
**Laminati za transformatorje in dušilke – 1. del: Mehanske in električne
karakteristike (IEC 60740-1:2005)**

(istoveten EN 60740-1:2005)

Laminations for transformers and inductors - Part 1: Mechanical and electrical
characteristics (IEC 60740-1:2005)

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN 60740-1:2006](https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006)

[https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-
8994-eb666c8a59b3/sist-en-60740-1-2006](https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006)

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 60740-1:2006

<https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006>

EUROPEAN STANDARD

EN 60740-1

NORME EUROPÉENNE

EUROPÄISCHE NORM

October 2005

ICS 29.100.10

English version

Laminations for transformers and inductors
Part 1: Mechanical and electrical characteristics
(IEC 60740-1:2005)

Tôles découpées pour transformateurs
et inductances
Partie 1: Caractéristiques électriques
et mécaniques
(CEI 60740-1:2005)

Kernbleche für Transformatoren
und Drosseln
Teil 1: Mechanische und elektrische
Eigenschaften
(IEC 60740-1:2005)

iTeh STANDARD PREVIEW
(standards.iteh.ai)

This European Standard was approved by CENELEC on 2005-08-01. CENELEC members are bound to comply with the 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.

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

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 51/823/FDIS, future edition 1 of IEC 60740-1, 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 60740-1 on 2005-08-01.

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) 2006-05-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2008-08-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60740-1:2005 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61797-1 NOTE Harmonized as EN 61797-1:1996 (not modified).
<https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006>

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 Where an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-221	- 1)	International electrotechnical vocabulary Chapter 221: Magnetic materials and components	-	-
IEC 60404-1	2000	Magnetic materials Part 1: Classification	-	-
IEC 60404-8-4	1998	Part 8-4: Specifications for individual materials - Cold-rolled non-oriented electrical steel sheet and strip delivered in the fully-processed state	-	-
IEC 60404-8-7	1998	Part 8-7: Specifications for individual materials - Cold-rolled grain-oriented electrical steel sheet and strip delivered in the fully-processed state	-	-
IEC 60404-11	1991	Part 11: Method of test for the determination of surface insulation resistance of magnetic sheet and strip	-	-
A1	1998		-	-
IEC 61021-1	1990	Laminated core packages for transformers and inductors used in telecommunication and electronic equipment Part 1: Dimensions	EN 61021-1	1997
IEC 61021-2	1995	Part 2: Electrical characteristics for cores using YEE 2 laminations	EN 61021-2	1997
ISO 286-1	1988	ISO system of limits and fits Part 1: Bases of tolerances, deviations and fits	EN 20286-1	1993

1) Undated reference.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 60740-1:2006

<https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006>

INTERNATIONAL STANDARD

IEC 60740-1

First edition
2005-08

Laminations for transformers and inductors – Part 1: Mechanical and electrical characteristics

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN 60740-1:2006](https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006)

<https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006>

© IEC 2005 — Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

XA

For price, see current catalogue

CONTENTS

FOREWORD	6
1 Scope	8
2 Normative references	8
3 Terms, definitions and symbols	9
4 Materials and lamination thicknesses.....	13
4.1 Materials.....	13
4.2 Nominal lamination thickness	13
4.3 Minimum stacking factor	14
5 Designation of laminations and lamination strips	14
5.1 Specified complete shapes.....	14
5.2 Lamination strips for specified shapes.....	15
5.3 Lamination strips for non-specified laminations.....	16
6 Packing and marking.....	16
7 Electrical tests	16
7.1 General	16
7.2 Core constants	16
7.3 Magnetic path length	17
7.4 Core cross-section.....	17
8 General conditions for electrical measurements	18
8.1 Atmospheric conditions.....	18
8.2 Test coils.....	18
8.3 Test cores.....	18
8.4 Harmonic content of the voltage.....	18
9 Measurements at high field strength	18
9.1 General	18
9.2 Measurement of power loss.....	19
9.3 Measurement of total apparent power	21
10 Measurements at low and medium field strength	22
10.1 General	22
10.2 Measurement of amplitude permeability	22
11 Preferred ranges of laminations	23
12 Dimensions and tolerances	24
12.1 Dimensions	24
12.2 Tolerances.....	24
12.3 Symmetry tolerances	25
13 Dimensions and effective parameters.....	25
13.1 General	25
13.2 Lamination strips Type YS.....	25
13.3 Laminations Type YEI 1	26
13.4 Laminations Type YUI 1	27
13.5 Lamination Types YUI 2.....	30
13.6 Lamination Types YEx 2, YEE 2 and YEI 2.....	32
13.7 Lamination Types YEE 2-..L.....	33
13.8 Lamination Types YEx 3, YEE 3, YEF 3, YEI 3 and YEL 3.....	35

13.9 Lamination Types YEx 4, YEE 4 and YEF 4.....	36
13.10 Laminations Type YM 1.....	38
14 Electrical characteristics for materials	39
15 Specific total apparent power for laminations.....	40
16 Specific power loss for laminations.....	41
17 Mechanical characteristics for laminations.....	42
17.1 General appearance and conditions	42
17.2 Cut and punch edge.....	42
17.3 Camber.....	43
17.4 Distortion.....	43
17.5 Bending.....	43
17.6 Insulation.....	43
17.7 Welding.....	44
 Annex A (informative) Conversion of polarisation and field strength into specific total apparent power	 45
A.1 Specific total apparent power from polarisation and field strength.....	45
A.2 Equations for the curves of the magnetic materials.....	49
A.3 Constants for non-oriented silicon steel C 21	50
A.4 Specific reactive power and specific power loss for non-oriented silicon steel C 21.....	52
A.5 Constants for grain-oriented silicon steel C 22	54
A.6 Specific reactive power and specific power loss for grain-oriented silicon steel C 22.....	56
A.7 Influence of the shape on the electrical characteristics for grain-oriented silicon steel C 22	58
 Bibliography	 59
 Figure 1 – Measurements at high field strength, direct and indirect method, single- phase cores.....	 20
Figure 2 – Measurements at high field strength, direct method, three-phase cores.....	21
Figure 3 – Measurements at low and medium field strength	23
Figure 4 – Lamination strips Type YS, dimensions and tolerances.....	25
Figure 5 – Laminations Type YEI 1, dimensions	26
Figure 6 – Laminations Type YUI 1, dimensions.....	28
Figure 7 – Layer plan for the lamination strip shapes Type YSUI 1	29
Figure 8 – Laminations Type YUI 2, dimensions.....	30
Figure 9 – Layer plan for the lamination strip shapes Type YSUI 2	32
Figure 10 – Laminations Type YEx 2, dimensions.....	32
Figure 11 – Laminations Type YEE 2-...L, using two long E parts, dimensions.....	34
Figure 12 – Laminations Type YEx 3, dimensions.....	35
Figure 13 – Laminations Type YEx 4, dimensions.....	36
Figure 14 – Laminations Type YM 1, dimensions.....	38
Figure 15 – Definition and limit of camber	43
Figure 16 – Definition and limit of distortion.....	43
Figure 17 – Definition and limit of bending.....	43

Figure A.1 – Specific total apparent power for non-oriented silicon steel C 21 48

Table 1 – Preferred magnetic steel and alloys used for laminations 13

Table 2 – Material and lamination thickness 13

Table 3 – Tolerance of the thickness of laminations 14

Table 4 – Lamination thickness and stacking factor 14

Table 5 – Test conditions for the materials C 21, C 22 and F 1 for power loss and total apparent power 19

Table 6 – Conditions for the measurement of amplitude permeability of cores using laminations of silicon steel 22

Table 7 – Conditions for the measurement of amplitude permeability of cores using laminations of nickel-iron alloys 23

Table 8 – Summary of preferred shapes 24

Table 9 – Tolerance according to ISO 286-1 24

Table 10 – Tolerances for lamination strips 25

Table 11 – Laminations Type YEI 1, relation factor of dimensions and tolerances 27

Table 12 – Laminations Type YEI 1, diameter of the holes and tolerance factor x 27

Table 13 – Laminations Type YUI 1, relation of dimensions and tolerances 28

Table 14 – Laminations Type YUI 1, diameter of the holes and tolerance factor x 29

Table 15 – Laminations Type YUI 2, relation of dimensions and tolerances 31

Table 16 – Laminations Type YUI 2, diameter of the holes and tolerance factor x 31

Table 17 – Laminations Type YEx 2, dimensions and tolerances 33

Table 18 – Laminations Type YEx 2, effective parameters 33

Table 19 – Laminations Type YEE 2-..L, using two long E parts, dimensions and tolerances 34

Table 20 – Laminations Type YEE 2-..L, using two long E parts effective parameters 35

Table 21 – Laminations Type YEx 3, dimensions and tolerances 35

Table 22 – Laminations Type YEx 3, effective parameters 36

Table 23 – Laminations Type YEE 4, dimensions and tolerances 37

Table 24 – Laminations Type YEF 4, dimensions and tolerances 37

Table 25 – Laminations Type YEx 4, effective parameters 37

Table 26 – Laminations Type YM 1, dimensions and tolerances 38

Table 27 – Laminations Type YM 1, effective parameters 39

Table 28 – Materials from IEC 60404-8-4 and IEC 60404-8-7 and Table 1. Characteristics for the electrical steel sheet and strips, and laminations for the specific total apparent power p_{S0} and the specific power loss p_{Fe0} 40

Table 29 – Specific total apparent power p_S in VA/kg for the materials from Table 1 for all types of laminations and limb width 41

Table 30 – Specific power loss p_{Fe} in W/kg for the materials from Table 1 for all types of laminations and limb width 42

Table 31 – Insulation resistance of coated surface of laminations made from material according to Table 1 44

Table 32 – Approximate values for the test of welding for laminations from materials C 21 and C 22 44

Table A.1 – Data for the specific total apparent power and the specific power loss for C 21 and C 22 materials 47

Table A.2 – Constants for the specific reactive power of non-oriented silicon steel C 21.....	50
Table A.3 – Constants for the specific power loss of non-oriented silicon steel C 21.....	51
Table A.4 – Specific reactive power for non-oriented silicon steel C 21.....	52
Table A.5 – Specific power loss for non-oriented silicon steel C 21.....	53
Table A.6 – Constants for the specific reactive power of grain-oriented silicon steel C 22.....	54
Table A.7 – Constants for the specific power loss of grain-oriented silicon steel C 22.....	55
Table A.8 – Specific reactive power for grain-oriented silicon steel C 22.....	56
Table A.9 – Specific power loss for grain-oriented silicon steel C22.....	57
Table A.10 – Parts of the magnetic path in rolling direction l_W / l_{Fe} and perpendicular to the rolling direction l_q / l_{Fe} for laminations of 13.3 to 13.10	58

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 60740-1:2006

<https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LAMINATIONS FOR TRANSFORMERS AND INDUCTORS –

Part 1: Mechanical and electrical characteristics

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60740-1 has been prepared by IEC technical committee 51: Magnetic components and ferrite materials.

IEC 60740-1 cancels and replaces IEC 60740 published in 1982 and its amendment 1 (1991). The main changes are listed below:

- a) ranges with lamination strips YS, YSUI 1, YSUI 2 and laminations YEE 2-...L added;
- b) range YEI 1 extended at the above end;
- c) ranges YED 2, YEF 2, YEL 2, YES 2, Type YM 1-5a and YM 1-7a cancelled;
- d) national designations cancelled;
- e) electrical characteristics for the laminations specified;
- f) mechanical characteristics for laminations added;
- g) holes added for lamination types YEI 1, YUI 1, YUI 2, YM 1;
- h) in Annex A, a conversion of the polarisation \hat{J} and the field strength \hat{H} in a specific total apparent power is defined. For the characteristics of the reactive power and the power loss, equations and constants are specified.

The text of this standard is based on the following documents:

FDIS	Report on voting
51/823/FDIS	51/836/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 60740 consists of the following parts under the general title *Laminations for transformers and inductors*:

Part 1: Mechanical and electrical characteristics

Part 2: Specification for the minimum permeabilities of laminations made of soft magnetic metallic materials.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

ITeH STANDARD PREVIEW
(standards.iteh.ai)

A bilingual version of this publication may be issued at a later date.

<https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-8994-eb666c8a59b3/sist-en-60740-1-2006>

LAMINATIONS FOR TRANSFORMERS AND INDUCTORS –

Part 1: Mechanical and electrical characteristics

1 Scope

This part of IEC 60740 specifies the characteristics of laminations. Their preferred use is cores for transformers and inductors. The laminations are made of sheets and strips of magnetic materials, specified in IEC 60404-8-4 and IEC 60404-8-7.

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.

IEC 60050-221, *International Electrotechnical Vocabulary (IEV) – Chapter 221: Magnetic materials and components*

IEC 60404-1:2000, *Magnetic materials – Part 1: Classification*

IEC 60404-8-4:1998, *Magnetic materials – Part 8-4: Specifications for individual materials – Cold-rolled non-oriented electrical steel sheet and strip delivered in the fully-processed state*

<https://standards.iteh.ai/catalog/standards/sist/1d0be15b-9bd9-4b31-99a6a596381a-56076011ca>

IEC 60404-8-7:1998, *Magnetic materials – Part 8-7: Specifications for individual materials – Cold-rolled grain-oriented electrical steel sheet and strip delivered in the fully-processed state*

IEC 60404-11:1999, *Magnetic materials – Part 11: Method of test for the determination of surface insulation resistance of magnetic sheet and strip*

IEC 61021-1:1990, *Laminated core packages for transformers and inductors used in telecommunication and electronic equipment – Part 1: Dimensions*

IEC 61021-2:1995, *Laminated core packages for transformers and inductors used in telecommunication and electronic equipment – Part 2: Electrical characteristics for cores using YEE 2 laminations*

ISO 286-1:1988, *ISO system of limits and fits – Part 1: Bases of tolerances, deviations and fits*

3 Terms, definitions and symbols

For the purposes of this document, the definitions of IEC 60050-221 and the following apply.

3.1

lamination

produced from a magnetic alloy sheet, usually consisting of one piece or several joined pieces, forming one complete layer of a laminated core

3.2

lamination strip

produced from a magnetic alloy sheet, which can be composed to a layer of laminations or stacks for limbs or yokes

3.3

square stack

results, if the height of the package h_p is equal to the limb width d .

3.4

specific power loss

loss of the core in an alternating field with specified frequency and sinusoidal waveform, generating a specified flux density divided by the core mass:

$$p_{Fe} = \frac{P_{Fe}}{m_{Fe}} \quad (1)$$

where

p_{Fe} is the specific power loss, in W/kg;

P_{Fe} is the power loss, in W;

m_{Fe} is the core mass, in kg.

NOTE 1 In the power loss both the hysteresis loss and eddy current loss are included.

NOTE 2 This is valid for cores with and without an air gap in the magnetic path.

3.5

specific reactive power

reactive power of the core in an alternating field by specified frequency and sinusoidal, specified flux density divided by the core mass:

$$p_{BFe} = \frac{P_{BFe}}{m_{Fe}} \quad (2)$$

where

p_{BFe} is the specific reactive power, in VA/kg;

P_{BFe} is the reactive power, in VA;

m_{Fe} is the core mass, in kg.