CISPR 11

Edition 7.0 2024-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE
COMITÉ INTERNATIONAL SPÉCIAL DES PERTURBATIONS RADIOÉLECTRIQUES

PRODUCT FAMILY EMC STANDARD
NORME DE FAMILLE DE PRODUITS EN CEM

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

Appareils industriels, scientifiques et médicaux – Caractéristiques de perturbations radioélectriques – Limites et méthodes de mesure



CISPR 11:2024-02(en-fr)



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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

FOREWORD

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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
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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 both, equipment assessed by means of 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 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 can apply to individual ISM RF applications operated at frequencies outside designated ISM bands (see Table 1). They also can apply to ISM RF applications operated at frequencies above 18 GHz.

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

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.

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.

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.

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 – Measuring apparatus*

1 Figures in square brackets refer to the Bibliography.

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 16-1-4:2019, *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 16-1-4:2019/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 16-2-3:2016, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*
CISPR 16-2-3:2016/AMD1:2019
CISPR 16-2-3:2016/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 60601-2-2:2017, *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 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*

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

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2 This publication was withdrawn.

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]

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 can be for example a photovoltaic or a fuel cell power generating system, or also a battery.

3.1.9
electro-discharge machining 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
phenomenon by which energy in the form of electromagnetic waves emanates from a source into space

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 can be a separate unit or part of a complex machine.

3.1.12
equipment with radio functionality
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
GCPC
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: 2020 – 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
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 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 a cylindrical volume of 1,5 m diameter and 1,5 m height (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

3.1.34
wired network port
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