

Calculation of the effective parameters of magnetic piece parts

The European Standard EN 60205:2001 has the status of a
British Standard

ICS 29.100.10

National foreword

This British Standard is the official English language version of EN 60205:2001. It is identical with IEC 60205:2001. It supersedes BS 6454:1983 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/51, Transformers, Indicators, Magnetic components and ferrite materials, which has the responsibility to:

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- monitor related international and European developments and promulgate them in the UK.

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Summary of pages

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**Calculation of the effective parameters of magnetic piece parts
(IEC 60205:2001)**

Calcul des paramètres effectifs
des pièces ferromagnétiques
(CEI 60205:2001)

Berechnung der effektiven Kernparameter
magnetischer Formteile
(IEC 60205:2001)

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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 51/532/FDIS, future edition 2 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 2001-05-01.

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) 2002-02-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2004-05-01

Annexes designated "informative" are given for information only.
In this standard, annex A is informative.

Endorsement notice

The text of the International Standard IEC 60205:2001 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

- IEC 60431 NOTE: Harmonized as EN 60431:1997 + A2:1998 (not modified).
- IEC 61247 NOTE: Harmonized as EN 61247:1997 (not modified).

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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 and 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.

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);

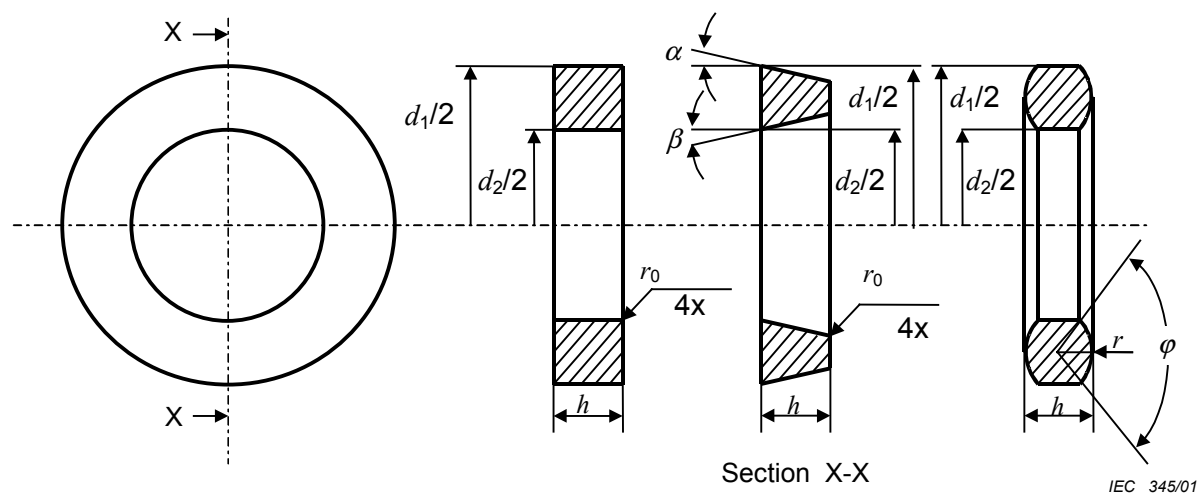
V_e is the effective volume (mm³);

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



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

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

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

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

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

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

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

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

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

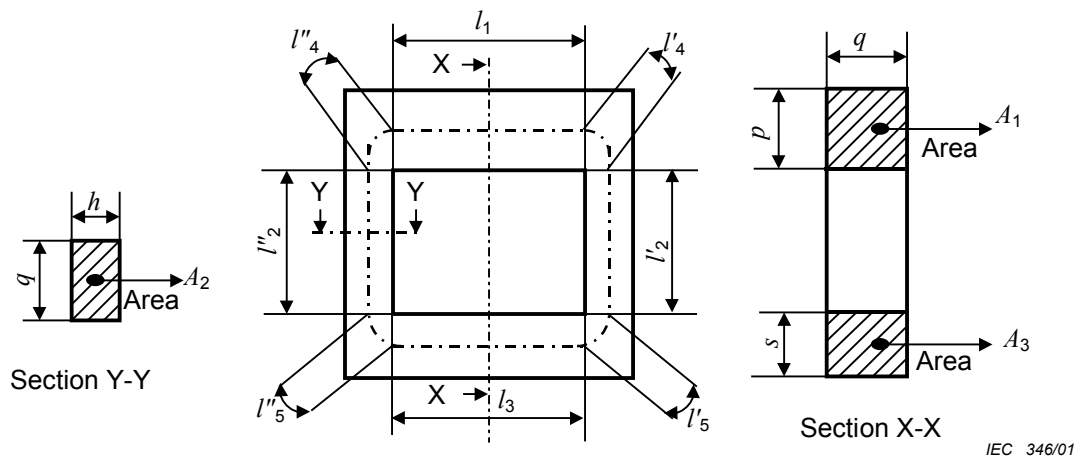
$$\varphi = 2 \arcsin \frac{d_1 - d_2}{4r};$$

φ , in radians.

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



Length of flux path associated with area A_2 :

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

Mean length of flux paths at corners:

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

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

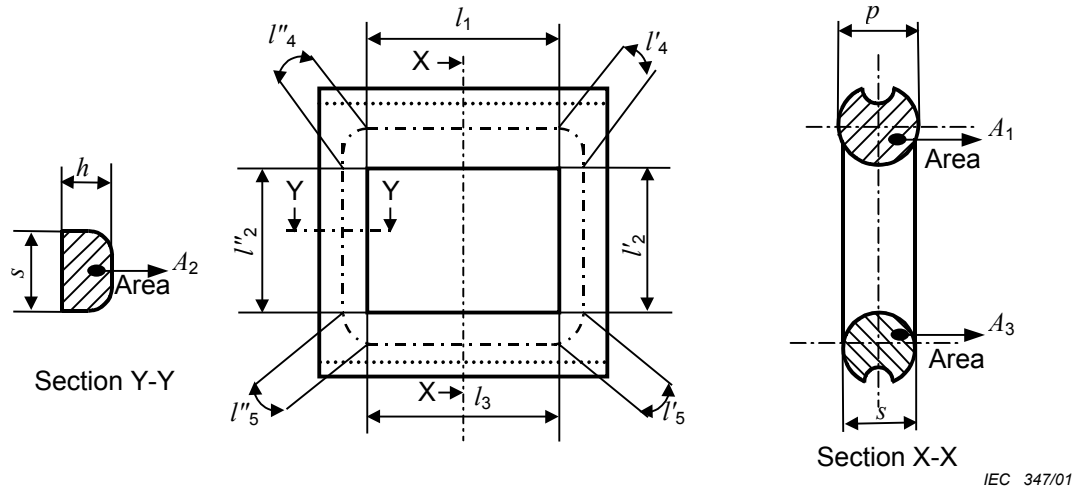
Mean areas associated with l_4 and l_5 :

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

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

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

3.3 Pair of U-cores of rounded section



In calculating A_2 , ignore any ridges introduced for the purpose of facilitating manufacture.

Length of flux path associated with area A_2 :

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

Mean length of flux path 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 :

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

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

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