

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

Winding wires – Test methods –  
Part 5: Electrical properties

STANDARD PREVIEW  
(standards.iteh.ai)

Fils de bobinage – Méthodes d'essai –  
Partie 5: Propriétés électriques

IEC 60851-5:2008  
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**WINDING WIRES –  
TEST METHODS –****Part 5: Electrical properties**

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International Standard IEC 60851-5 has been prepared by IEC technical committee 55: Winding wires.

This fourth edition cancels and replaces the third edition (1996) and its amendments 1 (1997) and 2 (2004). It constitutes a technical revision.

Significant revisions to the previous edition include the following points:

- in Subclause 5.3, the addition of the use of carbon brush electrodes for the counting discontinuities during the high voltage continuity test, as an alternative to the V-groove pulley electrode;
- clarifications in the breakdown voltage test for round wires larger than 2,500 mm and for fibrous covered wires.

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

FDIS	Report on voting
55/1069/FDIS	55/1078/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.

A list of all the parts in the IEC 60851 series, under the general title *Winding wires – Test methods*, can be found on the website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

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- withdrawn,
- replaced by a revised edition, or
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## INTRODUCTION

This part of IEC 60851 forms an element of a series of standards which deals with insulated wires used for windings in electrical equipment. The series has three groups describing

- a) winding wires – Test methods (IEC 60851);
- b) specifications for particular types of winding wires (IEC 60317);
- c) packaging of winding wires (IEC 60264).

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# WINDING WIRES – TEST METHODS –

## Part 5: Electrical properties

### 1 Scope

This part of IEC 60851 specifies the following tests:

- Test 5: Electrical resistance;
- Test 13: Breakdown voltage;
- Test 14: Continuity of insulation;
- Test 19: Dielectric dissipation factor;
- Test 23: Pin hole.

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.

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IEC 60851-1, *Winding wires – Test methods – Part 1: General*

### 3 Test 5: Electrical resistance

Electrical resistance is the d.c. resistance at 20 °C of 1 m of wire.

The method used shall provide a precision of 0,5 %.

For bunched wires a length of up to 10 m shall be used and the ends shall be soldered before the measurement. When measuring the resistance to check for an excessive number of broken wires, a length of 10 m of bunched wire shall be used.

If the resistance  $R_t$  is measured at a temperature  $t$  other than 20 °C, the resistance  $R_{20}$  at 20 °C shall be calculated by means of the following formula:

$$R_{20} = \frac{R_t}{1 + \alpha(t - 20)}$$

where

$t$  is the actual temperature in degrees Celsius during the measurement;

$\alpha$  is the temperature coefficient in K<sup>-1</sup>.

In the temperature range from 15 °C to 25 °C, the temperature coefficient to be used shall be:

- for copper:  $\alpha_{20} = 3,96 \times 10^{-3} \text{ K}^{-1}$ ;
- for aluminium:  $\alpha_{20} = 4,07 \times 10^{-3} \text{ K}^{-1}$ .

One test shall be made. The electrical resistance shall be reported.

#### 4 Test 13: Breakdown voltage

##### 4.1 Principle

The test voltage shall be an a.c. voltage of 50 Hz or 60 Hz nominal frequency. The test voltage shall be applied at zero and increased at a uniform rate according to Table 1.

**Table 1 – Rates of test voltage increase**

Breakdown voltage V		Rate of increase V/s
Over	Up to and including	
–	500	20
500 2 500	2 500 –	100 500

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##### 4.2 Equipment

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The following equipment shall be used:

- test transformer with a rated power of at least 500 VA providing an a.c. voltage of an undistorted sine waveform under test conditions, with a peak factor being within the limits of  $\sqrt{2} \pm 5 \%$  (1,34 to 1,48) and with a capacity to supply a current of 5 mA with a maximum voltage drop of 2 %;
- fault detection circuit, which operates at a current of 5 mA or more;
- arrangement to provide a uniform rise of the test voltage at the specified rate;
- oven with forced air circulation;
- polished metal cylinder, 25 mm  $\pm$  1 mm in diameter, mounted with its axis horizontal (see Figure 1) and electrically connected to one terminal of the test voltage supply;
- twisting device according to Figure 2, that allows to twist two pieces of wire for a length of 125 mm;
- strips of metal foil, 6 mm in width and pressure sensitive tape, 12 mm in width;
- container with metal shot of stainless steel or nickel-plated iron. The diameter of the shot shall not exceed 2 mm. The shot shall be cleaned periodically by suitable means;
- metal mandrel, 50 mm  $\pm$  2 mm in diameter;
- metal mandrel, 25 mm  $\pm$  1 mm in diameter.

#### 4.3 Enamelled round wire with a nominal conductor diameter up to and including 0,100 mm

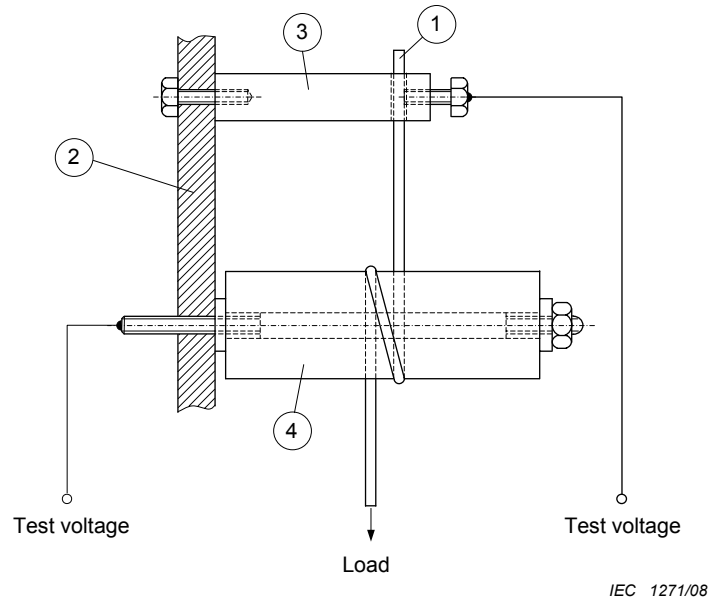
A straight piece of wire with the insulation removed at one end shall be connected to the upper terminal as shown in Figure 1 and wound once around the cylinder. A load as specified in Table 2 shall be applied to the lower end of the wire to keep the specimen in close contact with the cylinder.

The test voltage shall be applied according to 4.1 between the conductor of the wire and the cylinder. The test shall be carried out at room temperature.

Five specimens shall be tested. The five single values shall be reported.

**Table 2 – Loads applied to the wire**

Nominal conductor diameter mm		Load N
Over	Up to and including	
–	0,018	0,013
0,018	0,020	0,015
0,020	0,022	0,020
0,022	0,025	0,025
0,025	0,028	0,030
0,028	0,032	0,040
0,032	0,036	0,050
0,036	0,040	0,060
0,040	0,045	0,080
0,045	0,050	0,100
0,050	0,056	0,120
0,056	0,063	0,150
0,063	0,071	0,200
0,071	0,080	0,250
0,080	0,090	0,300
0,090	0,100	0,400



- 1 specimen
- 2 insulating material
- 3 upper terminal
- 4 cylinder

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**Figure 1 – Arrangement of cylinder and specimen for the breakdown voltage test**

#### **4.4 Enamelled round wire with a nominal conductor diameter over 0,100 mm up to and including 2,500 mm**

##### **4.4.1 Test at room temperature**

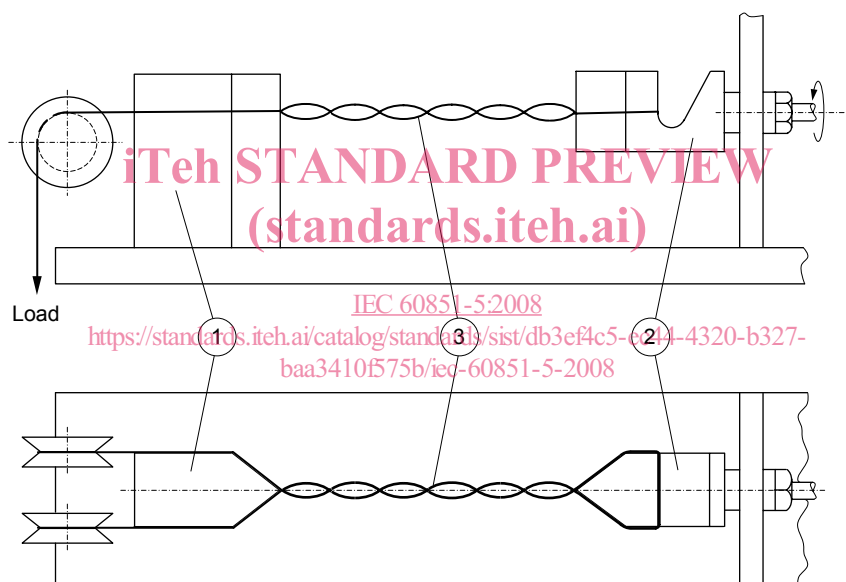
A straight piece of wire, approximately 400 mm in length, with the insulation removed at both ends, shall be twisted back on itself for a distance of  $(125 \pm 5)$  mm on the twisting device as shown in Figure 2. The ends of the wire shall be joined, and the load applied with the number of twists, as given in Table 3. The loop at the end of the twisted section shall be cut at two places to provide a maximum spacing between the cut ends. Any bending to ensure adequate separation between the two wire ends shall avoid sharp bends or damage to the coating.

The test voltage shall be applied according to 4.1 between the conductors of the wires.

Five specimens shall be tested. The five single values shall be reported.

**Table 3 – Loads applied to the wire and number of twists**

Nominal conductor diameter mm		Load N	Number of twists
Over	Up to and including		
0,100	0,250	0,85	33
0,250	0,355	1,70	23
0,355	0,500	3,40	16
0,500	0,710	7,00	12
0,710	1,060	13,50	8
1,060	1,400	27,00	6
1,400	2,000	54,00	4
2,000	2,500	108,00	3



IEC 1272/08

- 1 spacer
- 2 rotary hook
- 3 specimen

**Figure 2 – Device for twisting the specimen for breakdown voltage test****4.4.2 Test at elevated temperature**

A specimen prepared according to 4.4.1 shall be placed in the oven preheated to the specified test temperature  $\pm 3$  °C. The test voltage shall be applied according to 4.1 between the conductors of the wires in not less than 15 min after placing the specimen in the oven. The test shall be completed within 30 min.

Five specimens shall be tested. The five single values shall be reported.

#### **4.5 Round wire with a nominal conductor diameter over 2,500 mm**

##### **4.5.1 Test at room temperature**

A straight piece of wire of sufficient length, with the insulation removed at one end, shall be bent around a mandrel as shown in Figure 3.

The diameter of the mandrel shall be 50 mm ± 2 mm.

The specimen shall be placed in the container and shall be surrounded by shot at least 5 mm between the specimen and the inner walls of the container. The ends of the specimen shall be sufficiently long to avoid flashover.

The shot shall be poured gently into a container until the specimen is covered by shot at a depth of 90 mm. The metal shot shall be not more than 2 mm in diameter; balls of stainless steel, nickel or nickel-plated iron have been found suitable. The shot shall be cleaned periodically with a suitable solvent (for example, 1,1,1-trichloroethane).

The test voltage shall be applied according to 4.1, between the conductor and the shot.

NOTE By agreement between the purchaser and the supplier, the test may be carried out with the specimen under oil. Oil should be in accordance with IEC 60296 or as agreed upon between customer and supplier.

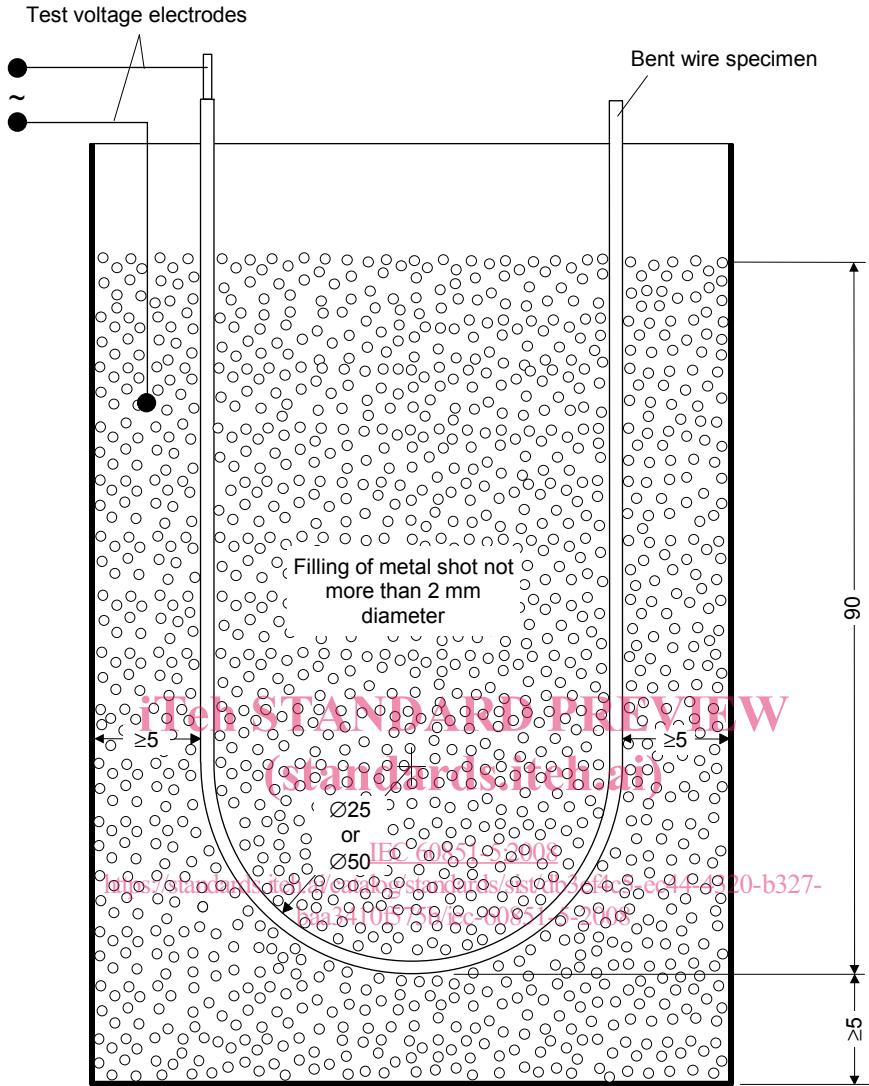
Five specimens shall be tested. The five single values shall be reported.

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Dimensions in millimetres



IEC 1273/08

Figure 3 – U-bend specimen for the breakdown voltage test (specimen placed in shot bath)