# CISPR PAS 39

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# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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

## Electromagnetic compatibility (EMC) – Conducted emission requirements on the low voltage AC mains port in the frequency range 9 kHz to 150 kHz for equipment intended to operate in residential environments



## Compatibilité électromagnétique (CEM) – Exigences en matière d'émissions conduites sur l'accès d'alimentation en courant alternatif basse tension dans la plage de fréquencesde 9 kHz à 150 kHz pour les appareils destinés à fonctionner dans des environnements résidentiels





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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# ELECTROMAGNETIC COMPATIBILITY (EMC) –

# Conducted emission requirements on the low voltage AC mains port in the frequency range 9 kHz to 150 kHz for equipment intended to operate in residential environments

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CISPR 39 has been prepared by CISPR subcommittee H: Limits for the protection of radio services. It is a Publicly Available Specification.

The text of this Publicly Available Specification is based on the following documents:

| Draft | Report on voting |
|---|---|
| CIS/H/505/DPAS | CIS/H/517/RVDPAS |

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 Publicly Available Specification 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.

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

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- withdrawn, or
- revised.

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# INTRODUCTION

This PAS complements IEC 61000-6-3:2020 by the addition of the following:

- addition of normative requirements for conducted emissions at the low voltage AC mains port in the frequency range 9 kHz to 150 kHz;
- addition of an informative annex providing background information on the normative limits;
- addition of an informative annex with recommendations to limit the spectral density of non-intentional emissions (NIE).

The technical content of this PAS was derived from a fragment of the maintenance of IEC 61000-6-3 and, as CIS/H/459/CDV, this fragment received 100 % support from the National Committees.

This PAS is published due to the urgent market needs for these requirements.

# ELECTROMAGNETIC COMPATIBILITY (EMC) –

# Conducted emission requirements on the low voltage AC mains port in the frequency range 9 kHz to 150 kHz for equipment intended to operate in residential environments

## 1 Scope

This document is applicable to electrical and electronic equipment within the scope of IEC 61000-6-3:2020, for which no relevant dedicated product or product family EMC emission standard has been published.

It defines low voltage AC mains conducted emission requirements in the frequency range 9 kHz to 150 kHz which are considered essential and have been selected to provide an adequate level of protection to both radio reception and Mains Communicating Systems (MCS) in the defined electromagnetic environment.

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



## 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.

NOTE The normative references in this clause are identical to those published in IEC 61000-6-3:2020.

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

CISPR 16-1-2:2014, *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/AMD 1:2017

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*
CISPR 16-2-1:2014/A1:2017

IEC 61000-6-3:2020, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for equipment in residential environments*

# 3 Terms, definitions and abbreviated terms

## 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61000-6-3:2020 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**
**primary function**
any function of an EUT considered essential for the user or for the majority of users

Note 1 to entry: An EUT can have more than one primary function. For example, the primary functions of a basic television set include broadcast reception, audio reproduction and display.

**3.1.2**
**UPS function**
power supply function, that provides power during unintentional AC mains power supply interruptions

**3.1.3**
**adjustable speed electric power drive function**
a power drive system function that provides adjustable speed AC or DC motor drives and can convert input and/or output voltages (line-to-line voltage).



## 3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in IEC 61000-6-3:2020 and the following apply.

| | |
|---|---|
| AC | Alternating Current |
| ACEC | Advisory Committee on Electromagnetic Compatibility |
| AMN | Artificial Mains Network |
| AP | Allowance Probability |
| AV | Average |
| BPSK | Binary Phase-Shift Keying |
| CF | Coupling Factor |
| CF(E) | Electric field Coupling Factor |
| CF(H) | Magnetic field Coupling Factor |
| CISPR | International Special Committee on Radio Interference |
| CM | Common Mode |
| DC | Direct Current |
| DM | Differential Mode |
| EMC | Electro-Magnetic Compatibility |
| EUT | Equipment Under Test |
| FS | Field Strength |
| FSFI | Free Space Field Impedance |
| FSK | Frequency-Shift Keying |

| | |
|---|---|
| H-Field | Magnetic Field |
| IEC | International Electrotechnical Commission |
| ISO | International Standards Organization |
| IVL | Integral Voltage Level |
| LED | Light Emitting Diode |
| LF | Low Frequency |
| MCE | Mains Communicating Equipment |
| MCS | Mains Communicating System |
| NEC2 | Numerical Electromagnetics Code 2 |
| NIE | Non-Intentional Emission |
| OFDM | Orthogonal Frequency-Division Multiplexing |
| RFI | Radio Frequency Interference |
| PR | Protection Ratio |
| QP | Quasi-Peak |
| UPS | Uninterruptible Power Systems |
| V-AMN | Artificial Mains V-Network |
| VLF | Very Low Frequency |

## 4 General



The requirements specified in this document are applicable to an equipment intended to operate in the residential environment. For any additional information needed to assess emissions according to Table 1, refer to IEC 61000-6-3:2020.



## 5 Documentation for the user

In addition to the requirements specified in Clause 6 of IEC 61000-6-3:2020, the instructions for use of the equipment shall include, where relevant, the notification required by footnote [a] to Table 1.

## 6 Emission test details

The requirements in Table 1 shall apply.

The following shall be taken into account during the application of the measurements defined in Table 1:

- At transitional frequencies, the lower limit applies.
- Where the limit value varies over a given frequency range, it changes linearly with respect to the logarithm of the frequency.

**Table 1 – Requirements for conducted emissions, low voltage AC mains port in the frequency range 9 kHz to 150 kHz**

| Measurement network | Frequency range MHz | Limits dB(µV) Detector | Measurement specifications | Limitations and restrictions |
|---|---|---|---|---|
| V-AMN | 0,009 to 0,05 | 120,5 to 110 Quasi-peak | Instrumentation, CISPR 16-1-1:2019, Clauses 4, 5 and 7<br>Networks, CISPR 16-1-2:2014 and CISPR 16-1-2:2014/AMD1:2017, Clause 4<br>Method, CISPR 16-2-1:2014 and CISPR 16-2-1:2014/AMD1:2017, Clause 7<br>Set-up, CISPR 16-2-1:2014 and CISPR 16-2-1:2014/AMD1:2017, Clause 7 | None |
| | 0,05 to 0,15 | 104 to 80 [a] Quasi-peak | | |

NOTE See Annex A for background information about the normative limits, including recommendations related to the limit application in the frequency range 9 kHz to 150 kHz, and Annex B for recommendations to improve compatibility with MCE by additional assessments.

[a] For equipment with a primary function according to 3.1.2 (UPS function) or 3.1.3 (adjustable speed electric power drive function), the following limits can be applied: 110 dB(µV) to 82,5 dB(µV). When these relaxed limits are applied, it shall be recorded in the test report and a notification shall be added in the user manual of the equipment. The notification shall state that such equipment has a higher risk of interference, and specific measures might be required for its installation and operation, or it can be necessary to disconnect the equipment.

# Annex A
(informative)

# Background information on the normative limits in the frequency range 9 kHz to 150 kHz

## A.1 Derivation of the normative limits

The starting point for the derivation of limits in the frequency range 9 kHz to 150 kHz for residential environment are the compatibility levels contained in IEC 61000-2-2:2002, IEC 61000-2-2:2002/AMD1:2017 and IEC 61000-2-2:2002/AMD2:2018.

The compatibility levels have been defined in the frequency range from 9 kHz to 150 kHz, after long controversial discussions in IEC SC77A, under direct supervision of ACEC, to improve EMC for equipment such as mains communicating systems, electricity meters and clocks supplied by public low voltage AC mains supply systems against disturbances generated by equipment such as switching power converters, switch mode power supplies, photovoltaic inverters, etc.

As explained in Annex D of IEC 61000-2-2:2002, IEC 61000-2-2:2002/AMD1:2017 and IEC 61000-2-2:2002/AMD2:2018, the defined compatibility level curve represents the best currently achievable compromise supported by all stakeholders and has been defined for voltage distortion in differential mode.



The task to derive emission limits from these compatibility levels has been given to a joint working group between CISPR H and IEC SC77A with the following terms of reference:

- Developing equipment emission limits in the frequency range 9 kHz to 150 kHz to accommodate the latest amendments to IEC 61000-2-2 for this frequency range.
- Developing the methodology for emission measurements against the newly developed limits, possibly using measuring equipment and methods from the CISPR 16 series for both differential mode and common mode disturbances. The suitability of the methodology shall be shown.
- Preparing appropriate implementation in standards, i.e. proposing an amendment to the generic standard – which has a pilot function for the product standards – and preparing the implementation into Product/Product Family standards.

Measurements in the 9 kHz to 150 kHz frequency range have been based on the established quasi-peak detector in a 200 Hz bandwidth, as defined in CISPR 16-1-1:2019, with the measuring methods specified in the CISPR 16 series. Accordingly, the same measuring equipment can be used to evaluate both the protection requirements for MCS and the protection requirements for radio services.

Since the CISPR method is based on the measurement of unsymmetrical voltages (i.e. voltage referenced to earth using the V-AMN, see Figure A.1), the calculation of the limit values is based on the recommendations from the Note in 4.12.1 of IEC 61000-2-2:2002, IEC 61000-2-2:2002/AMD1:2017 and IEC 61000-2-2:2002/AMD2:2018, which is quoted as follows.

NOTE Based on the following assumptions, an emission margin equal to or higher than 3 dB between the equipment emission limits in differential mode for non-intentional emissions and the corresponding compatibility levels, or a difference equal to or higher than 9 dB (3 dB for the emission margin +6 dB for the conversion factor between the unsymmetrical voltages and the voltage in differential mode) between the equipment emission limits for unsymmetrical voltage distortion and the compatibility levels in differential mode given in 4.12.2 and 4.12.3, is sufficient:

– for each bandwidth of 200 Hz, the probability that the compatibility level is exceeded is lower than 5 %;

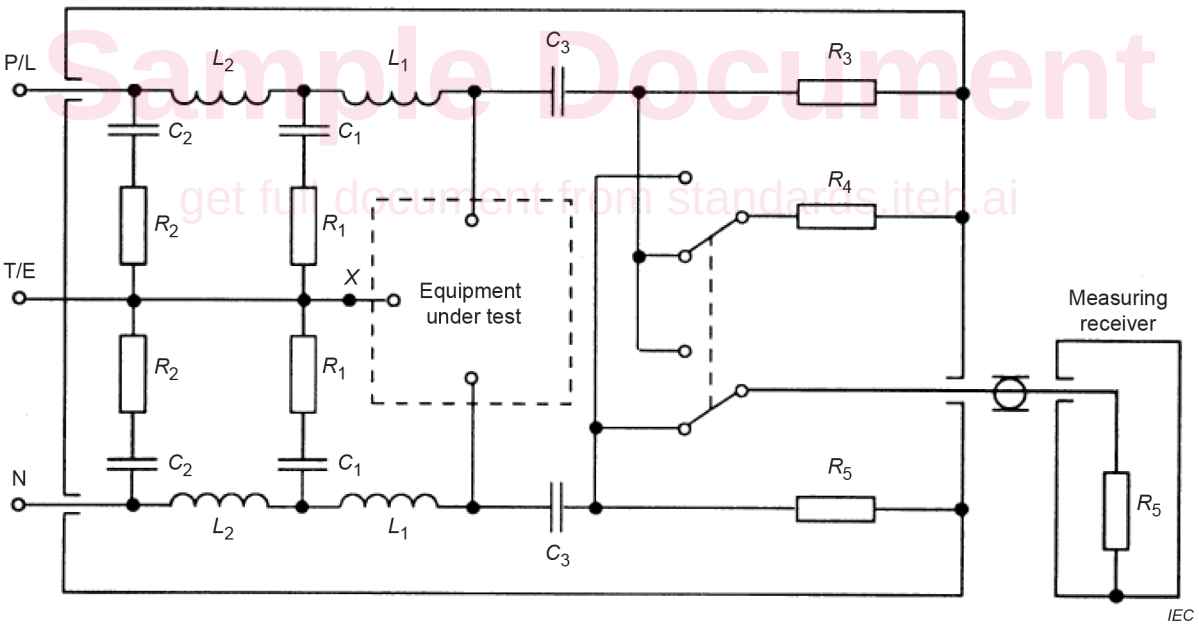
– at a given location, the disturbance level in a same bandwidth of 200 Hz does not result from more than two pieces of equipment generating non-intentional emissions close to the emission limit at the same time;

– non-intentional emissions from different equipment are generated independently from each other.

The 6 dB conversion factor is based on the very worst-case assumption that the EUT produces only differential mode emission. The compatibility levels in IEC 61000-2-2:2002, IEC 61000-2-2:2002/AMD1:2017 and IEC 61000-2-2:2002/AMD2:2018 are given only for symmetrical voltage (line to neutral) and in this case the measured unsymmetrical voltage is only half of a hypothetically produced 100 % symmetrical disturbance voltage. In reality, the unsymmetrical voltage is made by the combination of both differential mode and common mode disturbance voltages. Accordingly, the fixed 6 dB conversion factor gives an additional margin for the protection of mains communicating systems.

In summary, the normative limits for unsymmetrical voltage in the frequency range 9 kHz to 150 kHz have been set 9 dB lower than the compatibility levels for this frequency range, as suggested in IEC 61000-2-2:2002, IEC 61000-2-2:2002/AMD1:2017 and IEC 61000-2-2:2002/AMD2:2018.






SOURCE: CISPR 16-1-2:2014 and CISPR 16-1-2:2014/AMD1:2017, Figure 5.

**Figure A.1 – Example of a V-AMN**

Footnote a in Table 1 gives a slight relaxation of the limits for some equipment. This relaxation of the limits is based on the assumption that all such equipment is not used by more than 5 % of all customers connected to the same medium voltage / low voltage transformer. In case of interference generated by equipment, using this relaxation, the connection of such equipment might be restricted, for example by the distribution system operator.

For equipment widely used in household environment and consequently expected to be present in a high percentage of residential installations and with several units per installation (e.g. lighting equipment), in the frequency range 50 kHz to 150 kHz, it is recommended to apply a quasi-peak limit decreasing linearly with the logarithm of the frequency from 90 dB(µV) at 50 kHz to 80 dB(µV) at 150 kHz, in line with existing limits for lighting equipment in CISPR 15:2018.

## A.2 Radio protection analysis

### A.2.1 General

As explained in detail, the limits in the frequency range 9 kHz to 150 kHz were derived from the compatibility levels in IEC 61000-2-2:2002, IEC 61000-2-2:2002/AMD1:2017 and IEC 61000-2-2:2002/AMD2:2018 for protection of MCS operation. Additionally, those limits are also intended to protect radio reception in that frequency range. Therefore, the following considerations do not derive a whole new set of limits, but model the field strength expected at the frequencies of radio services at the given protection distance, when radio frequency emission having an amplitude equal to the limits specified in this document is injected into the mains grid and radiated by the cables of the grid. Since the V-AMN does not separate common and differential mode disturbance voltages, for these calculations, it is assumed that the measured value from the V-AMN is based on a disturbance voltage from the EUT, produced either 100 % in common mode or 100 % in differential mode. This would represent the worst case for each analysis.

### A.2.2 Radio protection analysis for common mode disturbance injections

#### A.2.2.1 Derivation of coupling factor by simulation

For the case at hand, a conducted limit line shall be derived based on the protection requirements of the radio services given in field strength values in the requested protection distance (which for residential environments is a distance of 10 m). At first a representative radiation model shall be defined. In a residential environment, electronic or electrical devices are typically connected to some wire in the house and will via connection to the installation topology around the house (including all possible directions) finally terminate in the circuit breaker box. From the viewpoint of which cable topology would possibly have the maximum radiation efficiency, a vertical wire (i.e. a vertical antenna) would represent the worst case of a possible common mode radiator. With respect to the length of such a wire, a length of 30 m is estimated as the worst case in typical residential environments. Therefore, the coupling factor for a 30 m long vertical antenna (see Figure A.2) was chosen to represent the worst possible coupling situation for common mode injection. Any real installation, where the low voltage line would take a respective path around the house connecting power outlets, switches, lamps and other appliances, would radiate less than the scenario chosen.