BS EN 10106:2015

BSI Standards Publication

Cold rolled non-oriented electrical steel strip and sheet delivered in the fully processed state

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National foreword

This British Standard is the UK implementation of EN 10106:2015. It supersedes BS EN 10106:2007 which is withdrawn.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.

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EUROPEAN STANDARD

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EN 10106

October 2015

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Supersedes EN 10106:2007

English Version

Cold rolled non-oriented electrical steel strip and sheet delivered in the fully processed state

Bandes et tôles en acier électrique à grains non orientés laminées à froid et livrées à l'état fini

Kaltgewalztes nicht kornorientiertes Elektroband und -blech im schlussgeglühten Zustand

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

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

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

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European foreword

This document (EN 10106:2015) 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of an identical text or by endorsement, at the latest by April 2016, and conflicting national standards shall be withdrawn at the latest by April 2016.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 10106:2007.

Regarding the changes that were made in this new edition of EN 10106, 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 specifies cold-rolled non-oriented electrical steel strip and sheet in nominal thicknesses of 0,35 mm, 0,50 mm, 0,65 mm and 1,00 mm. In particular, it specifies general requirements, the magnetic properties, geometric characteristics and tolerances, technological characteristics as well as the inspection procedure.

This European Standard applies to materials supplied in the fully annealed condition intended for the construction of magnetic circuits. It does not apply to semi-processed material.

These magnetic materials correspond to IEC 60404-1:2000, C.2.3.2.1.

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 10027-1, *Designation systems for steels — Part 1: Steel names*

EN 10027-2, *Designation systems for steels — Part 2: Numerical system*

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 10280, *Magnetic materials — Methods of measurement of the magnetic properties of electrical sheet and strip by means of a single sheet tester*

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

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 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*

3 Terms and definitions

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

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

3.2
flatness
property of a sheet or 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

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 indicating the ductility of the material

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

4 Classification and designation

4.1 Classification

The grades covered by this European Standard are classified according to the value of the maximum specific total loss in watts per kilogram and according to the nominal thickness of the material (0,35 mm, 0,50 mm, 0,65 mm and 1,00 mm).

4.2 Designation

For the steel grades covered by this European Standard, the steel names are allocated in accordance with EN 10027-1. The steel numbers are allocated in accordance with EN 10027-2.

The steel name comprises the following in the order given:

a) capital letter M for electrical steel;

b) number of one hundred times the specified value of maximum specific total loss at 50 Hz, in watts per kilogram and corresponding to the nominal product thickness, at 1,5 T;

c) one hundred times the nominal thickness of the material, in millimetres;

d) characteristic letter A for non-oriented electrical sheet or strip supplied in the fully processed state.

EXAMPLE Non-oriented electrical steel sheet or strip with a maximum specific total loss at 1,5 T of 2,50 W/kg at 50 Hz, a nominal thickness of 0,35 mm, supplied in the fully processed state: M250–35A.

5 Information supplied by the purchaser

5.1 Mandatory information

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

a) quantity;

b) type of product (strip or sheet);

c) number of this European Standard (EN 10106);

d) steel name or number (see 4.2);

e) dimensions of sheets or strips required (including any limitation on the external diameter of a coil) (see 6.2 and 7.2.2);

f) axis of coil (horizontal or vertical) (see 6.2);

g) internal diameter of coil (508 mm or 610 mm) (see 6.2);

h) limitation on the mass of a bundle of sheets or of a coil or limitation of external diameter (see 6.2);

i) limitation of the mass of the packing unit (see 6.2);

j) type of inspection procedure, and – for specific inspection – type of the related document (see 8.1).

5.2 Options

A number of options are specified in this standard and listed in Annex A. 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 5.1).

5.3 Example of an order

18 t strip with 0,35 mm thickness in accordance with EN 10106, made of steel grade M270-35A, delivered in coils with a width of 1 000 mm and a maximum mass of 3 500 kg, vertical coil axis (v), with specific inspection, inspection report 3.1 in accordance with EN 10204:

18 t – strip – EN 10106 — M270-35A – 1000 mm – max. 3500 kg – v – 3.1

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

For sheets the material is supplied in bundles and for strip the material is supplied in coils.

The mass of bundles of sheets or the mass and/or the external diameter of coils shall be agreed at the time of enquiry and order.

The mass of the package unit shall be agreed at the time of enquiry and order.

The recommended value for the internal diameter of coils is 508 mm or 610 mm.

The direction of coils, horizontal (h) or vertical (v), shall be agreed at the time of enquiry and order.

Sheets that 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 way that the edges are superimposed in a regular manner and that the side faces of the coil are substantially flat. Coils shall be sufficiently tightly wound so that they do not collapse under their own weight.

Strip may exhibit welds resulting from removing defective zones if agreed at the time of enquiry and order. If necessary the marking of welds may be agreed at the time of enquiry and order. For coils containing welds, 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 further processing of the material.

6.3 Delivery condition

The material may be supplied either without insulation or with insulation on one or both sides in accordance with EN 10342. lf the material is supplied with insulation, the nature of the insulation, its thickness and properties, the stacking factor and their verification shall be agreed at the time of enquiry and order (see Annex A, Option 2) and in accordance with the values stated in Table D.1.

6.4 Surface condition

The surfaces shall be smooth and clean, 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.

When an insulation coating is present on the surface of the material, it shall be sufficiently adherent so that the coating does not become detached during cutting operations. During the alternating bend test (see 8.4.4.2), the coating shall not be detached after a bend of 90°. If the coating becomes detached during the test, the piece from which the sample was taken shall be subjected to a shearing test. During this test, it shall not be admissible for large pieces of the coating to become detached; however, slight chipping of this coating at the shearing edges shall be tolerated.

6.5 Suitability for cutting

The material shall be able to be cut or punched at any point and in the usual shapes, thus ensuring accurate working with the correct cutting tools.

7 Technical requirements

7.1 Magnetic properties

7.1.1 General

The properties defined in 7.1.2 to 7.1.4 are applicable to products in the delivery conditions defined in 6.3.

For coated products, the mass of the insulation coating should be taken into account.

7.1.2 Magnetic polarization

The minimum specified values of peak magnetic polarization and for peak magnetic field strengths H of 2 500 A/m, 5 000 A/m and 10 000 A/m at 50 Hz shall be as given in Table 1.

1) Not to be confused with some colouration of the insulating coating inherent in the manufacturing process.

7.1.3 Specific total loss

The specified values of maximum specific total loss shall be as given in Table 1. They reflect the aged condition (see 8.3.1).

In certain cases, the specified value of maximum specific total loss can be made the subject of agreement for longitudinal test pieces only or for transverse test pieces only.

The values of the specific total loss are specified for a magnetic polarization of 1,5 T. The test shall be made in an alternating magnetic field at 50 Hz.

Annex B gives, for guidance only, the maximum specific total loss for a magnetic polarization of 1,0 T at 50 Hz and for a magnetic polarization of 1,5 T at 60 Hz.

7.1.4 Anisotropy of loss

This is specified at a polarization of 1,5 T. The maximum permitted values shall be as specified in Table 1.

Table 1 — Technological and magnetic properties

Steel grade		Nominal thickness	Maximum specific total loss at 50 Hz and at 1,5 T	Minimum magnetic polarization[a] *T* in an alternating magnetic field strength (A/m)			Maximum anisotropy of loss at 50 Hz and 1,5 T	Minimum stacking factor[b]	Minimum number of bends	Conventional density[c]
Steel name	Steel number	mm	W/kg	2 500	5 000	10 000	%			kg/dm³
M210–35A	1.0802	0,35	2,10	1,49	1,60	1,70	±17	0,95	2	7,60
M235–35A	1.0890		2,35	1,49	1,60	1,70	±17		2	7,60
M250–35A	1.0800		2,50	1,49	1,60	1,70	±17		2	7,60
M270–35A	1.0801		2,70	1,49	1,60	1,70	±17		2	7,65
M300–35A	1.0803		3,00	1,49	1,60	1,70	±17		3	7,65
M330–35A	1.0804		3,30	1,49	1,60	1,70	±17		3	7,65
M230–50A	1.0837	0,50	2,30	1,49	1,60	1,70	±17	0,96	2	7,60
M250–50A	1.0891		2,50	1,49	1,60	1,70	±17		2	7,60
M270–50A	1.0806		2,70	1,49	1,60	1,70	±17		2	7,60
M290–50A	1.0807		2,90	1,49	1,60	1,70	±17		2	7,60
M310–50A	1.0808		3,10	1,49	1,60	1,70	±14		3	7,65
M330–50A	1.0809		3,30	1,49	1,60	1,70	±14		3	7,65
M350–50A	1.0810		3,50	1,50	1,60	1,70	±12		5	7,65
M400–50A	1.0811		4,00	1,53	1,63	1,73	±12		5	7,70
M470–50A	1.0812		4,70	1,54	1,64	1,74	±10		10	7,70
M530–50A	1.0813		5,30	1,56	1,65	1,75	±10		10	7,70
M600–50A	1.0814		6,00	1,57	1,66	1,76	±10		10	7,75
M700–50A	1.0815		7,00	1,60	1,69	1,77	±10		10	7,80
M800–50A	1.0816		8,00	1,60	1,70	1,78	±10		10	7,80

Steel grade		Nominal thick-ness	Maximum specific total loss at 50 Hz and at 1,5 T	Minimum magnetic polarization[a] *T* in an alternating magnetic field strength (A/m)			Maximum anisotropy of loss at 50 Hz and 1,5 T	Minimum stacking factor[b]	Mini-mum number of bends	Conven-tional density[c]
Steel name	Steel number	mm	W/kg	2 500	5 000	10 000	%			kg/dm³
M940–50A	1.0817		9,40	1,62	1,72	1,81	±8		10	7,85
M310–65A	1.0892	0,65	3,10	1,49	1,60	1,70	±15	0,97	2	7,60
M330–65A	1.0819		3,30	1,49	1,60	1,70	±15		2	7,60
M350–65A	1.0820		3,50	1,49	1,60	1,70	±14		2	7,60
M400–65A	1.0821		4,00	1,52	1,62	1,72	±14		2	7,65
M470–65A	1.0823		4,70	1,53	1,63	1,73	±12		5	7,65
M530–65A	1.0824		5,30	1,54	1,64	1,74	±12		5	7,70
M600–65A	1.0825		6,00	1,56	1,66	1,76	±10		10	7,75
M700–65A	1.0826		7,00	1,57	1,67	1,76	±10		10	7,75
M800–65A	1.0827		8,00	1,60	1,70	1,78	±10		10	7,80
M1000–65A	1.0829		10,00	1,61	1,71	1,80	±10		10	7,80
M600–100A	1.0893	1,00	6,00	1,53	1,63	1,72	±10	0,98	2	7,60
M700–100A	1.0894		7,00	1,54	1,64	1,73	±6		3	7,65
M800–100A	1.0895		8,00	1,56	1,66	1,75	±6		5	7,70
M1000–100A	1.0896		10,00	1,58	1,68	1,76	±6		10	7,80
M1300–100A	1.0897		13,00	1,60	1,70	1,78	±6		10	7,80

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 which is defined as:

$J = B - \mu_0 H$

where

J peak magnetic polarization;

B magnetic flux density;

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

H magnetic field strength in accordance with IEC 60050–121.

NOTE The difference between B and J at 5 000 A/m is equal to 0,006 T.

b The stated values are valid only for uncoated products. For coated products the values stated in Annex D, Table D.1 apply.

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

7.2 Geometric characteristics and tolerances

7.2.1 Thickness

The nominal thicknesses of the material are 0,35 mm, 0,50 mm, 0,65 mm and 1,00 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 be ± 8 % of the nominal value for the thickness 0,35 mm and 0,50 mm, and ± 6 % of the nominal value for the thicknesses 0,65 mm and 1,00 mm. The additional thickness due to welds, with respect to the measured thickness of the steel sheet or strip 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 8 % for nominal thicknesses 0,35 mm and 0,50 mm, and 6 % for nominal thicknesses 0,65 mm and 1,00 mm.

The difference in thickness in a direction perpendicular to the direction of rolling shall not exceed 0,020 mm for thicknesses of 0,35 mm and 0,50 mm, and 0,030 mm for the thicknesses of 0,65 mm and 1,00 mm,

For measurements see 8.4.3.1.

7.2.2 Width

For the width tolerances a distinction is made between material supplied with edges in the as-rolled condition and material delivered with trimmed edges.

For material supplied with trimmed edges, the tolerances in Table 2 apply.

Table 2 — Tolerances for material supplied with trimmed edges

Nominal width *l* mm	**Tolerance[a, b] mm**
$l \leq 150$	+ 0,2 0
$150 < l \leq 300$	+ 0,3 0
$300 < l \leq 600$	+ 0,5 0
$600 < l \leq 1\,000$	+ 1,0 0
$1\,000 < l \leq 1\,250$	+ 1,5 0

[a] If so agreed at the time of enquiry and order, the unilateral tolerance on the nominal width shall be minus values.

[b] For nominal widths greater as 1 250 mm the tolerances shall be agreed at time of enquiry and order.

For materials supplied with as-rolled edges, the tolerances on nominal width should be the subject of agreement at the time of enquiry and order.

7.2.3 Length

The tolerance on length for sheets in relation to length ordered shall be $+\begin{matrix}0,5\\0\end{matrix}$ %, but with a maximum of + 6 mm.

7.2.4 Edge camber

The verification of edge camber applies only to material supplied with trimmed edges and with a width greater than 30 mm.

The edge camber shall for a measuring length of 1 m, not exceed:

— 0,5 mm for a nominal width l > 150 mm;

— 1,0 mm for a nominal width 30 mm < l ≤ 150 mm.

7.2.5 Flatness (wave factor)

The verification of flatness does not apply to material with a width less than or equal to 100 mm. The wave factor (see 8.4.3.4), expressed as a percentage, shall not exceed 2.

7.2.6 Residual curvature

The verification of residual curvature does not apply to material of a width less than or equal to 100 mm.

A requirement concerning residual curvature may be specified by agreement at the time of enquiry and order. In this case, the distance between the bottom edge of the test specimen and the supporting plate shall not exceed 35 mm for the products with thicknesses 0,35 mm, 0,50 mm and 0,65 mm. For the thickness 1,00 mm this distance shall be subject to an agreement at the time of enquiry and order.

7.3 Technological characteristics

7.3.1 Density

The density of the material is not specified.

The conventional values of density used to calculate the magnetic properties and the stacking factor shall be as given in Table 1 (but see Footnote [c] in Table 1).

7.3.2 Stacking factor

The minimum values shall be as specified in Table 1 and only apply to non-insulated material.

7.3.3 Number of bends

The minimum number of bends shall be as specified in Table 1. The values apply to test specimens cut perpendicular to the direction of rolling.

7.3.4 Internal stresses

The material shall be free, as far as possible, of internal stresses.

The verification of internal stresses does not apply to materials of a width less than or equal to 150 mm. The measured gap shall not exceed 2 mm (see 8.3.3.3.).

8 Inspection and testing

8.1 General

The material 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, for orders without inspection, the manufacturer shall supply a certificate giving the specific total loss of the supplied material.

For an order with specific inspection, the type of inspection document in accordance with EN 10204 shall be specified at the time of enquiry and order. In this case, the delivery shall be divided into acceptance units.

Each acceptance unit shall comprise of 20 t or the remaining fraction thereof of the same grade and the same nominal thickness. Different acceptance units may be agreed at the time of enquiry and order.

For coils of more than 20 t, each coil shall constitute an acceptance unit.

Unless otherwise agreed at the time of enquiry and order, the same rules apply to the inspection of internal stress, adherence of surface insulation and tolerances of shape and dimensions.

8.2 Selection of samples

Test samples shall be taken from each acceptance unit.

The first internal turn and the last external turn of the coil shall be considered as wrapping and not representative of the quality of the remainder of the coil; the selection shall be made from the first external turn excluding the wrapping turn and outside any welding zones.

In the case of sheets, the selection shall preferably be made from the upper part of the bundle.

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

8.3 Preparation of test specimens

8.3.1 Magnetic properties

For measuring magnetic polarization and specific total loss, the test specimen for the 25 cm Epstein frame shall consist of a minimum of 16 Epstein strips with the following dimensions:

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

— width (30 ± 0,2) mm.

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. The test strips shall be carefully cut without deformation. Punching shall be made only with well sharpened tools. The maximum tolerance between the direction of cutting in relation to the specified direction shall be ± 5°.

For measuring specific total loss on aged test pieces, these shall be heated at (225 ± 5) °C for 24 h and shall be cooled to ambient temperature before testing.

No further heat treatments such as stress relief annealing of the test specimen are allowed.

8.3.2 Geometrical characteristics and tolerances

For the measurement of thickness, width, edge camber and flatness, the test specimen shall consist of a sheet or a length of strip of about 1 m.

For the measurement of residual curvature, the test specimen shall consist of a sample of $\begin{pmatrix} 500 \begin{smallmatrix} +2,5 \\ 0 \end{smallmatrix} \end{pmatrix}$ mm in length and of width equal to the delivery width of the sheet or strip.

8.3.3 Technological characteristics

8.3.3.1 Stacking factor

The test specimen shall consist of at least 16 strips of the same size; but in case of a dispute, the test shall be made with 100 strips. They shall have a width of at least 20 mm and a surface area of at least 5 000 mm^2, their widths being equal within a tolerance of ± 0,1 mm as well as their lengths. The test strips shall be carefully deburred before the test.

8.3.3.2 Number of bends

Two test specimens at least 20 mm wide shall be cut perpendicular to the direction of rolling of the sheet, at a distance of at least 40 mm from the edge and from the middle, and outside any welding 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 1 also apply.

The test specimens shall be carefully cut, without deformation.

8.3.3.3 Internal stresses

The test specimen shall consist of a sheet or a length of strip of 1 m. The sample width shall be identical with the delivery width.

8.4 Test methods

8.4.1 General

For each specified property one test shall be carried out per acceptance unit. The tests shall be carried out at (23 ± 5) °C.

8.4.2 Magnetic properties

8.4.2.1 Magnetic polarization and specific total loss

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

As an alternative to the Epstein Method, the single sheet tester specified in EN 10280 may be used by agreement at the time of enquiry and order. In this case, the specified values obtained with the single sheet tester may also be subject to agreement.

8.4.2.2 Anisotropy of loss

The loss in watts per kilogram shall be measured separately and 16 Epstein test strips taken parallel and 16 Epstein test strips taken perpendicular to the direction of rolling.

The anisotropy of the loss *T*, (in percent) is calculated according to the following formula:

$$T = \frac{P_{90} - P_0}{P_{90} + P_0} 100 \quad (1)$$

where

P_{90} is the loss at 1,5 T, in watts per kilogram, perpendicular to the direction of rolling;

P_0 is the loss at 1,5 T, in watts per kilogram, parallel to the direction of rolling.

8.4.3 Geometrical characteristics and tolerances

8.4.3.1 Thickness

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 micrometer with a resolution of 0,001 mm.

8.4.3.2 Width

Width shall be measured perpendicular to the longitudinal axis of the product.

8.4.3.3 Edge camber

Edge camber shall be determined in accordance with EN 10251.

8.4.3.4 Flatness (wave factor)

Wave factor shall be determined in accordance with EN 10251.

8.4.3.5 Residual curvature

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

8.4.4 Technological characteristics

8.4.4.1 Stacking factor

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

8.4.4.2 Number of bends

The test consists of 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 then returned to the initial position counts as one bend.

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

8.4.4.3 Internal stresses

The internal stresses shall be determined in accordance with EN 10251.

8.5 Retests

When a test does not give the specified result, this test shall be repeated with double the number of test specimens from other sheets or strips from the same acceptance unit. The delivery shall be considered to conform to the order if all results of additional tests are in accordance with the requirements of this standard.

After re-treatment, the manufacturer has the right to again present for test the acceptance units that were not found to comply with the order.

9 Marking, labelling and packaging

Product marking, labelling and packaging may be agreed at the time of enquiry and order.

10 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 purchaser shall give to the supplier the opportunity to convince him/herself of the fairness of the claim by presenting 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
(normative)

Options

The following options may be agreed at the time of enquiry and order:

1) permissibility of welds and its marking (see 6.2);
2) material supply with insulation (see 6.3);
3) specific total loss only applicable for longitudinal or transverse test pieces (see 7.1.3);
4) density determination in accordance with Annex C (see Table 1, Footnote [c] and Annex C);
5) thickness tolerance perpendicular to the rolling direction for narrow strip (see 7.2.1);
6) minus tolerances for nominal width (see Table 2, Footnote [a]);
7) tolerances on nominal width for as-rolled edges (see 7.2.2);
8) requirement concerning residual curvature (see 7.2.6);
9) type of inspection and (for specific inspection) type of inspection document and/or deviating acceptance unit (see 8.1);
10) alternative method for determination of magnetic properties (see 8.4.2.1);
11) marking of the products (see Clause 9).

NOTE If agreed, the options are mandatory requirements (see 5.2).

Annex B
(informative)

Non-specified magnetic properties

Table B.1 — Specific total loss for conditions deviating from Table 1

Steel grade		Maximum specific total loss [W/kg]	
Steel name	Steel number	1,0 T at 50 Hz	1,5 T at 60 Hz
M210–35A	1.0802	0,90	2,65
M235–35A	1.0890	0,95	2,97
M250–35A	1.0800	1,00	3,14
M270–35A	1.0801	1,10	3,36
M300–35A	1.0803	1,20	3,74
M330–35A	1.0804	1,30	4,12
M230–50A	1.0837	1,00	2,95
M250–50A	1.0891	1,05	3,21
M270–50A	1.0806	1,10	3,47
M290–50A	1.0807	1,15	3,71
M310–50A	1.0808	1,25	3,95
M330–50A	1.0809	1,35	4,20
M350–50A	1.0810	1,50	4,45
M400–50A	1.0811	1,70	5,10
M470–50A	1.0812	2,00	5,90
M530–50A	1.0813	2,30	6,66
M600–50A	1.0814	2,60	7,53
M700–50A	1.0815	3,00	8,79
M800–50A	1.0816	3,60	10,06
M940–50A	1.0817	4,20	11,84
M310–65A	1.0892	1,25	4,08
M330–65A	1.0819	1,35	4,30
M350–65A	1.0820	1,50	4,57
M400–65A	1.0821	1,70	5,20
M470–65A	1.0823	2,00	6,13
M530–65A	1.0824	2,30	6,84
M600–65A	1.0825	2,60	7,71
M700–65A	1.0826	3,00	8,98
M800–65A	1.0827	3,60	10,26
M1000–65A	1.0829	4,40	12,77
M600–100A	1.0893	2,60	8,14
M700–100A	1.0894	3,00	9,38
M800–100A	1.0895	3,60	10,70
M1000–100A	1.0896	4,40	13,39
M1300–100A	1.0897	5,80	17,34

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 1, Footnote [c]):

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

where

ρ 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)

Minimum stacking factor for 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 D.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 D.1 is not valid.

Table D.1 — Minimum stacking factor for coated products according to coating thicknesses

Coating thickness[a]	Product thickness (uncoated)	Minimum stacking factor
≤ 2µm	0,35 mm	0,94
	0,50 mm	0,95
	0,65 mm	0,96
	1,00 mm	0,97
> 2µm ≤ 4µm	0,35 mm	0,93
	0,50 mm	0,94
	0,65 mm	0,95
	1,00 mm	0,96
> 4µm ≤ 8µm	0,35 mm	0,91
	0,50 mm	0,92
	0,65 mm	0,93
	1,00 mm	0,94

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

Annex E
(informative)

Changes to the previous version EN 10106:2007

The mainly changes to the previous version EN 10106:2007 are listed below:

1) normative references revised;
2) definitions aligned with EN 10107 and EN 10303;
3) new steel grades M210-35A and M230-50A and the corresponding data added in the standard;
4) statements on thickness/width tolerances and the measurements revised (see 7.2.1, 7.2.2 and 8.4.3.1);
5) supplementary requirement concerning the heat treatment of test pieces (see 8.3.1);
6) upper limit of test strips for Epstein frame extended to 320 mm and aligned with EN 60404-2;
7) requirements on test pieces aligned to 1 m (see 8.3.2 and 8.3.3.3);
8) new regulations concerning the width of the test pieces (see 8.3.3.3);
9) Table B.1 with data of the new steel grades updated;
10) new informative Annex D concerning the stacking factor for coated products added in the standard;
11) editorial changes.

Bibliography

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

[2] IEC 60404-1:2000, *Magnetic materials — Part 1: Classification*

[3] ASTM A 34/A 34M-01, *Standard practice for sampling and procurement testing of magnetic materials*

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