BS EN 62479:2010

BSI Standards Publication

Assessment of the compliance of low power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz)

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National foreword

This British Standard is the UK implementation of EN 62479:2010. It is derived from IEC 62479:2010. It supersedes BS EN 50371:2002 which is withdrawn.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text by tags C⟩ ⟨C.

The UK participation in its preparation was entrusted to Technical Committee GEL/106, Human exposure to low frequency and high frequency electromagnetic radiation.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English version

Assessment of the compliance of low power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz)

(IEC 62479:2010, modified)

Evaluation de la conformité des appareils électriques et électroniques de faible puissance aux restrictions de base concernant l'exposition des personnes aux champs électromagnétiques (10 MHz à 300 GHz)
(CEI 62479:2010, modifiée)

Beurteilung der Übereinstimmung von elektronischen und elektrischen Geräten kleiner Leistung mit den Basisgrenzwerten für die Sicherheit von Personen in elektromagnetischen Feldern (10 MHz bis 300 GHz)
(IEC 62479:2010, modifiziert)

This European Standard was approved by CENELEC on 2010-09-01. 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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists 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 Central Secretariat has the same status as the official versions.

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CENELEC

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

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Ref. No. EN 62479:2010 E

Foreword

The text of document 106/198/FDIS, future edition 1 of IEC 62479, prepared by IEC TC 106, Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure, was submitted to the IEC-CENELEC parallel vote.

A draft amendment to the European Standard was prepared by the Technical Committee CENELEC TC 106X, Electromagnetic fields in the human environment. It was submitted to the Unique Acceptance Procedure.

The combined texts were approved by CENELEC as EN 62479 on 2010-09-01.

This European Standard supersedes EN 50371:2002.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-09-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-09-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62479:2010 was approved by CENELEC as a European Standard with agreed common modifications.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 62311 (mod)	-	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)	EN 62311	-

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CONTENTS

ASSESMENT OF THE COMPLIANCE OF LOW-POWER ELECTRONIC AND ELECTRICAL EQUIPMENT WITH THE BASIC RESTRICTIONS RELATED TO HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS (10 MHz to 300 GHz)

1 Scope

This International Standard provides simple conformity assessment methods for low-power electronic and electrical equipment to an exposure limit relevant to electromagnetic fields (EMF). If such equipment cannot be shown to comply with the applicable EMF exposure requirements using the methods included in this standard for EMF assessment, then other standards, including IEC 62311 or other (EMF) product standards, may be used for conformity assessment.

2 Normative references

The following referenced documents are indispensable for the application 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.

[C) Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), Official Journal L 199 of 30 July 1999. (C]

IEC 62311, *Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz – 300 GHz)*

3 Terms and definitions

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

3.1
available antenna power
the maximum power, averaged over a time interval equal to the averaging time, supplied to the antenna feed line that can be theoretically delivered by a source having an impedance of positive real part to a directly connected load when the impedance of the load is widely varied

NOTE 1 The available antenna power is obtained when the resistance of the load is equal to that of the source and its reactance is equal in magnitude but of opposite sign. However, other scenarios are possible e.g. if the PA monitors the current rather than the actual power, a changing antenna impedance (when DUT is operated close to the body) might actually cause a higher output power than the matched load. Then, a push-pull analysis with varied realistic loads (according to antenna impedance in the vicinity of the body) should be performed.

NOTE 2 In some cases, conditions such as overheating or overvoltage prevent the available antenna power from being obtained.

NOTE 3 Time average shall be taken during continuous or maximum duty cycle transmission at maximum power to the extent possible for a given technology.

NOTE 4 Adapted from IEC 60050-702:1992 [11][1)], 702-07-10.

NOTE 5 Antenna feed line is defined by IEC 60050-712:1992 [12], 712-06-01.

[1)] Figures in square brackets refer to the Bibliography.

3.2
average total radiated power
the time average of the total radiated power over a time interval equal to the averaging time. This time average is taken during continuous or maximum duty cycle transmission at maximum power to the extent possible for a given technology

NOTE If the user is in the reactive near field of the antenna, the presence of the user may result in a change in the total radiated power due to a change in the antenna impedance. In this case, the average total radiated power must be the maximum possible power in the presence of the user.

3.3
averaging time
t_{avg}
the appropriate time over which exposure is averaged for purposes of determining compliance with exposure limits

3.4
basic restriction
restriction(s) on exposure to time-varying electric, magnetic, and electromagnetic fields that are based directly on established health effects

NOTE 1 Depending upon the frequency of the field, the physical quantities used to specify these restrictions are current density, specific absorption rate (SAR), and power density.

[C] NOTE 2 Basic restrictions can be found in Annex II (Table 1) of the Council Recommendation 1999/519/EC. [C]

3.5
conformity assessment
demonstration that specified requirements relating to a product, process, system, person or body are fulfilled

NOTE The subject field of conformity assessment includes activities such as testing, inspection and certification, as well as the accreditation of conformity assessment bodies.

[ISO 17000:2004 [14], definition 2.1, modified]

3.6
information technology equipment
ITE
any equipment which has a primary function of either (or a combination of) entry, storage, display, retrieval, transmission, processing, switching, or control, of data and of telecommunication messages and which may be equipped with one or more terminal ports typically operated for information transfer

EXAMPLE Types of ITE include data processing equipment, office machines, electronic business equipment and telecommunication equipment.

3.7
low-power equipment
equipment where the available antenna power and/or the average total radiated power is less than or equal to the low-power exclusion level

3.8
low-power exclusion level
P_{max}
specified condition on device output power, which may also depend on other variables such as frequency and distance of radiating source from persons, such that the exposure level produced by the source will not exceed a specific basic restriction. If the device output power is less than P_{max}, then the device is deemed to comply with the basic restrictions

3.9
multimedia equipment
MME
equipment that has the function of information technology equipment (ITE), audio, video or broadcast-receiving equipment, interaction and/or communication with the user of the product or combinations of these functions

[CISPR 32____2) [9], definition 3.1.17]

3.10
peak radiated power
the maximum instantaneous radiated power

3.11
power density
the power passing through an element of surface normal to the direction of propagation of energy of an electromagnetic wave divided by the area of the element

[IEC 60050-705:1995 [13], 705-02-03, power flux density]

NOTE Power density is expressed in watts per square meter.

3.12
pulse repetition frequency
PRF
the number of pulses transmitted per unit time

3.13
specific absorption
SA
energy absorbed by (dissipated in) an incremental mass contained in a volume element of biological tissue when exposure to a radio frequency electromagnetic field occurs

NOTE Specific absorption is expressed in joules per kilogram.

3.14
specific absorption rate
SAR
power absorbed by (dissipated in) an incremental mass contained in a volume element of biological tissue when exposure to a radio frequency electromagnetic field occurs

NOTE SAR is expressed in watts per kilogram.

3.15
total radiated power
the total power emitted by the equipment in the form of electromagnetic fields in the absence of any nearby objects (e.g. a human body)

NOTE For transmitters that use antennas, the total radiated power is independent of antenna gain.

3.16
unintentional radiator
non-intentional radiator
electrical or electronic equipment that radiates radio frequency (RF) energy, even though the emission is not a deliberate or necessary part of its function

EXAMPLE Examples of unintentional radiators include all types of ITE without antenna and/or wireless radio transmission function.

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2) In preparation.

4 Conformity assessment methods

4.1 General considerations

The electronic and electro technical apparatus shall comply with the basic restriction as specified in Annex II of Council Recommendation 1999/519/EC.

NOTE 1 The Council Recommendation 1999/519/EC is based on the ICNIRP guidelines [1] with some additional restrictions.

NOTE 2 The time averaging in the EU-Recommendation applies.

Compliance of electromagnetic emissions from electronic and electrical equipment with the basic restrictions usually is determined by measurements and, in some cases, calculation of the exposure level. If the electrical power used by or radiated by the equipment is sufficiently low, the electromagnetic fields emitted will be incapable of producing exposures that exceed the basic restrictions. This standard provides simple EMF assessment procedures for this low power equipment.

Any relevant compliance assessment procedure which is consistent with the state of the art, reproducible and gives valid results can be used.

For transmitters intended for use with more than one antenna configuration option, the combination of transmitter and antenna(s) which generates the highest available antenna power and/or average total radiated power shall be assessed.

Four routes, as illustrated in Figure 1 and described as follows, can be used to demonstrate compliance with this standard:

A Typical usage, installation and the physical characteristics of equipment make it inherently compliant with the applicable EMF exposure levels such as those listed in the bibliography. This low-power equipment includes unintentional (or non-intentional) radiators, for example incandescent light bulbs and audio/visual (A/V) equipment, information technology equipment (ITE) and multimedia equipment (MME) that does not contain radio transmitters.

NOTE Equipment is described as A/V equipment, ITE or MME if its main use is playback/recording of music, voice or images, or processing of digital information.

B The input power level to electrical or electronic components that are capable of radiating electromagnetic energy in the relevant frequency range is so low that the available antenna power and/or the average total radiated power cannot exceed the low-power exclusion level defined in 4.2.

C The available antenna power and/or the average total radiated power are limited by product standards for transmitters to levels below the low-power exclusion level defined in 4.2.

D Measurements or calculations show that the available antenna power and/or the average total radiated power are below the low-power exclusion level defined in 4.2.

If none of these routes can be used, then the equipment is deemed to be out of the scope of this standard and EMF assessment for conformity assessment purposes shall be made according to other standards, such as IEC 62311 or other EMF product standards.

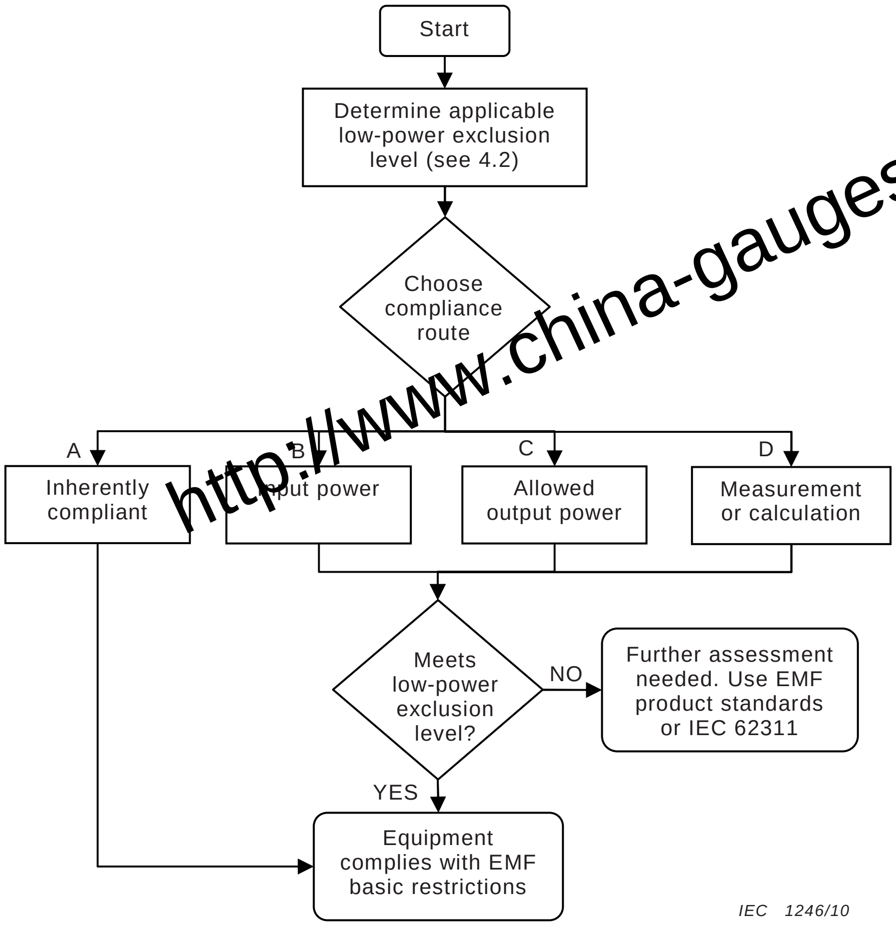

Figure 1 – Routes to show compliance with low-power exclusion level

4.2 Low-power exclusion level (P_{max})

Low-power electronic and electrical equipment is deemed to comply with the provisions of this standard if it can be demonstrated using routes B, C or D that the available antenna power and/or the average total radiated power is less than or equal to the applicable low-power exclusion level P_{max}.

Annex A contains example values for P_{max} derived from existing exposure limits listed in the bibliography, such as the ICNIRP guidelines [1], IEEE Std C95.1-1999 [2], and IEEE Std C95.1-2005 [3].

For wireless devices operated close to a person's body with available antenna powers and/or average total radiated powers higher than the P_{max} values given in Annex A, the alternative P_{max} values (called P_{max}'), described in Annex B can also be used.

NOTE In order to be able to use the alternative P_{max} values (P_{max}'), the device under assessment shall fit within the scope of applicability of P_{max}' as defined in Annex B. If P_{max}' as defined in Annex B is not applicable to a particular product, then the example values P_{max} for the corresponding exposure limits described in Annex A should be used.

For low power equipment using pulsed signals, other limits may apply in addition to those considered in Annex A and Annex B. Both ICNIRP guidelines [1] and IEEE standards [2], [3] have specific restrictions on exposures to pulsed fields, and the requirements of those standards with respect to exposure to pulses shall be met. Annex C discusses this topic further.

4.3 Exposure to multiple transmitting sources

If an equipment under test (EUT) is equipped with multiple intentional radiators, the overall conformity assessment might require more than just the assessment of conformity of each one of the radiators separately. The effect of multiple intentional radiators should be considered in the conformity assessment process.

Technical Report IEC 62630 [8] provides generic guidance on how to assess the EMFs generated by multiple intentional radiators.

5 EMF assessment report

5.1 General considerations

The means and rationale for determining compliance with the low-power exclusion level shall be recorded, as shall all information needed for performing repeatable assessments, tests, calculations, or measurements yielding results within the required calibration and uncertainty limits.

Further guidelines on the assessment report can be found in 5.10 of ISO/IEC 17025:2005. Annex D is a sample of what is contained in ISO/IEC 17025 as it might pertain to EMF assessment reports.

5.2 Equipment-related information

Relevant information concerning the settings of controls and the intended usage of the equipment shall be recorded. In addition, the following should be included in the assessment report:

- description of the equipment including type designation, serial number, etc.;
- any instructions needed for a user to properly operate the equipment such that exposures will be compliant with the basic restrictions;
- provisions for ensuring that the equipment cannot be modified to change its power so that it could exceed the low-power exclusion level.

6 Use of measurement uncertainty in the evaluation of compliance to limits

The equipment is deemed to fulfil the requirements of this standard if the assessment results are less than or equal to the limit and if the estimated uncertainty of the assessment results is less than the maximum measurement uncertainty specified for the assessment method(s) that are applied. This means that for each assessment route shown in Figure 1, separate uncertainty estimations must be performed as applicable for the route used. The uncertainty of the assessment method shall be determined by calculating the expanded uncertainty using a confidence interval of 95 % (coverage factor k = 1,96).

NOTE 1 The uncertainty of EMF assessment methods is generally given in %. If the uncertainty is stated in non-linear units, e.g. dB, then this value should be converted into percentage (%) first.

NOTE 2 Guidance about uncertainty estimation can be found in ISO/IEC Guide 98-3:2008, *Guide to the expression of uncertainty in measurement*, often referred to as the GUM [10].

Generally, a relative uncertainty (expanded) of 30 % is used for a number of EMF assessment methods. Therefore this level of relative uncertainty is used as a default maximum in this generic standard. The uncertainty values specified for each EMF assessment method are the maximum allowed uncertainties. If the uncertainty value is not specified, then a default value of 30 % shall be used.

If the relative uncertainty is less than 30 %, then the measured value L_m shall be compared directly with the applicable limit L_{lim} for evaluation of compliance.

If the computed uncertainty is larger than 30 %, then the computed uncertainty shall be included in the evaluation of compliance with the limit as follows (i.e. by adding this computed value to the measured or computed result).

Equation (1) shall be used to determine whether the measured value L_m complies with a "reduced" limit if the actual measurement uncertainty of the applicable assessment method is 30 % or more. If the computed assessment uncertainty is larger than the specified maximum allowed uncertainty value for any particular method and if it is also larger than the maximum default uncertainty value of 30 %, then a penalty value shall be added to the assessment result before comparison with the limit.

Conversely, one can also reduce the applicable limit L_{lim} with the same penalty value, and compare the actual measured L_m value with the reduced limit. The right-hand side of Equation (1) shows how the limit L_{lim} is reduced in case the computed uncertainty is larger then 30 %.

$$L_m \le \left(\frac{1}{0{,}7 + \frac{U(L_m)}{L_m}} \right) L_{lim} \qquad (1)$$

where

L_m is the measured value;

L_{lim} is the exposure limit;

$U(L_m)$ is the absolute value of the expanded uncertainty.

EXAMPLE Suppose the relative uncertainty of a certain EMF assessment method is 55 %. Then

$$\frac{U(L_m)}{L_m} = 0{,}55$$

Using Equation (1), the acceptance criterion for the measured value is then:

$$L_m \le \left(\frac{1}{0{,}7 + \frac{U(L_m)}{L_m}} \right) L_{lim} = \left(\frac{1}{0{,}7 + 0{,}55} \right) L_{lim} = \frac{1}{1{,}25} L_{lim} = 0{,}8\ L_{lim}$$

The uncertainty penalty (the amount of reduction of the limit) is then:

$$U_{pen} = L_{lim} - 0{,}8 L_{lim} = 0{,}2\ L_{lim}$$

Annex A
(informative)

Derivation of low-power exclusion level from ICNIRP and IEEE exposure limits

A.1 Introduction

In this annex, values of P_{max} (see 4.2 of this standard) are derived from EMF exposure limits listed in [1], [2] and [3][3].

NOTE Unless otherwise mentioned in other applicable regulations or standards, the most recent edition IEEE C95.1-2005 [3] takes precedence over the previous edition IEEE C95.1-1999 [2].

A.2 Low-power exclusion level P_{max} based on considerations of SAR

When SAR is the basic restriction, a conservative minimum value for P_{max} can be derived, equal to the localized SAR limit (SAR_{max}) multiplied by the averaging mass (m):

$$P_{max} = SAR_{max}\ m \tag{A.1}$$

Example values of P_{max} according to Equation (A.1) are provided in Table A.1 for cases described by the ICNIRP guidelines [1], IEEE Std C95.1-1999 [2] and IEEE Std C95.1-2005 [3] where SAR limits are defined. Other exposure guidelines or standards may be applicable depending on national regulations.

[3] Figures in square brackets refer to the Bibliography.

Table A.1 – Example values of SAR-based P_{max} for some cases described by ICNIRP, IEEE Std C95.1-1999 and IEEE Std C95.1-2005

Guideline / Standard	SAR limit, SAR_{max} W/kg	Averaging mass, m g	P_{max} mW	Exposure tier[a]	Region of body[a]
ICNIRP [1]	2	10	20	General public	Head and trunk
	4	10	40	General public	Limbs
	10	10	100	Occupational	Head and trunk
	20	10	200	Occupational	Limbs
IEEE Std C95.1-1999 [2]	1,6	1	1,6	Uncontrolled environment	Head, trunk, arms, legs
	4	10	40	Uncontrolled environment	Hands, wrists, feet and ankles
	8	1	8	Controlled environment	Head, trunk, arms, legs
	20	10	200	Controlled environment	Hands, wrists, feet and ankles
IEEE Std C95.1-2005 [3]	2	10	20	Action level	Body except extremities and pinnae
	4	10	40	Action level	Extremities and pinnae
	10	10	100	Controlled environment	Body except extremities and pinnae
	20	10	200	Controlled environment	Extremities and pinnae

[a] Consult the appropriate standard for more information and definitions of terms.

A.3 P_{max} based on considerations of power density

When power density is the basic restriction, a conservative minimum value for P_{max} can be derived, equal to the power density limit (S) multiplied by the averaging area (a):

$$P_{max} = S\,a \tag{A.2}$$

For example, ICNIRP guidelines [1] provide power density limits of 10 W/m^2 and 50 W/m^2 over the 10 GHz to 300 GHz frequency range for general public and occupational exposures, respectively. The averaging area specified by [1] is 20 cm^2 for both cases. Therefore, Equation (A.2) yields conservative values for P_{max} of 20 mW and 100 mW for general public and occupational exposures, respectively. Other exposure guidelines or standards may be applicable depending on national regulations.

A.4 Averaging time for P_{max}

The averaging time for P_{max} is per the applicable limit in the relevant exposure guidelines or standards.

Annex B
(informative)

Derivation of alternative low-power exclusion levels for wireless devices used close to the body

For wireless devices operated close to a person's body with output powers higher than the low-power exclusion levels (P_{max}) given in Annex A, alternative values (P_{max}') described in this annex can be applied. Other procedures or requirements may be applicable depending on national regulations. Other than entire exclusion from any EMF assessment for a given device, threshold levels of Annex B may be useful to support a reduction in the number of modes and configurations subject to assessment.

This annex describes formulae to establish P_{max}' values for the 300 MHz to 6 GHz frequency range for devices that are located within 25 mm of the body. The algorithm is generally applicable to many popular wireless transmitters such as cellular telephones (GSM, CDMA, PCS, etc.)[4)], land mobile radios, and wireless local area network (WLAN) devices. The formulae have been shown to be conservative for a wide variety of antennas typically used on portable wireless devices, such as dipoles, monopoles, planar inverted-F antennas (PIFAs), and inverted-F antennas (IFAs). However, the formulae may not apply for wireless devices having antennas whose directivity is significantly greater than that of a half-wavelength dipole antenna (i.e., 2,1 dBi). The following description is based on the work in references [4] and [5], where further details are available.

NOTE The exact range of antenna directivity at which the formula applies is dependent on frequency and distance and is the subject of future work. In [5], a microstrip patch antenna with a directivity of 6 dBi was analyzed. The formula did not to provide a conservative P_{max}' value at the highest frequency (6 GHz) and distance (20 mm) studied. However, the formula was found to be conservative at lower frequencies (2,45 and 3,7 GHz) and at a shorter distance (10 mm). The formula was also found to be conservative for all frequencies and distances when antennas with approximately 2 dBi directivity were analyzed. More information can be found in [5].

Recent studies by Ali et al. [4] and Sayem et al. [5] demonstrate that the SAR-based low-power exclusion levels specified in Annex A (P_{max}) are conservatively low. Equation (A.1) in Annex A specifies that a device is compliant with a basic restriction of SAR_{max} if the available antenna power and/or the average total radiated power is less than or equal to $P_{max} = SAR_{max} \times m$, where m is the appropriate averaging mass. By definition, the power P that is absorbed in a mass m at an SAR level of SAR_{max} is given by $P = SAR_{max} \times m$. Equation (A.1) therefore assumes that $P = P_{max}$ (i.e. all of the power radiated by the device is absorbed in the averaging mass m). In reality, however, not all of the power is absorbed in the body and that which is absorbed is not all concentrated in the averaging mass (i.e. 1 g or 10 g in Annex A).

Based on a systematic study of canonical dipole antennas of different lengths and at different distances from a flat phantom, a simple equation was developed for predicting alternative higher values of the low-power exclusion levels, P_{max}':

$$P_{max}' = \exp\left[As + Bs^2 + C\ln(BW) + D\right] \quad \text{(B.1)}$$

where s represents the nearest separation distance between the wireless device and the user's body, BW is the free-space antenna bandwidth, and A, B, C and D are third-order polynomials of frequency. The bandwidth corresponds to $|S_{11}| \leq -7$ dB, which is the reciprocal of the radiation quality factor, defined as the ratio between the stored and the radiated energies of an antenna. In Equation (B.1), s is expressed in mm and BW is expressed in percent (e.g. enter 10 in the equation if the bandwidth is 10 %). The frequency dependent parameters A, B, C and D can be found from the following equations, where f is the frequency in GHz.

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4) GSM: Global System for Mobile Communications; CDMA: Code Division Multiple Access; PCS: Personal Communication(s) Service(s)

For compliance with the SAR limit of $SAR_{\max}$ = 2 W/kg averaged over m = 10 g in ICNIRP Guidelines [1] and IEEE Std C95.1-2005 [3], use Equations (B.2) to (B5) in Equation (B.1):

$$A = \left(-0{,}4588 f^{3} + 4{,}407 f^{2} - 6{,}112 f + 2{,}497\right)/100 \quad (B.2)$$

$$B = \left(0{,}1160 f^{3} - 1{,}402 f^{2} + 3{,}504 f - 0{,}4367\right)/1000 \quad (B.3)$$

$$C = \left(-0{,}1333 f^{3} + 11{,}89 f^{2} - 110{,}8 f + 301{,}4\right)/1000 \quad (B.4)$$

$$D = -0{,}03540 f^{3} + 0{,}5023 f^{2} - 2{,}297 f + 6{,}104 \quad (B.5)$$

For other values of $SAR_{\max}$ using an averaging mass of m = 10 g, multiply the final $P_{\max}'$ value by $SAR_{\max}$ / 2 W/kg.

For compliance with the SAR limit of $SAR_{\max}$ = 1,6 W/kg averaged over m = 1 g in IEEE Std C95.1-1999 [2] for the uncontrolled environment, use Equations (B.6) to (B.9) in Equation (B.1):

$$A = \left(-0{,}4922 f^{3} + 4{,}831 f^{2} - 6{,}620 f + 8{,}312\right)/100 \quad (B.6)$$

$$B = \left(0{,}1191 f^{3} - 1{,}470 f^{2} + 3{,}656 f - 1{,}697\right)/1\,000 \quad (B.7)$$

$$C = \left(-0{,}4228 f^{3} + 13{,}24 f^{2} - 108{,}1 f + 339{,}4\right)/1\,000 \quad (B.8)$$

$$D = -0{,}02440 f^{3} + 0{,}4075 f^{2} - 2{,}330 f + 4{,}730 \quad (B.9)$$

For the $SAR_{\max}$ = 8 W/kg limit for the controlled environment, multiply the final $P_{\max}'$ value by a factor of 5.

Table B.1 provides values of $P_{\max}'$ calculated from Equations (B.1) through (B.9) for typical operating frequency bands used by portable wireless devices. The values of $P_{\max}'$ were calculated at s = 5 mm and 25 mm assuming that the –7 dB free-space bandwidth of the antenna in free space is equal to the frequency band of the communication system.

The values in Table B.1 may be used to get an impression of what kind of low-power exclusion levels could be expected in these frequency bands. For example, a GSM mobile telephone typically transmits at an average total radiated power less than or equal to 125 mW in a bandwidth centred at 1 795 MHz (including the receive band). Table B.1 shows that if the –7 dB bandwidth of the antenna covers at least the 9,5 % bandwidth of the communication system, it cannot be exempted from SAR testing if it is held 5 mm from the body, but it could be exempted at 25 mm distance from the body (e.g. while held in a 25 mm thick carry accessory).

Table B.1 is intended only as a guide. The reader should always use the correct values of s, BW, and f that apply to the specific portable wireless device under investigation. Please note that listing of any particular frequency, mode, and technology is not meant to construe EMF assessment requirements for device types selected or omitted.

Table B.1 – Some typical frequency bands of portable wireless devices and corresponding low-power exclusion levels P_{max}' predicted using Equations (B.1) through (B.9)

f GHz	*BW* %	**Example air interface**	P_{max}' mW			
			s = 5 mm		*s* = 25 mm	
			m = 1 g	*m* = 10 g	*m* = 1 g	*m* = 10 g
0,393	3,8	TETRA	97	292	265	526
0,420	4,8	TETRA	93	293	274	541
0,461	3,3	GSM	80	244	233	468
0,485	14,4	APCO	117	337	347	660
0,838	7,6	iDEN	48	148	198	399
0,859	8,1	IS-136	47	145	198	398
0,884	16,7	PDC	54	162	233	456
0,896	5,7	TETRA	40	127	176	360
0,918	4,8	iDEN	37	118	165	342
0,925	7,6	GSM	41	129	185	375
1,465	4,9	PDC	17	60	128	281
1,795	9,5	GSM	13	50	139	308
1,920	7,3	GSM	11	44	132	302
2,045	12,2	UMTS	11	44	146	330
2,350	4,3	WiBro	7,9	34	130	323
2,442	3,4	802.11b	7,3	32	130	328
3,550	14,1	WiMAX	6,7	37	244	657
5,250	3,8	WiMAX	6,8	53	258	845
5,788	1,3	WiMAX	6,2	52	164	564

Annex C
(informative)

Compliance requirement for a pulsed field

Both ICNIRP and IEEE have specific restrictions on exposure to pulsed fields. The example below refers to ICNIRP guidelines [1] because the analysis is straightforward in that case. If comparison is to be made to the exposure limits of IEEE Std C95.1-1999 [2] or IEEE Std C95.1-2005 [3], then the requirements of those standards with respect to exposure to pulses should be met.

The ICNIRP guidelines have a basic restriction on 6-minute time-averaged SAR, SAR_{avg}, of 2 W/kg in 10 g of tissue in the head and trunk for the general population (see Table A.1, Annex A). For continuous pulsed signals with duration of less than 30 µs and frequencies between 300 MHz and 10 GHz there is also a restriction on specific absorption, SA, in the head, of 2 mJ/kg in 10 g of tissue.

If the SAR averaged across the duration of a pulse is SAR_{pulse}, the pulse duration is δt and the repetition period is $t = 1/PRF$, then if there is one pulse per repetition period

$$SAR_{\text{avg}} = SAR_{\text{pulse}}\left(\delta t/t\right) \tag{C.1}$$

Because

$$SAR_{\text{pulse}}\delta t = SA \tag{C.2}$$

and

$$1/t = PRF \tag{C.3}$$

Equation (C.1) can be written as

$$SAR_{\text{avg}} = SA \cdot PRF \tag{C.4}$$

If the ICNIRP restrictions for a 6 minute-averaged SAR in the head and trunk and for SA are substituted into Equation (C.4), then it can be seen that if the pulse repetition frequency is greater than 1 000 Hz, compliance with the SAR restriction will ensure compliance with the SA restriction. If the pulse repetition frequency is less than 1 000 Hz, specific consideration will have to be given to showing compliance with the SA restriction.

Annex D
(informative)

Topics from ISO/IEC 17025 relevant for EMF assessment reports

The following items should be addressed when preparing an EMF assessment report. These items are from 5.10.2 and 5.10.3 of ISO/IEC 17025:2005, and are adapted for an EMF assessment report application. The information serves as guidance and is thus informative.

Each assessment report shall include at least the following information, unless the laboratory has valid reasons for not doing so:

a) a title (e.g. "EMF Assessment Report");
b) the name and address of the laboratory, and the location where the assessments and/or calibrations were carried out, if different from the address of the laboratory;
c) unique identification of the assessment report (such as the serial number), and on each page an identification in order to ensure that the page is recognized as a part of the assessment report and a clear identification of the end of the assessment report;
d) the name and address of the client;
e) identification of the method or standard used;
f) a description of, the condition of, and unambiguous identification of the item(s) assessed;
g) the assessment results with, where appropriate, the units of measurement;
h) the name(s), function(s) and signature(s) or equivalent identification of person(s) authorizing the assessment report;
i) where relevant, a statement to the effect that the results relate only to the items assessed.

NOTE 1 Paper copies of assessment reports should also include the page number and total number of pages.

NOTE 2 It is recommended that laboratories include a statement specifying that the assessment report shall not be reproduced except in full, without written approval of the laboratory.

In addition to the above requirements, assessment reports shall, where necessary for the interpretation of the assessment results, include the following:

j) deviations from, additions to, or exclusions from the test method, and information on specific test conditions, such as environmental conditions;
k) where relevant, a statement of compliance/non-compliance with requirements and/or specifications;
l) where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a client's instruction so requires, or when the uncertainty affects compliance to a specification limit;
m) where appropriate and needed, opinions and interpretations of test results.

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[6] IEC 60050-161, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

[7] ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*

[C] NOTE Harmonized as EN ISO/IEC 17025:2005 (not modified). [C]

[8] IEC/TR 62630:2010, *Guidance for evaluating exposure from multiple electromagnetic sources*

[9] CISPR 32, *Information technology, multimedia equipment and receivers – Radio disturbance characteristics – Limits and methods of measurement*[5)]

[10] ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

[11] IEC 60050-702:1992, *International Electrotechnical Vocabulary – Chapter 702: Oscillations, signals and related devices*

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[13] IEC 60050-705:1995, *International Electrotechnical Vocabulary – Chapter 705: Radio wave propagation*

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5) To be published.

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