BS EN 10303:2015

BSI Standards Publication

# Thin magnetic steel strip and sheet for use at medium frequencies

bsi.

...making excellence a habit.™

**National foreword**

This British Standard is the UK implementation of EN 10303:2015. It supersedes BS EN 10303:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/108, Magnetic Alloys and Steels.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.


Published by BSI Standards Limited 2015

ISBN 978 0 580 83973 3

ICS 77.140.40; 77.140.50

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2015.

**Amendments/corrigenda issued since publication**

| Date | Text affected |
|---|---|

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 10303

October 2015

ICS 77.140.40; 77.140.50

Supersedes EN 10303:2001

English Version

# Thin magnetic steel strip and sheet for use at medium frequencies

Bandes et tôles extra-minces en acier électrique pour utilisation à moyennes fréquences

Dünnes Elektroband und -blech aus Stahl zur Verwendung bei mittleren Frequenzen

This European Standard was approved by CEN on 29 August 2015.

CEN members are bound to comply with the CEN/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 CEN-CENELEC Management Centre or to any CEN 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 CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**

# Contents

Page

## European foreword

This document (EN 10303:2015) has been prepared by Technical Committee ECISS/TC 108 “Steel sheet and strip for electrical applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2016, and conflicting national standards shall be withdrawn at the latest by April 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10303:2001.

Regarding the changes that were made in this new edition of EN 10303, see Annex E.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# 1 Scope

This European Standard defines the grades of thin non-oriented magnetic steel strip and sheet in nominal thicknesses of 0,05 mm, 0,10 mm, 0,15 mm, 0,20 mm, 0,25 mm, 0,27 mm, 0,30 mm and 0,35 mm, and of thin grain-oriented magnetic 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 and technological characteristics, as well as inspection procedure.

This European Standard applies to magnetic steel strip and sheet supplied in the finally annealed condition in coils and intended for the construction of magnetic circuits used at frequencies equal to or higher than 100 Hz.

# 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10021, *General technical delivery conditions for steel products*

EN 10204, *Metallic products — Types of inspection documents*

EN 10251, *Magnetic materials — Methods of determination of the geometrical characteristics of electrical steel sheet and strip*

EN 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 60404-2)*

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

EN ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing (ISO 377)*

EN ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1)*

EN ISO 7799, *Metallic materials — Sheet and strip 3 mm thick or less — Reverse bend test (ISO 7799)*

IEC 60050-121, *International Electrotechnical Vocabulary — Chapter 121: Electromagnetism*

IEC 60050-221, *International Electrotechnical Vocabulary — Chapter 221: Magnetic materials and components*

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

# 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.

**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 indicating the ductility of the material

**3.2**
**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

# 4 Classification

The grades covered by this European Standard are classified according to the maximum value of the specific total loss, in watts per kilogram, and according to the nominal thickness of the material (0,05 mm; 0,10 mm; 0,15 mm; 0,20 mm; 0,25 mm, 0,27 mm, 0,30 mm and 0,35 mm for non-oriented steel, respectively 0,05 mm; 0,10 mm, 0,15 mm and 0,18 mm for grain-oriented steel).

# 5 Designation

The conventional designation of the different grades comprises the following in the order:

a) the characteristic letters:

   1) NO for non-oriented strip and sheet;

   2) GO for grain-oriented strip and sheet;

b) 100 times the nominal thickness of the material, in millimetres;

EXAMPLE NO 20: non-oriented strip in thickness of 0,20 mm.

c) maximum specific total loss by given frequency in cases where steel grades with different values for maximum specific total loss per nominal thickness are stated (see Table 2).

# 6 Information to be supplied by purchaser

## 6.1 Mandatory information

For material to comply adequately with the requirements of this standard, the purchaser shall include the following information in his enquiry or order:

a) the quantity required (including any limitations on the mass of a coil) (see 7.2);

b) type of product (strip or sheet);

c) number of this European Standard (EN 10303);

d) the grade designation of the material, in accordance with Clause 5;

e) the dimensions of strips required (including any limitations of the internal and external diameter of a coil) (see 7.2 and 8.3.2);

f) the inspection procedure required including the nature of the related documents (see 9.1);

### 6.2 Options

A number of options are specified in this standard and listed below. lf the purchaser does not indicate his wish to implement one of these options, the products shall be supplied in accordance with the basis specification of this standard (see 6.1):

1) presence of welds or interleaves and their optional marking (see 7.2);

2) compatibility of the surface insulation coating (see 7.4);

3) residual curvature (see 8.3.5);

4) insulation coating resistance (see 8.4.4).

5) mechanical properties for non-oriented products (see Table D.1)

## 7 General requirements

### 7.1 Production process

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

### 7.2 Form of supply

The material is supplied in coils.

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

The recommended value for the internal diameter of coils is approximately 400 mm except for non-oriented strip in thickness of 0,20 mm; 0,25 mm, 0,27 mm, 0,30 mm and 0,35 mm, and grain-oriented strip in thickness of 0,18 mm for which the recommended internal diameter is approximately 500 mm.

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

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

The strip can occasionally exhibit welds or interleaves resulting from the removal of defective zones, subject to prior agreement between the parties. The value of the additional thickness due to the weld is subject to the 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 material.

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

### 7.3 Delivery condition

Products according to this standard are delivered either with a coating on one or on both sides but also without coating. Different types of coating can be provided.

### 7.4 Surface condition

The surfaces shall be smooth and clean and free from grease and rust.[1)] Dispersed defects such as scratches, blisters, cracks, etc. are permitted if the products are within the tolerances and if these defects are not detrimental to the correct use of the supplied material.

Any insulation coating on the surface of the material shall be sufficiently adherent so as not to become detached during heat treatment under conditions specified by the supplier or during cutting operations.

If the product is to be immersed in a fluid or is to be given an additional coating or impregnation, an agreement initiated by the purchaser should be reached with the supplier to ensure compatibility with the surface insulation coating.

### 7.5 Suitability for cutting

The material shall be capable of being cut at any point and into the usual shapes thus ensuring accurate working with the correct cutting tools.

## 8 Technical requirements

### 8.1 Magnetic properties

#### 8.1.1 Magnetic polarization

The minimum specified values of magnetic polarization for a magnetic field strength of 800 A/m (peak value) and at the frequency specified in Table 1 for grain-oriented material shall be as given in Table 1.

The minimum specified values of magnetic polarization for a magnetic field strength of 2 500 A/m (peak value) and at the frequency specified in Table 2 for non-oriented material shall be as given in Table 2.

#### 8.1.2 Specific total loss

The specified maximum values of specific total loss shall be as given in Tables 1 and 2 and reflect the aged conditions (see 9.3.1). 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 thicknesses, the values are specified at 1,0 T for the non-oriented steel and at 1,0 T or 1,5 T for the grain-oriented material and at the frequency specified in Tables 1 and 2.

1) This should not be confused with some coloration of the insulating coating inherent in the manufacturing process.

**Table 1 — Magnetic and technological characteristics of grain-oriented strip**

| Designation | Nominal thickness [mm] | Maximum specific total loss W/kg at | | | Minimum magnetic polarization for $H$ = 800/Am[a] | | Minimum stacking factor | Minimum number of bends |
|---|---|---|---|---|---|---|---|---|
| | | 1,0 T | 1,5 T | Frequency [Hz] | T | Frequency [Hz] | | |
| GO 5 | 0,05 | 24 | - | 1 000 | 1,60 | 1 000 | 0,88 | 1 |
| GO 10 | 0,10 | - | 15 | 400 | 1,70 | 400 | 0,91 | 1 |
| GO 15 | 0,15 | - | 16 | 400 | 1,70 | 400 | 0,92 | 1 |
| GO 18 | 0,18 | - | 17 | 400 | 1,80 | 400 | 0,93 | 1 |

[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 ;

$\mu_0$ is the magnetic constant.

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

**Table 2 — Magnetic and technological characteristics of non-oriented strips**

| Designation | Nominal thickness [mm] | Maximum specific total loss W/kg at | | Minimum magnetic polarization at 50 Hz | | | Minimum stacking factor[a] | Minimum number of bends | Conventional density[c] [kg/dm³] |
|---|---|---|---|---|---|---|---|---|---|
| | | 1,0 T | Frequency[b] [Hz] | for 2 500 A/m [T] | for 5 000 A/m [T] | for 10 000 A/m [T] | | | |
| NO 5 | 0,05 | 45 | 1 000 | - | - | - | 0,88 | 2 | 7,60 |
| NO 10 | 0,10 | 13 | 400 | - | - | - | 0,91 | 2 | 7,60 |
| NO 15 | 0,15 | 14 | 400 | - | - | - | 0,92 | 2 | 7,60 |
| NO 20–13 | 0,20 | 13 | 400 | 1,47 | 1,58 | 1,68 | 0,93 | 2 | 7,60 |
| NO 20–15 | | 15 | 400 | 1,48 | 1,59 | 1,69 | | | |
| NO 25–14 | 0,25 | 14 | 400 | 1,48 | 1,59 | 1,69 | 0,94 | 2 | 7,60 |
| NO 25–17 | | 17 | 400 | 1,49 | 1,60 | 1,70 | | | |
| NO 27–15 | 0,27 | 15 | 400 | 1,48 | 1,59 | 1,69 | 0,94 | 2 | 7,60 |
| NO 27–18 | | 18 | 400 | 1,49 | 1,60 | 1,70 | | | |
| NO 30–16 | 0,30 | 16 | 400 | 1,48 | 1,59 | 1,69 | 0,94 | 2 | 7,60 |
| NO 30–19 | | 19 | 400 | 1,49 | 1,60 | 1,70 | | | |
| NO 35–19 | 0,35 | 19 | 400 | 1,49 | 1,60 | 1,70 | 0,95 | 2 | 7,60 |
| NO 35–22 | | 22 | 400 | 1,49 | 1,60 | 1,70 | | | 7,65 |

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

b For the steel grades in thicknesses of 0,20 mm; 0,25 mm; 0,27 mm; 0,30 mm and 0,35 mm values for the maximum specific total loss at 1,0 T and 700 Hz and at 1,5 T and 400 Hz are given in Annex B.

c Other values of density may be agreed at the time of enquiry and order (see Annex C).

## 8.2 Mechanical properties at room temperature for non-oriented products

By agreement at time of enquiry and order, the values in Table D.1 of Annex D apply (see 6.2, Option 5).

## 8.3 Geometric characteristics and tolerances

### 8.3.1 Thickness of grain-oriented steel products

The nominal thicknesses of the material 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 the Table 3.

The difference in thickness 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 the Table 3.

### 8.3.2 Thickness of non-oriented steel products

The nominal thicknesses of the material are:

— 0,05 mm; 0,10 mm; 0,15 mm; 0,20 mm; 0,25 mm; 0,27 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 or sheet shall not exceed 0,050 mm.

The difference in thickness in a sheet or 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 0,27 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 the Table 3.

**Table 3 — Thickness tolerances**

Dimensions in millimetres

| Nominal thickness | Permitted variation on the nominal thickness within the same acceptance unit | | Max. difference in thickness in a direction perpendicular to the direction of rolling | |
|---|---|---|---|---|
| | Non-oriented strip and sheet | Grain-oriented strip and sheet | Non-oriented strip and sheet | Grain-oriented strip and sheet |
| 0,05 | + 0,010<br>- 0,005 | + 0,010<br>- 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 | – |
| 0,27 | ±0,027 | - | 0,020 | - |
| 0,30 | ±0,030 | – | 0,020 | – |
| 0,35 | ±0,030 | - | 0,020 | - |

### 8.3.3 Width

#### 8.3.3.1 Non-oriented strip and sheet

The tolerance given in Table 4 shall apply.

**Table 4 — Width tolerance of non-oriented sheet and strip**

Dimensions in millimetres

| **Nominal width** $l$ | **Permitted deviations**[a] |
|---|---|
| $l \leq 150$ | $^{+0,4}_{0}$ |
| $150 < l \leq 500$ | $^{+0,6}_{0}$ |
| $500 < l \leq 1250$ | $^{+1,5}_{0}$ |
| NOTE By agreement when ordering, the tolerances on the width can be all minus values. | |
| [a] For nominal width greater as 1 250 mm the tolerances shall be agreed at time of enquiry and order. | |

#### 8.3.3.2 Grain-oriented strip and sheet

The tolerances given in Table 5 shall apply.

**Table 5 — Width tolerance of grain-oriented sheet and strip**

Dimensions in millimetres

| **Nominal width** $l$ | **Tolerance**[a] |
|---|---|
| $l \leq 150$ | $^{0}_{-0,2}$ |
| $150 < l \leq 400$ | $^{0}_{-0,3}$ |
| $400 < l \leq 750$ | $^{0}_{-0,5}$ |
| $l > 750$ | $^{0}_{-0,6}$ |
| [a] By agreement at the time of enquiry and order, the tolerances on the nominal width can be all positive. | |

### 8.3.4 Edge camber

The verification of edge camber applies only to non-oriented material of 0,20 mm, 0,25 mm, 0,27 mm, 0,30 mm and 0,35 mm thickness and width greater than 150 mm. The gap characterizes the edge camber shall not exceed 1 mm over the measured length of 1 m.

#### 8.3.5 Residual curvature

A requirement concerning residual curvature can be specified by agreement when ordering, for material of width greater than 150 mm.

#### 8.3.6 Burr height

The determination of the burr height applies only to non-oriented material of 0,20 mm, 0,25 mm, 0,27 mm, 0,30 mm and 0,35 mm thickness. The measured burr height shall not exceed 0,03 mm.

### 8.4 Technological characteristics

#### 8.4.1 Density

The conventional density of the material is not specified.

The conventional value of density serving as a basis for the calculation of magnetic properties and the stacking factor are given in Table 2 and Annex C for non-oriented material. For grain-oriented material the density is 7,65 kg/dm$^3$.

#### 8.4.2 Stacking factor

The specified minimum values for products without coating shall be as given in Tables 1 and 2.

For coated non-oriented products, informative values of the stacking factor are given in Annex A, Table A.1.

#### 8.4.3 Number of bends

##### 8.4.3.1 General

The specified minimum number of bends shall be as given in Tables 1 and 2.

##### 8.4.3.2 Non-oriented strip and sheet

The value applies to test specimens cut perpendicular to the direction of rolling.

##### 8.4.3.3 Grain-oriented strip and sheet

The value applies to test specimens cut parallel to the direction of rolling.

#### 8.4.4 Insulation coating resistance

The value of the insulation coating resistance may be agreed at time of enquiry and order (see 6.2, Option 4).

## 9 Inspection

### 9.1 General

The materials defined by this European Standard can be ordered with or without specific inspection in accordance with EN 10021. However, as a dispensation from EN 10021, in the case of an order without specific inspection, the producer shall supply a certificate giving the specific total loss of the delivered material.

In the case of an order with specific inspection, the purchaser shall specify, when ordering, the properties for which the verification shall be made and the type of inspection document in accordance with EN 10204.

Each acceptance unit shall comprise:

— 10 t for non-oriented strip and sheet in thicknesses of 0,20 mm, 0,25 mm, 0,27 mm, 0,30 mm and 0,35 mm;

— 1 t for non-oriented and grain-oriented strip and sheet in thicknesses of 0,05 mm; 0,10 mm, 0,15 mm and 0,18 mm;

or the remaining fraction there of the same grade and the same nominal thickness. Different acceptance units can be adopted by special agreement.

For coils of greater mass than the values given above, each coil shall constitute an acceptance unit.

Except by special agreement the same rules apply to the inspection of the verified characteristics.

When the products are delivered in the form of slit coils, the test results applying to the parent unit of acceptance shall apply.

## 9.2 Selection of samples

Test samples shall be taken from each acceptance unit.

The first internal turn and last external turn of the coils shall be considered as wrapping and not as representative of the quality of the rest of the coil. The selection shall be made from the first internal or external turns, excluding the wrapping turn. The selection shall be made away from weld zones or interleaves.

The same sample shall serve to check the various properties by choosing a suitable order for the execution of the tests.

## 9.3 Preparation of test specimens

### 9.3.1 Magnetic properties

For measuring magnetic polarization and specific total loss, the test specimen for the 25 cm Epstein frame shall be in accordance with EN 60404-2 and IEC 60404-10 as appropriate, and it shall consist of strips having the following dimensions:

— length: 280 mm to 320 mm, the lengths being equal within a tolerance of ± 0,5 mm;

— width: 30 mm ± 0,2 mm.

The number of Epstein strips for the magnetic measurements shall fulfil the requirements of EN 60404-2 and IEC 60404-10.

For non-oriented material, half the test strips shall be cut parallel to the direction of rolling and the other half perpendicular giving an even distribution across the width of the material.

For grain-oriented material, all the test strips shall be cut parallel to the direction of rolling. As far as possible, the selection of test strips shall be made uniformly across the width of the material.

The test strips shall be carefully cut without deformation. Cutting or punching shall be carried out only with well-sharpened tools.

The allowable tolerance for the angle between the direction of rolling and the direction of cutting is:

1) ± 5° for non-oriented material;

2) ± 1° for grain-oriented material.

For grain-oriented products, before testing, the test pieces shall be subject to the stress relief heat treatment as defined in 8.1.2. For measuring of the specific total loss on aged pieces, these shall be heated at (225 ± 5)°C for 24 h and shall be cooled to ambient temperature before testing.

For non-oriented products no further heat treatments such as stress relief annealing of the test specimen are allowed.

#### 9.3.2 Mechanical properties

Sampling and sample preparation for mechanical testing shall be in accordance with the requirements of EN ISO 377.

#### 9.3.3 Geometrical characteristics and tolerances

For the measurement of thickness, width, residual curvature and edge camber, the test specimen shall consist of a 1 m length of strip.

#### 9.3.4 Technological characteristics

##### 9.3.4.1 Stacking factor

The test specimen shall consist of strips of the same size, their number being the same as for the determination of the magnetic characteristics (see 9.3.1). The strips shall be at least 20 mm wide, with a surface area of at least 5 000 $mm^2$, their width being equal within a tolerance of ± 0,1 mm as well as their length. The test strips shall be carefully deburred before the test.

##### 9.3.4.2 Number of bends

###### 9.3.4.2.1 General

The test specimens shall be carefully cut without deformation.

###### 9.3.4.2.2 Non-oriented strip

Two test specimens at least 20 mm wide shall be cut perpendicular to the direction of rolling, at a distance of at least 40 mm from the edge and from the middle and outside any weld zones.

If the width of the material is not great enough for transverse test specimens of the prescribed length to be taken, the test specimens shall be taken in the direction of rolling. In this case, the values of Table 2 also apply.

###### 9.3.4.2.3 Grain-oriented strip

Five test specimens at least 20 mm wide shall be taken from outside the welding zones, parallel to the direction of rolling with a view to making the bend perpendicular to the direction of rolling. The edge of the material shall not constitute one side of the test specimen.

### 9.4 Test methods

#### 9.4.1 General

For each specified property one test shall be carried out per acceptance unit. Unless other-wise specified, the test shall be made at a temperature of 23°C ± 5°C.

#### 9.4.2 Magnetic properties

The test shall be made using a 25 cm Epstein frame in accordance with EN 60404-2.

### 9.4.3 Mechanical properties

The tensile test at room temperature shall be in accordance with EN ISO 6892-1.

### 9.4.4 Geometrical characteristics and tolerances

#### 9.4.4.1 Thickness

##### 9.4.4.1.1 Grain-oriented strip and sheet

The measurement of thickness shall be made at any point located more than 40 mm from the edges. For materials of a width less than 80 mm, the measurement of thickness shall be made along the longitudinal axis of the strip. This measurement shall be made using a micrometre accurate to 0,001 mm.

##### 9.4.4.1.2 Non-oriented strip and sheet

For the thickness variation perpendicular to the rolling direction two thickness measurements shall be made as follows:

— For products of width over 100 mm (inclusive) at any point located more than 30 mm from the edges.

— For products of width less than 100 mm, the measurement of thickness shall be made at any point located more than 10 mm from the edges.

For products of width less than 25 mm (inclusive) the measurement shall be made only in the longitudinal direction.

This measurement shall be made by using a micrometre with a resolution of 0,001 mm.

#### 9.4.4.2 Width

The width shall be measured perpendicular to the longitudinal axis of the strip.

#### 9.4.4.3 Residual curvature

The residual curvature in the longitudinal direction of the strip shall be determined in accordance with EN 10251.

#### 9.4.4.4 Edge camber

The edge camber shall be determined accordance with EN 10251.

#### 9.4.4.5 Burr height

The burr height shall be determined in accordance with EN 10251.

### 9.4.5 Technological characteristics

#### 9.4.5.1 Stacking factor

The stacking factor shall be measured in accordance with EN 60404-13.

#### 9.4.5.2 Number of bends

The test consists in bending the test specimen through 90° alternately to each side of its initial position, following the method of bending defined by EN ISO 7799. The radius of bending chosen shall be 5 mm.

A bend of 90° from the initial position with return to the initial position counts as one bend.

The test shall be stopped on the appearance in the base metal of the first crack visible to the naked eye. The last bend shall not be counted.

#### 9.4.6 Retests

When a test does not give the specified result, the test shall be repeated on double the number of test specimens from other lengths of strip of the acceptance unit. If all these additional tests give satisfactory results, the delivery shall be considered to conform with the order.

After re-treatment, the producer has the right to present again for test acceptance units which had not been found to comply with the order.

## 10 Marking, labelling and packaging

Marking, labelling and packaging of the products may be agreed at the time of ordering.

## 11 Complaints

Internal or external defects shall justify a complaint only if they are clearly prejudicial to the method of working or the judicious use of the material.

The user shall give to the manufacturer the opportunity of convincing himself of the fairness of the claim by representing the material in dispute and evidence for the complaint.

In all cases, the terms and conditions of complaints shall be made in accordance with EN 10021.

# Annex A
(informative)

# Minimum stacking factor for non-oriented coated products

It is common to use the cold-rolled non-oriented electrical steels in the fully processed state, described in this standard, in stacked assemblies for electrical machine construction. In order to minimize the machine loss, it is appropriate to apply an insulating coating to these electrical steels (see EN 10342). The presence of such a coating alters the stacking factor data given in Table 1. The measurement of the stacking factor described in EN 60404-13 will lead to a lower value in presence of a coating. Table A.1 describes the stacking factor values for common electrical steel coating thicknesses (when measured according to EN ISO 2178). For thicker coatings or specific coating conditions such as single sided application, other values and coating thickness measuring methods may be agreed between the manufacturer and purchaser. For the specific case of bonding varnishes, Table A.1 is not valid.

**Table A.1 — Minimum stacking factor for non-oriented coated products**

| **Coating thickness**[a] | **Nominal thickness** [mm] | **Minimum stacking factor** |
|---|---|---|
| ≤ 2µm | 0,05 | – |
| | 0,10 | 0,90 |
| | 0,15 | 0,91 |
| | 0,20 | 0,92 |
| | 0,25 | 0,93 |
| | 0,30 | 0,93 |
| > 2µm ≤ 4µm | 0,05 | – |
| | 0,10 | 0,89 |
| | 0,15 | 0,90 |
| | 0,20 | 0,91 |
| | 0,25 | 0,92 |
| | 0,30 | 0,92 |
| > 4µm ≤ 8µm | 0,05 | – |
| | 0,10 | 0,88 |
| | 0,15 | 0,89 |
| | 0,20 | 0,90 |
| | 0,25 | 0,91 |
| | 0,30 | 0,91 |

[a] This table gives the coating thickness on each side of the electrical steel strip and sheet.

# Annex B
(informative)

# Maximum specific total loss at 1,0T and 700 Hz and at 1,5T and 400Hz for non-oriented products

The values for the maximum specific total loss of non-oriented products at 1,0T and 700Hz and at 1,5T and 400 Hz shall be in accordance with Table B.1.

**Table B.1 — Maximum specific total loss of non-oriented products at 1,0T and 700Hz and at 1,5T and 400Hz**

| **Designation**[a] | **Nominal thickness** [mm] | **Maximum specific total loss** [W/kg] at | | | |
|---|---|---|---|---|---|
| | | **1,0 T** | **Frequency** [Hz] | **1,5 T** | **Frequency** [Hz] |
| NO 20–13 | 0,20 | 29 | 700 | 35 | 400 |
| NO 20–15 | | 32 | 700 | 38 | 400 |
| NO 25–14 | 0,25 | 34 | 700 | 38 | 400 |
| NO 25–17 | | 40 | 700 | 42 | 400 |
| NO 27–15 | 0,27 | 37 | 700 | 41 | 400 |
| NO 27–18 | | 41 | 700 | 43 | 400 |
| NO 30–16 | 0,30 | 41 | 700 | 43 | 400 |
| NO 30–19 | | 45 | 700 | 47 | 400 |
| NO 35–19 | 0,35 | 48 | 700 | 50 | 400 |
| NO 35–22 | | 54 | 700 | 55 | 400 |

[a] Designation of steel grades in accordance with Table 2.

# Annex C
(informative)

# Density determination

The following formula, which is in accordance with ASTM A 34/A 34M-01, may be used to determine the density values on agreement at the time of enquiry and order (see Table 2, Footnote [c]):

$$\rho = \left[ 7,865 - 0,065\left( c_{Si} + 1,7 c_{Al} \right) \right] \quad \text{(C.1)}$$

where

$\rho$ is the numerical value of the density, in kg/dm$^3$;

$C_{Si}$ is the numerical value of the silicon content, in % by mass;

$C_{Al}$ is the numerical value of the aluminium content, in % by mass.

# Annex D
(informative)

# Mechanical properties for non-oriented products

The values for the minimum 0,2 % proof strength, tensile strength and elongation shall be in accordance with Table D.1. The tensile test values apply to longitudinal test pieces.

**Table D.1 — Minimum tensile test values for non-oriented products**

| **Designation**[a] | **Nominal thickness [mm]** | **min. Proof strength $R_{p0,2}$ MPa** | **min. Tensile strength $R_m$ MPa** | **min. Elongation $A_{80}$ %** |
|---|---|---|---|---|
| NO 20–13 | 0,20 | 390 | 470 | 10 |
| NO 20–15 | | 320 | 430 | 13 |
| NO 25–14 | 0,25 | 390 | 470 | 12 |
| NO 25–17 | | 320 | 430 | 13 |
| NO 27–15 | 0,27 | 370 | 450 | 12 |
| NO 27–18 | | 320 | 430 | 13 |
| NO 30–16 | 0,30 | 370 | 450 | 12 |
| NO 30–19 | | 320 | 430 | 13 |
| NO 35–19 | 0,35 | 370 | 450 | 12 |
| NO 35–22 | | 320 | 430 | 13 |

[a] Designation of steel grades in accordance with Table 2.

# Annex E
(informative)

# Changes to the previous version EN 10303:2001

The mainly changes to the previous version EN 10303:2001 are listed below:

1) Scope of the standard extended with thicknesses of 0,18 mm for grain-oriented products and 0,25 mm; 0,27 mm, 0,30 mm and 0,35 mm for non-oriented products;

2) corresponding tables have been updated with new data;

3) normative references revised;

4) definitions aligned to EN 10106 and EN 10107;

5) requirements on surface condition revised and aligned to EN 10106 (see 7.4);

6) Tables 1 and 2 concerning magnetic and technological characteristic have been generally revised and aligned to the actual market requirements;

7) new Subclause 6.1 concerning ordering information;

8) Subclauses 7.2 and 7.3 concerning delivery conditions updated;

9) requirements on thickness tolerances split in statements on grain-oriented / non-oriented products;

10) requirements on width tolerances revised (see 8.3.3);

11) Table 6 in 9.3.1 concerning preparation of test pieces for testing of magnetic properties deleted;

12) statements in 9.3.1 generally revised;

13) new Annexes A, B, C and D inserted in the standard;

14) editorial changes.

# Bibliography

[1] EN 10106, *Cold rolled non-oriented electrical steel sheet and strip delivered in the fully processed state*

[2] EN 10107, *Grain-oriented electrical steel strip and sheet delivered in the fully processed state*

[3] EN 10252, *Magnetic materials — Methods of measurement of magnetic properties of magnetic steel sheet and strip at medium frequencies*

[4] EN 10342, *Magnetic materials — Classification of surface insulations of electrical steel sheet, strip and laminations*

[5] EN ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method (ISO 2178)*

[6] ASTM A 34/A 34M-01, *Standard Practice For Sampling And Procurement Testing Of Magnetic Materials*

*This page deliberately left blank*

*This page deliberately left blank*

# British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

## About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

## Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

## Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

## Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

**PLUS** is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

**BSI Group Headquarters**

389 Chiswick High Road London W4 4AL UK

## Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

## Copyright



## Useful Contacts:

**Customer Services**
**Tel:** +44 845 086 9001
**Email (orders):** orders@bsigroup.com
**Email (enquiries):** cservices@bsigroup.com

**Subscriptions**
**Tel:** +44 845 086 9001
**Email:** subscriptions@bsigroup.com

**Knowledge Centre**
**Tel:** +44 20 8996 7004
**Email:** knowledgecentre@bsigroup.com

**Copyright & Licensing**
**Tel:** +44 20 8996 7070
**Email:** copyright@bsigroup.com

bsi.

...making excellence a habit.™