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“Step Out From the Old to the New”

Indian Standard
WINDING WIRES — TEST METHODS
PART 2 DETERMINATION OF DIMENSIONS
( First Revision )

ICS 29.060.10
NATIONAL FOREWORD

This Indian Standard (Part 2) (First Revision) which is identical with IEC 60851-2 : 2009 ‘Winding wires — Test methods — Part 2: Determination of dimensions’ issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Winding Wires Sectional Committee and approval of the Electrotechnical Division Council.

This standard was first published in 1993. This revision has been undertaken with a view to bring it in line with the latest version of IEC 60851-2 : 2009.

The revised document has the following changes:

a) Recognition of the use of optical micrometers in determining the dimensions of round and rectangular enamelled wire.

b) Modifications in the values of measuring force in case of enamelled round wire while using mechanical contact micrometers.

c) Different methods of measurements have been specified for measuring conductor dimension and over all dimensions of round wire having nominal conductor diameter up to and including 0.20 mm and over 0.20 mm.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, references appear to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

<table>
<thead>
<tr>
<th>International Standard</th>
<th>Corresponding Indian Standard</th>
<th>Degree of Equivalence</th>
</tr>
</thead>
</table>

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (revised)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
1 Scope

This part of IEC 60851 specifies the following method of test:

– Test 4: Dimensions.

For definitions, general notes on methods of test and the complete series of methods of test for winding wires, see IEC 60851-1.

2 Normative references

The following referenced documents are indispensable for the application 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 60851-1, Winding wires – Test methods – Part 1: General


3 Test 4: Dimensions

3.1 Equipment

3.1.1 Round and rectangular wire

The equipment used shall have a resolution of 2 µm or less for wires over 0,200 mm and for wires up to and including 0,200 mm, a resolution of 1 µm or less. Both mechanical contact and optical non-contact micrometers may be used. If mechanical contact micrometers are used, the ratio of measuring force and anvil diameter shall be in accordance with the range as given in Table 1a and Table 1b. The diameter range of the spindle and anvil is also given in Table 1a and Table 1b. If optical micrometers are used, the average of the readings shall be recorded as the diameter of the conductor. If a specific measuring equipment must be used, it shall be agreed upon between the customer and the supplier.

<table>
<thead>
<tr>
<th>Type of winding wire</th>
<th>Nominal conductor diameter mm</th>
<th>Anvil diameter mm</th>
<th>Measuring force(N)/anvil diameter(mm) = P(N/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enamelled round wire</td>
<td>≤ 0,100</td>
<td>2 to 8</td>
<td>0,01 ≤ P ≤ 0,16</td>
</tr>
<tr>
<td></td>
<td>0,100 &lt; d ≤ 0,45</td>
<td>5 to 8</td>
<td>0,16 &lt; P ≤ 0,32</td>
</tr>
<tr>
<td></td>
<td>&gt; 0,45</td>
<td>5 to 8</td>
<td>0,32 &lt; P ≤ 0,80</td>
</tr>
</tbody>
</table>
### Table 1b – All the types of winding wires except enamelled round wire

<table>
<thead>
<tr>
<th>Type of winding wire</th>
<th>Nominal conductor diameter mm</th>
<th>Anvil diameter mm</th>
<th>Measuring force N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tape wrapped round wire</td>
<td>≥ 0.100</td>
<td>5 to 8</td>
<td>1 to 8</td>
</tr>
<tr>
<td>Enamelled rectangular and tape wrapped rectangular wire</td>
<td>-</td>
<td>5 to 8</td>
<td>4 to 10</td>
</tr>
<tr>
<td>Fibrous covered wire</td>
<td>-</td>
<td>5 to 8</td>
<td>4 to 10</td>
</tr>
<tr>
<td>Paper covered wire</td>
<td>-</td>
<td>5 to 8</td>
<td>8 to 14</td>
</tr>
</tbody>
</table>

#### 3.1.2 Bunched wire

The measurement shall be made with a polished conical mandrel having dimensions as shown in Figure 1.

#### 3.2 Procedure

##### 3.2.1 Conductor dimension

##### 3.2.1.1 Round wire

**NOTE** See Table 2.

1. **Nominal conductor diameter over 0.063 mm and up to and including 0.200 mm**

   From a straight piece of wire the insulation shall be removed at three places, 1 m apart, by any method that does not damage the conductor. One measurement shall be made at these three places.

   The three single values shall be reported. The mean value represents the conductor diameter.

2. **Nominal conductor diameter over 0.200 mm**

   From a straight piece of wire, the insulation shall be removed by any method that does not damage the conductor. Three measurements of the bare conductor diameter shall be made at points evenly distributed around the circumference of the conductor.

   The three single values shall be reported. The mean value represents the conductor diameter.

##### 3.2.1.2 Rectangular wire

The insulation shall be removed at the three places used for measurements in 3.2.5.2 by any method that does not damage the conductor. At each place one measurement of the two dimensions of the conductor shall be made.

The three single values shall be reported for each dimension of the conductor. The mean represents the conductor width or the conductor thickness respectively.

##### 3.2.2 Out-of-roundness of the conductor

Out-of-roundness is the maximum value of the difference between the three readings if measured in accordance with 3.2.1.1, or the three readings of the conductor diameter at the cross-section if measured in accordance with 3.2.1.2. The out-of-roundness shall be reported.
3.2.3 Rounding of corners of rectangular wire

For the purpose of this test, a cross-section of the wire shall be prepared and then examined under a sufficient magnification.

Three straight pieces of wire shall be cast in a suitable resinous compound that will not affect the insulation. After curing, the colour of the resinous compound shall contrast with the colour of the insulation.

The specimen consisting of the three pieces of wire embedded in the cured resinous compound shall be cut at right angles to the length of the wire pieces, and the cross-section shall be carefully ground and polished by suitable means. The polished surface shall be examined under a magnification which allows a correct judgement of the rounding of corners.

It shall be reported how the arc merges into the flat surface of the conductor. Any sharp, rough and projecting edges shall also be reported.

3.2.4 Increase in dimension due to the insulation

3.2.4.1 General

The increase in dimension due to the insulation is the difference between the overall dimension and the conductor dimension.

3.2.4.2 Round wire

The measurement shall be made in accordance with 3.2.1.1 and 3.2.5.1. The difference between the overall diameter and the conductor diameter shall be reported as the increase in diameter.

3.2.4.3 Rectangular wire

The measurement shall be made in accordance with 3.2.1.2 and 3.2.5.2. The difference between the overall width and the conductor width shall be reported as the increase in width. The difference between the overall thickness and the conductor thickness shall be reported as the increase in thickness.

3.2.5 Overall dimension

3.2.5.1 Round wire

3.2.5.1.1 Nominal diameter up to and including 0,200 mm

On a straight piece of wire, at three places 1 m apart, one measurement of the overall diameter shall be made.

The three single values shall be reported. The mean value represents the overall diameter.

3.2.5.1.2 Nominal conductor diameter over 0,200 mm

On a straight piece of wire, at each of two places 1 m apart, three measurements of the overall diameter shall be made at points evenly distributed around the circumference of the wire.

The six single values shall be reported. The mean value represents the overall diameter.

For determination of the conductor diameter as given in the relevant standards, the following applies:
### Table 2 – Determination of the conductor diameter

<table>
<thead>
<tr>
<th>Nominal conductor diameter</th>
<th>Measurement</th>
<th>Clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>( d \leq 0.063 \text{ mm} )</td>
<td>Resistance</td>
<td>3 of IEC 60851-5</td>
</tr>
<tr>
<td>( d &gt; 0.063 \text{ mm} )</td>
<td>Dimension</td>
<td>3.2.1.1</td>
</tr>
</tbody>
</table>

**NOTE** By agreement between purchaser and supplier, resistance measurements may be made in the range of nominal conductor diameters over 0.063 mm and up to and including 1.000 mm.

#### 3.2.5.2 Rectangular wire

On a straight piece of wire at each of three places at least 100 mm apart, one measurement shall be made of the two dimensions of the wire. Where the dimension of the specimen is greater than the diameter of the micrometer spindle, measurements shall be made both at the centre of the face of the specimen and over the edges. If these values differ, only the highest value shall be noted.

The three single values shall be reported for each dimension of the wire. The mean values represent the overall width or the overall thickness respectively.

#### 3.2.5.3 Bunched wire

**NOTE** The method indicated below gives useful values in practice, but not an accurate overall diameter.

The overall diameter is the width of a layer wound on a mandrel divided by the number of turns. The bunched wire shall be wound closely on a mandrel according to Figure 1 and under a tension in newtons, which is 65 times the total nominal cross-section of the conductors in square millimetres. The width of the layer shall be not less than 10 mm for bunched wires with overall diameters up to and including 0.5 mm, and be not less than 20 mm for larger diameters and shall be measured with a precision of 0.5 mm.

One measurement shall be made. The overall diameter rounded off to 0.01 mm shall be reported.

#### 3.2.6 Increase in diameter due to the bonding layer of enamelled round wire

The increase in diameter due to the bonding layer is the difference of the overall diameter with and without the bonding layer.

The overall diameter of the wire shall be measured according to 3.2.5.1. After removal of the bonding layer by means of a solvent or any other suitable agent or by any other method which does not damage the underlying coating, the measurement shall be repeated. The difference of the two mean values shall be reported as the increase in diameter due to the bonding layer.
Figure 1 – Conical mandrel
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This Indian Standard has been developed from Doc No.: ETD 33 (6337).

<table>
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<th>Date of Issue</th>
<th>Text Affected</th>
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