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Ultra-low carbon high boron steel wire rod for copper cladded wire

Fil machine en acier à haute teneur en bore et à très faible teneur en carbone pour les fils gainés de cuivre

Reference number
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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ultra-low carbon high boron steel wire rod for copper cladded wire

1 Scope

This document specifies requirements for ultra-low carbon high boron steel wire rod for copper cladded wire, mainly used in telecommunication cable (hereinafter referred to as wire rods). This document applies to wire rods with circular cross-sections and diameters of 5 mm to 20 mm.

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.

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

ISO 404:2013, *Steel and steel products — General technical delivery requirements*

ISO 4885, *Ferrous materials — Heat treatments — Vocabulary*

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

ISO 6929, *Steel products — Vocabulary*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ISO 16120-1, *Non-alloy steel wire rod for conversion to wire — Part 1: General requirements*

ISO 16120-4:2017, *Non-alloy steel wire rod for conversion to wire — Part 4: Specific requirements for wire rod for special applications*

ISO 16124, *Steel wire rod — Dimensions and tolerances*

IEC 60468, *Method of measurement of resistivity of metallic materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 377, ISO 404, ISO 4885, ISO 6929 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
copper cladded wire
wire which consists of a steel core with a continuous cladding of copper thoroughly bonded to the core throughout

3.2
out-of-roundness
difference between the maximum and minimum diameter measured at the same cross-section of a wire rod

4 Designation

CH#B is the special designation for hot rolled wire rod of ultra-low carbon high boron steel.

In the designation CH#B, C stands for carbon; H stands for high; # is specified maximum C content × 10 000; B stands for boron.

EXAMPLE Designation of ultra-low carbon high boron steel wire rod with specified maximum C content 0,01 %:CH1B.

5 Ordering information

The following information shall be supplied by the purchaser at the time of enquiry and order:

a) quantity to be delivered;

b) nominal dimensions and tolerance class;

c) the number of this standard;

d) steel grade, including any permitted additions/variations;

e) delivery condition;

f) special requirements, if any.

6 Production process

Steel shall be made by basic oxygen furnace or electric-arc furnace and refining.

Unless otherwise agreed at the time of order, the steelmaking process is left to the discretion of the supplier.

7 Requirements

7.1 Dimensions and tolerances

The tolerances on diameters and out-of-roundness of the wire rod shall comply with the requirements in Table 1. Four levels of tolerance are standardized: T1, T2, T3 and T4 in accordance with ISO 16124.

Table 1 — Tolerances on diameter and out-of-roundness

Diameter, *d* mm	**Tolerances on diameter**[b] mm				**out-of-roundness**, ≤ mm			
	T1[a]	**T2**	**T3**	**T4**	**T1**	**T2**	**T3**	**T4**
5,00 ≤ *d* ≤ 10,00	±0,30	±0,25	±0,20	±0,15	0,48	0,40	0,32	0,24
10,00 < *d* ≤ 15,00	±0,40	±0,30	±0,25	±0,20	0,64	0,48	0,40	0,32
15,00 < *d* ≤ 20,00	±0,50	±0,35	±0,30	±0,25	0,80	0,56	0,48	0,40

[a] For the size range 5,00 mm < d ≤ 10,00 mm, larger values for the tolerance can be agreed upon between the parties.

[b] For other strict class tolerances, tolerance can be agreed upon between the parties.

7.2 Chemical composition

The chemical composition (heat analysis) of the steel shall be in accordance with the requirements in Table 2.

Table 2 — Chemical composition (heat analysis)

Steel grade	Heat analysis							
	C %	Si %	Mn %	P %	S %	Al %	B %	N %
CH1B	≤0,01	≤0,01	≤0,10	≤0,008	≤0,005	≤0,005	0,012 to 0,015	≤0,003 0
CH3B	0,01 to 0,03	0,01 to 0,015	0,10 to 0,15	0,008 to 0,012	0,005 to 0,010	0,005 to 0,008	0,010 to 0,015	0,003 0 to 0,004 0
CH5B	0,03 to 0,05	0,015 to 0,02	0,15 to 0,20	0,012 to 0,016	0,010 to 0,015	0,008 to 0,012	0,008 to 0,010	0,004 0 to 0,005 0
CH6B	0,05 to 0,06	0,02 to 0,03	0,20 to 0,30	0,016 to 0,020	0,015 to 0,020	0,012 to 0,015	0,003 to 0,008	0,005 0 to 0,006 0

7.3 Delivery condition

The wire rod shall be supplied in hot-rolled or heat treated condition in coils of one continuous length.

7.4 Mechanical properties

The mechanical properties of the wire rod shall be in accordance with the requirements in Table 3.

Table 3 — Mechanical properties

Steel grade	Tensile strength R_m MPa	Elongation after break $A_{11.3}$ %
CH1B	≤320	≥40
CH3B	320 to 360	30 to 40
CH5B	360 to 400	25 to 30
CH6B	400 to 450	20 to 25

7.5 Internal soundness and surface quality

The wire rod shall have no internal or surface discontinuities, such as shrink holes, cracks, folds, incrustations, notches, scabs or rolling burrs, which can be detrimental to its subsequent processing.

7.6 Depth of surface discontinuities

The wire rod shall not have any surface discontinuities with depths greater than those shown in ISO 16120-4:2017, Table 3.

7.7 Non-metallic inclusion

If agreed at the time of enquiry and order, wire rods shall be inspected for non-metallic inclusions. The limit values of non-metallic inclusions shall be in accordance with ISO 16120-4.

7.8 Conductivity

The conductivity of the wire rod shall meet the requirements in Table 4.

Table 4 — Conductivity

Steel grade	Conductivity %
CH1B	17,5 to 19,0
CH3B	16,0 to 17,5
CH5B	14,0 to 16,0
CH6B	12,0 to 14,0

8 Inspection

8.1 Inspection and inspection documents

Inspection and inspection documents shall be in accordance with ISO 404 and ISO 10474.

8.2 Acceptance unit

Unless otherwise agreed, the acceptance unit is composed of wire rod of the same dimension and grade produced from same heat and same process in one continuous production operation.

8.3 Test methods

8.3.1 Diameter and out-of-roundness

The diameter shall be measured by using a micrometer or vernier caliper after both ends of the wire rod being removed.

8.3.2 Chemical composition

Where it has been agreed to verify the chemical composition of the product, sampling and preparation for heat analysis shall be performed in accordance with ISO 14284 and the available analytical methods for heat analysis are given in ISO/TR 9769. In case of dispute about analytical methods, the chemical composition shall be determined in accordance with a reference method.

8.3.3 Tensile strength

Samples shall be taken and prepared in accordance with ISO 377. The tensile test shall be carried out on wire rods in as-delivered condition in accordance with ISO 6892-1.

8.3.4 Surface discontinuities

The method to be used for revealing and measuring surface discontinuities shall be chosen by the supplier, as described in ISO 16120-1.

8.3.5 Non-metallic inclusion

The tests shall be carried out on the wire rod in the as-delivered condition and in accordance with ISO 16120-4.

8.3.6 Conductivity

One sample shall be taken from any two coils of each batch of wire rods. The test shall be carried out on wire rods in as-delivered condition. According to IEC 60468, the conductivity of the sample is calculated using Formula (1):

$$C_{\text{sample}}(\%\text{IACS}) = (0{,}017\ 241/\rho_{\text{sample}})\times 100 \quad (1)$$

where

C_{sample} is the conductivity of the wire rod sample;

0,017 241 is the resistivity of copper at standard temperature in $\Omega mm^2/m$ according to IEC 60028;

ρ_{sample} is the resistivity of the sample at standard temperature in $\Omega mm^2/m$, calculated from the following Formula (2) in accordance with IEC 60468:

$$\rho_{sample} = (A_{sample} \times R_{sample})/L_{sample} \quad (2)$$

where

A_{sample} is the area of sample at standard temperature in mm^2;

L_{sample} is the length of the sample at standard temperature in m;

R_{sample} is the resistance between the ends of the sample at standard temperature in Ω, shall be measured in accordance with IEC 60468.

9 Retest

Retests of wire rod and their criteria shall be as specified in ISO 404.

10 Marking

Each coil in each consignment shall be marked with the following information:

a) dimensions of the cross-section of the wire rod;

b) steel grade;

c) heat number;

d) the name and, if applicable, the symbol of the supplying mill;

e) conductivity;

f) any subsequently agreed information.

Unless otherwise agreed upon, the marking shall withstand pickling. The durability of the labels utilized for marking shall be agreed upon at the time of ordering.

11 Disputes

In case of dispute, the sampling conditions and test methods used to evaluate the dispute characteristics shall be those described in ISO 404:2013, 8.3.3 and 8.3.4.