IEC 62311

Edition 2.0 2019-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)

Évaluation des équipements électroniques et électriques en relation avec les restrictions d'exposition humaine aux champs électromagnétiques (0 Hz à 300 GHz)

IEC 62311:2019-04(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 97.030

ISBN 978-2-8322-6763-9

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ASSESSMENT OF ELECTRONIC AND ELECTRICAL EQUIPMENT RELATED TO HUMAN EXPOSURE RESTRICTIONS FOR ELECTROMAGNETIC FIELDS (0 Hz to 300 GHz)

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International Standard IEC 62311 has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

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

a) a clear distinction between intentional and unintentional radiators has been introduced;
b) the exposure to non-uniform fields is considered;
c) the treatment of uncertainty for the assessment procedures has been improved;
d) various summation regimes are described in Annex A;
e) the information from meanwhile published basic standards has been used and hence all informative annexes of the previous edition have been removed.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
106/480/FDIS	106/486/RVD

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

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

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

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- withdrawn,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

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ASSESSMENT OF ELECTRONIC AND ELECTRICAL EQUIPMENT RELATED TO HUMAN EXPOSURE RESTRICTIONS FOR ELECTROMAGNETIC FIELDS (0 Hz to 300 GHz)

1 Scope

This document applies to electronic and electrical equipment for which no dedicated product standard or product family standard regarding human exposure to electromagnetic fields applies. It covers equipment with intentional or non-intentional radiators as well as a combination thereof.

This document provides assessment methods and criteria to evaluate equipment against limits on exposure of people related to electric, magnetic and electromagnetic fields. The frequency range covered is from 0 Hz to 300 GHz.

NOTE 1 Further guidance concerning the application of this document and its relationship to other EMF standards is given in Figure 1.

This document does not specify limits expressed by means of basic restrictions and/or reference levels. Such limits are subject to the applied assessment scheme, for example by means of regional limits.

NOTE 2 The assessment methods and criteria to evaluate equipment against basic restrictions or reference levels can be used with regard to either general public or occupational exposure.

2 Normative references

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

IEC 60050-161:1990, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility* (available at http://www.electropedia.org)

IEC 62232:2017, *Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure*

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 terminological databases for use in standardization at the following addresses:

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

3.1.1
averaging time
t_{avg}
<for human exposure to electromagnetic fields> appropriate time interval over which exposure is averaged for purposes of determining compliance

3.1.2
basic restriction
restriction on exposure to time-varying electric, magnetic and electromagnetic fields that is based directly on established health effects

Note 1 to entry: Examples of basic restrictions can be found in Annex II of the Council Recommendation 1999/519/EC [1], ICNIRP Guidelines ([2], [3]), IEEE Std C95.6 [4] and IEEE Std C95.1 [5].

3.1.3
contact current
<for human body> current flowing into the body resulting from contact with a conductive object in an electromagnetic field

Note 1 to entry: This is the localized current flow into the body (usually the hand, for a light brushing contact).

3.1.4
current density
J
current per unit cross-sectional area flowing inside the human body as a result of exposure to electromagnetic fields

3.1.5
duty factor
<for human exposure to electromagnetic fields> ratio of pulse duration to the pulse period of a periodic pulse train

Note 1 to entry: A duty factor can also be considered as a measure of the temporal transmission characteristic of an intermittently transmitting RF source such as a paging antenna by dividing average transmission duration by the average period for transmissions.

Note 2 to entry: A duty factor of 1,0 corresponds to continuous operation.

3.1.6
effective radiated power
ERP
product of the power supplied by a radio transmitter to an antenna and the gain of this antenna relative to a half-wave dipole in a given direction

[SOURCE: IEC 60050-713:1998, 713-09-26]

3.1.7
electric field strength
E
vector field quantity E which exerts on any charged particle at rest a force F equal to the product of E and the electric charge Q of the particle

[SOURCE: IEC 60050-121:1998, 121-11-18]

3.1.8
exposure
situation that occurs wherever a person is subjected to electric, magnetic or electromagnetic fields

Note 1 to entry: The word “exposure” is also commonly used to mean “exposure level” (see 3.1.9).

[SOURCE: IEC 62226-1:2004, 3.1.7]

3.1.9
exposure level
value of the quantity used to assess exposure

Note 1 to entry: This may be an induced current density, SAR, power density, electric or magnetic field strength, a limb current or a contact current.

3.1.10
far-field region
region of the field of an antenna where the radial field distribution is essentially dependent inversely on the distance from the antenna

Note 1 to entry: In the far-field region the field has a predominantly plane-wave character, i.e. locally uniform distribution of electric field and magnetic field in planes transverse to the direction of propagation. The vectors of the electric field and the magnetic field are perpendicular to each other and the quotient between the value of the electric field strength E and the magnetic field strength H is constant and equals the impedance of free space Z_0.

3.1.11
highest internal frequency
highest fundamental frequency generated or used within the EUT, or the highest frequency at which it operates

3.1.12
induced current
<in a body> current induced inside the body as a result of exposure to electromagnetic fields

3.1.13
inherently compliant
considered to comply with a set of requirements without the need of applying an assessment method (such as measurements or calculations)

Note 1 to entry: A set of requirements can for example be a set of exposure limits for the general public.

Note 2 to entry: Equipment that is inherently compliant with respect to a certain set of requirements (for example exposure limits for workers) is not necessarily inherently compliant with a different set of requirements (for example exposure limits for the general public).

3.1.14
intentional radiator
electrical or electronic equipment in which electric, magnetic or electromagnetic fields are intentionally generated for the purpose of radio communication, radiodetermination, treatment of material or transfer of electromagnetic energy

3.1.15
limb current
current flowing in an arm or a leg, either as a result of a contact current or else induced by an external field

3.1.16
magnetic field strength
H
vector quantity obtained at a given point by subtracting the magnetization M from the magnetic flux density B divided by the magnetic constant μ_0

[SOURCE: IEC 60050-121:1998, 121-11-56, modified – The notes have been deleted.]

3.1.17
magnetic flux density
B
vector field quantity B which exerts on any charged particle having velocity v a force F equal to the product of the vector product v x B and the electric charge Q of the particle

[SOURCE: IEC 60050-121:1998, 121-11-19, modified – The notes have been deleted.]

3.1.18
near-field region
region generally in proximity to an antenna or other radiating structure, in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point

Note 1 to entry: The near-field region is further subdivided into the reactive near-field region, which is closest to the radiating structure and that contains most or nearly all of the stored energy, and the radiating near-field region where the radiation field predominates over the reactive field, but lacks substantial plane-wave character and is complex in structure.

3.1.19
partial-body exposure
localized exposure of part of the body, producing a corresponding localized SAR, power density or induced current density, as distinct from a whole-body exposure

3.1.20
plane-wave equivalent power density
<electromagnetic wave> power density equal in magnitude to the power density of a plane wave having the same electric (E) or magnetic (H) field strength as the measured field

3.1.21
power density
S

<of electromagnetic wave propagation> power per unit area normal to the direction of electromagnetic wave propagation

Note 1 to entry: For plane waves the power density (S), electric field strength (E) and magnetic field strength (H) are related by the space impedance (Z_0), in the case of plane wave or free space, i.e. 377 Ω:

$$S = \frac{E^2}{Z_0} = Z_0 H^2 = EH$$

E and H are expressed in units of V/m and A/m, respectively, and S in the unit of W/m^2. The value of 377 Ω is only valid for free space, far field measurement conditions.

Note 2 to entry: Although many survey instruments indicate power density units, the actual quantities measured are E or H or the square of those quantities.

3.1.22
reference level
level of field strength or power density derived from the basic restrictions using conservative assumptions about exposure

Note 1 to entry: If the reference levels are met, then the basic restrictions will be complied with, but if the reference levels are exceeded, that does not necessarily mean that the basic restrictions will not be met.

3.1.23
root-mean-square value
RMS
<of a periodic electromagnetic wave> effective value or the value associated with joule heating, of a periodic electromagnetic wave, obtained by taking the square root of the mean of the squared value of a function

Note 1 to entry: Although many survey instruments in the high frequency range indicate RMS, the actual quantity measured is root-sum-square (RSS) (equivalent field strength).

3.1.24
root-sum-square value
RSS
value obtained from three individual RMS field strength values, measured in three orthogonal directions, combined disregarding the phases

$$X = \sqrt{X_x^2 + X_y^2 + X_z^2}$$

Note 1 to entry: This note applies to the French language only.

3.1.25
transient
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared with the timescale of interest

[SOURCE: IEC 60050-161:1990, 161-02-01]

3.1.26
whole-body exposure
exposure of the whole body (or the torso when induced current density is considered)

3.2 Abbreviated terms

CISPR	Comité international spécial des perturbations radioélectriques
EIRP	equivalent isotropic radiated power
EMF	electromagnetic fields
EUT	equipment under test
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
SAR	specific absorption rate

4 Compliance criteria

In general, the basic restrictions shall be used as exposure limits for the assessment of compliance. However, in most cases reference levels are used as limits. Such reference levels for exposure to electric, magnetic and electromagnetic fields are derived from the basic restrictions using realistic worst-case assumptions about exposure. If the reference levels are met, then the basic restrictions will also be met; if the reference levels are exceeded, that does not necessarily mean that the basic restrictions are exceeded. In some situations, it may be possible to show compliance with the basic restrictions directly. It may also be possible to derive compliance criteria that allow a simple measurement or calculation to demonstrate compliance with the basic restrictions. Often these compliance criteria can be derived using realistic assumptions about conditions under which exposures from a device may occur, rather than the conservative assumptions that are the basis for the reference levels.

NOTE This document does not specify limits expressed by means of basic restrictions and/or reference levels. Such limits are subject to the applied assessment scheme, given for example in [1][1], [2], [3], [4] or [5] by means of regional limits (see also SMB/3979/DP).

If the technology in the equipment is not capable of producing, at the user position, an E-field, H-field, electromagnetic field, or contact current at levels higher than the reference levels, then the equipment is deemed to comply with the requirements in this document in respect of that E-field, H-field, electromagnetic field, or contact current without further assessment.

5 Performance of assessments

5.1 Assessment methods

The demonstration of compliance to limits regarding human exposure shall be done by means of an assessment. One or more of the assessment methods listed in Table 1 may be used for the assessment. The standards in the column 'Applicable standard, for example' are only examples of applicable standards. Other standards or measurement and calculation methods may be used if they are appropriate for the applied assessment method.

Table 1 – List of possible assessment methods

Assessment method	Subject of assessment		Applicability area and limitations	Applicable standard, for example
Simplified assessment (possible for particular cases)	Maximum output power (only applicable for f > 10 MHz)	SAR	Presumption of local/whole body SAR assessment by low power exclusion level	IEC 62479
	EIRP	SAR	Presumption of compliance with SAR values for installed equipment of various classes depending on product EIRP, installation height and distance to ambient sources.	IEC 62232
Measurement	Field strength	E and H/B	Near or far field. Direct measurement for comparison with reference levels or as input for more detailed assessment	IEC 62110 IEC 62233 IEC 62232 IEC 61786-2
	Current	Contact current	Direct measurement of physical properties of contact current	IEC TR 63167
	Basic restrictions	Induced current /internal E-field	Not developed	
		SAR	SAR measurement with a phantom	IEC 62209-1 (head) IEC 62209-2 (flat, small) IEC 62232 (flat phantom, large)
		Power density	In far field region, power density can be measured by measuring E-field or H-field strength For over 10 GHz (or 6 GHz) frequency range, power density can be measured with 2D scan on a measurement surface	IEC 62232 IEC TR 63170

[1] Numbers in square brackets refer to the bilbiography.

Assessment method	Subject of assessment		Applicability area and limitations	Applicable standard, for example
Calculation	Numerical model	Source	Prediction of exposures from calculation of emissions at a specific distance	IEC 62232
		Human body	Induced current density – induced electric field	IEC 62226-2-1 IEC 62226-3-1 IEC 62233
			SAR:100 kHz to 10 GHz Because there is an overlapped frequency range of electrical stimulation effect and thermal effect, both induced current/field and SAR shall be assessed in the overlapped range.	IEC 62232
	Field strength	Far field (E and H/B)	Electromagnetic fields far from source. Very small microwave equipment not used close to body, or large lower-frequency transmitters at greater distances. That region of the field of an antenna where the angular field distribution is essentially independent of the distance from the antenna. In this region (also called the free space region), the field has a predominantly plane-wave character, i.e., locally uniform distribution of electric field strength and magnetic field strength in planes transverse to the direction of propagation.	IEC 62232
		Near field (E and H/B)	Electromagnetic fields very close to the source. There can be an interaction between the radiated fields from the source and the user.	
	Current	Contact current	It can be calculated, but standard is not developed	
	Basic restrictions	Induced current density/internal E-field	Calculation with a phantom	IEC 62226-1 IEC 62226-2-1 IEC 62226-3-1
		SAR	Simulation with/without a phantom Evaluation of measurement results inside the phantom representing a body	IEC IEEE 62704-1 IEC IEEE 62704-2 IEC IEEE 62704-3 IEC 62232
		Power density	Power density can be calculated in far field region.	IEC 62232
The physical characteristics and intended use of the equipment may have an impact on the choice of assessment method. For example, radiators of EMF intended for use in close proximity to the body shall be assessed differently from transmitters intended for fixed installations in buildings.				

The assessments should preferably be made according to an existing basic or product specific standard, for example such as those given in Clause 2 or in Table 1. If the assessment method in a basic or product specific standard is not fully applicable or if there is no appropriate basic or product specific standard for the subject of assessment, then other types of assessments are allowed as long as

– a description of the assessment method used is given in the assessment report;

– an evaluation of the total uncertainty is given in the assessment report.

For transmitters intended for use with external antennas then at least the realistic worst-case combination (in terms of human exposure) of transmitter and antenna shall be assessed for compliance in order to cover all reasonably foreseeable exposures.

5.2 Frequency range under assessment for unintentional radiation

For unintentionally radiating equipment, the compliance assessment to emissions of E or H field shall be made according to the highest internal frequency used within the equipment under assessment or at which the equipment operates with the following criteria:

- if the highest internal frequency of the equipment is less than 10 kHz, the assessments should be made up to 400 kHz;
- if the highest internal frequency of the equipment is less than 108 MHz, the assessments should be made up to 1 GHz;
- if the highest internal frequency of the equipment is between 108 MHz and 500 MHz, the assessment should be made up to 2 GHz;
- if the highest internal frequency of the equipment is between 500 MHz and 1 GHz, the assessment should be made up to 5 GHz.

If the highest internal frequency of the equipment is above 1 GHz, the assessment should be made up to 5 times the internal frequency or 6 GHz, whichever is greater.

NOTE This frequency division is referenced by CISPR standards.

The criteria above can be considered as a general rule to consider harmonics of the highest internal frequency. Alternatively, the actual values of all the harmonics may be assessed.

5.3 General procedure for the assessment of equipment

The following steps of a generic procedure for assessment of equipment involve a decision tree drawing on information from Table 1 (assessment methods) and Table 2 (characteristics and parameters of the equipment to be considered).

1) The equipment should be characterized to determine the nature of EMF emissions and also the expected usage conditions. An analysis should be made to investigate which parts of the equipment emit EMF. A description of the different parts of an item of equipment is recommended in order to determine which parts are emitting EMF.

   An assessment shall be performed under conditions which cause the highest stable exposure within foreseeable or expected usage which is specified by the manufacturer.

   Because EMF from peripheral equipment of the EUT can affect the results of measurements, the fields may be measured with a minimum setup of the EUT where this setup contains the indispensable equipment only needed for the operation of the EUT.

   Measurements should be performed at the user position specified by the manufacturer and the area where the user would foreseeably approach the equipment.

   NOTE 1 For practical reasons it is acceptable to perform the assessment with the equipment being operated with settings that produce the maximum exposure levels (e.g., maximum rated load, maximum rated power consumption, maximum speed or other), consistent with reasonably foreseeable use. The equipment is operated for a sufficient period to ensure that the conditions of operation are stable.

   NOTE 2 Fields are usually measured with proper separation distances. In general, for practical reasons it is acceptable to perform the assessment with a specific separation distance defined by the manufacturer.

2) Analysis by means of measurements or calculations: if the assessed quantities, for example E-field strength or power density, are below the relevant reference levels, taking into account the impact of actual waveforms and spectral contributions, and any allowed time and spatial averaging then the equipment is deemed to meet the requirements in this document. If not, then go to step 3).

3) Measured or calculated field strengths or power density values should be compared with any product-specific compliance criteria (for example kind of emission, operating frequency (range), limits) that applies to the equipment. If the emission values are below