

Calculation of the effective parameters of magnetic piece parts

ICS 29.100.10

National foreword

This British Standard is the UK implementation of EN 60205:2006+A1:2009. It is identical with IEC 60205:2006, incorporating amendment 1:2009. It supersedes BS EN 60205:2006 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted to Technical Committee EPL/51, Transformers, inductors, magnetic components and ferrite materials.

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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Amendments/corrigenda issued since publication

Date	Comments
31 January 2010	Implementation of IEC amendment 1:2009 with CENELEC endorsement A1:2009

**Calculation of the effective parameters of magnetic piece parts
(IEC 60205:2006)**

Calcul des paramètres effectifs
des pièces ferromagnétiques
(CEI 60205:2006)

Berechnung der effektiven Kernparameter
magnetischer Formteile
(IEC 60205:2006)

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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 two official versions (English and 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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 51/848/FDIS, future edition 3 of IEC 60205, prepared by IEC TC 51, Magnetic components and ferrite materials, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60205 on 2006-05-01.

This European Standard supersedes EN 60205:2001.

This European Standard includes the following significant technical changes with respect to EN 60205:2001:

- a) unit of angles through the text are described by using “radian”;
- b) new words are added in 2.1 “All angles are in radians”;
- c) replacement, in 3.9, of the equation $\frac{l_2}{A_2} = \frac{\ln d_2 g / d_3}{D\pi(h_1 - h_2)}$ by $\frac{l_2}{A_2} = \frac{\ln d_2 g / d_3}{D\pi(h_1 - h_2)/2}$;
- d) new cores “EL, ER, PQ, EFD and E planar” are added in this edition.

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) 2007-02-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2009-05-01

Endorsement notice

The text of the International Standard IEC 60205:2006 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

The text of document 51/928A/CDV, future amendment 1 to IEC 60205:2006, prepared by IEC TC 51, Magnetic components and ferrite materials, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60205:2006 on 2009-02-01.

The following dates were fixed:

- latest date by which the amendment has to be
implemented at national level by publication of
an identical national standard or by endorsement (dop) 2009-11-01
- latest date by which the national standards conflicting
with the amendment have to be withdrawn (dow) 2012-02-01

Endorsement notice

The text of amendment 1:2009 to the International Standard IEC 60205:2006 was approved by CENELEC as an amendment to the European Standard without any modification.

CONTENTS

FOREWORD.....2

1 Scope.....4

2 Basic rules.....4

3 Formulae for the various types of cores.....5

 3.1 Ring cores.....5

 3.2 Pair of U-cores of rectangular section 6

 3.3 Pair of U-cores of rounded section 6

 3.4 Pair of E-cores of rectangular section 8

 3.5 Pair of ETD/EER-cores 9

 3.6 Pair of pot-cores 10

 3.7 Pair of RM-cores 12

 3.8 Pair of EP-cores 15

 3.9 Pair of PM-cores.....16

 3.10 Pair of EL-cores.....18

 3.11 Pair of ER-cores (low profile) 20

 3.12 Pair of PQ-cores.....22

 3.13 Pair of EFD-cores 25

 3.14 Pair of E planar-cores.....26

Annex A (informative) Purpose of revision 29

CALCULATION OF THE EFFECTIVE PARAMETERS OF MAGNETIC PIECE PARTS

1 Scope

This International Standard lays down uniform rules for the calculation of the effective parameters of closed circuits of ferromagnetic material.

2 Basic rules

The following basic rules are applicable to this standard.

2.1 All results shall be expressed in units based on the millimetre, shall be accurate to three significant figures, but to derive l_e , A_e , and V_e the values of C_1 and C_2 shall be calculated to five significant figures. All angles are in radians.

NOTE The purpose of specifying this degree of accuracy is only to ensure that parameters calculated at different establishments are identical and it is not intended to imply that the parameters are capable of being determined to this accuracy.

2.2 $A_{\min}$ is the nominal value of the smallest cross-section. All the dimensions used to calculate $A_{\min}$ shall be the mean values between the tolerance limits quoted on the appropriate piece part drawing.

2.3 Calculations are only applicable to the component parts of a closed magnetic circuit.

2.4 All dimensions used for the purpose of calculations shall be the mean value within the tolerance limits quoted on the appropriate piece part drawing.

2.5 All irregularities in the outline of the core, such as small cut-outs, notches, chamfers, etc. shall be ignored unless otherwise described.

2.6 When the calculation involves the sharp corner of a piece part, then the mean length of flux path for that corner shall be taken as the mean circular path joining the centres of area of the two adjacent uniform sections, and the cross-sectional area associated with that length shall be taken as the average area of the two adjacent uniform sections.

Calculation of effective parameters l_e , A_e and V_e .

The effective parameters can be defined as

$$l_e = C_1^2 / C_2 \quad A_e = C_1 / C_2 \quad V_e = l_e A_e = C_1^3 / C_2^2$$

where

l_e is the effective magnetic length of the core (mm);

A_e is the effective cross-sectional area (mm²);

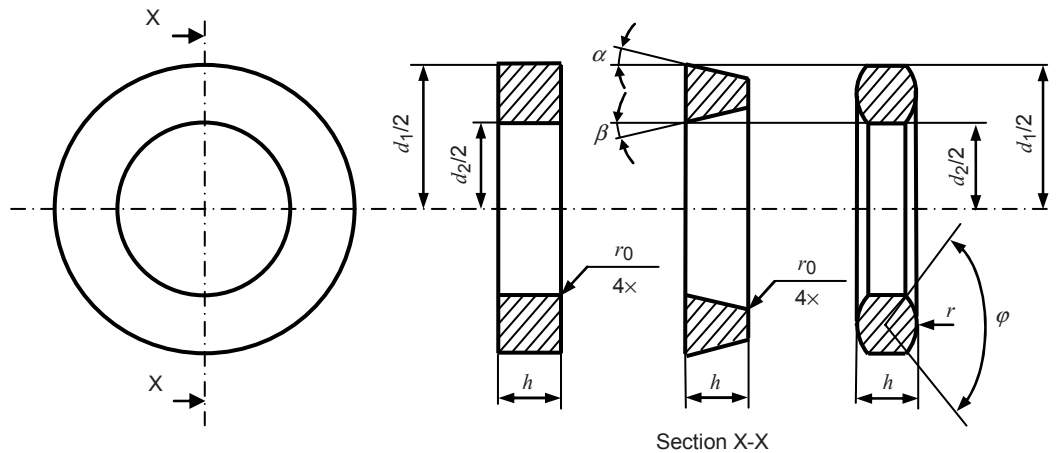
V_e is the effective volume (mm³);

C_1 is the core constant (mm⁻¹);

C_2 is the core constant (mm⁻³).

3 Formulae for the various types of cores

3.1 Ring cores



IEC 584/06

$$C_1 = \frac{2\pi}{h_e \ln(d_1/d_2)}$$

$$C_2 = \frac{4\pi(1/d_2 - 1/d_1)}{h_e^2 \ln^3(d_1/d_2)}$$

3.1.1 For ring cores of rectangular cross-section with sharp corners

$$h_e = h$$

3.1.2 For ring cores of rectangular cross-section with an appreciable average rounding radius r_0

$$h_e = h(1 - k_1) \quad k_1 = \frac{1,7168r_0^2}{h(d_1 - d_2)}$$

3.1.3 For ring cores of trapezoidal cross-section with sharp corners

$$h_e = h(1 - k_2) \quad k_2 = \frac{h(\tan \alpha + \tan \beta)}{d_1 - d_2}$$

3.1.4 For ring cores of trapezoidal cross-section with an appreciable average rounding radius r_0

$$h_e = (1 - k_1 - k_2)$$

3.1.5 For ring cores of cross-section with circular arc frontal sides

$$h_e = h - \frac{d_1 - d_2}{4 \sin^2(\varphi/2)} \left(2 \sin \frac{\varphi}{2} - \frac{\sin \varphi}{2} - \frac{\varphi}{2} \right)$$

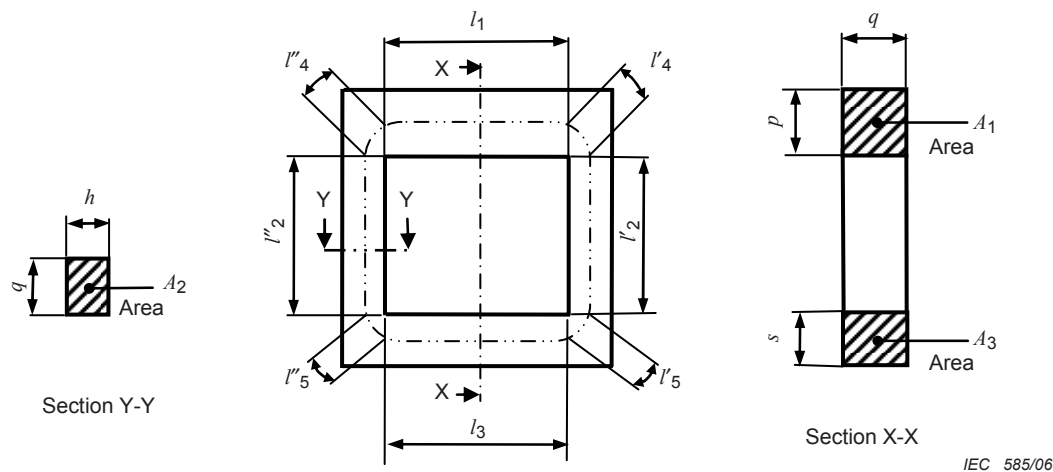
$$\varphi = 2 \arcsin \frac{d_1 - d_2}{4r}$$

NOTE When the winding is uniformly distributed over a ring core, it may be expected that, at all points inside the ring core, the flux lines will be parallel to its surface.

No leakage flux will therefore leave or enter the ring core. This justifies the use of a theoretically more correct derivation of the effective parameters which does not make use of the assumption that the flux is uniformly distributed over the cross-section.

3.2 Pair of U-cores of rectangular section

NOTE U + PLT (Plate)-cores use U core formulas



Length of flux path associated with area A_2 :

$$l_2 = l'_2 + l''_2$$

Mean length of flux paths at corners:

$$l_4 = l'_4 + l''_4 = \frac{\pi}{4}(p + h)$$

$$l_5 = l'_5 + l''_5 = \frac{\pi}{4}(s + h)$$

Mean areas associated with l_4 and l_5 :

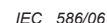
$$A_4 = \frac{A_1 + A_2}{2}$$

$$A_5 = \frac{A_2 + A_3}{2}$$

$$C_1 = \sum_{i=1}^5 \frac{l_i}{A_i} \quad C_2 = \sum_{i=1}^5 \frac{l_i}{A_i^2}$$

3.3 Pair of U-cores of rounded section

NOTE U + PLT (Plate)-cores use U core formulas.



Length of flux path associated with area A_2 :

$$l_2 = l_2' + l_2''$$

$$l_4 = l'_4 + l''_4 = \frac{\pi}{4}(p + h)$$

$$l_5 = l'_5 + l''_5 = \frac{\pi}{4}(s + h)$$

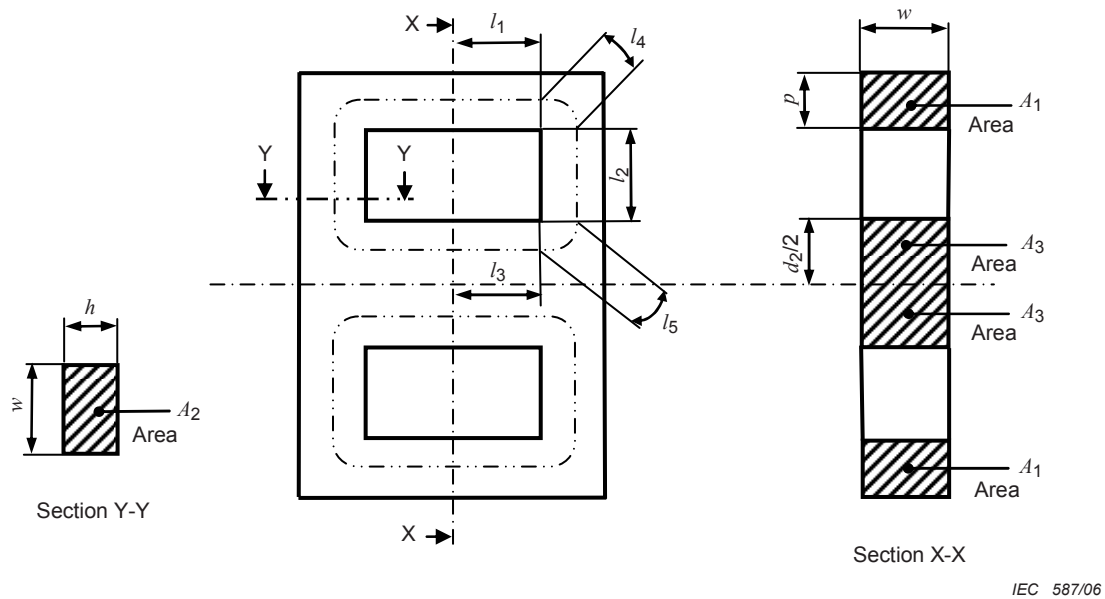
$$A_4 = \frac{A_1 + A_2}{2}$$

$$A_5 = \frac{A_2 + A_3}{2}$$

$$C_1 = \sum_{i=1}^5 \frac{l_i}{A_i} \quad C_2 = \sum_{i=1}^5 \frac{l_i}{A_i^2}$$

3.4 Pair of E-cores of rectangular section

NOTE E + I (Plate)-cores use E core formulas.



Area of half the centre limb: A_3

Mean length of flux paths at corners:

$$l_4 = \frac{\pi}{8}(p + h)$$

$$l_5 = \frac{\pi}{8}\left(\frac{d_2}{2} + h\right)$$

Mean areas associated with l_4 and l_5 :

$$A_4 = \frac{A_1 + A_2}{2}$$

$$A_5 = \frac{A_2 + A_3}{2}$$

$$C_1 = \sum_{i=1}^5 \frac{l_i}{A_i} \quad C_2 = \sum_{i=1}^5 \frac{l_i}{2A_i^2}$$