IEC 60404-8-7

Edition 5.0 2020-09
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.030

ISBN 978-2-8322-8876-4

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
INTRODUCTION 2
1 Scope 7
2 Normative references 7
3 Terms and definitions 8
4 Classification 9
5 Designation 9
6 General requirements 9
6.1 Production process 9
6.2 Form of supply 9
6.3 Delivery condition 10
6.4 Surface condition 10
6.5 Suitability for cutting 10
7 Technical requirements 10
7.1 Magnetic properties 10
7.1.1 General 10
7.1.2 Magnetic polarization 10
7.1.3 Specific total loss 11
7.1.4 Magnetic properties of magnetic domain refined high permeability grades 11
7.2 Geometric characteristics and tolerances 15
7.2.1 Thickness 15
7.2.2 Width 16
7.2.3 Length 16
7.2.4 Edge wave (wave factor) 17
7.2.5 Residual curvature 17
7.2.6 Edge camber 17
7.2.7 Burr height 17
7.3 Technological characteristics 17
7.3.1 Density 17
7.3.2 Stacking factor 17
7.3.3 Number of bends 17
7.3.4 Deviation from the shearing line (internal stress) 17
7.3.5 Insulation coating resistance 18
8 Inspection and testing 18
8.1 General 18
8.2 Selection of samples 18
8.3 Preparation of test specimens 18
8.3.1 Magnetic properties 18
8.3.2 Geometrical characteristics and tolerances 19
8.3.3 Technological characteristics 19
8.4 Test methods 20
8.4.1 General 20
8.4.2 Magnetic properties 20
8.4.3 Geometrical characteristics and tolerances 20

8.4.4 Technological characteristics 21
8.5 Retests 21
9 Marking, labelling and packaging 22
10 Complaints 22
11 Information to be supplied by the purchaser 22
Bibliography 23

Table 1 – Technological and magnetic properties of the conventional grades of grain-oriented electrical steel strip and sheet(magnetic properties are measured using the Epstein method according to IEC 60404-2) 12
Table 2 – Technological and magnetic properties of the high permeability grades of grain-oriented electrical steel strip and sheet(magnetic properties are measured using the Epstein method according to IEC 60404-2) 13
Table 3 – Technological and magnetic properties of magnetic domain refined high permeability grades of grain-oriented electrical steel strip and sheet(magnetic properties are measured using the Single Sheet Test method* according to IEC 60404-3). 15
Table 4 – Tolerances on nominal thickness 16
Table 5 – Tolerances on nominal width 16

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

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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
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.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 ~~two~~ three classes:

– conventional grades;

– high permeability grades~~, including grades which may be delivered in the domain refined condition~~.

– magnetic domain refined high permeability grades.

They correspond to Class C22 of IEC 60404-1.

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 60404-1, *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 ~~and strip~~ by means of an Epstein frame*

IEC 60404-3~~:1992~~, *Magnetic materials – Part 3: Methods of measurement of the magnetic properties of ~~magnetic~~ electrical steel strip and sheet ~~and strip~~ by means of a single sheet tester* ~~IEC 60404-3:1992/AMD1:2002~~

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

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

IEC 60404-8-7

Edition 5.0 2020-09

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



IEC 60404-8-7:2020-09 (en)

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms and definitions 8
4 Classification 8
5 Designation 9
6 General requirements 9
6.1 Production process 9
6.2 Form of supply 9
6.3 Delivery condition 9
6.4 Surface condition 10
6.5 Suitability for cutting 10
7 Technical requirements 10
7.1 Magnetic properties 10
7.1.1 General 10
7.1.2 Magnetic polarization 10
7.1.3 Specific total loss 10
7.1.4 Magnetic properties of magnetic domain refined high permeability grades 10
7.2 Geometric characteristics and tolerances 13
7.2.1 Thickness 13
7.2.2 Width 14
7.2.3 Length 14
7.2.4 Edge wave (wave factor) 14
7.2.5 Residual curvature 15
7.2.6 Edge camber 15
7.2.7 Burr height 15
7.3 Technological characteristics 15
7.3.1 Density 15
7.3.2 Stacking factor 15
7.3.3 Number of bends 15
7.3.4 Deviation from the shearing line (internal stress) 15
7.3.5 Insulation coating resistance 15
8 Inspection and testing 16
8.1 General 16
8.2 Selection of samples 16
8.3 Preparation of test specimens 16
8.3.1 Magnetic properties 16
8.3.2 Geometrical characteristics and tolerances 17
8.3.3 Technological characteristics 17
8.4 Test methods 18
8.4.1 General 18
8.4.2 Magnetic properties 18
8.4.3 Geometrical characteristics and tolerances 18

8.4.4 Technological characteristics 18
8.5 Retests 19
9 Marking, labelling and packaging 19
10 Complaints 19
11 Information to be supplied by the purchaser 19
Bibliography 21

Table 1 – Technological and magnetic properties of the conventional grades of grain-oriented electrical steel strip and sheet (magnetic properties are measured using the Epstein method according to IEC 60404-2) 11
Table 2 – Technological and magnetic properties of the high permeability grades of grain-oriented electrical steel strip and sheet (magnetic properties are measured using the Epstein method according to IEC 60404-2) 12
Table 3 – Technological and magnetic properties of magnetic domain refined high permeability grades of grain-oriented electrical steel strip and sheet (magnetic properties are measured using the Single Sheet Test method* according to IEC 60404-3). 13
Table 4 – Tolerances on nominal thickness 14
Table 5 – Tolerances on nominal width 14

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

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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
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 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

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

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

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*