

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Specifications for particular types of winding wires –
Part 0-7: General requirements – Fully insulated (FIW) zero-defect enamelled
round copper wire

Spécifications pour types particuliers de fils de bobinage –
Partie 0-7: Exigences générales – Fil de section circulaire, isolé en continu (FIW),
en cuivre émaillé, sans défaut d'isolation électrique



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INTERNATIONAL STANDARD

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**Specifications for particular types of winding wires –
Part 0-7: General requirements – Fully insulated (FIW) zero-defect enamelled round
copper wire**

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Partie 0-7: Exigences générales – Fil de section circulaire, isolé en continu (FIW),
en cuivre émaillé, sans défaut d'isolation électrique**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SPECIFICATIONS FOR PARTICULAR TYPES
OF WINDING WIRES –****Part 0-7: General requirements – Fully insulated (FIW)
zero-defect enamelled round copper wire**

FOREWORD

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International Standard IEC 60317-0-7 has been prepared by IEC technical committee 55: Winding wires.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

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

- a) reduction in the number of grades of FIW from 3 through 9 to 4, 6 and 8 only;
- b) reduction of the wire diameter range from (0,040 to 1,000) mm to (0,090 to 0,900) mm for several requirements;
- c) revision of Clause 5 to delete the Table 2 resistance requirements;

- d) revision of Clause 13 to clarify that breakdown is determined when a calculated minimum test voltage is reached, which can be less than 10 000 V;
- e) expansion of Annex A to include requirements for FIW 3, 5, 7 and 9 and for all grades, wire diameters below 0,090 mm and above 0,900 mm.

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

FDIS	Report on voting
55/1619/FDIS	55/1623/RVD

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 parts in the IEC 60317 series, published under the general title *Specifications for particular type of winding wires*, 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.

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INTRODUCTION

The IEC 60317 series is part of a group of International Standards which define insulated wires used for windings in electrical equipment:

- 1) IEC 60851 series, *Winding wires – Test methods*;
- 2) IEC 60317 series, *Specifications for particular types of winding wires*;
- 3) IEC 60264 series, *Packaging of winding wires*.

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SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

Part 0-7: General requirements – Fully insulated (FIW) zero-defect enamelled round copper wire

1 Scope

This part of IEC 60317 establishes general requirements for fully insulated (FIW) zero-defect enamelled round copper wires.

The nominal conductor diameter range is given in the relevant technical specification.

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 60172, *Test procedure for the determination of the temperature index of enamelled and tape wrapped winding wires*

IEC 60317-0-1:2013, *Specifications for particular types of winding wires – Part 0-1: General requirements – Enamelled round copper wire*

IEC 60851 (all parts), *Winding wires – Test methods*

IEC 60851-5:2008, *Winding wires – Test methods – Part 5: Electrical properties*
IEC 60851-5:2008/AMD1:2011

ISO 3, *Preferred numbers – Series of preferred numbers*

3 Terms, definitions, general notes and appearance

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1.1 class

thermal performance of a wire expressed by the temperature index and the heat shock temperature

3.1.2

coating

material that is deposited on a conductor or wire by suitable means and then dried and/or cured

3.1.3

conductor

bare metal after removal of the insulation

3.1.4

crack

opening in the insulation that exposes the conductor to view at the stated magnification

3.1.5

enamelled wire

wire coated with an insulation of cured resin

3.1.6

grade of FIW

range of overall diameter of a wire

3.1.7

increase

difference between measured overall outer diameter and measured conductor diameter

3.1.8

insulation

coating or covering on the conductor with the specific function of withstanding voltage

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3.1.9

nominal conductor dimension

designation of the conductor size in accordance with IEC 60317-0-1

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3.1.10

normal vision

20/20 vision, with corrective lenses if necessary

3.1.11

sole coating

insulation composed of one material

3.1.12

winding wire

wire used for winding a coil to provide a magnetic field

3.1.13

wire

conductor coated or covered with an insulation

3.1.14

zero-defect wire

winding wire that exhibits no electrical discontinuities when tested under specific conditions

3.2 General notes

3.2.1 Methods of test

All test methods used in this document shall be applied in accordance with the test methods of IEC 60851 (all parts).

The clause numbers used in this document are identical to the corresponding test numbers in the test methods of IEC 60851 (all parts).

In case of inconsistencies between the test methods standard and this document, this document shall prevail.

Where no specific range of nominal diameter is given for a test, the test method shall apply to all nominal dimensions covered by this document.

Unless otherwise agreed, all tests shall be carried out at a temperature between 15 °C and 40 °C, and at a relative humidity of 45 % to 75 %. Before each test, the specimen shall be preconditioned under these atmospheric conditions for a time sufficient to allow the specimens to reach a stable state. These requirements do not affect the online high voltage continuity test according to IEC 60851-5.

The wire to be tested shall be removed from the packaging in such a way that it is not subjected to elongation or unnecessary bending. Before each test, sufficient wire shall be discarded to ensure that no damaged wire is included in the test specimen.

3.2.2 Winding wire

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Where a wire type is referenced to Clause 2, the following information shall be provided:

- reference to the relevant standard;
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- nominal conductor diameter in mm;
- grade of FIW.

Example IEC 60317-56 – 0,500 grade of FIW 6.

3.3 Appearance

The wire coating shall be essentially smooth and uniform, and free from streaks, blisters and foreign material in accordance with good commercial practice when examined with normal vision, as wound on the original spool or reel.

When agreed upon between the user and supplier, examination using 6× to 10× magnification shall be used for wires with a nominal diameter less than 0,1 mm.

4 Dimensions

4.1 Conductor diameter

The series of preferred nominal conductor diameters shall correspond to series R 20 according to ISO 3. The actual values and their tolerances are given in Table 1.

The series of intermediate diameters from which the user may select intermediate nominal conductor diameters, when required for technical reasons, shall correspond to series R 40 according to ISO 3. The actual values and their tolerances are given in Table A.1.

The conductor diameter shall not differ from the nominal diameter by more than the tolerance given in Table 1.

4.2 Out of roundness of conductor (for nominal diameters over 0,090 mm up to 0,900 mm)

The difference between the minimum and maximum diameter shall not exceed the figures in column 2 of Table 1 at any point.

4.3 Minimum overall diameter

The minimum overall diameter of enamelled wires shall not be less than the values in Table 1.

4.4 Maximum overall diameter

The maximum overall diameter of enamelled wires shall not exceed the values in Table 1.

For intermediate nominal diameters, the minimum external diameter shall be calculated linearly to the next larger nominal diameter.

Table 1 – Dimensions of enamelled wires (R 20)

Nominal conductor diameter	Conductor tolerance	Minimum overall diameter			Maximum overall diameter		
		mm			mm		
mm	± mm	Grade of FIW 4	Grade of FIW 6	Grade of FIW 8	Grade of FIW 4	Grade of FIW 6	Grade of FIW 8
0,100	0,003	0,133	0,165	0,197	0,148	0,180	0,212
0,112	0,003	0,148	0,182	0,216	0,164	0,198	0,232
0,125	0,003	0,164	0,200	0,236	0,181	0,217	0,253
0,140	0,003	0,182	0,222	0,262	0,201	0,241	0,281
0,160	0,003	0,206	0,250	0,294	0,227	0,271	0,315
0,180	0,003	0,230	0,278	0,326	0,253	0,301	0,349
0,200	0,003	0,253	0,303	0,353	0,277	0,327	0,377
0,224	0,003	0,281	0,335	0,389	0,307	0,361	0,415
0,250	0,004	0,313	0,373	0,433	0,342	0,402	0,462
0,280	0,004	0,346	0,408	0,470	0,376	0,438	0,500
0,315	0,004	0,385	0,447	0,509	0,415	0,477	0,539
0,355	0,004	0,429	0,491	0,553	0,459	0,521	0,583
0,400	0,005	0,479	0,541	0,603	0,509	0,571	0,633
0,450	0,005	0,534	0,596	0,658	0,564	0,626	0,688
0,500	0,005	0,588	0,670		0,628	0,710	
0,560	0,006	0,654	0,736		0,694	0,776	
0,630	0,006	0,729	0,811		0,769	0,851	
0,710	0,007	0,815	0,897		0,855	0,937	
0,800	0,008	0,912	1,014		0,962	1,064	
0,900	0,009	1,019	1,121		1,069	1,171	

NOTE 1 Dimensions for additional R 20 series diameters are given in Annex A.

NOTE 2 Dimensions for grade FIW 3, 5, 7 and 9 are given in Annex A.

5 Electrical resistance

By agreement between purchaser and supplier, resistance measurements may be made for nominal conductor diameters over 0,090 mm up to and including 0,900 mm. In case of such agreement, the resistance at 20 °C shall be within the limits given in IEC 60317-0-1:2013, Annex C.

6 Elongation

The elongation at break shall not be less than the values in Table 2.

Table 2 – Elongation at break

Nominal conductor diameter	Minimum elongation at break	Nominal conductor diameter	Minimum elongation at break
mm	%	mm	%
0,100	16	0,315	23
0,112	17	0,355	23
0,125	17	0,400	24
0,140	18	0,450	25
0,160	19	0,500	25
0,180	20	0,560	26
0,200	21	0,630	27
0,224	21	0,710	28
0,250	22	0,800	28
0,280	22	0,900	29

7 Springiness

Wire shall not exceed the maximum springback given in Table 3, when tested on the mandrel using the specified tension.

For intermediate nominal conductor diameters, the springback value for the next larger nominal diameter shall apply.

Table 3 – Springiness

Nominal conductor diameter	Mandrel diameter	Tension	Maximum springback °				
			Grade of FIW 4	Grade of FIW 6	Grade of FIW 8		
mm	mm	N					
0,100	5,0	0,25	N/A	N/A	N/A		
0,112			N/A	N/A	N/A		
0,125			7,0	0,50	N/A	N/A	N/A
0,140					N/A	N/A	N/A
0,160					N/A	N/A	N/A
0,180	10,0	1,00	N/A	N/A	N/A		
0,200			N/A	N/A	N/A		
0,224			N/A	N/A	N/A		
0,250			12,5	2,00	N/A	N/A	N/A
0,280					N/A	N/A	N/A
0,315	19,0	4,00	N/A	N/A	N/A		
0,355			N/A	N/A	N/A		
0,400			N/A	N/A	N/A		
0,450			N/A	N/A	N/A		
0,500			25,0	8,00	63	80	N/A
0,560	60	77					
0,630	64	95					
0,710	37,5	12,00			68	90	
0,800					60	N/A	
0,900	50,0	15,00	61	N/A			

8 Flexibility and adherence

8.1 Mandrel winding test (for nominal conductor diameters over 0,090 mm up to 0,900 mm)

The coating shall show no crack after the wire has been elongated as specified in Table 4 and wound on the appropriate mandrel.

Table 4 – Mandrel diameters for mandrel winding test

Nominal conductor diameter		0 % elongation before winding		
		Grade of FIW 4	Grade of FIW 6	Grade of FIW 8
mm		Mandrel diameter	Mandrel diameter	Mandrel diameter
Over	Up to and incl.	mm	mm	mm
0,090	0,112	0,300	0,300	0,300
0,112	0,140	0,300	0,300	0,300
0,140	0,200	$1 \times d^a$	$2 \times d^a$	$2 \times d^a$
0,200	0,355	$1 \times d^a$	$2 \times d^a$	$3 \times d^a$
0,355	0,450	$1 \times d^a$	$2 \times d^a$	$3 \times d^a$
0,450	0,710	$2 \times d^a$	$4 \times d^a$	–
0,710	0,900	$2 \times d^a$	$4 \times d^a$	–

^a d is the nominal diameter of the wire.

8.2 Jerk test (for nominal diameters up to 0,900 mm)

This test shall be performed with elongation of the specimen as specified in Table 3. The coating shall show no crack or loss of adhesion to the conductor.

9 Heat shock

The coating shall show no cracking. The mandrel diameter shall be as specified in Table 5. The minimum heat shock temperature is given in the relevant technical specification sheet.

For nominal conductor diameters up to and including 0,140 mm, Table 4 shall apply.

For intermediate nominal conductor diameters, the mandrel diameter of the next smaller nominal conductor diameter shall be taken.