INTERNATIONAL STANDARD

IEC 60076-11

First edition
2004-05

Power transformers –

Part 11: Dry-type transformers

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*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

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International Electrotechnical Commission
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER TRANSFORMERS –

Part 11: Dry-type transformers

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

This standard cancels and replaces IEC 60726 (1982) and its amendment 1 (1986).

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

FDIS	Report on voting
14/476/FDIS	14/484/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.

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IEC 60076 consists of the following parts, under the general title *Power transformers:*

Part 1:	General
Part 2:	Temperature rise
Part 3:	Insulation levels, dielectric tests and external clearances in air
Part 4:	Guide to lightning impulse and switching impulse testing – Power transformers and reactors
Part 5:	Ability to withstand short-circuit
Part 6:	Reactors [1]
Part 7:	Loading guide for oil-immersed power transformers [1]
Part 8:	Application guide
Part 10:	Determination of sound levels
Part 10-1:	Determination of transformer and reactor sound levels – User guide [1]
Part 11:	Dry-type transformers
Part 12:	Loading guide for dry-type power transformers [1]
Part 13:	Self protected liquid filled transformers [1]
Part 14:	Guide for the design and application of liquid-immersed power transformers using high-temperature insulation materials [1]
Part 15:	Gas-filled-type power transformers [1]

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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[1] Under consideration.

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 kV and at least one winding operating at greater than 1,1 kV. The standard applies to all construction technologies.

This standard 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.

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

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

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

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

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

IEC 60076-3, *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 60085, *Thermal evaluation and classification of electrical insulation*

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 60905:1987, *Loading guide for dry-type power transformers*

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

3 Terms and definitions

For the purpose of this part of IEC 60076, the following terms and definitions apply.

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

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 standard.

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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4.2.2 Altitude

A height above sea level not exceeding 1 000 m.

4.2.3 Temperature of cooling air

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.

4.2.4 Wave-shape of supply voltage

A supply voltage of which the waveshape is approximately sinusoidal.

NOTE This requirement is normally not critical in public supply systems but may have to be considered in installations with considerable converter loading. In such cases, there is a conventional rule that the deformation shall neither exceed 5 % total harmonic content nor 1 % even harmonic content, see IEC 61000-2-4. Also note the importance of current harmonics for load loss and temperature rise, see IEC 61378-1.

4.2.5 Symmetry of polyphase supply voltages

For three-phase transformers, a set of three-phase supply voltages which are approximately symmetrical.

4.2.6 Humidity

The relative humidity of the surrounding air shall be less than 93 %. No drops of water shall be present on the surface of the coils.

4.3 Electromagnetic compatibility (EMC)

Transformers shall be considered as passive elements in respect to emission and immunity to electromagnetic disturbances.

4.4 Provision for unusual service conditions

The purchaser shall identify in his enquiry any service conditions not covered by the normal service conditions in 4.2. Examples of such conditions are:

– high or low ambient temperature outside the limits prescribed in 4.2.3;
– restricted ventilation;
– altitude in excess of the limit prescribed in 4.2.2;
– damaging fumes and vapours;
– steam;
– humidity in excess of the limit prescribed in 4.2.6;
– dripping water;
– salt spray;

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– excessive and abrasive dust;
– high harmonic content of the load current;
– distortion of the supply voltage waveform;
– fast transient overvoltages over the limits prescribed in 12.1 and Clause 21;
– associated power factor correction and method of capacitor switching to limit inrush current;
– superimposed DC current;
– seismic qualification which would otherwise require special considerations in the design;
– extreme mechanical shock and vibrations;
– transport and storage conditions not covered by the normal condition described in 4.5.

Transformer specification for operation under such abnormal conditions shall be subject to agreement between the supplier and purchaser.

Supplementary requirements, within defined limits, for the rating and testing of transformers designed for other than normal service conditions listed in 4.2, such as high temperature of cooling air or altitude above 1 000 m are given in 11.2 and 11.3.

4.5 Transport and storage conditions

All transformers shall be suitable for transportation and storage at ambient temperatures down to –25 °C.

The supplier shall be informed of anticipated high levels of shock, vibration and inclination during transportation to site.

5 Tappings

The requirements in IEC 60076-1 Clause 5 applies. The preferred tapping range is either:

± 5 % in steps of 2,5 % (5 tap positions);

or

± 5 % (3 tap positions).

Tapping selection shall be made off-circuit by the use of bolted links or off-circuit tap-changers.

6 Connections

Unless otherwise specified by the purchaser, transformer connections shall be Dyn with clock hour figure 5 or 11 in accordance with Clause 6 of IEC 60076-1. The neutral connection shall be capable of carrying full phase rated current.

7 Ability to withstand short circuit

Transformers shall fulfil the requirements in IEC 60076-5. If the purchaser requires a test to demonstrate this fulfilment, this shall be stated in the contract.

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