

# INTERNATIONAL STANDARD

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

**STANDARD PREVIEW**  
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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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

This fifth edition cancels and replaces the fourth edition published in 2017. This edition constitutes a technical revision.

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

- insertion of a third class of grain-oriented electrical steels for magnetic domain refined high permeability grades;
- introduction of the single sheet tester (SST) method as reference measurement method for this third class of material together with a conversion factor for transposition of the SST measurement results to equivalent Epstein values;
- update of the electrical steel range to take account of the current offers and demands of grades.

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

CDV	Report on voting
68/641/CDV	68/657/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, published under the general title *Magnetic materials*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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## INTRODUCTION

This revision of International Standard IEC 60404-8-7 has been prepared by the experts of the Working Group 1 of the IEC technical committee 68: Magnetic alloys and steels.

The insertion of a third class of electrical steels for magnetic domain refined high permeability grades is the main reason of this revision. Most of the technologies of magnetic domain refinement result in material that does not withstand the stress relief annealing after cutting without changing the magnetic properties (i.e. the specific total loss). In the case of this material, the Epstein method according to IEC 60404-2, requiring the annealing of the Epstein test specimens, is not suitable. Therefore, the single sheet tester (SST) method specified in IEC 60404-3 is employed for such non-heatproof magnetic material.

The introduction of the SST as the reference measurement method for these magnetic domain refined high permeability grades was preceded by intense discussions within IEC/TC 68.

The specific total loss measured by use of the SST specified in IEC 60404-3 tends to be larger than the value measured by the use of the Epstein frame in accordance with IEC 60404-2. The magnetic polarization at  $H = 800$  A/m measured by use of the SST tends to be a little lower than the value measured by the use of the Epstein frame.

The significant difference between Epstein and SST loss results made it necessary to introduce a conversion factor,  $F_c$ , applied to the SST results. This conversion factor is to create continuity in the quality characteristics ratio of conventional grain-oriented electrical steel grades and of high permeability grades (Epstein related loss values) to the magnetic domain refined high permeability grades (SST related loss values), particularly over the transition zone between these grades. Otherwise, it could be confusing to the users of this document that the higher quality materials assessed by the SST method would be listed with seemingly higher values of the specific total loss, compared with the lower values obtained by the Epstein method on the lower quality materials.

Considerations of the widely spread grades of domain refined high permeability grain-oriented electrical steel led to the consented value of  $F_c = 0,925$  to be applied to the specific total loss values at 1,7 T measured by the SST method.

The magnetic polarization of magnetic domain refined high permeability grades at  $H = 800$  A/m is the value taken from the SST measurement without conversion to an equivalent Epstein value.

Consequently, the magnetic domain refined high permeability grades will be listed in a new Table 3 as a new class of grain-oriented electrical steel strip and sheet.



## MAGNETIC MATERIALS –

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

#### 1 Scope

This part of IEC 60404 defines the grades of cold-rolled grain-oriented electrical steel strip and sheet in nominal thicknesses of 0,20 mm, 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 document applies to Goss textured grain-oriented electrical steel strip and sheet supplied in the final annealed condition in coils or sheets, and intended for the construction of magnetic circuits.

The grades are grouped into three classes:

- conventional grades;
- high permeability grades;
- magnetic domain refined high permeability grades.

They correspond to Class C22 of IEC 60404-1.

#### 2 Normative references

<https://standards.iteh.ai/catalog/standards/sist/181a90cd-d88b-4045-a41b-b846a431a0d7/iec-60404-8-7-2020>

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*

IEC 60050-221, *International Electrotechnical Vocabulary – Chapter 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 strip and sheet by means of an Epstein frame*

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

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

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

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, IEC 60050-221 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

#### 3.1

##### **edge wave**

##### **wave factor**

variations of flatness of a length of strip or a sheet taking a form of waves at the slit edge of the product

Note 1 to entry: The edge wave is characterized by the wave factor which is the relation of the height of the wave to its length, expressed as a percentage.

[SOURCE: IEC 60404-9:2018, 3.1]

#### 3.2

##### **residual curvature**

variations of flatness of a length of strip or a sheet taking a permanent curvature in the rolling direction of the product

[SOURCE: IEC 60404-9:2018, 3.2]

#### 3.3

##### **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

[SOURCE: IEC 60404-9:2018, 3.3]

#### 3.4

##### **deviation from the shearing line**

internal stress

greatest distance between corresponding points on the two sheared edges of a length of strip or a sheet sheared in the middle of the width, in parallel to the rolling direction of the product, which characterizes the internal stress of the materials

[SOURCE: IEC 60404-9:2018, 3.4]

#### 3.5

##### **number of bends**

counts of alternate bending in the reverse bend test prior to the appearance of the first crack in the base metal of the specimen visible to the naked eye or prior to when sudden failure occurs by fracture

[SOURCE: IEC TR 63114:2018, 3.2]

### 4 Classification

The grades covered by this document are classified according to the specified value of maximum specific total loss at a magnetic polarization of 1,7 T and 50 Hz, in watts per kilogram,

and according to the nominal thickness of the product<sup>1</sup> (0,20 mm, 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) a 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;
- 3) one hundred times the nominal thickness of the product, in millimeters;
- 4) the characteristic letter
  - "S" for conventional grades;
  - "P" for high permeability grades;
  - "R" for magnetic domain refined high permeability grades;
- 5) one tenth of the frequency 50 Hz, i.e. 5.

EXAMPLE M120-30S5 for cold-rolled grain-oriented electrical steel strip or sheet of conventional grade with a maximum specific total loss of 1,20 W/kg at 1,7 T and 50 Hz, and a nominal thickness of 0,30 mm, supplied in the fully-processed state.

## 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 or in bundles in the case of sheets.

The mass of the coils or 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 approximately 508 mm.

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 between the manufacturer and the purchaser at the time of enquiry and order. If necessary, the marking of welds or interleaves may be agreed between the manufacturer and the purchaser 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 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

Cold-rolled grain-oriented electrical steel products are usually supplied with an insulating coating on both sides. This coating generally consists of an EC-5-G coating on an EC-2 coating

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