IEC 60851-5

Edition 4.2 2019-09
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Winding wires – Test methods – Part 5: Electrical properties

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

IEC 60851-5:2008-07+AMD1:2011-06+AMD2:2019-09 CSV(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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WINDING WIRES – TEST METHODS –

Part 5: Electrical properties

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.
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This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

IEC 60851-5 edition 4.2 contains the fourth edition (2008-07) [documents 55/1069/FDIS and 55/1078/RVD], its amendment 1 (2011-06) [documents 55/1223/FDIS and 55/1251/RVD] and its amendment 2 (2019-09) [documents 55/1791/FDIS and 55/1818/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

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

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.

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 amendment 1 includes

- in Clause 4 the addition of dielectric breakdown requirements for fully insulated (FIW) zero-defect enamelled round copper wires;
- in Clause 5 the addition of continuity requirements for fully insulated (FIW) zero-defect enamelled round copper wires.

The committee has decided that the contents of the base publication and its amendments 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,
- 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 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).

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.

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;

α is the temperature coefficient in K^{-1}.

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

– for copper: α_{20} = 3,96 × 10^{-3} K^{-1};

– for aluminium: α_{20} = 4,07 × 10^{-3} 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	100
2 500	–	500

4.2 Equipment

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 ± 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 ± 2 mm in diameter;

– metal mandrel, 25 mm ± 1 mm in diameter;

– metal mandrel, 80 mm ± 3 mm in diameter.

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

4.3.1 Grade 1 to grade 3 with a nominal 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.~~

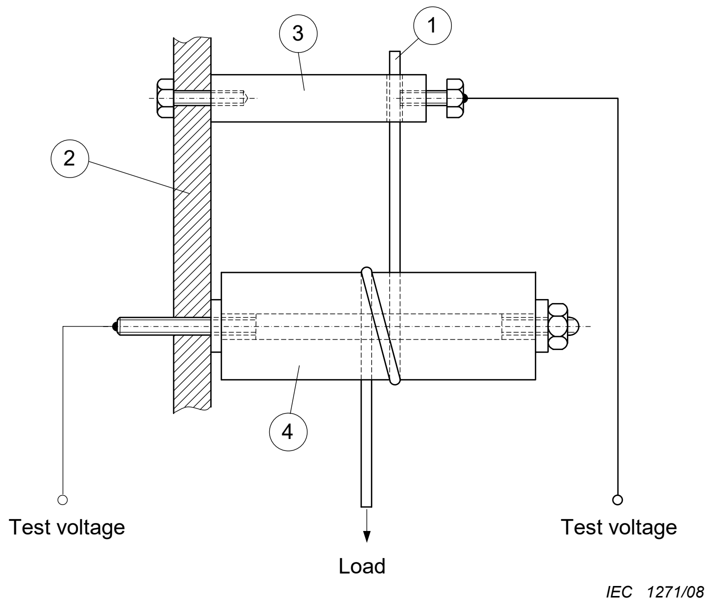
The test is carried out on a cylinder with a diameter of 25 mm ± 1 mm. A straight piece of wire with the insulation removed at one end shall be connected to the upper terminal as shown in Figure 1 and wound once around the cylinder. A load as specified in Table 2.1 shall be applied to the lower end of 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 2.1 – Loads applied to the wire

Nominal conductor diameter mm		Load
Over	Up to and including	N
–	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

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

4.3.2 Grade of FIW 3 to FIW 9 with a nominal conductor diameter up to and including 1,600 mm

The test is carried out on a cylinder with a diameter as set out in Table 2.2.

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 2.2 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.