreasing linearly with logarithm of frequency to 35
230 to 1 000	37	47	42

On an OATS or in a SAC, class B equipment ~~can~~ may be measured at a nominal distance of 3 m or 10 m.

At the transition frequency, the more stringent limit shall apply.

- a

The 3 m separation distance applies only to ~~small size equipment meeting the size criterion defined in 3.17~~ *small EUT* (see 3.1.32).
- b

The table-top equipment shall fit into the validated test volume of the FAR.

For medical electrical equipment intended to be permanently installed in shielded locations, further provisions with regard to the measurement arrangement and load conditions are found in IEC 60601-1-2 [10].

6.2.2.4 Frequency range 1 GHz to 18 GHz

The equipment shall meet the electromagnetic radiation disturbance limits specified in Table 11 up to the maximum measurement frequency determined in accordance with Table 10. If the highest internal frequency F_x is not known, measurements shall be performed up to 6 GHz. The equipment shall meet both the peak and the average limits. If the measurements using peak detector pass the average limit, there is no need to apply the average detector. 8

In the frequency range ~~4~~ 6 GHz to 18 GHz limits are not specified.

For emission measurements above 1 GHz, the peak detector limits shall not be applied to disturbances produced by arcs or sparks that are high voltage breakdown events. Such disturbances arise when devices contain or control mechanical switches that control current in inductors, or when devices contain or control subsystems that create static electricity. Only the average limits shall apply to disturbances from arcs and sparks, while both the peak and average limits shall apply to all other disturbances from such devices.

Measurements may be performed at distances of 3 m or 10 m taking into account the EUT size criterion as specified in 3.1.32. When using the 10 m distance, the limits of Table 11 shall be modified as follows:

$$Limit\ (10\ m) = Limit\ (3\ m) - 20\ log\ (10/3)$$

where both limits are expressed in dB(µV/m).

Table 10 – Required highest frequency for radiated measurements

Highest internal frequency F_x	Highest measured frequency
$F_x \leq 108\ \text{MHz}$	1 GHz
$108\ \text{MHz} < F_x \leq 500\ \text{MHz}$	2 GHz
$500\ \text{MHz} < F_x \leq 1\ \text{GHz}$	5 GHz
$F_x > 1\ \text{GHz}$	$5 \times F_x$ up to a maximum of 6 GHz
NOTE F_x is defined in 3.1.17.	

**Table 11 – Electromagnetic radiation disturbance limits
for group 1 equipment measured on a test site**

Frequency range GHz	Limits for a measurement distance of 3 m dB(µV/m)			
	Class A		Class B	
	Peak	Average	Peak	Average
1 to 3	76	56	70	50
3 to 6	80	60	74	54
At the transitional frequency, the more stringent limit shall apply.				

6.2.2.5 Frequency range 18 GHz to 400 GHz

In the frequency range 18 GHz to 400 GHz, limits are not specified.

6.3 Group 2 equipment measured on a test site

6.3.1 Limits for conducted disturbances

6.3.1.1 General

The equipment under test shall meet either:

- both the average limit specified for measurements with an average detector and the quasi-peak limit specified for measurements with a quasi-peak detector (see 7.3); or
- the average limit when using a quasi-peak detector (see 7.3).

6.3.1.2 Frequency range 9 kHz to 150 kHz

In the frequency range 9 kHz to 150 kHz, limits are not specified.

6.3.1.3 Frequency range 150 kHz to 30 MHz

Limits for the disturbance voltage at low voltage AC mains power ports in the frequency range 150 kHz to 30 MHz for equipment measured on a test site using the 50 Ω/50 µH CISPR artificial mains network (V-AMN) or the CISPR voltage probe (see 7.3.3 and Figure 1) are given in Table 12 and Table 13, except for the ITU designated frequency bands listed in Table 1 where no limits apply.

For electric welding equipment the limits of Table 12 or Table 13 apply in active mode of operation. In stand-by (or idle) mode, the limits of Table 2 or Table 4 apply.

For ISM RF lighting devices operating in dedicated ISM frequency bands (defined by the ITU in Table 1) the limits of Table 13 apply.

Limits for conducted disturbances at wired network ports in the frequency range 150 kHz to 30 MHz for equipment measured on a test site are given in Table 7.

Table 12 – Disturbance voltage limits for class A group 2 equipment measured on a test site (AC mains power port)

Frequency range MHz	Rated power of $\leq 75 \text{ kVA}$ ^{a, b}		Rated power of $> 75 \text{ kVA}$ ^{a, b, c}	
	Quasi-peak dB(μV)	Average dB(μV)	Quasi-peak dB(μV)	Average dB(μV)
0,15 to 0,50	100	90	130	120
0,50 to 5	86	76	125	115
5 to 30	90 decreasing linearly with logarithm of frequency to 73	80 60	115	105
At the transition frequency, the more stringent limit shall apply.				
^a Selection of the appropriate set of limits shall be based on the rated AC power stated in the product documentation. ^b For class A equipment with a rated power $\leq 75 \text{ kVA}$ intended to be connected solely to isolated neutral or high impedance earthed (IT) industrial power distribution networks (see IEC 60364-1[9]) the limits defined for group 2 equipment with a rated power $> 75 \text{ kVA}$ may be applied. ^c ~~The manufacturer and/or supplier shall provide information~~ Information shall be provided on installation measures that can be used to reduce emissions from the installed equipment.				

NOTE A rated input or output power of 75 kVA corresponds for example to a current of approximately 108 A per phase in case of 400 V three phase power supply networks and to a current of approximately 216 A per phase in case of 200 V three phase power supply networks.

High-frequency (HF) surgical equipment shall meet the limits of Table 2 or Table 4 specified for group 1 equipment in stand-by mode of operation. For high-frequency (HF) surgical equipment operating at frequencies outside designated ISM bands (see Table 1), these limits also apply at the operating frequency and inside the designated frequency bands. The related measurements shall be performed in a test arrangement in accordance with IEC 60601-2-2.

Table 13 – Disturbance voltage limits for class B group 2 equipment measured on a test site (AC mains power port)

Frequency range MHz	Quasi-peak dB(μV)	Average dB(μV)
0,15 to 0,50	66 Decreasing linearly with logarithm of frequency to 56	56 Decreasing linearly with logarithm of frequency to 46
0,50 to 5	56	46
5 to 30	60	50
At the transition frequency, the more stringent limit shall apply.		

6.3.2 Limits of electromagnetic radiation disturbance

6.3.2.1 General

The equipment under test shall meet the limits when using a measuring instrument with a peak, quasi-peak or average detector as indicated in the appropriate table.

Up to 30 MHz the limits refer to the magnetic component of the electromagnetic radiation disturbance. Above 30 MHz, the limits refer to the electric field strength component of the electromagnetic radiation disturbance.

6.3.2.2 Frequency range 9 kHz to 150 kHz

In the frequency range 9 kHz to 150 kHz, limits are not specified.

6.3.2.3 Frequency range 150 kHz to 1 GHz

Except for the designated frequency range listed in Table 1, the electromagnetic radiation disturbance limits for the frequency range 150 kHz to 1 GHz for group 2 class A equipment are specified in Table 14 and for group 2 class B equipment in Table 16.

The limits in Table 14 and Table 16 apply to all electromagnetic disturbances at all frequencies not exempted according to Table 1 footnote a.

For class A equipment for resistance welding, the limits of Table 14 apply in the frequency range 30 MHz to 1 GHz in active mode of operation. In stand-by (or idle) mode, the limits of Table 8 apply. For class B equipment for resistance welding, the limits of Table 16 apply in active mode of operation. In stand-by (or idle) mode, the limits of Table 9 apply.

For class A arc welding equipment, the limits of Table 15 apply in active mode of operation. In stand-by (or idle) mode, the limits of Table 8 apply. For class B arc welding equipment, the limits of Table 9 apply in active mode of operation and in stand-by (or idle) mode.

For class A EDM equipment the limits of Table 15 apply.

For ISM RF lighting devices operating in dedicated ISM frequency bands (in Table 1 as defined by the ITU) the limits of Table 16 apply.

For high-frequency (HF) surgical equipment, the limits of Table 8 or Table 9 apply. High-frequency (HF) surgical equipment shall meet the respective limits when tested in stand-by mode of operation.

Recommendations for the protection of specific safety services are given in Annex C and Table C.1.

On an open-area test site (OATS) or in a semi-anechoic chamber (SAC), class A equipment ~~can~~ may be measured at a nominal distance of 3 m, 10 m or 30 m, and class B equipment at a nominal distance of 3 m or 10 m (see Table 14 and Table 16).

In the frequency range 30 MHz to 1 GHz, a measuring distance of 3 m is allowed only for equipment which complies with the definition given in 3.1.32.

In a fully-anechoic room (FAR) class A or class B equipment ~~can~~ may be measured at a nominal distance of 3 m, provided that the EUT fits into the validated test volume of the given FAR. In conjunction with measurements according to this document, use of the FAR is restricted to table-top equipment.

For group 2 class A or class B equipment other than EDM or arc welding, measurements in the FAR in the range 30 MHz to 1 GHz shall be supplemented by measurement of the magnetic component of the disturbance field strength in the range 150 kHz to 30 MHz, at an OATS or in a SAC; see also footnote b in Table 14 and footnote c in Table 16.

**Table 14 – Electromagnetic radiation disturbance limits
for class A group 2 equipment measured on a test site**

Frequency range MHz	OATS or SAC						FAR
	Limits for a measuring distance D in m						
	$D = 30$ m		$D = 10$ m		$D = 3$ m ^a		$D = 3$ m ^{a, b}
	Electric field Quasi-peak dB(µV/m)	Magnetic field Quasi-peak dB(µA/m)	Electric field Quasi-peak dB(µV/m)	Magnetic field Quasi-peak dB(µA/m)	Electric field Quasi-peak dB(µV/m)	Magnetic field Quasi-peak dB(µA/m)	Electric field Quasi-peak dB(µV/m)
0,15 to 0,49	–	33,5	–	57,5	–	82	–
0,49 to 1,705	–	23,5	–	47,5	–	72	–
1,705 to 2,194	–	28,5	–	52,5	–	77	–
2,194 to 3,95	–	23,5	–	43,5	–	68	–
3,95 to 11	–	8,5	–	18,5	–	68 decreasing linearly with logarithm of frequency to 28,5	–
11 to 20	–	8,5	–	18,5	–	28,5	–
20 to 30	–	–1,5	–	8,5	–	18,5	–
30 to 47	58	–	68	–	78	–	80 to 78
~~47 – 53,91~~	~~40~~	~~–~~	~~50~~	~~–~~	~~60~~	~~–~~	~~60~~
~~53,91 – 54,56~~	~~40~~	~~–~~	~~50~~	~~–~~	~~60~~	~~–~~	~~60~~
47 to 54,56	40	–	50	–	60	–	60
54,56 to 68	40	–	50	–	60	–	60 to 59
68 to 80,872	53	–	63	–	73	–	72
80,872 to 81,848	68	–	78	–	88	–	87
81,848 to 87	53	–	63	–	73	–	72 to 71
87 to 134,786	50	–	60	–	70	–	68 to 67
134,786 to 136,414	60	–	70	–	80	–	77
136,414 to 156	50	–	60	–	70	–	67 to 66
156 to 174	64	–	74	–	84	–	80
174 to 188,7	40	–	50	–	60	–	56
188,7 to 190,979	50	–	60	–	70	–	66
190,979 to 230	40	–	50	–	60	–	56 to 55
230 to 400	50	–	60	–	70	–	65
400 to 470	53	–	63	–	73	–	68
470 to 1 000	50	–	60	–	70	–	65

On an OATS or in a SAC, class A equipment ~~can~~ may be measured at a nominal distance of 3 m, 10 m or 30 m. A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.1.32.

At the transition frequency, the more stringent limit shall apply. In certain frequency ranges, the limit for magnetic field strength and for measurements in the FAR decreases linearly with the logarithm of frequency.

- ^a In the frequency range 30 MHz to 1 GHz, the 3 m ~~separation~~ measuring distance applies only to ~~small size equipment meeting the size criterion defined in 3.17~~ *small EUT* (see 3.1.32).
- ^b The table-top equipment shall fit into the validated test volume of the FAR. In the range below 30 MHz, such group 2 equipment shall be measured at an OATS or in a SAC (see limits in the respective magnetic field column in this table).

**Table 15 – Electromagnetic radiation disturbance limits
for class A EDM and arc welding equipment measured on a test site**

Frequency range MHz	OATS or SAC		FAR
	10 m measuring distance	3 m measuring distance ^a	3 m measuring distance ^{a, b}
	Quasi-peak dB(µV/m)	Quasi-peak dB(µV/m)	Quasi-peak dB(µV/m)
30 to 230	80	90	102
	Decreasing linearly with logarithm of frequency to	Decreasing linearly with logarithm of frequency to	Decreasing linearly with logarithm of frequency to
	60	70	75
230 to 1 000	60	70	75

On an OATS or in a SAC, class A equipment ~~can~~ may be measured at a nominal distance of 3 m, 10 m or 30 m. In case of measurements at a separation distance of 30 m, an inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance.

^a The 3 m separation distance applies only to ~~small size equipment meeting the size criterion defined in 3.17~~ *small EUT* (see 3.1.32).

^b The table-top equipment shall fit into the validated test volume of the FAR.

Table 16 – Electromagnetic radiation disturbance limits for class B group 2 equipment measured on a test site

Frequency range MHz	OATS or SAC					FAR	
	Limits for a measuring distance D in m						
	$D = 10$ m		$D = 3$ m ^a		$D = 3$ m	$D = 3$ m ^b	
	Electric field				Magnetic field	Electric field	
	Quasi-peak	Average ^c	Quasi-peak	Average ^c	Quasi-peak	Quasi-peak	Average ^c
	dB(μV/m)		dB(μV/m)		dB(μA/m)	dB(μV/m)	
0,15 to 30	–	–	–	–	39 Decreasing linearly with the logarithm of frequency to 3		
30 to 80,872	30	25	40	35	–	42 to 39	37 to 34
80,872 to 81,848	50	45	60	55	–	59	54
81,848 to 134,786	30	25	40	35	–	39 to 37	34 to 32
134,786 to 136,414	50	45	60	55	–	57	52
136,414 to 230	30	25	40	35	–	37 to 35	32 to 30
230 to 1 000	37	32	47	42	–	42	37
On an OATS or in a SAC, class B equipment ~~can~~ may be measured at a nominal distance of 3 m or 10 m.							
At the transition frequency, the more stringent limit shall apply. In certain frequency ranges, the limit for magnetic field strength and for measurements in the FAR decrease linearly with the logarithm of frequency.							
^a In the frequency range 30 MHz to 1 GHz, the 3 m separation distance applies only to ~~small size equipment meeting the size criterion defined in 3.17~~ small EUT (see 3.1.32).							
^b The table-top equipment shall fit into the validated test volume of the FAR. In the range below 30 MHz, such group 2 equipment shall be measured at an OATS or in a SAC (see limits in the respective magnetic field column in this table).							
^c The average limits apply to magnetron driven equipment and microwave ovens only. If magnetron driven equipment or microwave ovens exceed the quasi-peak limit at certain frequencies, then the measurement shall be repeated at these frequencies with the average detector and the average limits specified in this table apply.							

6.3.2.4 Frequency range 1 GHz to 18 GHz

The limits in the frequency range 1 GHz to 18 GHz apply only to group 2 equipment operating at frequencies above 400 MHz. The limits specified in the Table 17 to Table 19 apply only to RF disturbances appearing outside designated ISM bands as listed in Table 1.

The electromagnetic radiation disturbance limits for the frequency range 1 GHz to 18 GHz are specified in Table 17 to Table 19. The equipment shall meet either the limits of Table 17, or at least the limits of Table 18 or Table 19 (see decision tree in 9.4.1, Figure 17).

ISM RF lighting devices operating in dedicated ISM frequency bands (in Table 1, as defined by the ITU) shall either meet the class B limits of Table 17 or at least the limits of Table 18.

For microwave-powered UV irradiators, the limits specified in Table 17 apply.

Recommendations for the protection of specific safety services are given in Annex C and Table C.1.

Table 17 – Electromagnetic radiation disturbance peak limits for group 2 equipment operating at frequencies above 400 MHz

Frequency range GHz	Limits for a measurement distance of 3 m Peak dB(µV/m)	
	Class A	Class B
1 to 18		
Within harmonic frequency bands	82 ^a	70
Outside harmonic frequency bands	70	70
Peak measurements with a resolution bandwidth of 1 MHz and a video signal bandwidth (VBW) higher than or equal to 1 MHz. The recommended VBW is 3 MHz.		
NOTE In this table, “harmonic frequency bands” means the frequency bands which are multiples of the ISM bands allocated above 1 GHz.		
^a At the upper and lower edge frequencies of harmonic frequency bands, the more stringent limit of 70 dB(µV/m) applies.		

Table 18 – Electromagnetic radiation disturbance weighted limits for group 2 equipment operating at frequencies above 400 MHz

Frequency range GHz	Limits for a measuring distance of 3 m weighted dB(µV/m)
1 to 2,4	60
2,5 to 5,725	60
5,875 to 18	60
Weighted measurements shall be performed with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.	
To check conformance with the limits of this table, weighted measurements shall be performed in all the following frequency ranges, in which the limit of Table 17 was exceeded during the peak measurement:	
a) 1,0 GHz to 2,4 GHz ^a ;	
b) 2,5 GHz to 6,125 GHz (outside the band 5,72 GHz to 5,88 GHz) ^a ;	
c) 6,125 GHz to 8,575 GHz;	
d) 8,575 GHz to 11,025 GHz;	
e) 11,025 GHz to 13,475 GHz ^b ;	
f) 13,475 GHz to 15,925 GHz;	
g) 15,925 GHz to 18,0 GHz ^a .	
At subranges where the limit of Table 17 was exceeded, a weighted measurement shall be performed with a span of 20 MHz around the centre frequency adjusted to the frequency of the highest disturbance level in the respective subrange.	
^a In cases where the frequency of highest emission during peak measurement is found closer than 10 MHz from the frequency edges 1 GHz, 2,4 GHz, 2,5 GHz, 5,72 GHz, 5,88 GHz or 18 GHz, the span for weighted measurements shall remain 20 MHz, but in such a case, the centre frequency shall be adjusted so that the frequency edges are not exceeded.	
^b In any case, a final weighted measurement shall be performed at the frequency of the highest emission, which exceeds the limit of Table 17 in the frequency range 11,7 GHz to 12,7 GHz for satellite downlink. If the highest disturbance level in this subrange is outside of the range for satellite downlink, in this subrange two final measurements shall be performed.	
~~NOTE – See Annex B for further guidance on the use of the spectrum analyzer.~~	

Table 19 – Electromagnetic radiation disturbance APD level corresponding to 10^{-1} limits for class B group 2 equipment operating at frequencies above 400 MHz

Frequency range GHz	Limits for a measurement distance of 3 m APD level corresponding to 10^{-1} dB(μ V/m)
1 to 2,4	70
2,5 to 5,725	70
5,875 to 18	70

To check conformance with the limits of this table, APD measurements shall be performed in all the following frequency subranges, in which the limit of Table 17 was exceeded during the peak measurement:

- a) 1,0 GHz to 2,4 GHz ^a;
- b) 2,5 GHz to 6,125 GHz (outside the band 5,72 GHz to 5,88 GHz) ^a;
- c) 6,125 GHz to 8,575 GHz;
- d) 8,575 GHz to 11,025 GHz;
- e) 11,025 GHz to 13,475 GHz ^b;
- f) 13,475 GHz to 15,925 GHz;
- g) 15,925 GHz to 18,0 GHz ^a.

Final APD measurements shall be performed at 5 frequencies as explained in 9.4.4.3.

^a In cases where the frequency of highest emission during peak measurement is found closer than 10 MHz from the frequency edges 1 GHz, 2,4 GHz, 2,5 GHz, 5,72 GHz, 5,88 GHz or 18 GHz, final APD measurements shall be omitted at frequencies outside the corresponding bands, ~~for which limits are defined~~ listed here.

^b In any case, final APD measurements shall be performed around the frequency of the highest emission, which exceeds the limit of Table 17 in the frequency range 11,7 GHz to 12,7 GHz for satellite downlink. If the highest disturbance level in this subrange is outside of the range for satellite downlink, in this subrange two final measurements shall be performed.

NOTE An APD level corresponding to 10^{-1} means that the amplitude of the disturbance exceeds the specified level during the observation time with a probability of 10 %.

6.4 Group 1 and group 2 class A equipment measured in situ

6.4.1 Limits for conducted disturbances

Under *in situ* conditions, an assessment of conducted disturbances is not required.

6.4.2 Limits of electromagnetic radiation disturbance

The limits given in Table 20 apply to class A group 1 equipment and the limits given in Table 21 apply to class A group 2 equipment.

Table 20 – Electromagnetic radiation disturbance limits for class A group 1 equipment measured *in situ*

Frequency range MHz	Limits with measuring distance 30 m from the outer face of the exterior wall of the building in which the equipment is situated	
	Electric field Quasi-peak dB(μV/m)	Magnetic field Quasi-peak ^a dB(μA/m)
0,15 to 0,49	–	13,5
0,49 to 3,95	–	3,5
3,95 to 20	–	–11,5
20 to 30	–	–21,5
30 to 230	30	–
230 to 1 000	37	–
At the transition frequency, the more stringent limit shall apply.		
If local conditions do not allow for measurements at 30 m, then a larger distance ~~can~~ may be used. In this case, an inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance.		
^a These limits apply in addition to the limits in the frequency range 30 MHz to 1 GHz to radiated disturbances originating from the operation frequency and its harmonics appearing in the frequency range 150 kHz to 30 MHz, caused by the installed class A group 1 equipment with a rated power exceeding 20 kVA. In the event that the ambient noise level exceeds the above limits, the emissions of the EUT shall not increase this noise floor by more than 3 dB.		

Table 21 – Electromagnetic radiation disturbance limits for class A group 2 equipment measured *in situ*

Frequency range MHz	Limits for a measuring distance of D in m from the exterior wall of the building	
	Electric field Quasi-peak dB(μ V/m)	Magnetic field Quasi-peak dB(μ A/m)
0,15 to 0,49	–	23,5
0,49 to 1,705	–	13,5
1,705 to 2,194	–	18,5
2,194 to 3,95	–	13,5
3,95 to 20	–	–1,5
20 to 30	–	–11,5
30 to 47	48	–
~~47 to 53,94~~	~~30~~	~~–~~
~~53,94 to 54,56~~	~~30~~	~~–~~
~~54,56 to 68~~	~~30~~	~~–~~
47 to 68	30	–
68 to 80,872	43	–
80,872 to 81,848	58	–
81,848 to 87	43	–
87 to 134,786	40	–
134,786 to 136,414	50	–
136,414 to 156	40	–
156 to 174	54	–
174 to 188,7	30	–
188,7 to 190,979	40	–
190,979 to 230	30	–
230 to 400	40	–
400 to 470	43	–
470 to 1 000	40	–
At the transition frequency, the more stringent limit shall apply.		

For group 2 equipment measured *in situ*, the measuring distance D from the exterior wall of the building in which the equipment is situated equals $(30 + x/a)$ m or 100 m whichever is smaller, provided that the measuring distance D is within the boundary of the premises. In the case where the calculated distance D is beyond the boundary of the premises, the measuring distance D equals x or 30 m, whichever is longer.

For the calculation of the above values:

- x is the ~~nearest~~ distance in m between the exterior wall of the building in which the equipment is situated and the boundary of the user's premises in each measuring direction;
- a = 2,5 for frequencies lower than 1 MHz;
- a = 4,5 for frequencies equal to or higher than 1 MHz.

7 Measurement requirements

7.1 General

The requirements specified in Clause 7, together with the limits specified in Clause 6, constitute the essential EMC requirements of this document. ~~For measurements at test sites (see Clause 8), verification of compliance of a given type of equipment with these essential EMC requirements qualifies as type test.~~

~~Requirements which relate to measurements at such test sites are type test requirements. A type test may be recognized as type approval if the conditions for the statistical assessment of measurement results according to Annex H are observed.~~ **9**

~~Class A equipment may be measured either on a test site or *in situ* as determined by the manufacturer. Class B equipment shall be measured on a test site.~~

Specific requirements for making measurements on a test site are given in Clause 8 and Clause 9, for making measurements *in situ* in Clause 10.

The requirements of the present clause are to be met for both test site and ~~or~~ *in situ* measurements.

Measurements ~~need~~ shall only be performed in frequency ranges where limits are specified in Clause 6.

For equipment with radio functionality, the additional requirements of Annex F shall apply.

Components or subassemblies for higher order equipment or systems which are intended to be only assembled at their respective place of operation can also be tested according to the requirements of this document. For testing purposes in the framework of this document, such components or subassemblies shall be regarded as stand-alone equipment. Components or subassemblies for which compliance with the relevant requirements cannot be shown when measured at a test site can also be assessed *in situ* when being installed into the higher order system, in which case the provisions of 6.4 shall apply.

NOTE 1 The environments encompassed in this document are residential, commercial ~~or~~ and industrial environments as described in IEC 61000-2-5 [11]. Adherence of equipment to the requirements of this document will allow for its operation and use in these environments without resulting in an increased risk of RFI. There ~~may~~ can also exist other IEC product standards which allow for compliance testing of components or subassemblies of higher order systems but which encompass other environments than those specified in IEC 61000-2-5 [11]. Choice of this document or the other appropriate IEC product standard for compliance testing of components or subassemblies is up to the manufacturer.

NOTE 2 Examples for such components include, but are not limited to: power converters used for distributed generation and supply of electric energy into LV AC mains networks or installations or, by means of their own dedicated transformer, into MV power distribution networks, but also power electric subassemblies intended for supply of higher order systems with power from LV AC mains networks.

7.2 Ambient noise

A test site ~~for type testing~~ shall allow emissions from the equipment under test to be distinguished from ambient noise. The suitability in this respect can be determined by measuring the ambient noise levels with the equipment under test inoperative and ensuring that the ambient noise levels are at least 6 dB below the limits specified in 6.2 or 6.3, as appropriate for the measurement being carried out. Further information on compliance testing in the presence of ambient noise is found in CISPR 16-2-1:2014, 6.2.2 and CISPR 16-2-3:2010/2016/AMD1:2019, 6.2.2.

It is not necessary to reduce the ambient noise level to 6 dB below the specified limit where the combination of the ambient noise plus the emission from the equipment under test does not

exceed the specified limit. Under these conditions the equipment under test is considered to satisfy the specified limit.

When carrying out measurements of conducted RF disturbances, local radio transmissions ~~may~~ **can** increase the ambient noise level at some frequencies. A suitable radio-frequency filter may be inserted between the artificial network (V-AMN and/or DC-AN) and the respective laboratory AC mains supply or DC power source, or measurements may be performed in a shielded enclosure. The components forming the radio-frequency filter should be enclosed in a metallic screen directly connected to the reference ground of the measuring system. The requirements for the impedance of the artificial network shall be satisfied at the frequency of measurement when the radio-frequency filter is connected.

If, when measuring radiated RF disturbances, the 6 dB ambient noise conditions cannot be met, then the antenna may be located at a distance closer to the equipment under test than specified in Clause 6 (see 8.3.4). Further advice on measurement conditions in presence of high level ambient noise is found in Annex B.

7.3 Measuring equipment

7.3.1 Measuring instruments

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

NOTE 1 Both detectors can be incorporated in a single receiver and measurements carried out by alternately using the quasi-peak detector and the average detector.

NOTE 2 The average detector in CISPR 16-1-1 is commonly referred to as “CISPR-Average”. This is to emphasize that the average detector used in a CISPR receiver obtains a measurement result that is equivalent to the peak reading of a meter with a time constant as defined in CISPR 16-1-1.

The measuring receiver used shall be operated in such a way that a variation in frequency of the disturbance being measured does not affect the results.

NOTE 3 Measuring instruments having other detector characteristics can be used provided the measurement of the disturbance values can be proved to be the same. Attention is drawn to the convenience of using a panoramic receiver or a spectrum analyzer, particularly if the working frequency of the equipment under test changes appreciably during the work cycle.

To avoid the possibility of the measuring instrument incorrectly indicating non-compliance with the limits, the measuring receiver shall not be tuned closer to the edge of one of the bands designated for ISM use than the frequency at which its 6 dB bandwidth point aligns with the edge of the designated band.

When making measurements on high power equipment, care should be taken to ensure that screening and the spurious response rejection characteristics of the measuring receiver are adequate.

For measurements at frequencies above 1 GHz, a spectrum analyzer or test receiver with characteristics as defined in CISPR 16-1-1 shall be used.

~~Precautions which can be taken in the use of a spectrum analyzer are given in Annex B.~~

7.3.2 Artificial network (AN)

7.3.2.1 General

The artificial network (AN) is required to provide a defined termination impedance for the EUT's AC mains power port or DC power port under test at radio frequencies at the point of measurement. The AN will also provide isolation of the equipment under test from ambient noise on the respective AC or DC power lines.

7.3.2.2 Artificial mains network (AMN)

Measurement of the disturbance voltage at low voltage AC mains power ports shall be made using an artificial mains network (V-AMN) as specified in CISPR 16-1-2.

7.3.2.3 Artificial DC network (DC-AN)

~~Measurement of the disturbance voltage at low voltage DC power ports shall be made either using the 150 Ω artificial mains Delta-network specified in 4.7 of CISPR 16-1-2:2014 (see also CISPR 16-1-2:2014, Figure A.2) or the 150 Ω artificial d.c. network specified in Annex I of this standard.~~ Measurement of the disturbance voltage at low voltage DC power ports shall be made using the 150 Ω artificial mains Delta-network specified in 4.7 of CISPR 16-1-2:2014 and CISPR 16-1-2:2014/AMD1:2017. Figure A.2 of CISPR 16-1-2:2014 and CISPR 16-1-2:2014/AMD1:2017 shows a suitable circuit for a delta-network, and another example for a 150 Ω Δ-AN is shown in Figure A.7 of CISPR 16-1-2:2014 and CISPR 16-1-2:2014/AMD1:2017. For simplified wording, any of these networks intended for use with measurements at low voltage DC power ports is further on denoted as DC-AN.

7.3.3 Voltage probe

The voltage probe shown in Figure 1 shall be used when the artificial mains network (V-AMN) cannot be used. The probe is connected sequentially between each line and the reference earth chosen (metal plate, metal tube). The probe consists mainly of a decoupling capacitor and a resistor such that the total resistance between the line and earth is at least 1 500 Ω. The effect on the accuracy of measurement of the capacitor or any other device which ~~may~~ can be used to protect the measuring receiver against dangerous currents shall be either less than 1 dB or allowed for in calibration. The voltage probe shall meet the requirements specified in CISPR 16-1-2:2014, Clause 5.

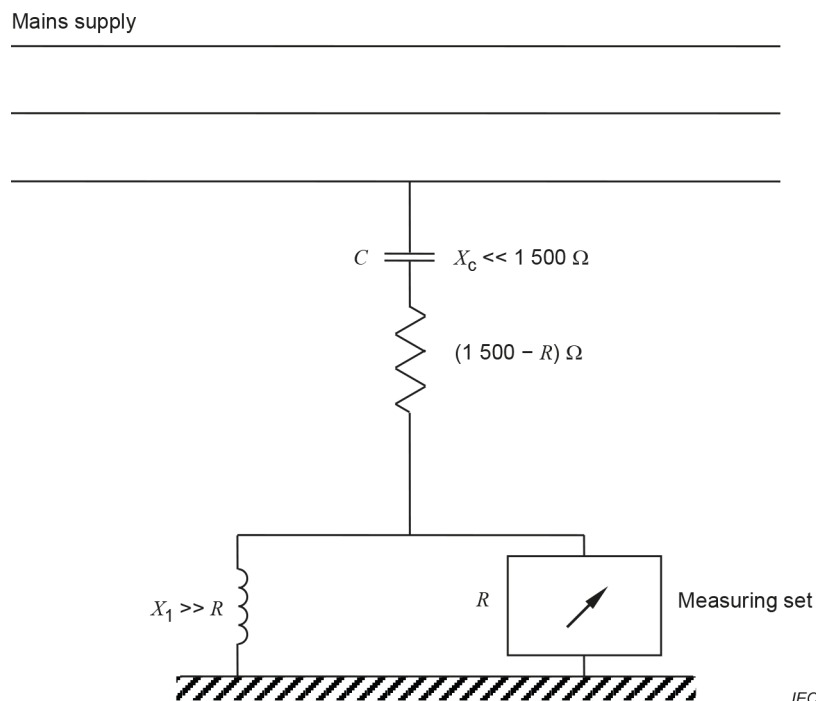


Figure 1 – Circuit for disturbance voltage measurements on mains supply

7.3.4 Antennas

7.3.4.1 Frequency range below 30 MHz

In the frequency range below 30 MHz the antenna shall be a loop as specified in CISPR 16-1-4. The antenna shall be supported in the vertical plane and be rotatable about a vertical axis.

~~lowest point~~ centre of the loop shall be 1,3 m above ground level, in each orientation of the loop antenna.

7.3.4.2 Frequency range from 30 MHz to 1 GHz

7.3.4.2.1 General

In the frequency range from 30 MHz to 1 GHz the antenna used shall be as specified in CISPR 16-1-4.

Other antennas may be used provided the results can be shown to be within ± 2 dB of the results which would have been obtained using a balanced dipole antenna.

7.3.4.2.2 Open-area test site (OATS) and semi-anechoic chamber (SAC)

For measurements on an OATS or in a SAC, the centre of the antenna shall be varied between 1 m and 4 m height for maximum indication at each test frequency. The nearest point of the antenna to the ground shall be not less than 0,2 m. Measurements shall be performed with the antenna oriented in both horizontal and ~~subsequently in~~ vertical polarizations.

7.3.4.2.3 Fully-anechoic room (FAR)

For measurements in a FAR, the antenna height is fixed at the geometrical middle height of the validated test volume. Measurements shall be performed with the antenna oriented in both horizontal and ~~subsequently in~~ vertical polarizations.

7.3.4.2.4 Other sites

For measurements *in situ* the centre of the antenna shall be fixed at $(2,0 \pm 0,2)$ m height above the ground.

7.3.4.3 Frequency range from 1 GHz to 18 GHz

In the frequency range from 1 GHz to 18 GHz, the antenna used shall be as specified in CISPR 16-1-4.

7.3.5 Artificial hand

In order to simulate the influence of the user's hand, the application of the artificial hand is required for hand-held equipment during the mains disturbance voltage measurement.

The artificial hand consists of metal foil which is connected to one terminal (terminal M) of an RC element consisting of a capacitor of $220 \text{ pF} \pm 20 \%$ in series with a resistance of $510 \Omega \pm 10 \%$ (see Figure 2); the other terminal of the RC element shall be connected to the reference ground of the measuring system (see CISPR 16-1-2). The RC element of the artificial hand may be incorporated in the housing of the artificial mains network.

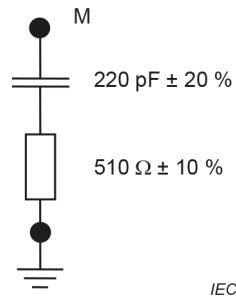


Figure 2 – Artificial hand, RC element

7.4 Frequency measurement

For equipment which is intended to operate with a fundamental frequency in one of the designated bands listed in Table 1, the frequency shall be checked with measuring equipment having an inherent error of measurement not greater than 1/10 of the permissible tolerance for the mid-band frequency of the designated band. The frequency shall be measured over all the load range from the lowest power normally used up to the maximum.

7.5 Configuration of equipment under test

7.5.1 General

Consistent with typical applications of the equipment under test, the level of the disturbance shall be maximized by varying the configuration of the equipment. An example of a typical setup for measurements of radiated disturbances from a table-top EUT is provided in Figure 3. The measurement arrangement shall be typical of normal installation practice and centred to the turntable's vertical axis.

NOTE 1 The extent to which this subclause is applicable to the measurement of an installation *in situ* will depend on the flexibility inherent in each particular installation. The provisions of this subclause apply to *in situ* measurements in so far as a particular installation allows for the position of cables to be varied and different units within the installation to be operated independently, the extent to which the position of the installation can be moved within the premises, etc.

For measurement of radiated disturbances on an OATS or in a SAC with a separation distance of 3 m the assessment of the radiation from the cabling of the EUT shall be restricted to those fractions of interconnecting cables (see 7.5.2) and mains cables (see 7.5.3) which are within the test volume not exceeding ~~4,2~~ 1,5 m diameter times 1,5 m height above ground.

For the measurement of radiated disturbances in a FAR, all cables dropping to the floor shall be visible from the position of the antenna reference point for at least 80 cm, see Figure 3b.

~~Peripheral~~ Associated equipment not fitting into the test volume shall be excluded from the measurements or decoupled from the test environment. If cables to ~~peripheral~~ associated equipment cannot be extended to run out of test volume, then the ~~peripheral~~ associated equipment shall be placed within the imaginary circle around the complete configuration of the EUT.

The measuring distance is defined from the reference point of the antenna to the boundaries of an imaginary circle around the complete configuration of the EUT, see Figure 3a.

NOTE 2 Restriction of radiation assessment to the cable fractions inside the test volume can be achieved for example by application of CMADs to the cables at the position where they leave the test volume. CISPR 16-2-3 gives further guidance on the application of CMADs.

Dimensions in metres

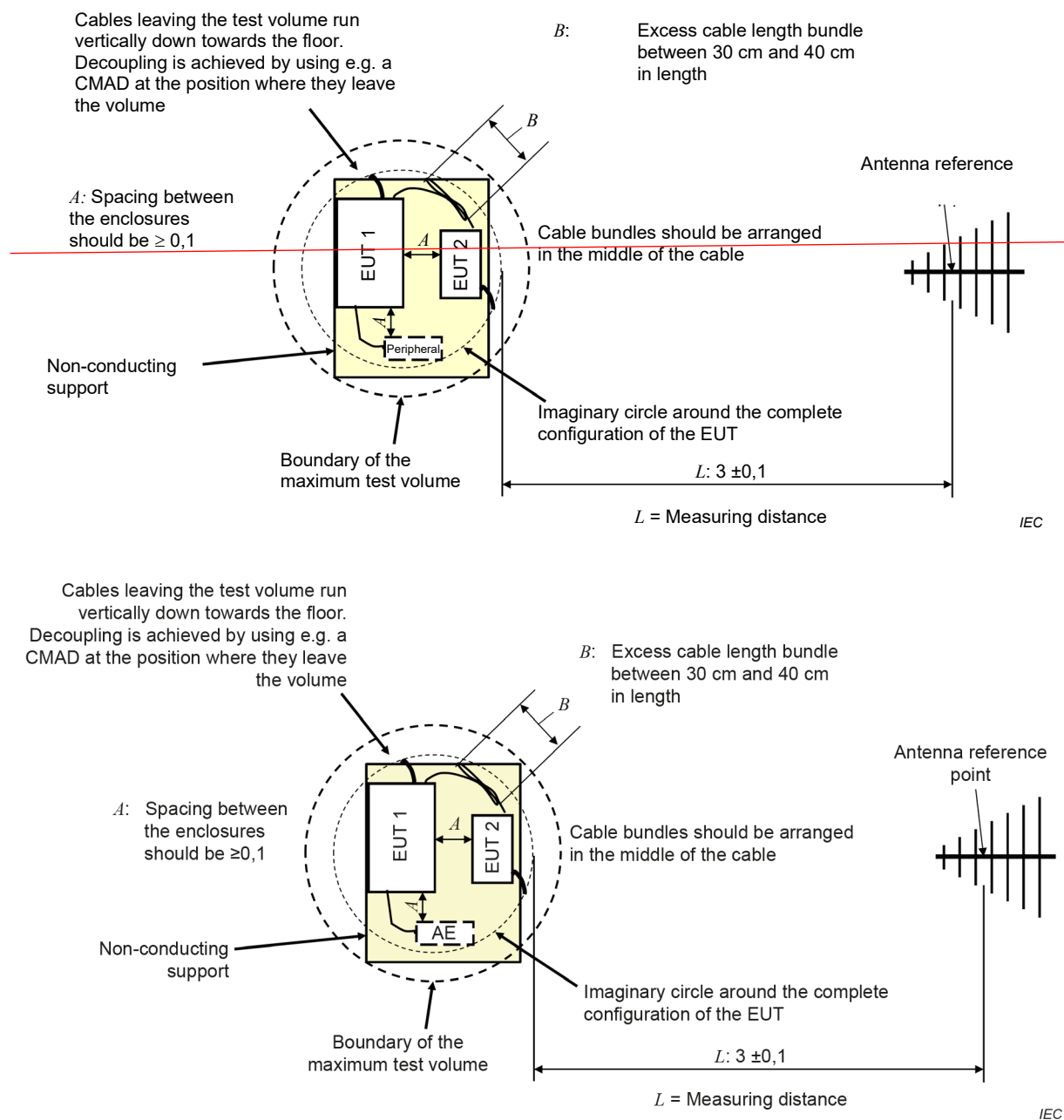


Figure 3a – Top view

Dimensions in metres

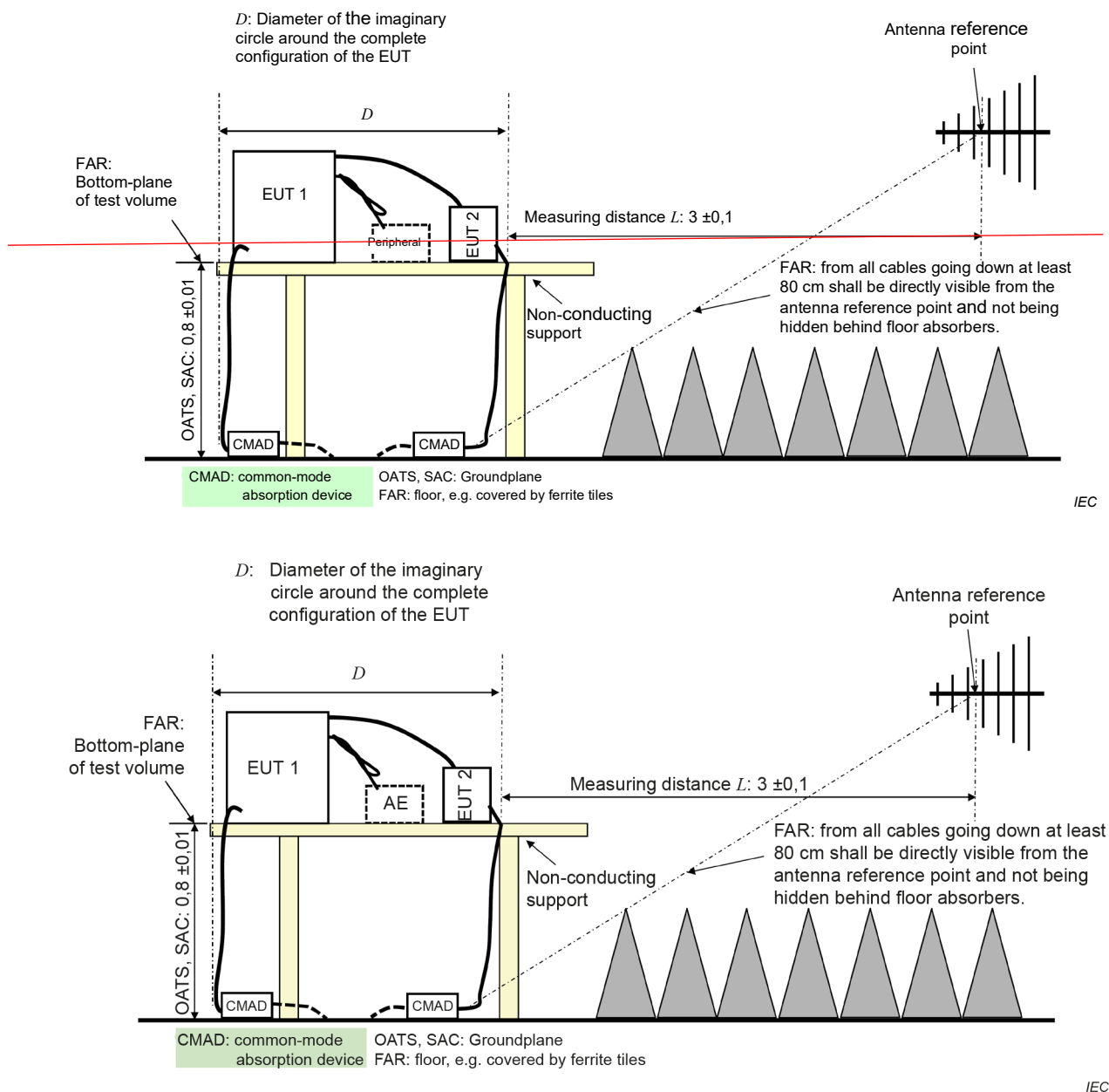


Figure 3b – Side view

Figure 3 – Example for a typical cable arrangement for measurements of radiated disturbances in 3 m separation distance, Table-top EUT

An example of a typical unified test set up for floor standing equipment suitable for measurement of conducted as well as radiated disturbances is shown in Figure 4. Further examples of typical arrangements of the EUT and associated peripherals are given in CISPR 16-2-3 and CISPR 16-2-1.