IEC 60404-8-7

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Withdrawn

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

Matériaux magnétiques –
Partie 8-7: Spécifications pour matériaux particuliers – Bandes et tôles magnétiques en acier à grains orientés, laminées à froid et livrées à l'état fini

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MAGNETIC MATERIALS –

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

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International Standard IEC 60404-8-7 has been prepared by IEC technical committee 68: Magnetic alloys and steels.

This third edition cancels and replaces the second edition published in 1998 of which it constitutes a technical revision. This revision extends the range of electrical steels to include the improved grades.

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

FDIS	Report on voting
68/367/FDIS	68/370/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.

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This publication 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 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

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MAGNETIC MATERIALS –

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

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1 Scope

This part of IEC 60404 defines the grades of cold-rolled grain-oriented electrical steel strip and sheet in nominal thicknesses of 0,23 mm, 0,27 mm, 0,30 mm and 0,35 mm. In particular, it gives general requirements, magnetic properties, geometric characteristics, tolerances and technological characteristics, as well as inspection procedures.

This standard applies to Goss textured grain-oriented electrical steel strip and sheet supplied in the final annealed condition in sheets or coils, and intended for the construction of magnetic circuits.

The grades are grouped into two classes:

– conventional grades;

– high permeability grades.

They correspond to Class C.22 of IEC 60404-1.

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 60050-121, *International Electrotechnical Vocabulary – Part 121: Electromagnetism*

IEC 60050-221, *International Electrotechnical Vocabulary – Part 221: Magnetic materials and components*

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

IEC 60404-1-1, *Magnetic materials – Part 1-1: Classification - Surface insulations of electrical steel sheet, strip and laminations*

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 60404-3, *Magnetic materials – Part 3: Methods of measurement of the magnetic properties of magnetic sheet and strip by means of a single sheet tester*

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

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

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

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 definitions of the principal terms relating to magnetic properties given in IEC 60050-121 and IEC 60050-221 apply, as well as the following definitions:

3.1
edge camber
greatest distance between a longitudinal edge of the sheet and the line joining the two extremities of the measured length of this edge

NOTE See IEC 60404-9.

3.2
flatness (wave factor)
the property of a sheet or of a length of strip which is characterized by the wave factor, i.e. by the relation of the height of the wave to its length

NOTE See IEC 60404-9.

3.3
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 It constitutes an indication of the ductility of the material.

3.4
internal stresses
stresses which are characterized by a deviation in relation to the line of cutting

4 Classification

The grades covered by this standard are classified according to the value of maximum specific total loss in watts per kilogram and according to the nominal thickness of the material[1)] (0,23 mm, 0,27 mm, 0,30 mm and 0,35 mm).

5 Designation

The steel name comprises the following in the order given:

1) the letter M for electrical steel;
2) one hundred times the specified value of maximum specific total loss at 1,7 T and 50 Hz, in watts per kilogram and corresponding to the nominal product thickness;

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

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3) one hundred times the nominal thickness of the material, in millimetres;
4) the characteristic letter
   – S for conventional grades;
   – P for high permeability grades;
5) one tenth of the frequency 50 Hz, i.e. 5.

EXAMPLE M140-30S5 for cold-rolled grain-oriented electrical steel sheet or strip of conventional grade with a maximum specific total loss at 1,7 T of 1,40 W/kg at 50 Hz and a nominal thickness of 0,30 mm, supplied in the fully-processed state.

NOTE The corresponding steel numbers used in the relevant European Standard are given in Annex A.

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

The mass of the bundles of sheets or coils shall be agreed at the time of ordering.

The recommended value for the internal diameter of coils is approximately 508 mm.

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

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

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

Strip may exhibit welds or interleaves resulting from the removal of defective zones if agreed at the time of enquiry and order. If necessary, the marking of welds or interleaves may be agreed at the time of enquiry and order.

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 material.

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6.3 Delivery condition

Cold-rolled grain-oriented steel material is usually supplied with an insulating coating on both sides. This coating generally consists of an EC-5-G coating on an EC-2 coating in accordance with IEC 60404-1-1[2)].

6.4 Surface condition

The surfaces shall be smooth and clean, free from grease and rust[3)]. 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 material.

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

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

6.5 Suitability for cutting

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

7 Technical requirements

7.1 Magnetic properties

7.1.1 General

The properties defined in 7.1.2 and 7.1.3 shall apply to materials in the delivery condition defined in 6.3 and to the aged condition defined in 8.3.1.

The Epstein strips shall receive a stress relief heat treatment after cutting under conditions specified by the manufacturer.

The single sheet test specimens shall not be heat treated.

7.1.2 Magnetic polarization

The specified minimum values of peak magnetic polarization for the peak magnetic field strength of 800 A/m at 50 Hz or 60 Hz shall be as given in Tables 1 and 2.

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2) Other types of coating exist which are used only when particularly specified.

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

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Table 1 – Technological and magnetic properties of the conventional grades of grain-oriented material

Steel name	Nominal thickness	Maximum specific total loss at 1,5 T W/kg		Maximum specific total loss at 1,7 T W/kg		Minimum magnetic polarization for H = 800 A/m [a]	Minimum stacking factor
	mm	50 Hz	60 Hz	50 Hz	60 Hz	T	
M110-23S5	0,23	0,73	0,96	1,10	1,45	1,78	0,945
M120-23S5	0,23	0,77	1,01	1,20	1,57	1,78	0,945
M120-27S5	0,27	0,80	1,07	1,20	1,58	1,78	0,950
M130-27S5	0,27	0,85	1,12	1,30	1,68	1,78	0,950
M130-30S5	0,30	0,85	1,15	1,30	1,71	1,78	0,955
M140-30S5	0,30	0,92	1,21	1,40	1,83	1,78	0,955
M145-35S5	0,35	1,03	1,36	1,45	1,91	1,78	0,960
M155-35S5	0,35	1,07	1,41	1,55	2,04	1,78	0,960

[a] It has been common practice for many years to give values of magnetic flux density. 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;

μ_0 is the magnetic constant: $4 \pi \times 10^{-7}$ H·m^{-1};

H is the magnetic field strength.

NOTE The difference between B and J at 800 A/m is equal to 0,001 T.

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Table 2 – Technological and magnetic properties of the high permeability grades of grain-oriented material

Steel name	Nominal thickness	Maximum specific total loss at 1,7 T W/kg		Minimum magnetic polarization for H = 800 A/m [a]	Minimum stacking factor
	mm	50 Hz	60 Hz	T	
M85-23P5 [b]	0,23	0,85	1,12	1,85	0,945
M90-23P5 [b]	0,23	0,90	1,19	1,85	0,945
M95-23P5	0,23	0,95	1,25	1,85	0,945
M100-23P5	0,23	1,00	1,32	1,85	0,945
M90-27P5 [b]	0,27	0,90	1,19	1,85	0,950
M95-27P5 [b]	0,27	0,95	1,25	1,85	0,950
M100-27P5	0,27	1,00	1,32	1,88	0,950
M110-27P5	0,27	1,10	1,45	1,88	0,950
M105-30P5	0,30	1,05	1,38	1,88	0,955
M110-30P5	0,30	1,10	1,46	1,88	0,955
M120-30P5	0,30	1,20	1,58	1,85	0,955
M115-35P5	0,35	1,15	1,51	1,88	0,960
M125-35P5	0,35	1,25	1,64	1,88	0,960
M135-35P5	0,35	1,35	1,77	1,88	0,960

[a] It has been common practice for many years to give values of magnetic flux density. 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;

μ_0 is the magnetic constant: $4\pi \times 10^{-7}$ H·m^{-1};

H is the magnetic field strength.

NOTE The difference between B and J at 800 A/m is equal to 0,001 T.

[b] This grade may be delivered in the domain refined condition. The magnetic properties of some domain refined material may deteriorate when the material is subjected to heat treatment.

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7.1.3 Specific total loss

The specified values of maximum specific total loss at 50 Hz or 60 Hz shall be as given in Tables 1 and 2.

7.2 Geometric characteristics and tolerances

7.2.1 Thickness

The nominal thicknesses of the material are 0,23 mm, 0,27 mm, 0,30 mm and 0,35 mm.

For thickness tolerance, a distinction is made between

– the allowable tolerance on the nominal thickness within the same acceptance unit;

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