

INTERNATIONAL STANDARD

CONSOLIDATED VERSION

Magnetic materials -

Part 8-8: Specifications for individual materials - Thin electrical steel strip and sheet for use at medium frequencies

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IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Magnetic materials -
Part 8-8: Specifications for individual materials -
Thin electrical steel strip and sheet for use at medium frequencies**

FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60404-8-8 edition 2.1 contains the second edition (2017-09) [documents 68/546/CDV and 68/562/RVC] and its amendment 1 (2026-06) [documents 68/795/CDV and 68/803/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 60404-8-8 has been prepared by IEC technical committee 68: Magnetic alloys and steels.

This second edition cancels and replaces the first edition published in 1991.

This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- extension of the range of electrical steels to include the improved grades.

The text of this International Standard is based on the following documents:

CDV	Report on voting
68/546/CDV	68/562/RVC

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

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

A list of all the parts in the IEC 60404 series, under the general title *Magnetic materials*, can be found on the IEC website.

The committee has decided that the contents of this document and its amendment will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

1 Scope

This part of IEC 60404 defines the grades of thin non-oriented electrical steel strip and sheet in nominal thicknesses of 0,05 mm, 0,10 mm, 0,15 mm, 0,20 mm, 0,25 mm, 0,30 mm and 0,35 mm and of thin grain-oriented electrical steel strip and sheet in nominal thicknesses of 0,05 mm, 0,10 mm, 0,15 mm and 0,18 mm. In particular, it gives general requirements, magnetic properties, geometric characteristics and tolerances, technological characteristics, as well as inspection procedures.

NOTE For thin non-oriented electrical steel strip and sheet, other nominal thicknesses (i.e. 0,12 mm, 0,18 mm, 0,23 mm and 0,27 mm) can be agreed between the manufacturer and the purchaser.

This document applies to electrical steel strip and sheet supplied in the finally annealed condition in coils or sheets and intended for the construction of magnetic circuits predominantly used at frequencies in the range from 100 Hz to 10 kHz.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-121, *International Electrotechnical Vocabulary – Part 121: Electromagnetism* (available at <http://www.electropedia.org/>)

IEC 60050-221, *International Electrotechnical Vocabulary – Chapter 221: Magnetic materials and components* (available at <http://www.electropedia.org/>)

IEC 60404-2, *Magnetic materials – Part 2: Methods of measurement of the magnetic properties of electrical steel sheet and strip by means of an Epstein frame*

IEC 60404-9, *Magnetic materials – Part 9: Methods of determination of the geometrical characteristics of magnetic steel sheet and strip*

IEC 60404-10, *Magnetic materials – Part 10: Methods of measurement of magnetic properties of magnetic steel sheet and strip at medium frequencies*

IEC 60404-13, *Magnetic materials – Part 13: Methods of measurement of resistivity, density and stacking factor of electrical steel strip and sheet*

ISO 404, *Steel and steel products – General technical delivery requirements*

ISO 7799, *Metallic materials – Sheet and strip 3 mm thick or less – Reverse bend test*

ISO 10474, *Steel and steel products – Inspection documents*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-121 and IEC 60050-221 and the following apply.

3.1**number of bends**

number of alternate bends possible before the appearance of the first crack in the base metal visible to the naked eye

Note 1 to entry The number of bends constitutes an indication of the ductility of the product.

3.2**edge camber**

greatest distance between a longitudinal edge of a length of strip or a sheet and the line joining the two extremities of the measured length of this edge

Note 1 to entry: See IEC 60404-9.

4 Classification

The grades covered by this document are classified according to the maximum value of the specific total loss in watts per kilogram and according to the nominal thickness of the product¹ (0,05 mm, 0,10 mm, 0,15 mm, 0,20 mm, 0,25 mm, 0,30 mm and 0,35 mm for non-oriented electrical steel; 0,05 mm, 0,10 mm, 0,15 mm and 0,18 mm for grain-oriented electrical steel).

5 Designation

The steel name comprises the following in the order given:

- a) the characteristic letters:
 - NO for non-oriented electrical steel;
 - GO for grain-oriented electrical steel;
- b) one hundred times the nominal thickness of the product, in millimetres;
- c) the specified value of the maximum specific total loss at 1,0 T and the given frequency for non-oriented electrical steel grades.

EXAMPLE: NO 20-13: non-oriented strip or sheet in nominal thickness of 0,20 mm with a maximum specific total loss of 13 W/kg at 1,0 T and 400 Hz.

6 General requirements**6.1 Production process**

The production process of the steel and its chemical composition are left to the discretion of the manufacturer.

6.2 Form of supply

The product is supplied in coils in the case of strip and in bundles in the case of sheets.

The mass of the coils or the bundles of sheets shall be agreed between the manufacturer and the purchaser at the time of enquiry and order.

The recommended value for the internal diameter of coils is 508 mm; however, another value (e.g. 400 mm) may be agreed for the internal diameter of coils between the manufacturer and the purchaser.

¹ In the rest of the document, the word "product" is used to mean "strip and sheet".

The strip shall be of constant width and wound in such a manner that the edges are superimposed in a regular manner and that the side faces of the coil are substantially flat.

The coils shall be sufficiently tightly wound in order that they do not collapse under their own weight.

The strip may exhibit welds or interleaves resulting from the removal of defective zones, subject to prior agreement between the manufacturer and the purchaser at the time of enquiry and order. The value of the additional thickness due to the weld shall be the subject of an agreement. If necessary, the marking of welds or interleaves may form the subject of a special agreement.

For coils containing repair welds or interleaves, each part of the strip shall be of the same grade.

The edges of parts welded together shall not be so much out of alignment as to affect the further processing of the product.

Sheets which make up each bundle shall be stacked so that the side faces are substantially flat and approximately perpendicular to the top face.

6.3 Delivery condition

Products according to this document are delivered without coating or with a coating on one or both sides. Different types of coating can be provided (see IEC 60404-1-1).

6.4 Surface condition

The surfaces shall be smooth and clean, free from grease and rust². Dispersed defects such as scratches, blisters, cracks, etc. are permitted if they are within the limits of the tolerances on thickness and if they are not detrimental to the correct use of the supplied products.

The insulation coating present on the surface of the product shall be sufficiently adherent so that it does not become detached during cutting operations or heat treatment under conditions specified by the supplier.

If the product is to be immersed in a fluid, an agreement between the manufacturer and the purchaser, initiated by the purchaser, should be reached to ensure compatibility between the fluid and the coating.

6.5 Suitability for cutting

The product shall be suitable for cutting accurately into the usual shapes at any point when appropriate cutting tools are used.

² Not to be confused with some coloration of the insulating coating inherent to the manufacturing process.

7 Technical requirements

7.1 Magnetic properties

7.1.1 Magnetic polarization

The specified minimum values of magnetic polarization for a magnetic field strength of 5 000 A/m (peak value) and at 50 Hz for non-oriented electrical steel shall be as given in Table 1.

Table 1 – Magnetic and technological characteristics of non-oriented electrical steel strip and sheet

Steel name	Nominal thickness mm	Maximum specific total loss at 1,0 T and ^{b,c} W/kg		Minimum magnetic polarization at 50 Hz for 5 000 A/m ^d T	Minimum stacking factor ^a	Minimum number of bends	Conventional density ^e kg/dm ³
		at 400 Hz	at 1 000 Hz				
NO 5-45	0,05	–	45	1,50	0,88	2	7,60
NO 10-13	0,10	13	–	1,55	0,91		
NO 15-11	0,15	11	–	1,55	0,92	2	7,60
NO 15-14		14	–	1,55			
NO 20-13	0,20	13	–	1,58	0,93	2	7,60
NO 20-15		15	–	1,59			
NO 25-14	0,25	14	–	1,59	0,94	2	7,60
NO 25-17		17	–	1,60			
NO 30-16	0,30	16	–	1,59	0,94	2	7,60
NO 30-19		19	–	1,60			
NO 35-19	0,35	19	–	1,60	0,95	2	7,60
NO 35-22		22	–	1,60			7,65

^a Values determined on test specimens without coating. For coated products, the values given in Annex A, Table A.1 apply.

^b For some steel grades in nominal thicknesses of 0,20 mm; 0,30 mm and 0,35 mm values for the optional maximum specific total loss at 1,0 T and 700 Hz are given in Annex B and may be agreed between the manufacturer and the purchaser at the time of enquiry and order.

^c For some steel grades in nominal thicknesses of 0,25 mm and 0,30 mm, values for the optional maximum specific total loss at 1,0 T and 1 000 Hz are given in Annex B and may be agreed between the manufacturer and the purchaser at the time of enquiry and order.

^d The values of minimum magnetic polarization at 50 Hz for 2 500 A/m and 10 000 A/m may be agreed between the manufacturer and the purchaser at the time of enquiry and order (see Annex B).

^e Other values may be agreed between the manufacturer and the purchaser, see Annex C.

The specified minimum values of magnetic polarization for a magnetic field strength of 800 A/m (peak value) and at 50 Hz for grain-oriented electrical steel shall be as given in Table 2.

Table 2 – Magnetic and technological characteristics of grain-oriented electrical steel strip and sheet

Steel name	Nominal thickness mm	Maximum specific total loss W/kg at			Minimum magnetic polarization at 50 Hz for $H = 800 \text{ A/m}^a$	Minimum stacking factor	Minimum number of bends
		1,0 T	1,5 T	Frequency Hz	T		
GO 5	0,05	24	–	1 000	1,60	0,88	1
GO 10	0,10	–	15	400	1,70	0,91	1
GO 15	0,15	–	16	400	1,70	0,92	1
GO 18	0,18	–	17	400	1,80	0,93	1
NOTE The difference between B and J at 800 A/m amounts up to 0,001 T.							
^a It has been common practice for many years to give values of magnetic flux density in tables such as the one above. In fact the Epstein frame is used to determine magnetic polarization (intrinsic flux density) which is defined as: $J = B - \mu_0 H$ where J is the magnetic polarization; B is the magnetic flux density; H is the magnetic field strength; μ_0 is the magnetic constant.							

7.1.2 Specific total loss

The specified values of the maximum specific loss shall be as given in Table 1 and Table 2 and reflect the aged conditions (see 8.3.1).

For grain-oriented electrical steel, they also apply to test specimens that have received, after cutting, a stress relief heat treatment under conditions specified by the manufacturer.

Depending on the nominal thicknesses, the values are specified at 1,0 T for non-oriented electrical steel grades and at 1,0 T or 1,5 T for grain-oriented electrical steel grades and at the frequency specified in Table 1 and Table 2.

7.2 Geometric characteristics and tolerances

7.2.1 Thickness

7.2.1.1 Non-oriented electrical steel products

The nominal thicknesses are 0,05 mm, 0,10 mm, 0,15 mm, 0,20 mm, 0,25 mm, 0,30 mm and 0,35 mm.

For thickness tolerance, a distinction is made between:

- allowable tolerance on the nominal thickness within the same acceptance unit;
- difference in thickness in a sheet or in a length of strip in a direction parallel to the direction of rolling;
- difference in thickness in a direction perpendicular to the direction of rolling. This tolerance applies only to materials with a width greater than 25 mm.

At any point the allowable tolerance on the nominal thickness within the same acceptance unit shall not exceed the values given in Table 3. The additional thickness due to welds, with respect to the measured thickness of the steel strip shall not exceed 0,050 mm.

The difference in thickness in a length of strip (see 8.3.2) in a direction parallel to the direction of rolling shall not exceed 10 % for nominal thicknesses of 0,05 mm, 0,10 mm, 0,15 mm, 0,20 mm, 0,25 mm and 8 % for nominal thicknesses of 0,30 mm and 0,35 mm.

The difference in thickness in a direction perpendicular to the direction of rolling shall not exceed the values given in Table 3.

7.2.1.2 Grain-oriented electrical steel products

The nominal thicknesses are 0,05 mm, 0,10 mm, 0,15 mm and 0,18 mm.

For thickness tolerance, a distinction is made between:

- the allowable tolerance on nominal thickness within the same acceptance unit;
- the difference in thickness in a direction parallel to the direction of rolling;
- the difference in thickness in a direction perpendicular to the direction of rolling. This tolerance applies only to material with a width greater than 150 mm, the measurement being made at least 40 mm from the edges.

At any point, the allowable tolerance on the nominal thickness within the same acceptance unit shall not exceed the values given in Table 3.

The difference in thickness in a length of strip (see 8.3.2) in a direction parallel to the direction of rolling shall not exceed 0,020 mm.

The difference in thickness in a direction perpendicular to the direction of rolling shall not exceed the values given in Table 3.

Table 3 – Thickness tolerances

Nominal thickness mm	Permitted variation on the nominal thickness within the same acceptance unit mm		Maximum difference in thickness in a direction perpendicular to the direction of rolling mm	
	Non-oriented electrical steel products	Grain-oriented electrical steel products	Non-oriented electrical steel products	Grain-oriented electrical steel products
0,05	+ 0,010 – 0,005	+ 0,010 – 0,005	0,008	0,008
0,10	± 0,010	± 0,010	0,010	0,010
0,15	± 0,015	± 0,015	0,020	0,020
0,18	–	± 0,025	–	0,020
0,20	± 0,020	–	0,020	–
0,25	± 0,025	–	0,020	–
0,30	± 0,030	–	0,020	–
0,35	± 0,030	–	0,020	–