

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

Specifications for particular types of winding wires –  
Part 0-2: General requirements – Enamelled rectangular copper wire

Spécifications pour types particuliers de fils de bobinage –  
Partie 0-2: Exigences générales – Fil de section rectangulaire en cuivre émaillé

ITeH STANDARD PREVIEW  
(standards.iteh.ai)

IEC 60317-0-2:2013

<https://standards.iteh.ai/catalog/standards/sist/c601b755-04cc-4476-81db-0ce72000f989/iec-60317-0-2-2013>

0ce72000f989/iec-60317-0-2-2013



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2013 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

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

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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 corrigenda or an amendment might have been published.

#### Useful links:

IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables you 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](http://webstore.iec.ch/justpublished)

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

Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - [webstore.iec.ch/csc](http://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: [csc@iec.ch](mailto:csc@iec.ch).

### A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Liens utiles:

Recherche de publications CEI - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée vous permet de trouver des publications CEI en utilisant différents critères (numéro de référence, texte, comité d'études,...).

Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

Just Published CEI - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications de la CEI. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).



# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

Specifications for particular types of winding wires –  
Part 0-2: General requirements – Enamelled rectangular copper wire

Spécifications pour types particuliers de fils de bobinage –  
Partie 0-2: Exigences générales – Fil de section rectangulaire en cuivre émaillé

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
CODE PRIX

T

ICS 29.060.10

ISBN 978-2-8322-1149-6

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

|   |    |
|---|----|
| FOREWORD.....   | 4  |
| INTRODUCTION.....   | 6  |
| 1 Scope.....  | 7  |
| 2 Normative references.....   | 7  |
| 3 Terms, definitions, general notes and appearance.....                                       | 7  |
| 3.1 Terms and definitions .....   | 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.....  | 9  |
| 4.3 Rounding of corners .....   | 10 |
| 4.4 Increase in dimensions due to the insulation .....  | 12 |
| 4.5 Overall dimensions .....  | 12 |
| 4.5.1 Nominal overall dimensions.....   | 12 |
| 4.5.2 Minimum overall dimensions.....   | 12 |
| 4.5.3 Maximum overall dimensions.....   | 12 |
| 5 Electrical resistance.....  | 13 |
| 6 Elongation .....  | 13 |
| 7 Springiness.....  | 13 |
| 8 Flexibility and adherence .....   | 13 |
| 8.1 Mandrel winding test.....   | 13 |
| 8.2 Adherence test .....  | 13 |
| 9 Heat shock .....  | 14 |
| 10 Cut-through .....  | 14 |
| 11 Resistance to abrasion .....   | 14 |
| 12 Resistance to solvents .....   | 14 |
| 13 Breakdown voltage .....  | 14 |
| 14 Continuity of insulation.....  | 14 |
| 15 Temperature index.....   | 14 |
| 16 Resistance to refrigerants .....   | 15 |
| 17 Solderability.....   | 15 |
| 18 Heat or solvent bonding .....  | 15 |
| 19 Dielectric dissipation factor .....  | 15 |
| 20 Resistance to transformer oil .....  | 15 |
| 21 Loss of mass .....   | 15 |
| 23 Pin hole test .....  | 15 |
| 30 Packaging.....   | 15 |
| Annex A (informative) Nominal cross-sectional areas for preferred and intermediate sizes..... | 17 |
| Bibliography.....   | 25 |

ITih STANDARD PREVIEW

(standards.iteh.ai)

IEC 60317-0-2:2013

[https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-](https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0cc720001989/iec-60317-0-2-2013)

[0cc720001989/iec-60317-0-2-2013](https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0cc720001989/iec-60317-0-2-2013)

|  |    |
|--|----|
| Table 1 – Conductor tolerances .....   | 10 |
| Table 2 – Nominal cross-sectional areas of preferred sizes.....  | 11 |
| Table 3 – Corner radii .....   | 12 |
| Table 4 – Increases in dimensions.....   | 12 |
| Table 5 – Elongation .....   | 13 |
| Table 6 – Mandrel winding.....   | 13 |
| Table 7 – Breakdown voltage .....  | 14 |
| Table A.1 – Nominal cross-sectional areas (1 of 7) .....   | 17 |
| Table B.1 – Tolerances for calculating special maximum and minimum dimensions of grade 2 rectangular wire..... | 24 |

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[IEC 60317-0-2:2013](https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013)

<https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013>

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

### Part 0-2: General requirements – 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.  
<https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db->
- 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 60317-0-2 has been prepared by IEC technical committee 55: Winding wires.

This third edition cancels and replaces the second edition published in 1997, Amendment 1:1999 and Amendment 2:2005. This edition constitutes a technical revision.

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

- addition of 3.2.2, transferring general winding wire requirements from the scope;
- correction to Table 7 units;
- change to Clause 15 requirements with a simple reference to IEC 60172;
- deletion of Annex E.

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

| FDIS         | Report on voting |
|--------------|------------------|
| 55/1410/FDIS | 55/1431/RVD      |

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

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

This International standard is to be read in conjunction with the IEC 60851 series. The clause numbers used in this part of IEC 60317 are identical with the respective test numbers of IEC 60851 series.

In case of inconsistencies between IEC 60851 and this part of IEC 60317, the latter prevails.

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

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

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

- reconfirmed, [IEC 60317-0-2:2013](#)
- withdrawn, <https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-72000f989/iec-60317-0-2-2013>
- replaced by a revised edition, or
- amended.

## INTRODUCTION

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

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

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[IEC 60317-0-2:2013](https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013)

<https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013>



## SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES –

### Part 0-2: General requirements – Enamelled rectangular copper wire

#### 1 Scope

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

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

#### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

iTeh STANDARD PREVIEW

IEC 60172, *Test procedure for the determination of the temperature index of enamelled winding wires*

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

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

#### 3 Terms, definitions, general notes and appearance

##### 3.1 Terms and definitions

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

###### 3.1.1

###### class

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

###### 3.1.2

###### coating

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

###### 3.1.3

###### conductor

bare metal after removal of the insulation

###### 3.1.4

###### crack

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

**3.1.5**

**dual coating**

insulation composed of two different materials, an underlying and a superimposed coating

**3.1.6**

**enamelled wire**

wire coated with an insulation of cured resin

**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 the IEC 60317 series

**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

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[IEC 60317-0-2:2013](https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013)

<https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013>

**3.2 General notes**

**3.2.1 Methods of test**

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

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

In case of inconsistencies between the publication on methods of test and this standard, IEC 60317-0-2 shall prevail.

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

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

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

### 3.2.2 Winding wire

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

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

EXAMPLE: IEC 60317-17 – 4,00 × 1,00 Grade 1

### 3.3 Appearance

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

## 4 Dimensions

### 4.1 Conductor dimensions

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

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

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

This standard covers:

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

For thicknesses over 5,60 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 20 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 2\*.

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

### 4.2 Tolerance on conductor dimensions

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

---

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

**Table 1 – Conductor tolerances**

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

### 4.3 Rounding of corners

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

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[IEC 60317-0-2:2013](https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013)

<https://standards.iteh.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013>

Table 2 – Nominal cross-sectional areas of preferred sizes

| Width<br>mm | Thickness<br>mm       |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|-------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|             | Corner radius 0.5 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   |        |
|             | Corner radius 0.65 mm |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|             | Corner radius 0.8 mm  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|             | Corner radius 1.0 mm  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| 2.00        | 1.463                 | 1.626  | 1.785  | 1.944  | 2.103  | 2.025  | 2.285  | 2.585  | 2.910  | 3.285  | 3.785  | 4.137  | 4.677  | 5.237  | 5.813  | 6.403  | 7.005  | 7.627  |
| 2.12        | 1.655                 | 1.842  | 2.025  | 2.212  | 2.400  | 2.294  | 2.585  | 2.921  | 3.285  | 3.785  | 4.290  | 4.800  | 5.325  | 5.865  | 6.420  | 7.000  | 7.595  | 8.205  |
| 2.36        | 1.963                 | 2.076  | 2.285  | 2.500  | 2.720  | 2.585  | 2.910  | 3.285  | 3.785  | 4.290  | 4.800  | 5.325  | 5.865  | 6.420  | 7.000  | 7.595  | 8.205  | 8.820  |
| 2.50        | 1.863                 | 2.076  | 2.285  | 2.500  | 2.720  | 2.585  | 2.910  | 3.285  | 3.785  | 4.290  | 4.800  | 5.325  | 5.865  | 6.420  | 7.000  | 7.595  | 8.205  | 8.820  |
| 2.65        | 1.863                 | 2.076  | 2.285  | 2.500  | 2.720  | 2.585  | 2.910  | 3.285  | 3.785  | 4.290  | 4.800  | 5.325  | 5.865  | 6.420  | 7.000  | 7.595  | 8.205  | 8.820  |
| 2.80        | 2.103                 | 2.346  | 2.585  | 2.824  | 3.063  | 2.921  | 3.285  | 3.785  | 4.290  | 4.800  | 5.325  | 5.865  | 6.420  | 7.000  | 7.595  | 8.205  | 8.820  | 9.435  |
| 3.00        | 2.346                 | 2.585  | 2.824  | 3.063  | 3.302  | 3.160  | 3.524  | 4.024  | 4.524  | 5.024  | 5.524  | 6.024  | 6.524  | 7.024  | 7.524  | 8.024  | 8.524  | 9.024  |
| 3.15        | 2.383                 | 2.661  | 2.935  | 3.209  | 3.483  | 3.313  | 3.723  | 4.195  | 4.625  | 5.013  | 5.400  | 5.787  | 6.174  | 6.561  | 6.948  | 7.335  | 7.722  | 8.109  |
| 3.35        | 2.661                 | 3.021  | 3.335  | 3.650  | 3.965  | 3.761  | 4.223  | 4.755  | 5.287  | 5.820  | 6.353  | 6.886  | 7.419  | 7.952  | 8.485  | 9.018  | 9.551  | 10.084 |
| 3.55        | 2.703                 | 3.021  | 3.335  | 3.650  | 3.965  | 3.761  | 4.223  | 4.755  | 5.287  | 5.820  | 6.353  | 6.886  | 7.419  | 7.952  | 8.485  | 9.018  | 9.551  | 10.084 |
| 3.75        | 3.021                 | 3.426  | 3.785  | 4.144  | 4.503  | 4.265  | 4.785  | 5.385  | 5.985  | 6.585  | 7.185  | 7.785  | 8.385  | 8.985  | 9.585  | 10.185 | 10.785 | 11.385 |
| 4.00        | 3.063                 | 3.426  | 3.785  | 4.144  | 4.503  | 4.265  | 4.785  | 5.385  | 5.985  | 6.585  | 7.185  | 7.785  | 8.385  | 8.985  | 9.585  | 10.185 | 10.785 | 11.385 |
| 4.25        | 3.426                 | 3.785  | 4.144  | 4.503  | 4.862  | 4.365  | 4.965  | 5.565  | 6.165  | 6.765  | 7.365  | 7.965  | 8.565  | 9.165  | 9.765  | 10.365 | 10.965 | 11.565 |
| 4.50        | 3.463                 | 3.876  | 4.285  | 4.694  | 5.103  | 4.825  | 5.410  | 6.085  | 6.760  | 7.435  | 8.110  | 8.785  | 9.460  | 10.135 | 10.810 | 11.485 | 12.160 | 12.835 |
| 4.75        | 3.876                 | 4.326  | 4.785  | 5.244  | 5.703  | 5.385  | 6.035  | 6.785  | 7.535  | 8.285  | 9.035  | 9.785  | 10.535 | 11.285 | 12.035 | 12.785 | 13.535 | 14.285 |
| 5.00        | 3.863                 | 4.326  | 4.785  | 5.244  | 5.703  | 5.385  | 6.035  | 6.785  | 7.535  | 8.285  | 9.035  | 9.785  | 10.535 | 11.285 | 12.035 | 12.785 | 13.535 | 14.285 |
| 5.30        | 4.343                 | 4.866  | 5.385  | 5.904  | 6.423  | 6.057  | 6.785  | 7.625  | 8.465  | 9.305  | 10.145 | 10.985 | 11.825 | 12.665 | 13.505 | 14.345 | 15.185 | 16.025 |
| 5.60        | 4.343                 | 4.866  | 5.385  | 5.904  | 6.423  | 6.057  | 6.785  | 7.625  | 8.465  | 9.305  | 10.145 | 10.985 | 11.825 | 12.665 | 13.505 | 14.345 | 15.185 | 16.025 |
| 6.00        | 4.903                 | 5.496  | 6.085  | 6.674  | 7.263  | 6.841  | 7.660  | 8.605  | 9.550  | 10.495 | 11.440 | 12.385 | 13.330 | 14.275 | 15.220 | 16.165 | 17.110 | 18.055 |
| 6.30        | 4.903                 | 5.496  | 6.085  | 6.674  | 7.263  | 6.841  | 7.660  | 8.605  | 9.550  | 10.495 | 11.440 | 12.385 | 13.330 | 14.275 | 15.220 | 16.165 | 17.110 | 18.055 |
| 6.70        | 5.496                 | 6.216  | 6.885  | 7.554  | 8.223  | 7.737  | 8.660  | 9.725  | 10.790 | 11.855 | 12.920 | 13.985 | 15.050 | 16.115 | 17.180 | 18.245 | 19.310 | 20.375 |
| 7.10        | 5.496                 | 6.216  | 6.885  | 7.554  | 8.223  | 7.737  | 8.660  | 9.725  | 10.790 | 11.855 | 12.920 | 13.985 | 15.050 | 16.115 | 17.180 | 18.245 | 19.310 | 20.375 |
| 7.50        | 6.216                 | 7.085  | 7.954  | 8.823  | 9.692  | 9.144  | 10.220 | 11.395 | 12.570 | 13.745 | 14.920 | 16.095 | 17.270 | 18.445 | 19.620 | 20.795 | 21.970 | 23.145 |
| 8.00        | 6.216                 | 7.085  | 7.954  | 8.823  | 9.692  | 9.144  | 10.220 | 11.395 | 12.570 | 13.745 | 14.920 | 16.095 | 17.270 | 18.445 | 19.620 | 20.795 | 21.970 | 23.145 |
| 8.50        | 7.085                 | 8.054  | 9.023  | 10.092 | 11.161 | 10.513 | 11.785 | 13.157 | 14.530 | 15.903 | 17.275 | 18.648 | 20.021 | 21.394 | 22.767 | 24.140 | 25.513 | 26.886 |
| 9.00        | 7.085                 | 8.054  | 9.023  | 10.092 | 11.161 | 10.513 | 11.785 | 13.157 | 14.530 | 15.903 | 17.275 | 18.648 | 20.021 | 21.394 | 22.767 | 24.140 | 25.513 | 26.886 |
| 9.50        | 8.054                 | 9.123  | 10.192 | 11.261 | 12.330 | 11.582 | 12.955 | 14.427 | 15.900 | 17.373 | 18.846 | 20.319 | 21.792 | 23.265 | 24.738 | 26.211 | 27.684 | 29.157 |
| 10.0        | 8.054                 | 9.123  | 10.192 | 11.261 | 12.330 | 11.582 | 12.955 | 14.427 | 15.900 | 17.373 | 18.846 | 20.319 | 21.792 | 23.265 | 24.738 | 26.211 | 27.684 | 29.157 |
| 10.6        | 9.123                 | 10.292 | 11.461 | 12.630 | 13.800 | 12.952 | 14.425 | 16.097 | 17.770 | 19.443 | 21.116 | 22.789 | 24.462 | 26.135 | 27.808 | 29.481 | 31.154 | 32.827 |
| 11.2        | 9.123                 | 10.292 | 11.461 | 12.630 | 13.800 | 12.952 | 14.425 | 16.097 | 17.770 | 19.443 | 21.116 | 22.789 | 24.462 | 26.135 | 27.808 | 29.481 | 31.154 | 32.827 |
| 11.8        | 10.292                | 11.561 | 12.830 | 14.100 | 15.370 | 14.422 | 16.095 | 17.967 | 19.840 | 21.713 | 23.586 | 25.459 | 27.332 | 29.205 | 31.078 | 32.951 | 34.824 | 36.697 |
| 12.5        | 10.292                | 11.561 | 12.830 | 14.100 | 15.370 | 14.422 | 16.095 | 17.967 | 19.840 | 21.713 | 23.586 | 25.459 | 27.332 | 29.205 | 31.078 | 32.951 | 34.824 | 36.697 |
| 13.2        | 11.561                | 12.930 | 14.300 | 15.670 | 17.040 | 16.092 | 17.965 | 20.037 | 22.110 | 24.183 | 26.256 | 28.329 | 30.402 | 32.475 | 34.548 | 36.621 | 38.694 | 40.767 |
| 14.0        | 11.561                | 12.930 | 14.300 | 15.670 | 17.040 | 16.092 | 17.965 | 20.037 | 22.110 | 24.183 | 26.256 | 28.329 | 30.402 | 32.475 | 34.548 | 36.621 | 38.694 | 40.767 |
| 15.0        | 12.930                | 14.400 | 15.870 | 17.340 | 18.810 | 17.862 | 20.035 | 22.307 | 24.580 | 26.853 | 29.126 | 31.400 | 33.673 | 35.946 | 38.219 | 40.492 | 42.765 | 45.038 |
| 16.0        | 12.930                | 14.400 | 15.870 | 17.340 | 18.810 | 17.862 | 20.035 | 22.307 | 24.580 | 26.853 | 29.126 | 31.400 | 33.673 | 35.946 | 38.219 | 40.492 | 42.765 | 45.038 |

Figure from R 40 series  
 Figure from R 20 series  
 Preferred size  
 R 20 x R 20  
 Nominal cross-sectional area (mm<sup>2</sup>)  
 Intermediate size  
 R 20 x R 40, R 40 x R 20  
 Nominal cross-sectional area (See Annex A)  
 Dimension not recommended  
 R 40 x R 40

Not recommended  
 Ratio width/thickness smaller than 1.4:1

Not recommended  
 Ratio width/thickness over 8:1

\* 0.5 nominal thickness.

**Table 3 – Corner radii**

| Nominal thickness of conductor<br>mm |                     | Corner<br>radius<br>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 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 given in Table 4.

**Table 4 – Increases in dimensions**

| Grade | Increase in dimensions<br>mm |         |         |
|-------|------------------------------|---------|---------|
|       | Minimum                      | Nominal | Maximum |
| 1     | 0,06                         | 0,085   | 0,11    |
| 2     | 0,12                         | 0,145   | 0,17    |

**4.5 Overall dimensions**

**4.5.1 Nominal overall dimensions**

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

**4.5.2 Minimum overall dimensions**

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

**4.5.3 Maximum overall dimensions**

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

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

## 5 Electrical resistance

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

The maximum value of resistance shall be not greater than the value calculated for the minimum tolerated cross-sectional area of the conductor resulting from the minimum dimensions in thickness and width and the maximum for the corner radius, and with a resistivity of  $1/58 \Omega \cdot \text{mm}^2 \cdot \text{m}^{-1}$ .

One measurement shall be made.

## 6 Elongation

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

**Table 5 – Elongation**

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

## 7 Springiness <https://standards.itech.ai/catalog/standards/sist/cdbfb735-04c6-449b-81db-0ce72000f989/iec-60317-0-2-2013>

The wire shall not exceed the maximum springback of 5 degrees.

## 8 Flexibility and adherence

### 8.1 Mandrel winding test

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

**Table 6 – Mandrel winding**

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

### 8.2 Adherence test

The wire shall be stretched by 15 %. The distance of loss of adherence shall be less than 1 × width.