IEC 60317-0-9

Edition 1.0 2015-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Specifications for particular types of winding wires – Part 0-9: General requirements – Enamelled rectangular aluminium wire

Spécifications pour types particuliers de fils de bobinage – Partie 0-9: Exigences générales – Fil de section rectangulaire émaillé en aluminium

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SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

Part 0-9: General requirements – Enamelled rectangular aluminium wire

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The text of this standard is based on the following documents:

FDIS	Report on voting
55/1519/FDIS	55/1525/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The numbering of clauses in this standard is not continuous from Clauses 21 through 30 in order to reserve space for possible future wire requirements prior to those for wire packaging.

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A list of all parts in the IEC 60317 series, published under the general title *Specifications for particular types of winding wires*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
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INTRODUCTION

This part of IEC 60317 is one of a series which deals with insulated wires used for windings in electrical equipment. The series has three groups describing:

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

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SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

Part 0-9: General requirements – Enamelled rectangular aluminium wire

1 Scope

This part of IEC 60317 specifies the general requirements of enamelled rectangular aluminium winding wires.

The range of nominal conductor dimensions is given in the relevant specification sheet.

When reference is made to a winding wire according to a standard of the IEC 60317 series mentioned under Clause 2, the following information is given in the description:

– reference to IEC specification;
– nominal conductor dimensions in millimetres (width × thickness);
– grade.

EXAMPLE IEC 60317-16 – 4,00 x 1,00 Grade 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.

IEC 60172[1], *Test procedure for the determination of the temperature index of enamelled and tape wrapped winding wires*

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

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

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 terms and definitions given in IEC 60317-0-1 apply.

3.2 General notes

3.2.1 Methods of test

All methods of test to be used for this standard are given in IEC 60851.

[1] Fourth edition to be published.

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The clause numbers used in this standard are identical to the corresponding test numbers in the IEC 60851 series of standards.

In case of inconsistencies between the publication on methods of test and this standard, IEC 60317-0-9 shall prevail.

Where no specific range of nominal conductor dimensions is given for a test, the test applies to all nominal conductor dimensions covered by the specification sheet.

Unless otherwise specified, all tests shall be carried out at a temperature from 15 °C to 35 °C and a relative humidity from 45 % to 75 %. Before measurements are made, the specimens shall be preconditioned under these atmospheric conditions for a time sufficient to allow the specimens to reach stability.

The wire to be tested shall be removed from the packaging in such a way that the wire will not be subjected to tension or unnecessary bends. Before each test, sufficient wire should be discarded to ensure that any damaged wire is not included in the test specimens.

3.2.2 Winding wire

When reference is made to a winding wire according to a standard of the IEC 60317 series mentioned under Clause 2, the following information is given in the description:

– reference to IEC specification;
– nominal conductor dimensions in millimetres (width × thickness);
– grade.

EXAMPLE IEC 60317-18 – 4,00 × 1,00 Grade 1

3.3 Appearance

The film coating shall be smooth and continuous, free from streaks, blisters and foreign material when examined with normal vision, as wound on the original spool or reel.

4 Dimensions

4.1 Conductor dimensions

The dimensions for widths and thickness of conductors of winding wires with rectangular cross-section recommended in this standard are taken from the R 20 and R 40 series according to ISO 3.

Preferred sizes are combinations of width and thickness both according to the R 20 series.

Intermediate sizes are combinations of width or thickness according to the R 20 series with the other dimension according to the R 40 series.

This standard covers:

– widths from 2,00 mm up to and including 16,00 mm;
– thicknesses from 0,80 mm up to and including 5,60 mm.

For thicknesses over 5,600 mm up to and including 10 mm and for widths over 16 mm up to and including 25 mm where, for technical reasons, additional sizes may be needed, the R 40 series shall be used. The ratio width/thickness shall be within the specified limits and combinations of R 40 by R 40 are not allowed in the case of additional sizes.

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The ratio width/thickness shall be greater than or equal to 1,4:1 and shall not exceed 8:1.

The actual values of dimensions are given in Table 2.

The nominal cross-sectional areas for preferred sizes are given in Table 2, and the nominal cross-sectional areas for intermediate sizes are given in Table A.1.

4.2 Tolerance on conductor dimensions

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

Table 1– Conductor tolerances

Nominal width or thickness of the conductor mm		Tolerance ± mm
Over	**Up to and including**	
–	3,15	0,030
3,15	6,30	0,050
6,30	12,50	0,070
12,50	16,00	0,100

4.3 Rounding of corners

The arc shall merge smoothly into the flat surfaces of the conductor and the strip shall be free from sharp, rough and projecting edges. The conductor shall have radiused corners complying with Table 3. The specified radii shall be maintained within ±25 %.

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Table 2 – Nominal cross-sectional areas of preferred sizes

Width	Thickness →																	
mm	0,80	0,90	1,00	1,12	1,25	1,40	1,60	1,80	2,00	2,24	2,50	2,80	3,15	3,55	4,00	4,50	5,00	5,60
	Corner radius (0,5 mm*)			Corner radius (0,5 mm*)				Corner radius (0,65 mm*)			Corner radius (0,80 mm*)				Corner radius (1,0 mm*)			
2,00	1,463	1,626	1,785	2,025	2,285	2,585												
2,24	1,655	1,842	2,205	2,294	2,582	2,921	3,369											
2,50	1,863	2,076	2,285	2,585	2,910	3,285	3,785	4,137					Not recommended Ratio width-thickness smaller than 1,4:1					
2,80	2,103	2,346	2,585	2,921	3,285	3,705	4,265	4,677	5,237									
3,15	2,383	2,661	2,935	3,313	3,723	4,195	4,825	5,307	5,937	6,693								
3,55	2,703	3,021	3,335	3,761	4,223	4,755	5,465	6,027	6,737	7,589	8,326							
4,00	3,063	3,426	3,785	4,265	4,785	5,385	6,185	6,831	7,637	8,597	9,451	10,65						
4,50	3,463	3,876	4,285	4,825	5,410	6,085	6,85	7,737	8,631	9,717	10,70	12,05	13,63					
5,00	3,863	4,326	4,785	5,385	6,035	6,785	7,785	8,637	9,637	10,84	12,18	13,45	15,20	17,20				
5,60	4,363	4,866	5,385	6,057	6,785	7,625	8,745	9,717	10,84	12,18	13,45	15,13	17,09	19,33	21,54			
6,30	4,903	5,496	6,085	6,841	7,660	8,605	9,865	10,98	12,24	13,75	15,20	17,09	19,30	21,82	24,34	27,49		
7,10		6,216	6,885	7,737	8,660	9,725	11,15	12,42	13,84	15,54	17,20	19,33	21,82	24,66	27,54	31,09	34,64	
8,00			7,785	8,745	9,785	10,99	12,59	14,04	15,64	17,56	19,45	21,85	24,65	27,85	31,14	35,14	39,14	43,94
9,00				9,865	11,04	12,39	14,19	15,84	17,64	19,80	21,95	24,65	27,80	31,40	35,14	39,64	44,14	49,54
10,0					12,29	13,79	15,79	17,64	19,64	22,04	24,45	27,45	30,95	34,95	39,14	44,14	49,14	55,14
11,2						15,47	17,71	19,80	22,04	24,79	27,46	30,81	34,73	39,21	43,94	49,54	55,14	61,86
12,5	Not recommended Ratio width-thickness over 8:1						19,79	22,14	24,64	27,64	30,70	34,45	38,83	43,83	49,14	55,39	61,64	69,14
14,0								24,84	27,64	31,00	34,45	38,65	43,55	49,15	55,14	62,14	69,14	77,54
16,0									31,64	35,48	39,45	44,25	49,85	56,25	63,14	71,14	79,14	88,74

* Nominal thickness

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Table 3 – Corner radii

Nominal thickness of conductor mm		Corner radius ± mm
Over	Up to and including	
–	1,00	0,50 nominal thickness
1,00	1,60	0,50*
1,60	2,24	0,65**
2,24	3,55	0,80
3,55	5,60	1,00

NOTE If agreed between purchaser and supplier, the corner radii for wires with a width greater than 4,8 mm may be:

* 0,50 nominal thickness

** 0,80 mm

4.4 Increase in dimensions due to the insulation

The increase in width or thickness due to the insulation shall be as given in Table 4.

Table 4 – Increases in dimensions

Grade	Increase in dimensions mm		
	Minimum	Nominal	Maximum
1	0,06	0,085	0,11
2	0,12	0,145	0,17

4.5 Overall dimensions

4.5.1 Nominal overall dimensions

The nominal overall dimensions shall be calculated as the sum of the nominal bare conductor and the nominal increase in dimension due to the insulation.

4.5.2 Minimum overall dimensions

The minimum overall dimensions shall be calculated as the sum of the minimum bare conductor and the minimum increase in dimension due to the insulation. See also note under 4.5.3.

4.5.3 Maximum overall dimensions

The maximum overall dimensions shall be calculated as the sum of the maximum bare conductor and the maximum increase in dimension due to the insulation.

NOTE When agreed between purchaser and supplier, special tolerances for grade 2 as given in Annex B have been established to calculate special maximum and minimum dimensions.

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5 Electrical resistance

The resistance of the wire shall be expressed as the d.c. resistance at 20 °C. The method used shall provide an accuracy of 0,5 %.

The maximum value of resistance shall be not greater than the value calculated for the minimum tolerated cross-sectional area of the conductor resulting from the minimum dimensions in thickness and width and the maximum for the corner radius, and with a resistivity of 1/35,85 (0,027 894) $\Omega \cdot mm^2 \cdot m^{-1}$.

One measurement shall be made.

6 Elongation

The minimum elongation at fracture shall be 15 %.

7 Springiness

Test appropriate but no requirements specified.

8 Flexibility and adherence

8.1 Mandrel winding test

The coating shall show no crack after the wire has been bent flatwise and edgewise on a mandrel with a diameter as specified in Table 5.

Table 5 – Mandrel winding

Wire bent on		Mandrel diameter
Width	Sizes up to and including 10 mm	4width
	Sizes over 10 mm	5 × width
Thickness	All sizes	4 × thickness

8.2 Adherence test

The wire shall be stretched by 15 %. The distance of loss of adhesion shall be less than one time the width.

9 Heat shock

The coating shall show no crack after the wire has been bent flatwise on a mandrel with a diameter of six times the thickness.

The minimum heat shock temperature is given in the relevant specification sheet.

10 Cut-through

Test inappropriate.

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11 Resistance to abrasion

Test inappropriate.

12 Resistance to solvents

Following immersion in standard solvent, the coating shall not be removed using a pencil of hardness "H".

13 Breakdown voltage

When tested at room temperature at least four of the five specimens tested shall not break down at a voltage less than or equal to that given in Table 6, and the fifth shall not break down at less than 50 % of the values specified.

When required by the purchaser, the wire shall be tested at elevated temperature.

The elevated temperature is given in the relevant specification sheet.

Table 6 – Breakdown voltage

Grade	Minimum breakdown voltage (r.m.s.) V	
	Room temperature	Elevated temperature
1	1 000	750
2	2 000	1 500

14 Continuity of insulation

Test inappropriate.

15 Temperature index

The test shall be carried out on a rectangular wire according to IEC 60172, unless otherwise agreed between purchaser and supplier.

When required by a purchaser, the supplier of the enamelled wire shall supply evidence that the wire meets the requirements for the temperature index.

NOTE 1 The temperature index requirement based on an extrapolated life of 20 000 h relates to enamelled wires tested unvarnished and not as part of an insulation system.

NOTE 2 Temperature in degrees Celsius corresponding to the temperature index is not necessarily that at which it is recommended that the wire be operated and this will depend on many factors, including the type of equipment involved.

16 Resistance to refrigerants

Test inappropriate.

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17 Solderability

Test inappropriate.

18 Heat or solvent bonding

Test inappropriate.

19 Dielectric dissipation factor

For requirements, see the relevant specification sheet.

20 Resistance to transformer oil

For requirements, see the relevant specification sheet.

21 Loss of mass

Test inappropriate.

23 Pin hole test

Test inappropriate.

30 Packaging

The kind of packaging may influence certain properties of the wire, for example springback. Therefore the kind of packaging for example, the type of spool, shall be agreed between purchaser and supplier.

The wire shall be evenly and compactly wound on spools or placed in containers. No spool or container shall contain more than one length of wire unless agreed to by purchaser and supplier. Marking of the label when there is more than one length and/or identification of the separate lengths in the package shall be agreed to by purchaser and supplier.

Where wires are delivered in coils, the dimensions and the maximum weights of such coils shall be agreed between purchaser and supplier. Any additional protection for coils shall also be agreed between purchaser and supplier.

Labels shall be attached to each packaging unit as agreed between supplier and user and shall include the following information:

a) manufacturer name and/or trade mark;

b) type of wire and insulation, for instance trade name and/or IEC specification number;

c) net mass of wire;

d) nominal dimension(s) of wire and grade of insulation;

e) date of manufacture.

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