IEC 60076-11

Edition 2.0 2018-08
REDLINE VERSION

INTERNATIONAL STANDARD

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Power transformers –
Part 11: Dry-type transformers

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IEC IEC 60076-11:2018-08 RLV(en)

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IEC 60076-11
Edition 2.0 2018-08

POWER TRANSFORMERS –

Part 11: Dry-type transformers

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by IEC technical committee 14: Power transformers.

The text of this interpretation sheet is based on the following documents:

DISH	Report on voting
14/1052/DISH	14/1054/RVDISH

SIST Preview
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Full information on the voting for the approval of this interpretation sheet can be found in the report on voting indicated in the above table.

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14.3.2 Temperature-rise test

Question

The independent certification body in Poland "Instytut Energetyki" carries out the testing of transformers or its inspectors witness this testing at the manufacturers' premises. The description of resistance measurement during the temperature rise test has caused a dispute between a manufacturer and the inspector on where exactly the resistance should be measured. The inspector requested that the resistance be measured on "winding lead exits" inside the enclosure, while the manufacturer argued for the measurement to be made on "winding terminals" which in its opinion were the bushings on the enclosure cover.

IEC 60076-11:2018-08/ISH1:2020-07(en)

ICS 29.180

Subclause 14.3.2.1 General, states:

> The winding temperature rise shall be established by the rise in resistance method or by superposition method. For the determination of the average winding temperature rise the measured temperatures of the cooling air or of the water intake of the cooling equipment shall be used.
>
> For three-phase transformers, the resistance measurements shall be made between the central and an outer phase line terminals.
>
> NOTE When the temperature rise is performed it is advisable to measure the windings resistance close to the windings.

Where should the measurements be made?

Interpretation

Testing of the winding resistance at transformer terminals (bushings) includes leadwork or busbars and often also multiple connections. Because of this, the tested winding resistance and its change due to heating is affected by the resistance of all these leads and connections. Consequently, the derived winding temperature rise if measured at the transformer terminals could be lower than if the winding resistance were tested directly on the winding lead exits. That is why the standard suggests (in the NOTE) that measurement of the windings' resistance be carried out close to the windings. That way, the accuracy of the indirect winding temperature measurement by resistance is higher.

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In the case of dry-type transformers without enclosures, it is possible to have access close to the winding lead exits and not only to the transformer line terminals. Therefore, measurements shall normally be made at such locations.

On the other hand, if the dry-type transformer is equipped with an enclosure, the resistance measurement close to the winding lead exits requires opening the enclosure to have access to carry out the test (hence, affecting the normal cooling efficiency of the unit). Nevertheless, the advice to measure the resistance normally close to the winding lead exits holds. Limiting the enclosure opening by using special through elements for the cabling and/or by closing the required opening by temporary means as well as possible will minimize the impact on the normal cooling efficiency.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER TRANSFORMERS –

Part 11: Dry-type transformers

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International Standard IEC 60076-11 has been prepared by IEC technical committee 14: Power transformers.

This second edition cancels and replaces the first edition published in 2004 and constitutes a technical revision.

The main changes with regard to the previous edition are as follows:

- Extension of the scope up to 72,5kV
- Enclosure management in regards of the performance
- Management of the dielectric and thermal features with altitude
- New climatic classes for a better adaptation of customers' need
- Establishment of the relation between location and environmental classes
- For fire behaviour classes, limitation at 1 000 kVA and process of test more robust
- Introduction of Seismic class
- Recommendations for amorphous transformers

The text of this International Standard is based on the following documents:

FDIS	Report on voting
14/964/FDIS	14/972/RVD

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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.

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A list of all parts in the IEC 60076 series, published under the general title *Power transformers*, can be found on the IEC website.

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.

The contents of the corrigendum of March 2019 and the Interpretation sheet 1 of July 2020 have been included in this copy.

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POWER TRANSFORMERS –

Part 11: Dry-type transformers

1 Scope

This part of IEC 60076 applies to dry-type power transformers (including auto-transformers) having values of highest voltage for equipment up to and including ~~36~~ 72,5 kV and at least one winding operating at greater than 1,1 kV. ~~The standard applies to all construction technologies.~~

This document does not apply to:

- gas-filled dry-type transformers where the gas is not air;
- single-phase transformers rated at less than 5 kVA;
- polyphase transformers rated at less than 15 kVA;
- instrument transformers ~~(see IEC 60044 and IEC 60186)~~;
- starting transformers;
- testing transformers;
- traction transformers mounted on rolling stock;
- flameproof and mining transformers;
- welding transformers;
- voltage regulating transformers;
- small power transformers in which safety is a special consideration.

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Where IEC standards do not exist for the transformers mentioned above or for other special transformers, this document may be applicable as a whole or in parts.

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 60050 (all parts), *International electrotechnical vocabulary (IEV)*~~

IEC 60068-3-3, *Environmental testing – Part 3-3: Guidance – Seismic test methods for equipments*

~~IEC 60071 (all parts), *Insulation co-ordination*~~

IEC 60071-1, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60071-2, *Insulation co-ordination – Part 2: Application guidelines*

IEC 60076-1:~~1993~~ 2011, *Power transformers – Part 1: General*
~~Amendment 1 (1999)~~

IEC 60076-2, *Power transformers – Part 2: Temperature rise for liquid-immersed transformers*

IEC 60076-3:2013, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-5, *Power transformers – Part 5: Ability to withstand short-circuit*

IEC 60076-10, *Power transformers – Part 10: Determination of sound levels*

IEC 60076-12:2008, *Power transformers – Part 12: Loading guide for dry-type power transformers*

IEC 60085, *Electrical insulation – Thermal evaluation and ~~classification of electrical insulation~~ designation*

IEC 60270, *High-voltage test techniques – Partial discharge measurements*

IEC 60332-3-10, *Tests on electric cables under fire conditions – Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60721-3-4, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 4: Stationary use at non-weatherprotected locations*

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(https://ecommerce.sist.si)

IEC TS 60815-1, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles*

IEC 60076-11:2018
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~~IEC 60905:1987, *Loading guide for dry-type power transformers*~~

~~IEC 61330, *High-voltage/low voltage prefabricated substations*~~

IEC 61378-1, *Converter transformers – Part 1: Transformers for industrial applications*

IEC 62271-202, *High-voltage switchgear and controlgear – Part 202: High-voltage/low-voltage prefabricated substation*

ISO 12944-6, *Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 6: Laboratory performance test methods*

3 Terms and definitions

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
dry-type transformer
transformer of which the magnetic circuit and windings are not immersed in an insulating liquid

3.2
totally enclosed dry-type transformer
transformer in an un-pressurised enclosure cooled by the circulation of the internal air having no intentional exchange with external air

3.3
enclosed dry-type transformer
transformer in a ventilated enclosure cooled by the circulation of the external air

3.4
non-enclosed dry-type transformer
transformer supplied without a protective enclosure cooled by natural or forced air ventilation

4 Service conditions

4.1 General

The requirements of IEC 60076-1 apply to dry-type transformers only in so far as they are referred to in this document.

4.2 Normal service conditions

~~**4.2.1 General**~~

~~Unless otherwise stated, the service conditions in 4.2.2 to 4.2.6 apply. When transformers are required to operate outside the normal service conditions, de-rating in accordance with 11.2 and/or 11.3 applies.~~

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a) Altitude:

~~A height above sea level not exceeding 1 000 m.~~ See IEC 60076-1.

b) Temperature of cooling air and water:

~~The temperature of cooling air not exceeding:~~

~~40 °C at any time;~~
~~30 °C monthly average of the hottest month;~~
~~20 °C yearly average.~~

~~and not below:~~

~~–25 °C in the case of outdoor transformers;~~
~~–5 °C in the case of indoor transformers.~~

~~where the monthly and yearly averages are as defined in 3.12 of IEC 60076-1.~~

See IEC 60076-1.

For water cooled transformers, specification of the water (temperature, water flow, etc.) has to be defined by agreement between manufacturer and purchaser if the temperature of the water is different from that specified in IEC 60076-1 and IEC 60076-2

NOTE Liquids other than water can be used as a cooling medium then all technical data of the liquid has to be defined by agreement between manufacturer and purchaser.

c) Wave-shape of supply voltage:

~~A supply voltage of which the waveshape is approximately sinusoidal.~~