

INTERNATIONAL STANDARD



Specifications for particular types of winding wires –
Part 0-8: General requirements – Polyester glass-fibre wound **unvarnished**
and fused, or resin or varnish impregnated **or not impregnated**, bare or
enamelled rectangular copper wire



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IECNORM.COM : Click to view the full text of IEC 60910-8:2019 PLV

INTERNATIONAL STANDARD



Specifications for particular types of winding wires –
Part 0-8: General requirements – Polyester glass-fibre wound **unvarnished**
and fused, or resin or varnish impregnated ~~or not impregnated~~, bare or
enamelled rectangular copper wire

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.060.10

ISBN 978-2-8322-7313-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	4
INTRODUCTION	2
1 Scope	7
2 Normative references	7
3 Terms, definitions and general notes on tests and appearance	7
3.1 Terms and definition	7
3.2 General notes	8
3.2.1 Methods of test	8
3.2.2 Winding wire	9
3.3 Appearance	9
4 Dimensions	9
4.1 Conductor dimensions	9
4.2 Tolerance on conductor dimensions	13
4.3 Rounding of corners	13
4.4 Increase in dimensions due to the insulation	13
4.5 Overall dimensions	15
4.5.1 Nominal overall dimensions	15
4.5.2 Minimum overall dimensions	15
4.5.3 Maximum overall dimensions	15
5 Electrical resistance	15
6 Elongation	15
7 Springiness	15
8 Flexibility and adherence	16
8.1 Mandrel winding test	16
8.2 Adherence test	16
8.2.1 Fibre covered bare wires	16
8.2.2 Fibre covered enamelled wires	16
9 Heat shock	16
10 Cut-through	16
11 Resistance to abrasion	16
12 Resistance to solvents	16
13 Breakdown voltage	16
14 Continuity of insulation	17
15 Temperature index	17
16 Resistance to refrigerants	17
17 Solderability	17
18 Heat or solvent bonding	17
19 Dielectric dissipation factor	17
20 Resistance to transformer oil	17
21 Loss of mass	17
23 Pin hole test	18
30 Packaging	18

Annex A (informative) Nominal cross-sectional areas for preferred and intermediate sizes	19
Bibliography	28
Table 1 – Nominal cross-sectional areas of preferred sizes	11
Table 2 – Conductor tolerances	13
Table 3 – Corner radii	13
Table 4 – Increase in dimensions	14
Table 5 – Elongation	15
Table 6 – Mandrel winding	16
Table 7 – Breakdown voltage	17
Table A.1 – Nominal cross-sectional areas	19

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

**Part 0-8: General requirements – Polyester glass-fibre
wound **unvarnished and fused**, or resin or varnish impregnated
~~or not impregnated~~, bare or enamelled rectangular copper wire**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60317-0-8 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) revision to the title of the standard indicating that the glass fibre covering is fused and unvarnished;
- b) revision to subclause 3.2 adding winding wire requirements for the fibrous covering and a list of covering classifications;
- c) revision to subclause 3.3 requirements for appearance;
- d) revision to subclause 8.2, adherence test requirements.

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

FDIS	Report on voting
55/1784/FDIS	55/1796/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 the 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 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.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This Part of IEC 60317 ~~is one~~ forms an element of a series of standards which deals with insulated wires used for windings in electrical equipment. The ~~series~~ set of standards has three ~~groups~~ series describing:

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

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

Part 0-8: General requirements – Polyester glass-fibre wound **unvarnished and fused**, or resin or varnish impregnated ~~or not impregnated~~, bare or enamelled rectangular copper wire

1 Scope

This part of IEC 60317 specifies the general requirements of polyester glass-fibre wound **fused, unvarnished**, or resin or varnish impregnated ~~or not impregnated~~, bare, of **grade 1 or grade 2** or enamelled rectangular copper **winding** wires.

The range of nominal conductor dimensions is given in **4.1** and in the relevant specification sheet.

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

ISO 3:~~1973~~, *Preferred numbers – Series of preferred numbers*

3 Terms, definitions and general notes on tests and appearance

3.1 Terms and definition

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 coating

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

3.1.2 conductor

bare metal after removal of the insulation

3.1.3 covering

material which is wound, wrapped or braided around a bare or insulated conductor

3.1.4

crack

opening in the insulation which 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

fused

state of polyester fibres after having been melted then re-solidified for support/adherence of glass fibres

3.1.7

grade

range of thickness of the insulation of a wire

3.1.8

insulation

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

3.1.9

nominal conductor dimension

designation of the conductor size in accordance with IEC 60317 (all parts)

3.1.10

normal vision

20/20 vision, with corrective lenses, if necessary

3.1.11

winding wire

wire used for winding a coil to provide a magnetic field

3.1.12

wire

conductor coated or covered with an insulation

3.2 General notes

3.2.1 Methods of test

All methods of test to be used for this document are given in the IEC 60851 series.

The clause numbers used in this document are identical with the respective test numbers in the IEC 60851 series.

In case of inconsistencies between the IEC 60851 series and this document, IEC 60317-0-8 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 40 °C and a relative humidity from ~~45~~ 25 % 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

The fibre covering shall consist of a combination of polyester and glass fibres. The glass fibres shall be electrical-grade continuous-filament glass yarn. The polyester fibre shall be a high-grade yarn resulting from the linear polymerization of ethylene glycol and terephthalic acid. The maximum content by weight of polyester fibre in the yarn shall not exceed 50 %.

The coating shall be characterized by the following different grades of thickness:

- PG1, bare conductor with 1 layer of polyester glass fibre or 2 layers of finer polyester glass fibres that together, comply with the dimensional requirements in Table 1;
- PG2, bare conductor with 2 layers of polyester glass fibre;
- Grade 1 PG1, enamelled grade 1 (grade 1) with 1 layer of polyester glass fibre (PG1);
- Grade 1 PG2, enamelled grade 1 (grade 1) with 2 layers of polyester glass fibre (PG2);
- Grade 2 PG1, enamelled grade 2 (grade 2) with 1 layer of polyester glass fibre (PG1);
- Grade 2 PG2, enamelled grade 2 (grade 2) with 2 layers of polyester glass fibre (PG2).

When reference is made to a winding wire according to a standard of the IEC 60317 series, the following information is ~~included~~ given in the description:

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

EXAMPLE IEC 60317-60 – 4,00 × 1,00 Grade 2PG1.

3.3 Appearance

The fibrous covering shall be essentially smooth and ~~continuous~~ uniform as agreed upon between customer and supplier in accordance with good commercial practice, and free from physical damage and foreign material when examined with normal vision, as wound on the original spool or reel. Fibres shall be bound to the underlying enamelled or bare wire.

NOTE Evidence of physical damage includes gashes, broken fibre strands, and the like.

4 Dimensions

4.1 Conductor dimensions

The dimensions for widths and thicknesses of conductors of winding wires with rectangular cross-section recommended in this part of IEC 60317 shall be in accordance with Table 1, and are taken from the R 20 ~~and R 40~~ series according to ISO 3:1973.

Preferred sizes are combinations of width and thickness both according to the R 20 and R 40 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 part of IEC 60317 covers:

- widths from 2,00 mm up to and including 16,00 mm;

- thicknesses from 0,80 mm up to and including 5,60 mm¹.

For thickness over 5,60 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 and R 40 are not allowed in the case of additional sizes.

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 1².

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

¹) ~~For thicknesses over 5,60 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; R 40 is not allowed in the case of additional sizes.~~

²) ~~Dimensions according to the R 20 series are printed in larger type.~~

Table 1 – Nominal cross-sectional areas of preferred sizes

Width mm	Thickness mm																												Corner radius 1.0 mm									
	Corner radius 0.5 mm														Corner radius 0.8 mm														Corner radius 1.0 mm									
	0.80	0.85	0.90	0.95	1.00	1.06	1.12	1.18	1.25	1.32	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.12	2.24	2.36	2.50	2.65	2.80	3.00	3.15	3.35	3.55	3.75	4.00	4.25	4.50	4.75	5.00	5.30	5.60			
Not recommended																																						
2.00	1.463	1.626	1.785	—	—	—	2.025	—	2.285	2.585	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
2.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
2.24	1.655	1.842	2.025	—	—	—	2.294	—	2.585	2.921	3.369	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
2.36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
2.50	1.863	2.076	2.285	—	—	—	2.585	—	2.910	3.285	3.785	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
2.65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
2.80	2.103	2.346	2.585	—	—	—	2.921	—	3.285	3.705	4.265	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
3.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
3.15	2.383	2.661	2.935	—	—	—	3.313	—	3.723	4.195	4.825	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
3.35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
3.55	2.703	3.021	3.335	—	—	—	3.761	—	4.223	4.755	5.465	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
3.75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
4.00	3.063	3.426	3.785	—	—	—	4.265	—	4.785	5.385	6.185	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
4.25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
4.50	3.463	3.876	4.285	—	—	—	4.825	—	5.410	6.085	6.985	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
4.75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
5.00	3.863	4.326	4.785	—	—	—	5.385	—	6.035	6.785	7.785	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
5.30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
5.60	4.343	4.866	5.385	—	—	—	6.057	—	6.785	7.625	8.745	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
6.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
6.30	4.903	5.496	6.085	—	—	—	6.841	—	7.660	8.605	9.865	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
6.70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
7.10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
7.50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
8.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
8.50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
9.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
9.50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
10.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
10.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
11.2	—	—	—	—	—	—	—	—	—	—	—																											

* 0.5 nominal thickness.

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	3,56	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 (0,65 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										
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						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	Ratio width/thickness over 8:1							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.

NOTE Dimensions according to R 20 series are printed in larger type.

4.2 Tolerance on conductor dimensions

The conductor dimensions shall not differ from the nominal values by more than the tolerance given in Table 2.

Table 2 – 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 corner radii complying with Table 3. The specified radii shall be maintained within ±25 %.

Table 3 – Corner radii

Nominal width or thickness of the conductor mm		Corner radius mm
Over	Up to and including	
–	1,00	0,5 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:

* 0,5 mm nominal thickness

** 0,8 mm

4.4 Increase in dimensions due to the insulation

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

7. **Increase in dimensions**

Nominal width of the conductor mm		Increase in dimensions mm																	
		Polyester-glass fibre covering over bare conductor				Polyester-glass fibre covering over grade 1 enamelled wire				Polyester-glass fibre covering over grade 2 enamelled wire									
		Single covering (PG1)			Double covering (PG2)			Single covering (grade 1 PG1)			Double covering (grade 1 PG2)			Single covering (grade 2 PG1)			Double covering (grade 2 PG2)		
Over	Up to and incl.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
–	3,15	0,08	0,12	0,16	0,19	0,25	0,31	0,14	0,21	0,27	0,25	0,34	0,42	0,20	0,27	0,33	0,31	0,40	0,48
3,15	6,30	0,10	0,14	0,18	0,21	0,28	0,35	0,16	0,23	0,29	0,27	0,37	0,46	0,22	0,29	0,35	0,33	0,43	0,52
6,30	12,50	0,11	0,16	0,21	0,22	0,30	0,38	0,17	0,25	0,32	0,28	0,39	0,49	0,23	0,31	0,38	0,34	0,45	0,55
12,50	16,00	0,12	0,18	0,24	0,24	0,32	0,40	0,18	0,27	0,35	0,30	0,41	0,51	0,24	0,33	0,41	0,36	0,47	0,57

NOTE-1 The maximum increase in thickness or width due to the insulation may be exceeded, provided the overall thickness or width of the insulated wire does not exceed the sum of the maximum thickness or width of the bare wire plus the maximum increase in dimension given in the table above.

NOTE-2 The minimum increases in dimensions apply only to the increase in thickness.

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~~ dimension 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~~ dimension and the minimum increase in dimension due to the insulation.

4.5.3 Maximum overall dimensions

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

5 Electrical resistance

The resistance of the wire shall be expressed as the DC 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 $1/58 \Omega \text{ mm}^2 \text{ m}^{-1}$.

One measurement shall be made.

6 Elongation

The elongation at fracture shall be in accordance with Table 5.

Table 5 – Elongation

Nominal thickness of the conductor mm		Minimum elongation %
Over	Up to and including	
–	2,50	30
2,50	5,60	32

7 Springiness

The wire shall not exceed the maximum springback of:

- 5,0° for polyester-glass fibre covered bare wires
- 5,5° for polyester-glass fibre covered enamelled wires

8 Flexibility and adherence

8.1 Mandrel winding test

The covering shall show no crack after the wire has been bent flatwise and edgewise on a mandrel with a diameter as specified in Table 6.

Table 6 – Mandrel winding

Wire bent on		Mandrel diameter
Width	Sizes up to and including 8 mm	10 × width
	Sizes over 8 mm	15 × width
Thickness	All sizes	10 × thickness

Specimens showing no crack or opening shall meet the requirements of Clause 13.

8.2 Adherence test

8.2.1 Fibre covered bare wires

The specimen shall be elongated 20 %. ~~There shall be no loss of adhesion of the fibre covering.~~ There shall be no loosening, fraying or detachment of the covering except at the point of rupture.

8.2.2 Fibre covered enamelled wires

The specimen shall be elongated 20 %. ~~There shall be no loss of adhesion either of the fibre covering or the enamel.~~ There shall be either no loosening, fraying or detachment of the covering and no cracks visible in the coating without removing the glass-fiber covering.

9 Heat shock

Test inappropriate.

10 Cut-through

Test inappropriate.

11 Resistance to abrasion

Test inappropriate.

12 Resistance to solvents

Test inappropriate.

13 Breakdown voltage

The wire shall meet the requirements of Table 7.

Table 7 – Breakdown voltage

Type of insulation		Minimum breakdown voltage (root-mean-square value) (RMS) V
Bare conductor with	Single covering (PG1)	350
	Double covering (PG2)	560
Grade 1 enamelled wire with	Single covering (grade 1 PG1)	1 350
	Double covering (grade 1 PG2)	1 560
Grade 2 enamelled wire with	Single covering (grade 2 PG1)	2 350
	Double covering (grade 2 PG2)	2 560

14 Continuity of insulation

Test inappropriate.

15 Temperature index

The temperature index is dependent on the type of impregnating agent used. The method of test used shall be agreed between purchaser and supplier. The maximum service temperature shall be determined by experience.

16 Resistance to refrigerants

Test inappropriate.

17 Solderability

Test inappropriate.

18 Heat or solvent bonding

Test inappropriate.

19 Dielectric dissipation factor

Test inappropriate.

20 Resistance to transformer oil

Test inappropriate.

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. In order to reduce the risk of wire damage, the spool with the wire shall be delivered and used with the axis in horizontal position. No spool or container shall contain more than one length of wire unless agreed ~~to by~~ between 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~~ between 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's 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.

Annex A (informative)

Nominal cross-sectional areas for preferred and intermediate sizes

Table A.1 provides nominal cross-sectional areas for preferred and intermediate sizes of rectangular copper bare conductors, from which the user may select intermediate sizes only for technical reasons.

Table A.1 – Nominal cross-sectional areas

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
2,00	0,80	*	1,463
	0,85	*	1,545
	0,90	*	1,626
	0,95	*	1,706
	1,00	*	1,785
	1,06	0,5	1,905
	1,12	0,5	2,025
	1,18	0,5	2,145
	1,25	0,5	2,285
	1,32	0,5	2,425
	1,40	0,5	2,585
2,12	0,80	*	1,559
	0,90	*	1,734
	1,00	*	1,905
	1,12	0,5	2,160
	1,25	0,5	2,435
	1,40	0,5	2,753
2,24	0,80	*	1,655
	0,85	*	1,749
	0,90	*	1,842
	0,95	*	1,934
	1,00	*	2,025
	1,06	0,5	2,160
	1,12	0,5	2,294
	1,18	0,5	2,429
	1,25	0,5	2,585
	1,32	0,5	2,742
	1,40	0,5	2,921
	1,50	0,5	3,145
	1,60	0,5	3,369
2,36	0,80	*	1,751
	0,90	*	1,950
	1,00	*	2,145

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
2,50	1,25	0,5	2,910
	1,32	0,5	3,085
	1,40	0,5	3,285
	1,50	0,5	3,535
	1,60	0,5	3,785
	1,70	0,65	3,887
	1,80	0,65	4,137
2,65	0,80	*	1,983
	0,90	*	2,211
	1,00	*	2,435
	1,12	0,5	2,753
	1,25	0,5	3,098
	1,40	0,5	3,495
	1,60	0,5	4,025
	1,80	0,65	4,407
2,80	0,80	*	2,103
	0,85	*	2,225
	0,90	*	2,346
	0,95	*	2,466
	1,00	*	2,585
	1,06	0,5	2,753
	1,12	0,5	2,921
	1,18	0,5	3,089
	1,25	0,5	3,285
	1,32	0,5	3,481
	1,40	0,5	3,705
	1,50	0,5	3,985
	1,60	0,5	4,265
	1,70	0,65	4,397
	1,80	0,65	4,677
	1,90	0,65	4,957
	2,00	0,65	5,237

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	1,12	0,5	2,429
	1,25	0,5	2,735
	1,40	0,5	3,089
	1,60	0,5	3,561
2,50	0,80	*	1,863
	0,85	*	1,970
	0,90	*	2,076
	0,95	*	2,181
	1,00	*	2,285
	1,06	0,5	2,435
	1,12	0,5	2,585
	1,18	0,5	2,736
3,15	0,90	*	2,661
	0,95	*	2,799
	1,00	*	2,935
	1,06	0,5	3,124
	1,12	0,5	3,313
	1,18	0,5	3,502
	1,25	0,5	3,723
	1,32	0,5	3,943
	1,40	0,5	4,195
	1,50	0,5	4,510
	1,60	0,5	4,825
	1,70	0,65	4,992
	1,80	0,65	5,307
	1,90	0,65	5,622
	2,00	0,65	5,937
	2,12	0,65	6,315
	2,24	0,65	6,693
3,35	0,80	*	2,543
	0,90	*	2,841
	1,00	*	3,135
	1,12	0,5	3,537
	1,25	0,5	3,973
	1,40	0,5	4,475
	1,60	0,5	5,145
	1,80	0,65	5,667
	2,00	0,65	6,337
	2,24	0,65	7,141

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
3,00	0,80	*	2,263
	0,90	*	2,526
	1,00	*	2,785
	1,12	0,5	3,145
	1,25	0,5	3,535
	1,40	0,5	3,985
	1,60	0,5	4,585
	1,80	0,65	5,037
3,15	0,80	*	2,383
	0,85	*	2,522
3,75	0,80	*	2,863
	0,90	*	3,201
	1,00	*	3,535
	1,12	0,5	3,985
	1,25	0,5	4,473
	1,40	0,5	5,035
	1,60	0,5	5,785
	1,80	0,65	6,387
	2,00	0,65	7,137
	2,24	0,65	8,037
	2,50	0,8	8,826
4,00	0,80	*	3,063
	0,85	*	3,245
	0,90	*	3,426
	0,95	*	3,606
	1,00	*	3,785
	1,06	0,5	4,025
	1,12	0,5	4,265
	1,18	0,5	4,505
	1,25	0,5	4,785
	1,32	0,5	5,065
	1,40	0,5	5,385
	1,50	0,5	5,785
	1,60	0,5	6,185
	1,70	0,65	6,437
	1,80	0,65	6,837
	1,90	0,65	7,237

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
3,55	0,80	*	2,703
	0,85	*	2,862
	0,90	*	3,021
	0,95	*	3,179
	1,00	*	3,335
	1,06	0,5	3,548
	1,12	0,5	3,761
	1,18	0,5	3,974
	1,25	0,5	4,223
	1,32	0,5	4,471
	1,40	0,5	4,755
	1,50	0,5	5,110
	1,60	0,5	5,465
	1,70	0,65	5,672
	1,80	0,65	6,027
	1,90	0,65	6,382
	2,00	0,65	6,737
	2,12	0,65	7,163
	2,24	0,65	7,589
	2,36	0,8	7,829
	2,50	0,8	8,326
4,50	0,80	*	3,463
	0,85	*	3,670
	0,90	*	3,876
	0,95	*	4,081
	1,00	*	4,285
	1,06	0,5	4,555
	1,12	0,5	4,825
	1,18	0,5	5,095
	1,25	0,5	5,410
	1,32	0,5	5,725
	1,40	0,5	6,085
	1,50	0,5	6,535
	1,60	0,5	6,985
	1,70	0,65	7,287
	1,80	0,65	7,737
	1,90	0,65	8,187
	2,00	0,65	8,637
	2,12	0,65	9,177
	2,24	0,65	9,717
	2,36	0,8	10,07

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	2,00	0,65	7,637
	2,12	0,65	8,117
	2,24	0,65	8,597
	2,36	0,8	8,891
	2,50	0,8	9,451
	2,65	0,8	10,05
	2,80	0,8	10,65
4,25	0,80	*	3,263
	0,90	*	3,651
	1,00	*	4,035
	1,12	0,5	4,545
	1,25	0,5	5,098
	1,40	0,5	5,735
	1,60	0,5	6,585
	1,80	0,65	7,287
	2,00	0,65	8,137
	2,24	0,65	9,157
	2,50	0,8	10,08
	2,80	0,8	11,35
5,00	1,70	0,65	8,137
	1,80	0,65	8,637
	1,90	0,65	9,137
	2,00	0,65	9,637
	2,12	0,65	10,24
	2,24	0,65	10,84
	2,36	0,8	11,25
	2,50	0,8	11,95
	2,65	0,8	12,70
	2,80	0,8	13,45
	3,00	0,8	14,45
	3,15	0,8	15,20
	3,35	0,8	16,20
	3,55	0,8	17,20
5,30	0,80	*	4,103
	0,90	*	4,596
	1,00	*	5,085
	1,12	0,5	5,721
	1,25	0,5	6,410
	1,40	0,5	7,205

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	2,50	0,8	10,70
	2,65	0,8	11,38
	2,80	0,8	12,05
	3,00	0,8	12,95
	3,15	0,8	13,63
4,75	0,80	*	3,663
	0,90	*	4,101
	1,00	*	4,535
	1,12	0,5	5,105
	1,25	0,5	5,723
	1,40	0,5	6,435
	1,60	0,5	7,385
	1,80	0,65	8,188
	2,00	0,65	9,137
	2,24	0,65	10,28
	2,50	0,8	11,33
	2,80	0,8	12,75
	3,15	0,8	14,41
5,00	0,80	*	3,863
	0,85	*	4,095
	0,90	*	4,326
	0,95	*	4,556
	1,00	*	4,785
	1,06	0,5	5,085
	1,12	0,5	5,385
	1,18	0,5	5,685
	1,25	0,5	6,035
	1,32	0,5	6,385
	1,40	0,5	6,785
	1,50	0,5	7,285
	1,60	0,5	7,785
5,60	3,00	0,8	16,25
	3,15	0,8	17,09
	3,35	0,8	18,21
	3,55	0,8	19,33
	3,75	1,0	20,14
	4,00	1,0	21,54
6,00	0,80	*	4,663
	0,90	*	5,226

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	1,60	0,5	8,265
	1,80	0,65	9,177
	2,00	0,65	10,24
	2,24	0,65	11,51
	2,50	0,8	12,70
	2,80	0,8	14,29
	3,15	0,8	16,15
	3,55	0,8	18,27
5,60	0,80	*	4,343
	0,85	*	4,605
	0,90	*	4,866
	0,95	*	5,126
	1,00	*	5,385
	1,06	0,5	5,721
	1,12	0,5	6,057
	1,18	0,5	6,393
	1,25	0,5	6,785
	1,32	0,5	7,177
	1,40	0,5	7,625
	1,50	0,5	8,185
	1,60	0,5	8,745
	1,70	0,65	9,157
	1,80	0,65	9,717
	1,90	0,65	10,28
	2,00	0,65	10,84
	2,12	0,65	11,51
	2,24	0,65	12,18
	2,36	0,8	12,67
	2,50	0,8	13,45
	2,65	0,8	14,29
	2,80	0,8	15,13
6,30	3,75	1,0	22,77
	4,00	1,0	24,34
	4,25	1,0	25,92
	4,50	1,0	27,49
6,70	0,90	*	5,856
	1,00	*	6,485
	1,12	0,5	7,289
	1,25	0,5	8,160

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	1,00	*	5,785
	1,12	0,5	6,505
	1,25	0,5	7,285
	1,40	0,5	8,185
	1,60	0,5	9,385
	1,80	0,65	10,44
	2,00	0,65	11,64
	2,24	0,65	13,08
	2,50	0,8	14,45
	2,80	0,8	16,25
	3,15	0,8	18,35
	3,55	0,8	20,75
	4,00	1,0	23,14
6,30	0,80	*	4,903
	0,85	*	5,200
	0,90	*	5,496
	0,95	*	5,791
	1,00	*	6,085
	1,06	0,5	6,463
	1,12	0,5	6,841
	1,18	0,5	7,219
	1,25	0,5	7,660
	1,32	0,5	8,101
	1,40	0,5	8,605
	1,50	0,5	9,235
	1,60	0,5	9,865
	1,70	0,65	10,35
	1,80	0,65	10,98
	1,90	0,65	11,61
	2,00	0,65	12,24
	2,12	0,65	12,99
	2,24	0,65	13,75
	2,36	0,8	14,32
	2,50	0,8	15,20
	2,65	0,8	16,15
	2,80	0,8	17,09
	3,00	0,8	18,35
	3,15	0,8	19,30
	3,35	0,8	20,56

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	1,40	0,5	9,165
	1,60	0,5	10,51
	1,80	0,65	11,70
	2,00	0,65	13,04
	2,24	0,65	14,65
	2,50	0,8	16,20
	2,80	0,8	18,21
	3,15	0,8	20,56
	3,55	0,8	23,24
	4,00	1,0	25,94
	4,50	1,0	29,29
7,10	0,90	*	6,216
	0,95	*	6,551
	1,00	*	6,885
	1,06	0,5	7,311
	1,12	0,5	7,737
	1,18	0,5	8,163
	1,25	0,5	8,660
	1,32	0,5	9,157
	1,40	0,5	9,725
	1,50	0,5	10,44
	1,60	0,5	11,15
	1,70	0,65	11,71
	1,80	0,65	12,42
	1,90	0,65	13,13
	2,00	0,65	13,84
	2,12	0,65	14,69
	2,24	0,65	15,54
	2,36	0,8	16,21
	2,50	0,8	17,20
	2,65	0,8	18,27
	2,80	0,8	19,33
	3,00	0,8	20,75
	3,15	0,8	21,82
	3,35	0,8	23,24
	3,55	0,8	24,66
	3,75	1,0	25,77
	4,00	1,0	27,54
	4,25	1,0	29,32

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	3,55	0,8	21,82
7,10	4,50	1,0	31,09
	4,75	1,0	32,87
	5,00	1,0	34,64
7,50	1,00	*	7,285
	1,12	0,5	8,185
	1,25	0,5	9,160
	1,40	0,5	10,29
	1,60	0,5	11,79
	1,80	0,65	13,14
	2,00	0,65	14,64
	2,24	0,65	16,44
	2,50	0,8	18,20
	2,80	0,8	20,45
	3,15	0,8	23,08
	3,55	0,8	26,08
	4,00	1,0	29,14
	4,50	1,0	32,89
	5,00	1,0	36,64
8,00	1,00	*	7,785
	1,06	0,5	8,265
	1,12	0,5	8,745
	1,18	0,5	9,225
	1,25	0,5	9,785
	1,32	0,5	10,35
	1,40	0,5	10,99
	1,50	0,5	11,79
	1,60	0,5	12,59
	1,70	0,65	13,24
	1,80	0,65	14,04
	1,90	0,65	14,84
	2,00	0,65	15,64
	2,12	0,65	16,60
	2,24	0,65	17,56
	2,36	0,8	18,33
	2,50	0,8	19,45

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
8,50	1,12	0,5	9,305
	1,25	0,5	10,41
	1,40	0,5	11,69
	1,60	0,5	13,39
	1,80	0,65	14,94
	2,00	0,65	16,64
	2,24	0,65	18,68
	2,50	0,8	20,70
	2,80	0,8	23,25
	3,15	0,8	26,23
	3,55	0,8	29,63
	4,00	1,0	33,14
	4,50	1,0	37,39
	5,00	1,0	41,64
	5,60	1,0	46,74
9,00	1,12	0,5	9,865
	1,18	0,5	10,41
	1,25	0,5	11,04
	1,32	0,5	11,67
	1,40	0,5	12,39
	1,50	0,5	13,29
	1,60	0,5	14,19
	1,70	0,65	14,94
	1,80	0,65	15,84
	1,90	0,65	16,74
	2,00	0,65	17,64
	2,12	0,65	18,72
	2,24	0,65	19,80
	2,36	0,8	20,69
	2,50	0,8	21,95
	2,65	0,8	23,30
	2,80	0,8	24,65
	3,00	0,8	26,45
	3,15	0,8	27,80
	3,35	0,8	29,60
	3,55	0,8	31,40
	3,75	1,0	32,89

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	2,65	0,8	20,65
	2,80	0,8	21,85
	3,00	0,8	23,45
	3,15	0,8	24,65
	3,35	0,8	26,25
	3,55	0,8	27,85
	3,75	1,0	29,14
	4,00	1,0	31,14
	4,25	1,0	33,14
	4,50	1,0	35,14
	4,75	1,0	37,14
	5,00	1,0	39,14
	5,30	1,0	41,54
	5,60	1,0	43,94
9,50	2,50	0,8	23,20
	2,80	0,8	26,05
	3,15	0,8	29,38
	3,55	0,8	33,18
	4,00	1,0	37,14
	4,50	1,0	41,89
	5,00	1,0	46,64
	5,60	1,0	52,34
10,00	1,25	0,5	12,29
	1,32	0,5	12,99
	1,40	0,5	13,79
	1,50	0,5	14,79
	1,60	0,5	15,79
	1,70	0,65	16,64
	1,80	0,65	17,64
	1,90	0,65	18,64
	2,00	0,65	19,64
	2,12	0,65	20,84
	2,24	0,65	22,04
	2,36	0,8	23,05
	2,50	0,8	24,45
	2,65	0,8	25,95
	2,80	0,8	27,45
	3,00	0,8	29,45
	3,15	0,8	30,95
	3,35	0,8	32,95
	3,55	0,8	34,95

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	4,00	1,0	35,14
	4,25	1,0	37,39
	4,50	1,0	39,64
	4,75	1,0	41,89
	5,00	1,0	44,14
	5,30	1,0	46,84
	5,60	1,0	49,54
9,50	1,25	0,5	11,66
	1,40	0,5	13,09
	1,60	0,5	14,99
	1,80	0,65	16,74
	2,00	0,65	18,64
	2,24	0,65	20,92
11,20	1,70	0,65	18,68
	1,80	0,65	19,80
	1,90	0,65	20,92
	2,00	0,65	22,04
	2,12	0,65	23,38
	2,24	0,65	24,73
	2,36	0,8	25,88
	2,50	0,8	27,45
	2,65	0,8	29,13
	2,80	0,8	30,81
	3,00	0,8	33,05
	3,15	0,8	34,73
	3,35	0,8	36,97
	3,55	0,8	39,21
	3,75	1,0	41,14
	4,00	1,0	43,94
	4,25	1,0	46,74
	4,50	1,0	49,54
	4,75	1,0	52,34
	5,00	1,0	55,14
	5,30	1,0	58,50
	5,60	1,0	61,86
11,80	1,60	0,5	18,67
	1,80	0,65	20,88
	2,00	0,65	23,24
	2,24	0,65	26,07
	2,50	0,8	28,95

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	3,75	1,0	36,64
	4,00	1,0	39,14
	4,25	1,0	41,64
	4,50	1,0	44,14
	4,75	1,0	46,64
	5,00	1,0	49,14
	5,30	1,0	52,14
	5,60	1,0	55,14
10,60	1,40	0,5	14,63
	1,60	0,5	16,75
	1,80	0,65	18,72
	2,00	0,65	20,84
	2,24	0,65	23,38
	2,50	0,8	25,95
	2,80	0,8	29,13
	3,15	0,8	32,84
	3,55	0,8	37,08
	4,00	1,0	41,54
	4,50	1,0	46,84
	5,00	1,0	52,14
	5,60	1,0	58,50
11,20	1,40	0,5	15,47
	1,50	0,5	16,59
	1,60	0,5	17,71
12,50	4,50	1,0	55,39
	4,75	1,0	58,52
	5,00	1,0	61,64
	5,30	1,0	65,39
	5,60	1,0	69,14
13,20	1,80	0,65	23,40
	2,00	0,65	26,04
	2,24	0,65	29,21
	2,50	0,8	32,45
	2,80	0,8	36,41
	3,15	0,8	41,03
	3,55	0,8	46,31
	4,00	1,0	51,94
	4,50	1,0	58,54

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	2,80	0,8	32,49
	3,15	0,8	36,62
	3,55	0,8	41,34
	4,00	1,0	46,34
	4,50	1,0	52,24
	5,00	1,0	58,14
	5,60	1,0	65,22
12,50	1,60	0,5	19,79
	1,70	0,65	20,89
	1,80	0,65	22,14
	1,90	0,65	23,39
	2,00	0,65	24,64
	2,12	0,65	26,14
	2,24	0,65	27,64
	2,36	0,8	28,95
	2,50	0,8	30,70
	2,65	0,8	32,58
	2,80	0,8	34,45
	3,00	0,8	36,95
	3,15	0,8	38,83
	3,35	0,8	41,33
	3,55	0,8	43,83
	3,75	1,0	46,02
	4,00	1,0	49,14
	4,25	1,0	52,27
14,00	4,75	1,0	65,64
	5,00	1,0	69,14
	5,30	1,0	73,34
	5,60	1,0	77,54
15,00	2,00	0,65	29,64
	2,24	0,65	33,24
	2,50	0,8	36,95
	2,80	0,8	41,45
	3,15	0,8	46,70
	3,55	0,8	52,70
	4,00	1,0	59,14
	4,50	1,0	66,64
	5,00	1,0	74,14
	5,60	1,0	83,14

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	5,00	1,0	65,14
	5,60	1,0	73,06
14,00	1,80	0,65	24,84
	1,90	0,65	26,24
	2,00	0,65	27,64
	2,12	0,65	29,32
	2,24	0,65	31,00
	2,36	0,8	32,49
	2,50	0,8	34,45
	2,65	0,8	36,55
	2,80	0,8	38,65
	3,00	0,8	41,45
	3,15	0,8	43,55
	3,35	0,8	46,35
	3,55	0,8	49,15
	3,75	1,0	51,64
	4,00	1,0	55,14
	4,25	1,0	58,64
	4,50	1,0	62,14

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
16,00	2,00	0,65	31,64
	2,12	0,65	33,56
	2,24	0,65	35,48
	2,36	0,8	37,21
	2,50	0,8	39,45
	2,65	0,8	41,85
	2,80	0,8	44,25
	3,00	0,8	47,45
	3,15	0,8	49,85
	3,35	0,8	53,05
	3,55	0,8	56,25
	3,75	1,0	59,14
	4,00	1,0	63,14
	4,25	1,0	67,14
	4,50	1,0	71,14
	4,75	1,0	75,14
	5,00	1,0	79,14
	5,30	1,0	83,94
	5,60	1,0	88,74

* 0,5 nominal thickness.

Bibliography

IEC 60264 (all parts), *Packaging of winding wires*

IEC 60317 (all parts), *Specifications for particular types of winding wires*

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

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Specifications for particular types of winding wires –
Part 0-8: General requirements – Polyester glass-fibre wound unvarnished
and fused, or resin or varnish impregnated, bare or enamelled rectangular
copper wire**

**Spécifications pour types particuliers de fils de bobinage –
Partie 0-8: Exigences générales – Fil de section rectangulaire en cuivre nu
ou émaillé, guipé de fibres de verre avec polyester fondues sans vernis, ou
imprégnées de résine ou de vernis**

CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	7
2 Normative references	7
3 Terms, definitions and general notes on tests and appearance	7
3.1 Terms and definition	7
3.2 General notes	8
3.2.1 Methods of test	8
3.2.2 Winding wire	9
3.3 Appearance	9
4 Dimensions	9
4.1 Conductor dimensions	9
4.2 Tolerance on conductor dimensions	12
4.3 Rounding of corners	12
4.4 Increase in dimensions due to the insulation	12
4.5 Overall dimensions	14
4.5.1 Nominal overall dimensions	14
4.5.2 Minimum overall dimensions	14
4.5.3 Maximum overall dimensions	14
5 Electrical resistance	14
6 Elongation	14
7 Springiness	14
8 Flexibility and adherence	15
8.1 Mandrel winding test	15
8.2 Adherence test	15
8.2.1 Fibre covered bare wires	15
8.2.2 Fibre covered enamelled wires	15
9 Heat shock	15
10 Cut-through	15
11 Resistance to abrasion	15
12 Resistance to solvents	15
13 Breakdown voltage	15
14 Continuity of insulation	16
15 Temperature index	16
16 Resistance to refrigerants	16
17 Solderability	16
18 Heat or solvent bonding	16
19 Dielectric dissipation factor	16
20 Resistance to transformer oil	16
21 Loss of mass	16
23 Pin hole test	17
30 Packaging	17

Annex A (informative) Nominal cross-sectional areas for preferred and intermediate sizes	18
Bibliography	27
Table 1 – Nominal cross-sectional areas of preferred sizes	11
Table 2 – Conductor tolerances	12
Table 3 – Corner radii	12
Table 4 – Increase in dimensions	13
Table 5 – Elongation	14
Table 6 – Mandrel winding	15
Table 7 – Breakdown voltage	16
Table A.1 – Nominal cross-sectional areas	18

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

**Part 0-8: General requirements – Polyester glass-fibre
wound unvarnished and fused, or resin or varnish impregnated,
bare or enamelled rectangular copper wire**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60317-0-8 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) revision to the title of the standard indicating that the glass fibre covering is fused and unvarnished;
- b) revision to subclause 3.2 adding winding wire requirements for the fibrous covering and a list of covering classifications;

- c) revision to subclause 3.3 requirements for appearance;
- d) revision to subclause 8.2, adherence test requirements.

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

FDIS	Report on voting
55/1784/FDIS	55/1796/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 the 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 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.

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.

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

INTRODUCTION

This Part of IEC 60317 forms an element of a series of standards which deals with insulated wires used for windings in electrical equipment. The set of standards has three series describing:

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

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

Part 0-8: General requirements – Polyester glass-fibre wound unvarnished and fused, or resin or varnish impregnated, bare or enamelled rectangular copper wire

1 Scope

This part of IEC 60317 specifies the general requirements of polyester glass-fibre wound fused, unvarnished, or resin or varnish impregnated bare, or grade 1 or grade 2 or enamelled rectangular copper winding wires.

The range of nominal conductor dimensions is given in 4.1 and in the relevant specification sheet.

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

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

3 Terms, definitions and general notes on tests and appearance

3.1 Terms and definition

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 coating

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

3.1.2 conductor

bare metal after removal of the insulation

3.1.3 covering

material which is wound, wrapped or braided around a bare or insulated conductor

3.1.4

crack

opening in the insulation which 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

fused

state of polyester fibres after having been melted then re-solidified for support/adherence of glass fibres

3.1.7

grade

range of thickness of the insulation of a wire

3.1.8

insulation

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

3.1.9

nominal conductor dimension

designation of the conductor size in accordance with IEC 60317 (all parts)

3.1.10

normal vision

20/20 vision, with corrective lenses, if necessary

3.1.11

winding wire

wire used for winding a coil to provide a magnetic field

3.1.12

wire

conductor coated or covered with an insulation

3.2 General notes

3.2.1 Methods of test

All methods of test to be used for this document are given in the IEC 60851 series.

The clause numbers used in this document are identical with the respective test numbers in the IEC 60851 series.

In case of inconsistencies between the IEC 60851 series and this document, IEC 60317-0-8 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 40 °C and a relative humidity from 25 % 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

The fibre covering shall consist of a combination of polyester and glass fibres. The glass fibres shall be electrical-grade continuous-filament glass yarn. The polyester fibre shall be a high-grade yarn resulting from the linear polymerization of ethylene glycol and terephthalic acid. The maximum content by weight of polyester fibre in the yarn shall not exceed 50 %.

The coating shall be characterized by the following different grades of thickness:

- PG1, bare conductor with 1 layer of polyester glass fibre or 2 layers of finer polyester glass fibres that together, comply with the dimensional requirements in Table 1;
- PG2, bare conductor with 2 layers of polyester glass fibre;
- Grade 1 PG1, enamelled grade 1 (grade 1) with 1 layer of polyester glass fibre (PG1);
- Grade 1 PG2, enamelled grade 1 (grade 1) with 2 layers of polyester glass fibre (PG2);
- Grade 2 PG1, enamelled grade 2 (grade 2) with 1 layer of polyester glass fibre (PG1);
- Grade 2 PG2, enamelled grade 2 (grade 2) with 2 layers of polyester glass fibre (PG2).

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

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

EXAMPLE IEC 60317-60 – 4,00 × 1,00 Grade 2PG1.

3.3 Appearance

The fibrous covering shall be essentially smooth and uniform as agreed upon between customer and supplier in accordance with good commercial practice, and free from physical damage and foreign material when examined with normal vision, as wound on the original spool or reel. Fibres shall be bound to the underlying enamelled or bare wire.

NOTE Evidence of physical damage includes gashes, broken fibre strands, and the like.

4 Dimensions

4.1 Conductor dimensions

The dimensions for widths and thicknesses of conductors of winding wires with rectangular cross-section recommended in this part of IEC 60317 shall be in accordance with Table 1, and are taken from the R 20 series according to ISO 3.

Preferred sizes are combinations of width and thickness both according to the R 20 and R 40 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 part of IEC 60317 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 thickness over 5,60 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 and R 40 are not allowed in the case of additional sizes.

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 1.

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

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

Table 1 – Nominal cross-sectional areas of preferred sizes

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 (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												
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						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		Ratio width/thickness over 8:1							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.

NOTE Dimensions according to R 20 series are printed in larger type.

* Nominal thickness.

NOTE Dimensions according to R 20 series are printed in larger type.

4.2 Tolerance on conductor dimensions

The conductor dimensions shall not differ from the nominal values by more than the tolerance given in Table 2.

Table 2 – 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 corner radii complying with Table 3. The specified radii shall be maintained within ±25 %.

Table 3 – Corner radii

Nominal thickness of the conductor mm		Corner radius mm
Over	Up to and including	
–	1,00	0,5 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
If agreed between purchaser and supplier, the corner radii for wires with a width greater than 4,8 mm may be:		
* 0,5 mm nominal thickness		
** 0,8 mm		

4.4 Increase in dimensions due to the insulation

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

Table 4 – Increase in dimensions

Nominal width of the conductor mm		Increase in dimensions mm																	
		Polyester-glass fibre covering over bare conductor					Polyester-glass fibre covering over grade 1 enamelled wire					Polyester-glass fibre covering over grade 2 enamelled wire							
		Single covering (PG1)			Double covering (PG2)			Single covering (grade 1 PG1)			Double covering (grade 1 PG2)			Single covering (grade 2 PG1)			Double covering (grade 2 PG2)		
Over	Up to and incl.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
—	3,15	0,08	0,12	0,16	0,19	0,25	0,31	0,14	0,21	0,27	0,25	0,34	0,42	0,20	0,27	0,33	0,31	0,40	0,48
3,15	6,30	0,10	0,14	0,18	0,21	0,28	0,35	0,16	0,23	0,29	0,27	0,37	0,46	0,22	0,29	0,35	0,33	0,43	0,52
6,30	12,50	0,11	0,16	0,21	0,22	0,30	0,38	0,17	0,25	0,32	0,28	0,39	0,49	0,23	0,31	0,38	0,34	0,45	0,55
12,50	16,00	0,12	0,18	0,24	0,24	0,32	0,40	0,18	0,27	0,35	0,30	0,41	0,51	0,24	0,33	0,41	0,36	0,47	0,57

The maximum increase in thickness or width due to the insulation may be exceeded, provided the overall thickness or width of the insulated wire does not exceed the sum of the maximum thickness or width of the bare wire plus the maximum increase in dimension given in the table above.

NOTE The minimum increases in dimensions apply only to the increase in thickness.

4.5 Overall dimensions

4.5.1 Nominal overall dimensions

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

4.5.3 Maximum overall dimensions

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

5 Electrical resistance

The resistance of the wire shall be expressed as the DC 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 $1/58 \Omega \text{ mm}^2 \text{ m}^{-1}$.

One measurement shall be made.

6 Elongation

The elongation at fracture shall be in accordance with Table 5.

Table 5 – Elongation

Nominal thickness of the conductor mm		Minimum elongation %
Over	Up to and including	
–	2,50	30
2,50	5,60	32

7 Springiness

The wire shall not exceed the maximum springback of:

- 5,0° for polyester-glass fibre covered bare wires
- 5,5° for polyester-glass fibre covered enamelled wires

8 Flexibility and adherence

8.1 Mandrel winding test

The covering shall show no crack after the wire has been bent flatwise and edgewise on a mandrel with a diameter as specified in Table 6.

Table 6 – Mandrel winding

Wire bent on		Mandrel diameter
Width	Sizes up to and including 8 mm	10 × width
	Sizes over 8 mm	15 × width
Thickness	All sizes	10 × thickness

Specimens showing no crack or opening shall meet the requirements of Clause 13.

8.2 Adherence test

8.2.1 Fibre covered bare wires

The specimen shall be elongated 20 %. There shall be no loosening, fraying or detachment of the covering except at the point of rupture.

8.2.2 Fibre covered enamelled wires

The specimen shall be elongated 20 %. There shall be either no loosening, fraying or detachment of the covering and no cracks visible in the coating without removing the glass-fiber covering.

9 Heat shock

Test inappropriate.

10 Cut-through

Test inappropriate.

11 Resistance to abrasion

Test inappropriate.

12 Resistance to solvents

Test inappropriate.

13 Breakdown voltage

The wire shall meet the requirements of Table 7.

Table 7 – Breakdown voltage

Type of insulation		Minimum breakdown voltage (root-mean-square value) (RMS) V
Bare conductor with	Single covering (PG1)	350
	Double covering (PG2)	560
Grade 1 enamelled wire with	Single covering (grade 1 PG1)	1 350
	Double covering (grade 1 PG2)	1 560
Grade 2 enamelled wire with	Single covering (grade 2 PG1)	2 350
	Double covering (grade 2 PG2)	2 560

14 Continuity of insulation

Test inappropriate.

15 Temperature index

The temperature index is dependent on the type of impregnating agent used. The method of test used shall be agreed between purchaser and supplier. The maximum service temperature shall be determined by experience.

16 Resistance to refrigerants

Test inappropriate.

17 Solderability

Test inappropriate.

18 Heat or solvent bonding

Test inappropriate.

19 Dielectric dissipation factor

Test inappropriate.

20 Resistance to transformer oil

Test inappropriate.

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. In order to reduce the risk of wire damage, the spool with the wire shall be delivered and used with the axis in horizontal position. No spool or container shall contain more than one length of wire unless agreed between 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 between 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's 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.

Annex A (informative)

Nominal cross-sectional areas for preferred and intermediate sizes

Table A.1 provides nominal cross-sectional areas for preferred and intermediate sizes of rectangular copper bare conductors, from which the user may select intermediate sizes only for technical reasons.

Table A.1 – Nominal cross-sectional areas

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
2,00	0,80	*	1,463
	0,85	*	1,545
	0,90	*	1,626
	0,95	*	1,706
	1,00	*	1,785
	1,06	0,5	1,905
	1,12	0,5	2,025
	1,18	0,5	2,145
	1,25	0,5	2,285
	1,32	0,5	2,425
	1,40	0,5	2,585
2,12	0,80	*	1,559
	0,90	*	1,734
	1,00	*	1,905
	1,12	0,5	2,160
	1,25	0,5	2,435
	1,40	0,5	2,753
2,24	0,80	*	1,655
	0,85	*	1,749
	0,90	*	1,842
	0,95	*	1,934
	1,00	*	2,025
	1,06	0,5	2,160
	1,12	0,5	2,294
	1,18	0,5	2,429
	1,25	0,5	2,585
	1,32	0,5	2,742
	1,40	0,5	2,921
	1,50	0,5	3,145
	1,60	0,5	3,369
2,36	0,80	*	1,751
	0,90	*	1,950
	1,00	*	2,145

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
2,50	1,25	0,5	2,910
	1,32	0,5	3,085
	1,40	0,5	3,285
	1,50	0,5	3,535
	1,60	0,5	3,785
	1,70	0,65	3,887
	1,80	0,65	4,137
2,65	0,80	*	1,983
	0,90	*	2,211
	1,00	*	2,435
	1,12	0,5	2,753
	1,25	0,5	3,098
	1,40	0,5	3,495
	1,60	0,5	4,025
	1,80	0,65	4,407
2,80	0,80	*	2,103
	0,85	*	2,225
	0,90	*	2,346
	0,95	*	2,466
	1,00	*	2,585
	1,06	0,5	2,753
	1,12	0,5	2,921
	1,18	0,5	3,089
	1,25	0,5	3,285
	1,32	0,5	3,481
	1,40	0,5	3,705
	1,50	0,5	3,985
	1,60	0,5	4,265
	1,70	0,65	4,397
	1,80	0,65	4,677
	1,90	0,65	4,957
	2,00	0,65	5,237

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	1,12	0,5	2,429
	1,25	0,5	2,735
	1,40	0,5	3,089
	1,60	0,5	3,561
2,50	0,80	*	1,863
	0,85	*	1,970
	0,90	*	2,076
	0,95	*	2,181
	1,00	*	2,285
	1,06	0,5	2,435
	1,12	0,5	2,585
	1,18	0,5	2,736
3,15	0,90	*	2,661
	0,95	*	2,799
	1,00	*	2,935
	1,06	0,5	3,124
	1,12	0,5	3,313
	1,18	0,5	3,502
	1,25	0,5	3,723
	1,32	0,5	3,943
	1,40	0,5	4,195
	1,50	0,5	4,510
	1,60	0,5	4,825
	1,70	0,65	4,992
	1,80	0,65	5,307
	1,90	0,65	5,622
	2,00	0,65	5,937
	2,12	0,65	6,315
	2,24	0,65	6,693
3,35	0,80	*	2,543
	0,90	*	2,841
	1,00	*	3,135
	1,12	0,5	3,537
	1,25	0,5	3,973
	1,40	0,5	4,475
	1,60	0,5	5,145
	1,80	0,65	5,667
	2,00	0,65	6,337
	2,24	0,65	7,141

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
3,00	0,80	*	2,263
	0,90	*	2,526
	1,00	*	2,785
	1,12	0,5	3,145
	1,25	0,5	3,535
	1,40	0,5	3,985
	1,60	0,5	4,585
	1,80	0,65	5,037
3,15	0,80	*	2,383
	0,85	*	2,522
3,75	0,80	*	2,863
	0,90	*	3,201
	1,00	*	3,535
	1,12	0,5	3,985
	1,25	0,5	4,473
	1,40	0,5	5,035
	1,60	0,5	5,785
	1,80	0,65	6,387
	2,00	0,65	7,137
	2,24	0,65	8,037
	2,50	0,8	8,826
4,00	0,80	*	3,063
	0,85	*	3,245
	0,90	*	3,426
	0,95	*	3,606
	1,00	*	3,785
	1,06	0,5	4,025
	1,12	0,5	4,265
	1,18	0,5	4,505
	1,25	0,5	4,785
	1,32	0,5	5,065
	1,40	0,5	5,385
	1,50	0,5	5,785
	1,60	0,5	6,185
	1,70	0,65	6,437
	1,80	0,65	6,837
	1,90	0,65	7,237

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
3,55	0,80	*	2,703
	0,85	*	2,862
	0,90	*	3,021
	0,95	*	3,179
	1,00	*	3,335
	1,06	0,5	3,548
	1,12	0,5	3,761
	1,18	0,5	3,974
	1,25	0,5	4,223
	1,32	0,5	4,471
	1,40	0,5	4,755
	1,50	0,5	5,110
	1,60	0,5	5,465
	1,70	0,65	5,672
	1,80	0,65	6,027
	1,90	0,65	6,382
	2,00	0,65	6,737
	2,12	0,65	7,163
	2,24	0,65	7,589
	2,36	0,8	7,829
	2,50	0,8	8,326
4,50	0,80	*	3,463
	0,85	*	3,670
	0,90	*	3,876
	0,95	*	4,081
	1,00	*	4,285
	1,06	0,5	4,555
	1,12	0,5	4,825
	1,18	0,5	5,095
	1,25	0,5	5,410
	1,32	0,5	5,725
	1,40	0,5	6,085
	1,50	0,5	6,535
	1,60	0,5	6,985
	1,70	0,65	7,287
	1,80	0,65	7,737
	1,90	0,65	8,187
	2,00	0,65	8,637
	2,12	0,65	9,177
	2,24	0,65	9,717
	2,36	0,8	10,07

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	2,00	0,65	7,637
	2,12	0,65	8,117
	2,24	0,65	8,597
	2,36	0,8	8,891
	2,50	0,8	9,451
	2,65	0,8	10,05
	2,80	0,8	10,65
4,25	0,80	*	3,263
	0,90	*	3,651
	1,00	*	4,035
	1,12	0,5	4,545
	1,25	0,5	5,098
	1,40	0,5	5,735
	1,60	0,5	6,585
	1,80	0,65	7,287
	2,00	0,65	8,137
	2,24	0,65	9,157
	2,50	0,8	10,08
	2,80	0,8	11,35
5,00	1,70	0,65	8,137
	1,80	0,65	8,637
	1,90	0,65	9,137
	2,00	0,65	9,637
	2,12	0,65	10,24
	2,24	0,65	10,84
	2,36	0,8	11,25
	2,50	0,8	11,95
	2,65	0,8	12,70
	2,80	0,8	13,45
	3,00	0,8	14,45
	3,15	0,8	15,20
	3,35	0,8	16,20
	3,55	0,8	17,20
5,30	0,80	*	4,103
	0,90	*	4,596
	1,00	*	5,085
	1,12	0,5	5,721
	1,25	0,5	6,410
	1,40	0,5	7,205

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	2,50	0,8	10,70
	2,65	0,8	11,38
	2,80	0,8	12,05
	3,00	0,8	12,95
	3,15	0,8	13,63
4,75	0,80	*	3,663
	0,90	*	4,101
	1,00	*	4,535
	1,12	0,5	5,105
	1,25	0,5	5,723
	1,40	0,5	6,435
	1,60	0,5	7,385
	1,80	0,65	8,188
	2,00	0,65	9,137
	2,24	0,65	10,28
	2,50	0,8	11,33
	2,80	0,8	12,75
	3,15	0,8	14,41
5,00	0,80	*	3,863
	0,85	*	4,095
	0,90	*	4,326
	0,95	*	4,556
	1,00	*	4,785
	1,06	0,5	5,085
	1,12	0,5	5,385
	1,18	0,5	5,685
	1,25	0,5	6,035
	1,32	0,5	6,385
	1,40	0,5	6,785
	1,50	0,5	7,285
	1,60	0,5	7,785
5,60	3,00	0,8	16,25
	3,15	0,8	17,09
	3,35	0,8	18,21
	3,55	0,8	19,33
	3,75	1,0	20,14
	4,00	1,0	21,54
6,00	0,80	*	4,663
	0,90	*	5,226

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	1,60	0,5	8,265
	1,80	0,65	9,177
	2,00	0,65	10,24
	2,24	0,65	11,51
	2,50	0,8	12,70
	2,80	0,8	14,29
	3,15	0,8	16,15
	3,55	0,8	18,27
5,60	0,80	*	4,343
	0,85	*	4,605
	0,90	*	4,866
	0,95	*	5,126
	1,00	*	5,385
	1,06	0,5	5,721
	1,12	0,5	6,057
	1,18	0,5	6,393
	1,25	0,5	6,785
	1,32	0,5	7,177
	1,40	0,5	7,625
	1,50	0,5	8,185
	1,60	0,5	8,745
	1,70	0,65	9,157
	1,80	0,65	9,717
	1,90	0,65	10,28
	2,00	0,65	10,84
	2,12	0,65	11,51
	2,24	0,65	12,18
	2,36	0,8	12,67
	2,50	0,8	13,45
	2,65	0,8	14,29
	2,80	0,8	15,13
6,30	3,75	1,0	22,77
	4,00	1,0	24,34
	4,25	1,0	25,92
	4,50	1,0	27,49
6,70	0,90	*	5,856
	1,00	*	6,485
	1,12	0,5	7,289
	1,25	0,5	8,160

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	1,00	*	5,785
	1,12	0,5	6,505
	1,25	0,5	7,285
	1,40	0,5	8,185
	1,60	0,5	9,385
	1,80	0,65	10,44
	2,00	0,65	11,64
	2,24	0,65	13,08
	2,50	0,8	14,45
	2,80	0,8	16,25
	3,15	0,8	18,35
	3,55	0,8	20,75
	4,00	1,0	23,14
6,30	0,80	*	4,903
	0,85	*	5,200
	0,90	*	5,496
	0,95	*	5,791
	1,00	*	6,085
	1,06	0,5	6,463
	1,12	0,5	6,841
	1,18	0,5	7,219
	1,25	0,5	7,660
	1,32	0,5	8,101
	1,40	0,5	8,605
	1,50	0,5	9,235
	1,60	0,5	9,865
	1,70	0,65	10,35
	1,80	0,65	10,98
	1,90	0,65	11,61
	2,00	0,65	12,24
	2,12	0,65	12,99
	2,24	0,65	13,75
	2,36	0,8	14,32
	2,50	0,8	15,20
	2,65	0,8	16,15
	2,80	0,8	17,09
	3,00	0,8	18,35
	3,15	0,8	19,30
	3,35	0,8	20,56

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	1,40	0,5	9,165
	1,60	0,5	10,51
	1,80	0,65	11,70
	2,00	0,65	13,04
	2,24	0,65	14,65
	2,50	0,8	16,20
	2,80	0,8	18,21
	3,15	0,8	20,56
	3,55	0,8	23,24
	4,00	1,0	25,94
	4,50	1,0	29,29
7,10	0,90	*	6,216
	0,95	*	6,551
	1,00	*	6,885
	1,06	0,5	7,311
	1,12	0,5	7,737
	1,18	0,5	8,163
	1,25	0,5	8,660
	1,32	0,5	9,157
	1,40	0,5	9,725
	1,50	0,5	10,44
	1,60	0,5	11,15
	1,70	0,65	11,71
	1,80	0,65	12,42
	1,90	0,65	13,13
	2,00	0,65	13,84
	2,12	0,65	14,69
	2,24	0,65	15,54
	2,36	0,8	16,21
	2,50	0,8	17,20
	2,65	0,8	18,27
	2,80	0,8	19,33
	3,00	0,8	20,75
	3,15	0,8	21,82
	3,35	0,8	23,24
	3,55	0,8	24,66
	3,75	1,0	25,77
	4,00	1,0	27,54
	4,25	1,0	29,32

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	3,55	0,8	21,82
7,10	4,50	1,0	31,09
	4,75	1,0	32,87
	5,00	1,0	34,64
7,50	1,00	*	7,285
	1,12	0,5	8,185
	1,25	0,5	9,160
	1,40	0,5	10,29
	1,60	0,5	11,79
	1,80	0,65	13,14
	2,00	0,65	14,64
	2,24	0,65	16,44
	2,50	0,8	18,20
	2,80	0,8	20,45
	3,15	0,8	23,08
	3,55	0,8	26,08
	4,00	1,0	29,14
	4,50	1,0	32,89
	5,00	1,0	36,64
8,00	1,00	*	7,785
	1,06	0,5	8,265
	1,12	0,5	8,745
	1,18	0,5	9,225
	1,25	0,5	9,785
	1,32	0,5	10,35
	1,40	0,5	10,99
	1,50	0,5	11,79
	1,60	0,5	12,59
	1,70	0,65	13,24
	1,80	0,65	14,04
	1,90	0,65	14,84
	2,00	0,65	15,64
	2,12	0,65	16,60
	2,24	0,65	17,56
	2,36	0,8	18,33
	2,50	0,8	19,45

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
8,50	1,12	0,5	9,305
	1,25	0,5	10,41
	1,40	0,5	11,69
	1,60	0,5	13,39
	1,80	0,65	14,94
	2,00	0,65	16,64
	2,24	0,65	18,68
	2,50	0,8	20,70
	2,80	0,8	23,25
	3,15	0,8	26,23
	3,55	0,8	29,63
	4,00	1,0	33,14
	4,50	1,0	37,39
	5,00	1,0	41,64
	5,60	1,0	46,74
9,00	1,12	0,5	9,865
	1,18	0,5	10,41
	1,25	0,5	11,04
	1,32	0,5	11,67
	1,40	0,5	12,39
	1,50	0,5	13,29
	1,60	0,5	14,19
	1,70	0,65	14,94
	1,80	0,65	15,84
	1,90	0,65	16,74
	2,00	0,65	17,64
	2,12	0,65	18,72
	2,24	0,65	19,80
	2,36	0,8	20,69
	2,50	0,8	21,95
	2,65	0,8	23,30
	2,80	0,8	24,65
	3,00	0,8	26,45
	3,15	0,8	27,80
	3,35	0,8	29,60
	3,55	0,8	31,40
	3,75	1,0	32,89

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	2,65	0,8	20,65
	2,80	0,8	21,85
	3,00	0,8	23,45
	3,15	0,8	24,65
	3,35	0,8	26,25
	3,55	0,8	27,85
	3,75	1,0	29,14
	4,00	1,0	31,14
	4,25	1,0	33,14
	4,50	1,0	35,14
	4,75	1,0	37,14
	5,00	1,0	39,14
	5,30	1,0	41,54
	5,60	1,0	43,94
9,50	2,50	0,8	23,20
	2,80	0,8	26,05
	3,15	0,8	29,38
	3,55	0,8	33,18
	4,00	1,0	37,14
	4,50	1,0	41,89
	5,00	1,0	46,64
	5,60	1,0	52,34
10,00	1,25	0,5	12,29
	1,32	0,5	12,99
	1,40	0,5	13,79
	1,50	0,5	14,79
	1,60	0,5	15,79
	1,70	0,65	16,64
	1,80	0,65	17,64
	1,90	0,65	18,64
	2,00	0,65	19,64
	2,12	0,65	20,84
	2,24	0,65	22,04
	2,36	0,8	23,05
	2,50	0,8	24,45
	2,65	0,8	25,95
	2,80	0,8	27,45
	3,00	0,8	29,45
	3,15	0,8	30,95
	3,35	0,8	32,95
	3,55	0,8	34,95

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	4,00	1,0	35,14
	4,25	1,0	37,39
	4,50	1,0	39,64
	4,75	1,0	41,89
	5,00	1,0	44,14
	5,30	1,0	46,84
	5,60	1,0	49,54
9,50	1,25	0,5	11,66
	1,40	0,5	13,09
	1,60	0,5	14,99
	1,80	0,65	16,74
	2,00	0,65	18,64
	2,24	0,65	20,92
11,20	1,70	0,65	18,68
	1,80	0,65	19,80
	1,90	0,65	20,92
	2,00	0,65	22,04
	2,12	0,65	23,38
	2,24	0,65	24,73
	2,36	0,8	25,88
	2,50	0,8	27,45
	2,65	0,8	29,13
	2,80	0,8	30,81
	3,00	0,8	33,05
	3,15	0,8	34,73
	3,35	0,8	36,97
	3,55	0,8	39,21
	3,75	1,0	41,14
	4,00	1,0	43,94
	4,25	1,0	46,74
	4,50	1,0	49,54
	4,75	1,0	52,34
	5,00	1,0	55,14
	5,30	1,0	58,50
	5,60	1,0	61,86
11,80	1,60	0,5	18,67
	1,80	0,65	20,88
	2,00	0,65	23,24
	2,24	0,65	26,07
	2,50	0,8	28,95

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	3,75	1,0	36,64
	4,00	1,0	39,14
	4,25	1,0	41,64
	4,50	1,0	44,14
	4,75	1,0	46,64
	5,00	1,0	49,14
	5,30	1,0	52,14
	5,60	1,0	55,14
10,60	1,40	0,5	14,63
	1,60	0,5	16,75
	1,80	0,65	18,72
	2,00	0,65	20,84
	2,24	0,65	23,38
	2,50	0,8	25,95
	2,80	0,8	29,13
	3,15	0,8	32,84
	3,55	0,8	37,08
	4,00	1,0	41,54
	4,50	1,0	46,84
	5,00	1,0	52,14
	5,60	1,0	58,50
11,20	1,40	0,5	15,47
	1,50	0,5	16,59
	1,60	0,5	17,71
12,50	4,50	1,0	55,39
	4,75	1,0	58,52
	5,00	1,0	61,64
	5,30	1,0	65,39
	5,60	1,0	69,14
13,20	1,80	0,65	23,40
	2,00	0,65	26,04
	2,24	0,65	29,21
	2,50	0,8	32,45
	2,80	0,8	36,41
	3,15	0,8	41,03
	3,55	0,8	46,31
	4,00	1,0	51,94
	4,50	1,0	58,54

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	2,80	0,8	32,49
	3,15	0,8	36,62
	3,55	0,8	41,34
	4,00	1,0	46,34
	4,50	1,0	52,24
	5,00	1,0	58,14
	5,60	1,0	65,22
12,50	1,60	0,5	19,79
	1,70	0,65	20,89
	1,80	0,65	22,14
	1,90	0,65	23,39
	2,00	0,65	24,64
	2,12	0,65	26,14
	2,24	0,65	27,64
	2,36	0,8	28,95
	2,50	0,8	30,70
	2,65	0,8	32,58
	2,80	0,8	34,45
	3,00	0,8	36,95
	3,15	0,8	38,83
	3,35	0,8	41,33
	3,55	0,8	43,83
	3,75	1,0	46,02
	4,00	1,0	49,14
	4,25	1,0	52,27
14,00	4,75	1,0	65,64
	5,00	1,0	69,14
	5,30	1,0	73,34
	5,60	1,0	77,54
15,00	2,00	0,65	29,64
	2,24	0,65	33,24
	2,50	0,8	36,95
	2,80	0,8	41,45
	3,15	0,8	46,70
	3,55	0,8	52,70
	4,00	1,0	59,14
	4,50	1,0	66,64
	5,00	1,0	74,14
	5,60	1,0	83,14

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
	5,00	1,0	65,14
	5,60	1,0	73,06
14,00	1,80	0,65	24,84
	1,90	0,65	26,24
	2,00	0,65	27,64
	2,12	0,65	29,32
	2,24	0,65	31,00
	2,36	0,8	32,49
	2,50	0,8	34,45
	2,65	0,8	36,55
	2,80	0,8	38,65
	3,00	0,8	41,45
	3,15	0,8	43,55
	3,35	0,8	46,35
	3,55	0,8	49,15
	3,75	1,0	51,64
	4,00	1,0	55,14
	4,25	1,0	58,64
	4,50	1,0	62,14

Nominal width	Nominal thickness	Radius on corners	Nominal cross-sectional area
mm	mm	mm	mm ²
16,00	2,00	0,65	31,64
	2,12	0,65	33,56
	2,24	0,65	35,48
	2,36	0,8	37,21
	2,50	0,8	39,45
	2,65	0,8	41,85
	2,80	0,8	44,25
	3,00	0,8	47,45
	3,15	0,8	49,85
	3,35	0,8	53,05
	3,55	0,8	56,25
	3,75	1,0	59,14
	4,00	1,0	63,14
	4,25	1,0	67,14
	4,50	1,0	71,14
	4,75	1,0	75,14
	5,00	1,0	79,14
	5,30	1,0	83,94
	5,60	1,0	88,74

* 0,5 nominal thickness.

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019.PDF

Bibliography

IEC 60264 (all parts), *Packaging of winding wires*

IEC 60317 (all parts), *Specifications for particular types of winding wires*

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

SOMMAIRE

AVANT-PROPOS	30
INTRODUCTION	32
1 Domaine d'application	33
2 Références normatives	33
3 Termes, définitions et notes générales sur les essais et l'aspect	33
3.1 Termes et définitions	33
3.2 Notes générales	34
3.2.1 Méthodes d'essai	34
3.2.2 Fil de bobinage	35
3.3 Aspect	35
4 Dimensions	36
4.1 Dimensions du conducteur	36
4.2 Tolérance sur les dimensions du conducteur	38
4.3 Arrondi des angles	38
4.4 Accroissement des dimensions dû à l'isolant	38
4.5 Dimensions extérieures	40
4.5.1 Dimensions extérieures nominales	40
4.5.2 Dimensions extérieures minimales	40
4.5.3 Dimensions extérieures maximales	40
5 Résistance électrique	40
6 Allongement	40
7 Effet de ressort	40
8 Souplesse et adhérence	41
8.1 Essai d'enroulement sur mandrin	41
8.2 Essai d'adhérence	41
8.2.1 Fils nus recouverts de fibres	41
8.2.2 Fils émaillés recouverts de fibres	41
9 Choc thermique	41
10 Thermoplasticité	41
11 Résistance à l'abrasion	41
12 Résistance aux solvants	41
13 Tension de claquage	41
14 Continuité de l'isolant	42
15 Indice de température	42
16 Résistance aux réfrigérants	42
17 Brasabilité	42
18 Adhérence par chaleur ou par solvant	42
19 Facteur de dissipation diélectrique	42
20 Résistance à l'huile de transformateur	42
21 Perte de masse	42
23 Détection des microfissures en immersion	43
30 Conditionnement	43

Annexe A (informative) Sections nominales des dimensions préférentielles et intermédiaires	44
Bibliographie.....	53
Tableau 1 – Sections nominales des dimensions préférentielles	37
Tableau 2 – Tolérances du conducteur	38
Tableau 3 – Rayons d'arrondi	38
Tableau 4 – Accroissement des dimensions.....	39
Tableau 5 – Allongement	40
Tableau 6 – Enroulement sur mandrin.....	41
Tableau 7 – Tension de claquage	42
Tableau A.1 – Sections nominales	44

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

SPÉCIFICATIONS POUR TYPES PARTICULIERS DE FILS DE BOBINAGE –

Partie 0-8: Exigences générales – Fil de section rectangulaire en cuivre nu ou émaillé, guipé de fibres de verre avec polyester fondues sans vernis, ou imprégnées de résine ou de vernis

AVANT-PROPOS

- 1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s)" de l'IEC). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 60317-0-8 a été établie par le comité d'études 55 de l'IEC: Fils de bobinage.

Cette deuxième édition annule et remplace la première édition parue en 2012. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) révision du titre de la norme indiquant que l'enveloppe de fibre de verre est fondue et sans vernis;

- b) révision du paragraphe 3.2 comprenant l'ajout d'exigences pour les fils de bobinage pour l'enveloppe fibreuse et une liste de classifications d'enveloppes;
- c) révision des exigences du paragraphe 3.3 relatives à l'aspect;
- d) révision du paragraphe 8.2, exigences portant sur l'essai d'adhérence.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
55/1784/FDIS	55/1796/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 60317, publiées sous le titre général *Spécifications pour types particuliers de fils de bobinage*, peut être consultée sur le site web de l'IEC.

La numérotation des articles dans la présente norme n'est pas continue entre les Articles 21 et 30 afin de permettre l'introduction d'éventuelles futures exigences pour les fils avant celles concernant le conditionnement des fils.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

La présente partie de l'IEC 60317 appartient à une série de normes traitant des fils isolés utilisés pour les enroulements des appareils électriques. L'ensemble est composé des trois séries de normes suivantes:

- 1) *Fils de bobinage – Méthodes d'essai* (IEC 60851);
- 2) *Spécifications pour types particuliers de fils de bobinage* (IEC 60317);
- 3) *Conditionnement des fils de bobinage* (IEC 60264).

IECNORM.COM : Click to view the full PDF of IEC 60317-0-8:2019 RLV

SPÉCIFICATIONS POUR TYPES PARTICULIERS DE FILS DE BOBINAGE –

Partie 0-8: Exigences générales – Fil de section rectangulaire en cuivre nu ou émaillé, guipé de fibres de verre avec polyester fondues sans vernis, ou imprégnées de résine ou de vernis

1 Domaine d'application

La présente partie de l'IEC 60317 spécifie les exigences générales pour les fils de bobinage de section rectangulaire en cuivre nus ou émaillés, soit de grade 1 soit de grade 2, guipés de fibres de verre avec polyester fondues, non vernies, ou imprégnées de résine ou de vernis.

La gamme des dimensions nominales des conducteurs est donnée au 4.1 et dans la feuille de spécification correspondante.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60851 (toutes les parties), *Fils de bobinage – Méthodes d'essai*

ISO 3, *Nombres normaux – Séries de nombres normaux*

3 Termes, définitions et notes générales sur les essais et l'aspect

3.1 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse <http://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <http://www.iso.org/obp>

3.1.1

revêtement

matériau qui est déposé sur un conducteur ou sur un fil par des moyens appropriés, puis séché et/ou cuit

3.1.2

conducteur

métal nu après enlèvement de l'isolant

3.1.3

enveloppe

matériau enroulé, rubané ou tressé autour d'un conducteur nu ou isolé

3.1.4

craquelure

fente dans l'isolant qui rend le conducteur visible sous un grossissement donné

3.1.5

fil émaillé

fil revêtu d'un isolant fait d'une résine cuite

3.1.6

fondue

état des fibres avec polyester ayant subi une fusion puis une resolidification pour permettre le soutien/l'adhérence des fibres de verre

3.1.7

grade

gamme d'épaisseurs d'isolant d'un fil

3.1.8

isolant

revêtement ou enveloppe sur le conducteur qui a pour fonction particulière de supporter la tension électrique

3.1.9

dimension nominale du conducteur

désignation de la taille du conducteur selon l'IEC 60317 (toutes les parties)

3.1.10

vision normale

vision de 20/20, avec si nécessaire des lentilles correctives

3.1.11

fil de bobinage

fil utilisé pour fabriquer un bobinage qui fournit un champ magnétique

3.1.12

fil

conducteur revêtu ou enveloppé d'un isolant

3.2 Notes générales

3.2.1 Méthodes d'essai

Toutes les méthodes d'essai à utiliser dans le présent document figurent dans la série IEC 60851.

Les numéros d'articles du présent document sont identiques aux numéros d'essais respectifs de la série IEC 60851.

En cas de divergences entre la série IEC 60851 et le présent document, l'IEC 60317-0-8 doit prévaloir.

Dans le cas où aucune gamme spécifique des dimensions nominales des conducteurs n'est donnée pour un essai, l'essai s'applique à toutes les dimensions nominales des conducteurs couvertes par la feuille de spécification.

Sauf spécification contraire, tous les essais doivent être effectués à une température comprise entre 15 °C et 40°C et à une humidité relative de 25 % à 75 %. Avant l'exécution des mesures, les éprouvettes doivent être préconditionnées dans ces conditions atmosphériques pendant un temps suffisant pour que ces éprouvettes atteignent la stabilité.

Le fil à soumettre à l'essai doit être retiré de son conditionnement de façon qu'il ne soit pas soumis à une tension ou à des pliages inutiles. Avant chaque essai, il convient d'éliminer une longueur de fil suffisante pour être sûr que les éprouvettes d'essai ne comportent aucun fil endommagé.

3.2.2 Fil de bobinage

L'enveloppe de la fibre doit être constituée d'une combinaison de fibres avec polyester et de fibres de verre. Les fibres de verre doivent être composées d'un fil de verre à filament continu de grade électrique. La fibre avec polyester doit être un fil de grade élevé résultant de la polymérisation linéaire de l'éthylène glycol et de l'acide téréphtalique. La teneur maximale en poids de fibre avec polyester dans le fil ne doit pas dépasser 50 %.

Le revêtement doit être caractérisé par les différents grades d'épaisseur suivants:

- PG1, conducteur nu avec 1 couche de fibre de verre avec polyester ou 2 couches de fibres de verre avec polyester plus minces qui, ensemble, satisfont aux exigences dimensionnelles du Tableau 1;
- PG2, conducteur nu avec 2 couches de fibre de verre avec polyester;
- Grade 1 PG1, grade 1 émaillé (grade 1) avec 1 couche de fibre de verre avec polyester (PG1);
- Grade 1 PG2, grade 1 émaillé (grade 1) avec 2 couches de fibre de verre avec polyester (PG2);
- Grade 2 PG1, grade 2 émaillé (grade 2) avec 1 couche de fibre de verre avec polyester (PG1);
- Grade 2 PG2, grade 2 émaillé (grade 2) avec 2 couches de fibre de verre avec polyester (PG2).

Quand il est fait référence à un fil de bobinage conforme à une norme de la série IEC 60317, les informations suivantes sont données dans la description:

- la référence de la spécification IEC;
- les dimensions nominales du conducteur en millimètres (largeur × épaisseur);
- le grade.

EXEMPLE IEC 60317-60 – 4,00 × 1,00 Grade 2PG1.

3.3 Aspect

L'enveloppe fibreuse doit être essentiellement lisse et uniforme, selon accord entre le client et le fournisseur conformément aux bonnes pratiques commerciales, et exempt de l'endommagement physique et de corps étranger, lorsqu'elle est examinée avec une vision normale, telle qu'enroulée sur la bobine d'origine. Les fibres doivent adhérer au fil émaillé ou nu sous-jacent.

NOTE Les preuves d'endommagement physique comprennent les entailles, les brins de fibre cassés et autres éléments similaires.

4 Dimensions

4.1 Dimensions du conducteur

Les dimensions pour les largeurs et les épaisseurs des conducteurs des fils de bobinage de section nominale rectangulaire recommandées dans la présente partie de l'IEC 60317 doivent être conformes au Tableau 1, et correspondent à la série R 20 de l'ISO 3.

Les dimensions préférentielles combinent une largeur et une épaisseur selon les séries R 20 et R 40.

Les dimensions intermédiaires combinent une largeur et une épaisseur selon la série R 20 et avec l'autre dimension conforme à la série R 40.

La présente partie de l'IEC 60317 couvre:

- les largeurs de 2,00 mm jusques et y compris 16,00 mm;
- les épaisseurs de 0,80 mm jusques et y compris 5,60 mm.

Pour les épaisseurs supérieures à 5,60 mm jusques et y compris 10 mm et pour les largeurs supérieures à 16 mm jusques et y compris 25 mm, la série R 40 doit être utilisée dans le cas où des dimensions supplémentaires peuvent être nécessaires pour des raisons techniques. Le rapport largeur/épaisseur doit rester dans les limites spécifiées et les combinaisons série R 40 - série R 40 ne sont pas autorisées en cas de dimensions supplémentaires.

Le rapport largeur/épaisseur doit être supérieur ou égal à 1,4:1 et ne doit pas dépasser 8:1.

Les valeurs réelles des dimensions sont données dans le Tableau 1.

Les sections nominales des dimensions préférentielles sont données dans le Tableau 1 et les sections nominales des dimensions intermédiaires sont données dans le Tableau A.1 de l'Annexe A.

Tableau 1 – Sections nominales des dimensions préférentielles

Epaisseur																			Largeur	
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		
	Rayon d'arrondi (0,5 mm*)														Rayon d'arrondi (0,80 mm*)				Rayon d'arrondi (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												
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	Non recommandé														43,94	49,54	55,14	61,86		
14,0	Rapport largeur/épaisseur supérieur à 8:1														49,14	55,39	61,64	69,14		
16,0								24,84	27,64	31,00	34,45	38,65	43,55	49,15	55,14	62,14	69,14	77,54		
									31,64	35,48	39,45	44,25	49,85	56,25	63,14	71,14	79,14	88,74		

* Epaisseur nominale.

NOTE Les dimensions de la série R 20 sont imprimées en caractères plus gros.

4.2 Tolérance sur les dimensions du conducteur

Les dimensions du conducteur ne doivent pas s'écarter des valeurs nominales d'une valeur supérieure à la tolérance donnée dans le Tableau 2.

Tableau 2 – Tolérances du conducteur

Largeur ou épaisseur nominale du conducteur mm		Tolérance mm
Supérieure à	Jusques et y compris	
–	3,15	± 0,030
3,15	6,30	± 0,050
6,30	12,50	± 0,070
12,50	16,00	± 0,100

4.3 Arrondi des angles

L'arrondi doit se raccorder progressivement aux surfaces planes du conducteur et le méplat ne doit présenter aucune aspérité, rugosité ou bavure. Les rayons d'arrondi du conducteur doivent être conformes aux valeurs du Tableau 3. Les rayons spécifiés doivent se maintenir dans les limites de $\pm 25\%$.

Tableau 3 – Rayons d'arrondi

Epaisseur nominale du conducteur mm		Rayon d'arrondi mm
Supérieure à	Jusques et y compris	
–	1,00	0,5 épaisseur nominale
1,00	1,60	0,50*
1,60	2,24	0,65**
2,24	3,55	0,80
3,55	5,60	1,00

En cas d'accord entre acheteur et fournisseur, les rayons d'arrondi pour les fils dont la largeur est supérieure à 4,8 mm peuvent être:

* 0,5 mm épaisseur nominale

** 0,8 mm

4.4 Accroissement des dimensions dû à l'isolant

L'accroissement de la largeur ou de l'épaisseur dû à l'isolant doit être tel que spécifié dans le Tableau 4.