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Household and similar electrical appliances - Electromagnetic fields - Methods for evaluation and measurement

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EUROPEAN STANDARD **EN 50366**

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English version

Household and similar electrical appliances – Electromagnetic fields – Methods for evaluation and measurement

Appareils électrodomestiques et analogues – Champs électromagnétiques – Méthodes d'évaluation et de mesure

Elektrische Geräte für den Hausgebrauch und ähnliche Zwecke – Elektromagnetische Felder – Verfahren zur Bewertung und Messung

This European Standard was approved by CENELEC on 2003-02-01. 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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Foreword

A proposal for a standard dealing with the evaluation and measurement of electromagnetic fields around household and similar electrical appliances was prepared by a joint group of experts representing TC 61, Safety of household and similar electrical appliances, and TC 106X, Electromagnetic fields in the human environment. Document CLC/TC 61(Sec)1292, was circulated under the enquiry procedure in October 2000. The results of the enquiry were discussed during the Delft meeting in May 2001, when it was decided to prepare a new draft. This new draft, document CLCL/TC 61(Sec)1335, was discussed during the Paris meeting in November 2001, when it was decided to submit a new draft to the Unique Acceptance Procedure.

This draft was circulated in April 2002 and was approved by CENELEC as EN 50366 on 2003-02-01.

The following dates are applicable:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2004-02-01

- date on which national standards conflicting with the EN have to be withdrawn (dow) 2006-02-01

This European Standard has been prepared under mandate M/305 given to CENELEC by the European Commission and the European Free Trade Association and supports the principal objectives of the Low Voltage Directive 73/23/EEC.

Annexes A and C are normative and annexes B, D, E and F are informative.

NOTE Words in **bold** in the text are defined in Clause 3. When a definition concerns an adjective, the adjective and the associated noun are also in bold.

Contents

INTRODUCTION

This standard establishes a suitable evaluation method for determining the electromagnetic fields in the space around household and similar electrical appliances and defines standardized operating conditions and **measuring distances**. It provides a method to show compliance with the European Council Recommendation 1999/519/EC concerning human exposure to electromagnetic fields.

NOTE 1 The fact that magnetic fields in the surrounding space of a household appliance are non-homogeneous has to be taken into account. For household appliances, magnetic flux densities are at their highest on the appliance surfaces and decrease with increasing distance r from the appliance surface by at least $1/r$.

For evaluating the risk of magnetic flux densities the $1/r$ reduction in magnitude represents a worst-case assumption. The magnetic flux density is obtained by:

$$B(r) = \frac{c}{r + r_0}$$

where

$B(r)$ is the magnetic flux density,

c is a constant,

r is the distance from the appliance surface,

r_0 is the distance between the field source and the appliance surface.

NOTE 2 The reference levels of the recommendation are derived for homogeneous fields and for whole-body exposure to larger field sources, such as high voltage transmission lines. The magnetic fields surrounding household appliances are restricted to small parts of the body, e.g. hands and limbs.

It has been assumed in the drafting of this European Standard that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

1 Scope

This European Standard deals with electromagnetic fields and defines methods for evaluating the electric field and the magnetic field for frequencies up to 300 GHz around household and similar electrical appliances.

The methods also apply to appliances not intended for normal household use, but which nevertheless may be accessible to the general public, such as appliances intended to be used by laymen in shops, in light industry and on farms.

NOTE The methods are not suitable for comparing the fields from different appliances.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 60335 series, Household and similar electrical appliances - Safety

3 Definitions

For the purpose of this standard the following definitions apply.

3.1
basic restriction
restriction, based on established health effects, of exposure to time-varying electric fields and magnetic fields

3.2
reference level
r.m.s. value of the magnetic field strength of homogeneous fields, derived from the **basic restriction**, to which a person may be exposed without adverse effects

3.3
measuring distance
distance between the surface of the appliance and the closest point of the sensor surface

3.4
operator distance
distance between the surface of the appliance and the closest point of the head or torso of the operator

3.5
hot spot
localized area of high magnetic field due to irregularities of the field distribution

3.6
coupling factor
factor taking into account the irregularities of the magnetic fields around appliances and the dimensions of a part of the human body

4 Measuring methods

4.1 Electric fields

In general, there is no need to evaluate electric fields around household appliances. For most appliances, the electric field strength can be deemed to comply with the **reference levels** without testing. If electric fields are found to be relevant, a test method will be established.

4.2 Magnetic fields

4.2.1 Frequency range

The frequency range considered is from 10 Hz to 400 kHz .

NOTE 1 The methods of measurement for frequencies from 0 Hz up to 10 Hz are under consideration.

The frequency range evaluated shall cover all frequencies of magnetic fields produced by an appliance, including a sufficient number of harmonics. If this is not feasible in one measurement, the weighted results of each measured frequency range shall be added.

In the frequency range above 400 kHz, appliances are deemed to comply without testing.

NOTE 2 The operating frequency of microwave ovens is covered by EN 60335-2-25 or EN 60335-2-90.

4.2.2 Measuring distances, sensor locations and operating conditions

The **measuring distances**, sensor locations and operating conditions are specified in Annex A.

4.2.3 Magnetic field sensor

Measurement values of magnetic flux density are averaged over an area of 100 cm² in each direction. The reference sensor consists of three mutually perpendicular concentric coils with a measuring area of 100 cm² ± 5 cm² to provide isotropic sensitivity. The outside diameter of the reference sensor is not to exceed 13 cm.

For the determination of **coupling factors**, as specified in Annex C, an isotropic sensor having a measuring area of 3 cm² ± 0,3 cm² is used.

NOTE The final value of the magnetic flux density is the vector addition of the values measured in each direction. This ensures that the measured value is independent of the direction of the magnetic field.

4.2.4 Measuring procedures for magnetic fields

Appliances have at least one independent magnetic field source, each of which generates a fundamental frequency and possibly harmonics.

The magnetic flux density is measured using the procedure in 4.2.4.1. For appliances producing only line spectra, the procedure described in 4.2.4.2 may be applied instead. The simplified procedure in 4.2.4.3 may be used for appliances producing magnetic fields at mains frequency and its harmonics only.

The magnetic flux density is measured using a suitable instrument. In case of doubt, the reference sensor specified in 4.2.3 is used.

Transient magnetic fields with a duration of less then 200 ms, e.g. during switching events, are disregarded. If a switching action occurs during the measurements, the measurement has to be repeated.

The measuring equipment is to have a maximum noise level of 5 % of the limit value. Any measured value below the maximum noise level is disregarded.

The background level is to be less than 5 % of the limit value.

The response time for the measuring equipment to reach 90 % of the final value is not to exceed 2 s.

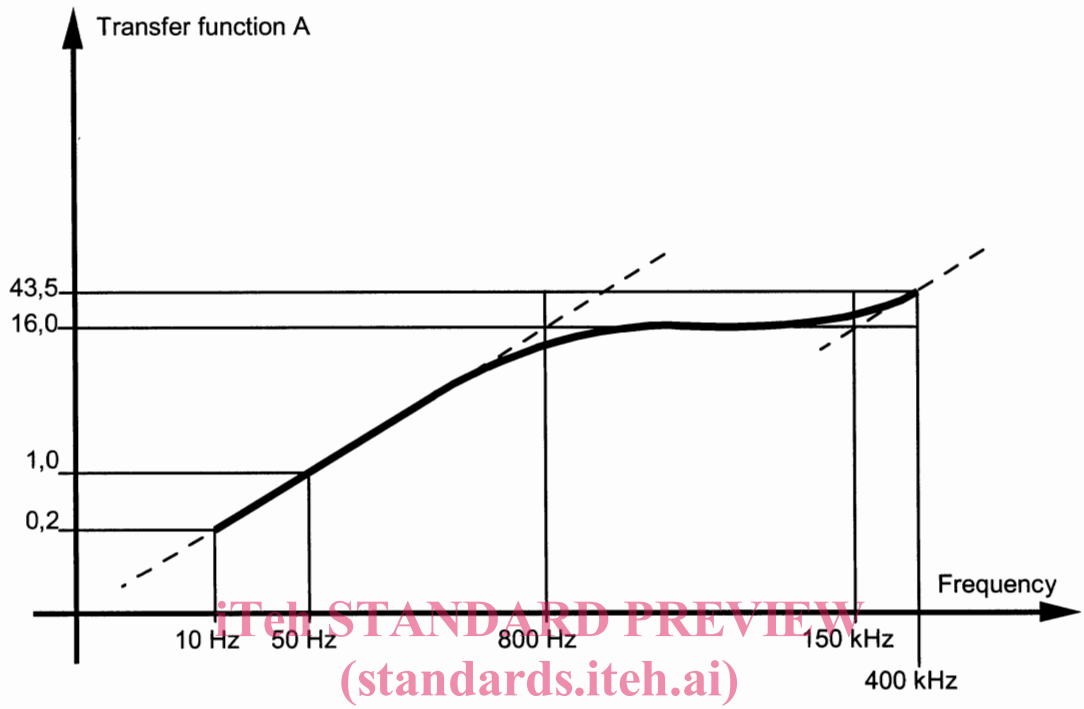
The magnetic flux density is determined by using an averaging time of 1 s.

4.2.4.1 Time domain evaluation

This is the reference method and is used in case of doubt.

Independent of the type of signal, a time domain measurement of the value of the magnetic flux density can be carried out. For fields having several frequencies, the frequency characteristic of the transfer function takes into account the frequency dependency of the **reference levels**.

The transfer function is to be established using a first order filter and shall have the characteristics shown in Figure 1.



NOTE Logarithmic scales are used for both axes.

Figure 1 - Transfer function

The following sequence is used for the measurements:

- separate measurement of each coil signal;
- weighting of the signal by the transfer function;
- squaring the signals;
- adding the squared signals;
- averaging the sum of the squared signals;
- obtaining the square root of the average.

The result is the r.m.s. value of the magnetic flux density.

This procedure is shown schematically in Figure 2.

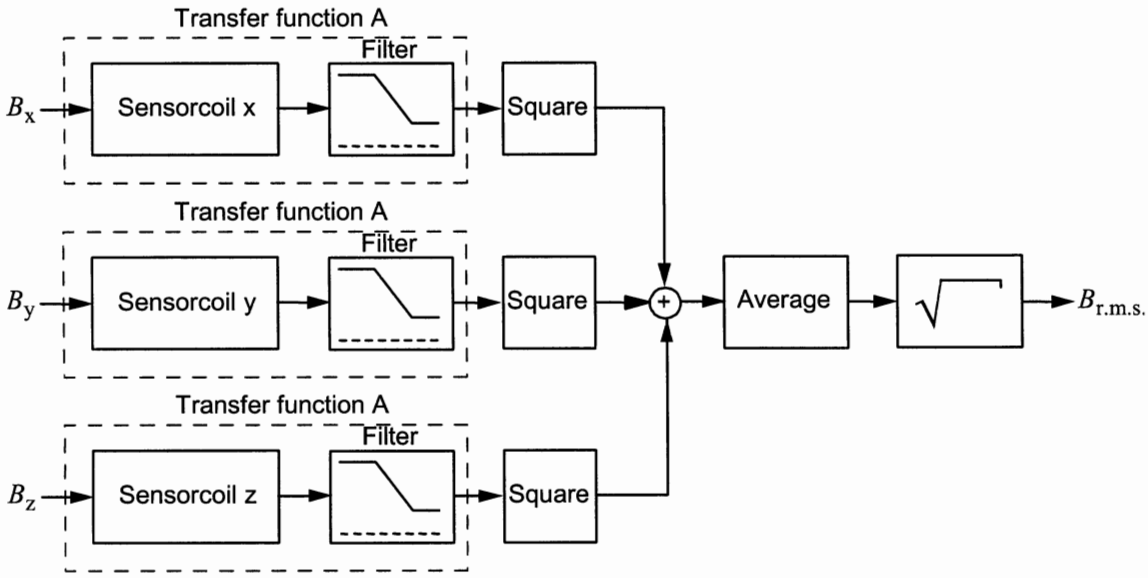


Figure 2 - Schematic diagram of the reference method

The measured value shall not exceed the **reference level** of the magnetic flux density at 50 Hz. However, if this level is exceeded, the value is recalculated taking into account the **coupling factor** $a_c(r_1)$ given in Annex A.

The weighted result is obtained from the following formula:

$$W = \frac{a_c(r_1) B_{r.m.s.}}{B_{RL}}$$

where

W is the weighted result;

$B_{r.m.s.}$ is the r.m.s. value of the magnetic flux density;

B_{RL} is the **reference level** of the magnetic flux density at 50 Hz;

$a_c(r_1)$ is the **coupling factor**.

The value W shall not exceed 1.

4.2.4.2 Line spectrum evaluation

This method may be used when there are only line spectra, for example magnetic fields having a fundamental frequency of 50 Hz and some harmonics.

The magnetic flux density is measured at each relevant frequency. This can be achieved by recording the time signal of the flux density and using a Fourier transformation for evaluating the spectral components.

The following sequence is used for the measurements:

- separate measurement of each coil signal;
- Fourier transformation for each coil signal to obtain the estimated spectrum;
- vector addition of all three spectra for each discrete frequency.

NOTE If the frequency steps of the Fourier transformation are comparatively large, e.g. in the order of 10 %, an additional calculation of the discrete spectral lines may be necessary.

The magnetic flux density, B_f, is given by:

$$B_f = \sqrt{B_{xf}^2 + B_{yf}^2 + B_{zf}^2}$$

where

B_f is the magnetic flux density at frequency f;

B_{xf}, B_{yf} and B_{zf} are the individual flux densities of the three coils at any one frequency.

The weighted result is obtained from the sum of the frequency components using the following formula:

$$W = \sqrt{\sum_{1}^{n} \left(\frac{B_f}{B_{RLf}} \right)^2}$$

where

W is the weighted result;

B_{RLf} is the **reference level** of the magnetic flux density at frequency f obtained from Annex B;

n is the number of relevant frequencies (harmonics).

The value W shall not exceed 1. However, if this value is exceeded, the weighted result is multiplied by the relevant **coupling factor** $a_e(r_1)$ given in Annex A. The result shall not exceed 1.

4.2.4.3 Simplified test methods

Appliances that are constructed so that they can only produce magnetic fields at mains frequency and its harmonics need only be tested in the frequency range below 2 kHz.

Appliances are considered to meet the requirements of this standard when all the following conditions are fulfilled:

- the currents, including the harmonic currents, generating the magnetic fields are known;
- all harmonic currents with amplitudes higher than 10 % of the amplitude of the mains frequency decrease continuously over the frequency range;
- the magnetic flux density measured at mains frequency is less than 50 % of the **reference level** specified for the mains frequency;

- the magnetic flux density measured during a broadband measurement over the frequency range, with the mains frequency suppressed, is less than 15 % of the **reference level** specified for the mains frequency.

NOTE An active notch filter is a suitable means for suppressing the mains frequency.