SLOVENSKI STANDARD
oSIST prEN 50413:2018

01-marec-2018

Osnovni standard za merjenje in izračunavanje izpostavljenosti ljudi električnim, magnetnim in elektromagnetnim poljem (0 Hz–300 GHz)

Basic standard on measurement and calculation procedures for human exposure to electric, magnetic and electromagnetic fields (0 Hz - 300 GHz)

Grundnorm zu Mess- und Berechnungsverfahren der Exposition von Personen in elektrischen, magnetischen und elektromagnetischen Feldern (0 Hz bis 300 GHz)

Norme de base pour les procédures de mesures et de calculs pour l'exposition des personnes aux champs électriques, magnétiques et électromagnétiques (0 Hz - 300 GHz)

Ta slovenski standard je istoveten z: **prEN 50413**

ICS:

17.200.20	Instrumenti za merjenje temperature	Temperature-measuring instruments
33.100.01	Elektromagnetna združljivost na splošno	Electromagnetic compatibility in general

oSIST prEN 50413:2018 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 50413

January 2018

ICS 17.200.20; 33.100.01

Will supersede EN 50413:2008

English Version

Basic standard on measurement and calculation procedures for human exposure to electric, magnetic and electromagnetic fields (0 Hz - 300 GHz)

Norme de base pour les procédures de mesures et de calculs pour l'exposition des personnes aux champs électriques, magnétiques et électromagnétiques (0 Hz - 300 GHz)

Grundnorm zu Mess- und Berechnungsverfahren der Exposition von Personen in elektrischen, magnetischen und elektromagnetischen Feldern (0 Hz bis 300 GHz)

This draft European Standard is submitted to CENELEC members for enquiry.
Deadline for CENELEC: 2018-04-06.

It has been drawn up by CLC/TC 106X.

If this draft becomes a European Standard, CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CENELEC in three official versions (English, French, German).
A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents

Page

European foreword ... 3
1 Scope ... 4
2 Normative references ... 4
3 Terms and definitions ... 5
4 Introduction ... 9
4.1 General remarks ... 9
4.2 Exposure assessment approaches ... 10
4.3 Static and low frequency fields ... 10
4.4 High frequency range ... 10
4.5 Multiple frequency fields and multiple sources ... 10
5 Assessment of human exposure by measurement ... 10
5.1 General remarks ... 10
5.2 Characterization of the field source ... 11
5.3 Electromagnetic field measurement ... 11
5.4 Body current measurement ... 15
5.5 Contact current measurement ... 15
5.6 SAR measurement ... 15
5.7 Uncertainty of measurement ... 15
5.8 Calibration ... 16
6 Assessment of exposure by calculation ... 16
6.1 Low frequency ... 16
6.2 High frequency ... 17
6.3 Uncertainty of calculation ... 17
7 Assessment report ... 17
7.1 General ... 17
7.2 Items to be recorded in the assessment report ... 17
Annex A (informative) List of standards ... 19
Annex B (informative) Uncertainty assessment for the measurement of EMF ... 21
B.1 Steps in establishing an uncertainty budget ... 21
B.2 Examples for uncertainty budgets ... 24
Bibliography ... 26

European foreword

This document (prEN 50413:2018) has been prepared by CLC/TC 106X “Electromagnetic fields in the human environment”.

This document is currently submitted to the Enquiry.

The following dates are proposed:

• latest date by which the existence of this document has to be announced at national level	(doa)	dor + 6 months
• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	dor + 12 months
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	dor + 36 months (to be confirmed or modified when voting)

This document will supersede EN 50413:2008.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association.

1 Scope

This document provides general methods for measurement and calculation of quantities associated with human exposure to electric, magnetic and electromagnetic fields in the frequency range from 0 Hz to 300 GHz. It is intended specifically to be used for the assessment of emissions from products and comparison of these with the exposure levels for the general public given in Council Recommendation 1999/519/EC, and those given for workers in Directive 2013/35/EU, as appropriate. It also is intended to be used for assessment of human exposure to electromagnetic fields in the workplace to determine compliance with the requirements of Directive 2013/35/EU.

This standard deals with quantities that can be measured or calculated external to the body, notably electric and magnetic field strength or power density, and includes the measurement and calculation of quantities inside the body that forms the basis for protection guidelines. In particular the standard provides information on

- definitions and terminology,
- characteristics of electric, magnetic and electromagnetic fields,
- measurement of exposure quantities,
- instrumentation requirements,
- methods of calibration,
- measurement techniques and procedures for evaluating exposure,
- calculation methods for exposure assessment.

This standard may be used when no applicable electric, magnetic and electromagnetic field standard specific to a product or technology exists. Annex A gives a list of relevant standards at the time of writing.

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.

EN 62311:2008, *Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)*

EN 61786-1:2014, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 1: Requirements for measuring instruments*

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

COUNCIL OF THE EUROPEAN UNION. Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC). *Official Journal of the European Communities*. 1999, **199** (L) pp. 59–70

EUROPEAN PARLIAMENT AND COUNCIL OF THE EUROPEAN UNION. Directive 2013/35/EU of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC. *Official Journal of the European Union*. 2013, **179** (L) p. 21

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
action level
operational levels established for the purpose of simplifying the process of demonstrating the compliance with relevant ELVs or, where appropriate, to take relevant protection or prevention measures specified in this Directive

[SOURCE: Directive 2013/35/EU]

3.2
antenna
device that serves as a transducer between a guided wave for example in a coaxial cable and a free space wave, or vice versa

3.3
basic restriction
restrictions on exposure to time-varying electric, magnetic, and electromagnetic fields that are based directly on established health effects

[SOURCE: ICNIRP guidelines]

3.4
contact current
current flowing into the body resulting from contact with a conductive object in an electromagnetic field. This is the localised current flow into the body (usually the hand, for a light brushing contact)

3.5
current density (*J*)
current per unit cross-sectional area flowing inside the human body as a result of direct exposure to electromagnetic fields

Note 1 to entry: The current density is expressed in the unit ampere per square m (A/m^2).

3.6
electric flux density (*D*)
vector quantity obtained at a given point by adding the electric polarization ***P*** to the product of the electric field strength ***E*** and the permittivity of free space ε_0:

$$\boldsymbol{D} = \varepsilon_0 \boldsymbol{E} + \boldsymbol{P}$$

Note 1 to entry: Electric flux density is expressed in units of coulombs per square m (C/m^2).

Note 2 to entry: In vacuum, the electric flux density is at all points equal to the product of the electric field strength and the permittivity of free space: $D = \varepsilon_0 E$.

3.7
electric field strength (*E*)
vector quantity obtained at a given point that represents the force (***F***) on an infinitely small charge (q) divided by the charge:

$$E = \frac{F}{q}$$

Note 1 to entry: Electric field strength is expressed in the unit volt per m (V/m).

3.8
exposure
exposure occurs when there is an electric, magnetic or electromagnetic field at the same location as the person from an external source

3.9
exposure level
value of the quantity used to assess exposure

3.10
exposure limit values
values established on the basis of biophysical and biological considerations, in particular on the basis of scientifically well-established short-term and acute direct effects, i.e. thermal effects and electrical stimulation of tissues. Compliance with these limits will ensure that workers exposed to electromagnetic fields are protected against all known adverse health effects

[source: Directive 2013/35/EU]

3.11
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. In this 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

Note 1 to entry: In the far-field region the vectors of the electric field *E* and the magnetic field *H* 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.

3.12
impedance of free space
impedance of free space Z_0 is defined as the square root of the free space permeability μ_0 divided by the permittivity of free space ε_0

$$Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}} \approx 120\pi\ \Omega \approx 377\ \Omega$$

3.13
isotropic
qualifies a physical medium or technical device where the relevant properties are independent of the direction

3.14
induced current (*I*)
current induced inside the body as a result of direct exposure to electromagnetic fields, expressed in the unit ampere (A)

3.15
linearity of measurement instrument
maximum deviation over the measurement range of the measured quantity from the closest linear reference curve defined over a given interval

3.16
magnetic flux density (*B*)
the field vec/tor in a point that results in a force (***F***) on a charge (*q*) moving with the velocity (***v***)

$$\boldsymbol{F} = q\,(\boldsymbol{v} \times \boldsymbol{B})$$

Note 1 to entry: The magnitude of the magnetic flux density is expressed in the unit Tesla (T)

3.17
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 permeability of free space μ_0:

$$H = \frac{B}{\mu_0} - M$$

Note 1 to entry: Magnetic field strength is expressed in the unit ampere per metre (A/m).

Note 2 to entry: In vacuum, the magnetic field strength is at all points equal to the magnetic flux density divided by the permeability of free space: $H = B / \mu_0$.

3.18
modulation
process of modifying the amplitude, phase and/or frequency of a periodic waveform in order to convey information

3.19
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. 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

3.20
permeability (*μ*)
property of a material which defines the relationship between magnetic flux density *B* and magnetic field strength *H*. It is commonly used as the combination of the permeability of free space (μ_0) and the relative permeability for specific materials (μ_r)

$$\mu = \mu_r \mu_0 = \frac{\mathrm{B}}{\mathrm{H}}$$

where

μ_r is the relative permeability of the material

μ_0 is the permeability of vacuum

Note 1 to entry: The permeability is expressed in units of henry per metre (H/m)

3.21
permittivity (ε)
property of a dielectric material, e.g., biological tissue, defined by the electric flux density *D* divided by the electric field strength *E*

$$\varepsilon = \varepsilon_r \varepsilon_0 = D / E$$

where

ε_r is the relative permittivity of the material

ε_0 is the permittivity of vacuum

Note 1 to entry: The permittivity is expressed in units of farads per metre (F/m).

3.22
phantom
simplified model of the human body or body part composed of materials with dielectric properties close to the organic tissue

3.23
power density (*S*)
power per unit area normal to the direction of electromagnetic wave propagation

Note 1 to entry: The power density is expressed in units of Watts per square m (W/m^2).

Note 2 to entry: For plane waves the power density (S), electric field strength (E) and magnetic field strength (H) are related by the impedance of free space Z_0.

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

Note 3 to entry: Although many survey instruments indicate power density units, the actual quantities measured are *E* or *H*, or the square of those quantities.

3.24
probe
input device of a measuring instrument, generally made as a separate unit, which transforms the measured input value to a suitable output value

3.25
reference level
these levels are provided for practical exposure assessment purposes to determine whether the basic restrictions are likely to be exceeded. Some reference levels are derived from relevant basic restrictions using measurement and/or computational techniques, and some address perception and adverse indirect effects of exposure to EMF (from ICNIRP guidelines)

Note 1 to entry: In any particular exposure situation, measured or calculated values can be compared with the appropriate reference level. Compliance with the reference level will ensure compliance with the relevant basic restriction. If the measured or calculated value exceeds the reference level, it does not necessarily follow that the basic restriction will be exceeded. However, whenever a reference level is exceeded it is necessary to test compliance with the relevant basic restriction and to determine whether additional protective measures are necessary.

3.26
root-mean-square (r.m.s.)
r.m.s. value is obtained by taking the square root of the average of the square of the value of the time-varying function taken throughout a suitable period of time

Note 1 to entry: For periodic functions a suitable time interval is any multiple of the period of the function. For non-periodic functions the time interval used shall be recorded.

3.27
specific absorption rate (SAR)
time derivative of the incremental electromagnetic energy *(*d*W)* absorbed by (dissipated in) an incremental mass *(*d*m)* contained in a volume element *(*d*V)* of given mass density (*ρ*)

$$\mathrm{SAR} = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho\, dV}\right)$$

Note 1 to entry: SAR is expressed in units of watts per kilogram (W/kg)

Note 2 to entry: SAR can be calculated by:

$$\mathrm{SAR} = \frac{\sigma E_i^2}{\rho}, \qquad \mathrm{SAR} = c_i \frac{dT}{dt}\Big|_{\mathrm{at}\ t_0}$$

where

E_i	r.m.s. value of the electric field strength in the tissue in V/m;
σ	conductivity of body tissue in S/m;
ρ	density of body tissue in kg/m³;
c_i	heat capacity of body tissue in J/kg K;
d*T* / d*t*	time derivative of temperature in body tissue in K/s.

3.28
unperturbed field
field that exists in a space in the absence of a person or an object that could influence the field

Note 1 to entry: The field measured or calculated with a person or object present may differ considerably.

4 Introduction

4.1 General remarks

Electric, magnetic and electromagnetic fields can have direct and indirect effects on the human body. Depending on the frequency of the fields, these can be effects on the nervous system in the low frequency range and thermal effects in the high frequency range. Besides these direct effects there exist several indirect effects such as the occurrence of contact currents or the possible influence on the intended operation of active medical implants. This standard addresses only effects for which there exists a measurable limit.

The Council Recommendation 1999/519/EC provides basic restrictions and derived reference levels for exposure of the general public in the areas where they spend significant time.

The Directive 2013/35/EU provides exposure limit values and derived action level for exposures in the workplace.

The basic restrictions given in the Recommendation, and the exposure limit values given in the Directive are in both cases the actual limits which are expressed in terms of quantities that are mostly not measurable: including induced currents or internal electric field strength for low frequency, specific absorption rate (SAR) for higher frequency and power density for the highest frequencies.