
Močnostni transformatorji – 11. del: Suhi transformatorji (IEC 60076-11:2004)

Power transformers - Part 11: Dry-type transformers (IEC 60076-11:2004)

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN 60076-11:2005](https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005)

<https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 60076-11:2005

<https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005>

EUROPEAN STANDARD

EN 60076-11

NORME EUROPÉENNE

EUROPÄISCHE NORM

July 2004

ICS 29.180

Supersedes EN 60726:2003

English version

Power transformers
Part 11: Dry-type transformers
(IEC 60076-11:2004)

Transformateurs de puissance
Partie 11: Transformateurs de type sec
(CEI 60076-11:2004)

Leistungstransformatoren
Teil 11: Trockentransformatoren
(IEC 60076-11:2004)

iTeh STANDARD PREVIEW

(standards.iteh.ai)

This European Standard was approved by CENELEC on 2004-07-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 14/476/FDIS, future edition 1 of IEC 60076-11, prepared by IEC TC 14, Power transformers, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60076-11 on 2004-07-01.

This European Standard supersedes EN 60726:2003.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2005-04-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2007-07-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60076-11:2004 was approved by CENELEC as a European Standard without any modification. (standards.iteh.ai)

[SIST EN 60076-11:2005](https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005)
<https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005>

Annex ZA
(normative)

**Normative references to international publications
with their corresponding European publications**

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.

NOTE Where an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050	Series	International Electrotechnical Vocabulary	-	-
IEC 60071	Series	Insulation co-ordination	EN 60071	Series
IEC 60076-1 (mod)	1993	Power transformers Part 1: General	EN 60076-1 A11	1997 1997
A1	1999		A1 A12	2000 2002
IEC 60076-2 (mod)	- ¹⁾	Part 2: Temperature rise	EN 60076-2	1997 ²⁾
IEC 60076-3	- ¹⁾	Part 3: Insulation levels, dielectric tests and external clearances in air	EN 60076-3	2001 ²⁾
IEC 60076-5	- ¹⁾	Part 5: Ability to withstand short circuit	EN 60076-5	2000 ²⁾
IEC 60076-10	- ¹⁾	Part 10: Determination of sound levels	EN 60076-10	2001 ²⁾
IEC 60085	- ¹⁾	Electrical insulation - Thermal classification	-	-
IEC 60270	- ¹⁾	High-voltage test techniques - Partial discharge measurements	EN 60270	2001 ²⁾
IEC 60332-3-10	- ¹⁾	Test on electric cables under fire conditions Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables - Apparatus	-	-
IEC 60529	- ¹⁾	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May	1991 ²⁾ 1993
IEC 60905	1987	Loading guide for dry-type power transformers	-	-
IEC 61330	- ¹⁾	High-voltage/low-voltage prefabricated substations	EN 61330	1996 ²⁾

¹⁾ Undated reference.

²⁾ Valid edition at date of issue.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 60076-11:2005

<https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005>

NORME
INTERNATIONALE
INTERNATIONAL
STANDARD

CEI
IEC

60076-11

Première édition
First edition
2004-05

Transformateurs de puissance –

**Partie 11:
Transformateurs de type sec**

iTeh STANDARD PREVIEW
Power transformers –
(standards.iteh.ai)

**Part 11:
Dry-type transformers**

<https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005>

© IEC 2004 Droits de reproduction réservés — Copyright - all rights reserved

Aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'éditeur.

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE

W

*Pour prix, voir catalogue en vigueur
For price, see current catalogue*

CONTENTS

FOREWORD.....	9
1 Scope.....	13
2 Normative references	13
3 Definitions	15
4 Service conditions	15
4.1 General	15
4.2 Normal service conditions	15
4.3 Electromagnetic compatibility (EMC)	17
4.4 Provision for unusual service conditions	17
4.5 Transport and storage conditions	19
5 Tappings	19
6 Connections	19
7 Ability to withstand short circuit	19
8 Rating	21
8.1 General	21
8.2 Rated power	21
8.3 Preferred values of rated power	21
8.4 Operation at higher than rated voltage	21
8.5 Operation with fan cooling	21
8.6 Operation in an enclosure	21
9 Rating plate	23
9.1 Rating plate fitted to the transformer	23
9.2 Rating plate fitted to the transformer enclosure	23
10 Identification according to cooling method	23
10.1 Identification symbols	23
10.2 Arrangement of symbols	25
11 Temperature-rise limits.....	25
11.1 Normal temperature-rise limits.....	25
11.2 Reduced temperature rises for transformers designed for high cooling air temperatures or special air cooling conditions	27
11.3 High altitude temperature rise correction	27
12 Insulation levels	27
12.1 General	27
12.2 Transformers for use at high altitudes	31
13 Climatic, environmental and fire behaviour classes.....	31
13.1 Climatic classes	31
13.2 Environmental classes.....	31
13.3 Fire behaviour classes	31
13.4 Test criteria for climatic, environmental and fire behaviour classes.....	33
14 General requirements for tests	33
15 Measurement of winding resistance (routine test)	33

16	Measurement of voltage ratio and check of phase displacement (routine test)	35
17	Measurement of short-circuit impedance and load loss (routine test)	35
18	Measurement of no-load loss and current (routine test)	35
19	Separate-source AC withstand voltage test (routine test)	35
20	Induced AC withstand voltage test (routine test)	35
21	Lightning impulse test (type test)	37
22	Partial discharge measurement (routine and special test)	37
	22.1 General	37
	22.2 Basic measuring circuit (typical only)	37
	22.3 Calibration of the measuring circuit	37
	22.4 Voltage application	39
	22.5 Partial discharge acceptance levels	41
23	Temperature-rise test (type test)	43
	23.1 General	43
	23.2 Methods of loading	43
	23.3 Winding temperature-rise correction for reduced current	49
	23.4 Determination of steady state conditions	49
24	Measurement of sound level (special test)	49
25	Short-circuit test (special test)	51
26	Environmental test (special test)	51
	26.1 General	51
	26.2 Validity of the test	51
	26.3 Testing procedure	51
27	Climatic test (special test)	53
	27.1 Thermal shock test (special test)	53
	27.2 Validity of the test	53
	27.3 Thermal shock test for C1 class transformers	55
	27.4 Thermal shock test for C2 class transformers	57
28	Fire behaviour test (special test)	57
	28.1 General	57
	28.2 Checking of corrosive and harmful gases emission	57
	28.3 Fire behaviour test for F1 class transformer	59
	28.4 Quantities to be measured and measuring devices	63
	28.5 Calibration of the test chamber without test object	63
	28.6 Test method	63
	28.7 Test report	65
	28.8 Criteria for evaluating the test results	65
29	Tolerances	67
30	Protection against direct contact	67
31	Degrees of protection provided by enclosures	67
32	Earthing terminal	67
33	Information required with enquiry and order	67
	Annex A (informative) Installation and safety of dry-type transformers	73

Figure 1 – Basic measuring circuit for the partial discharge test for a single-phase transformer	39
Figure 2 – Basic measuring circuit for the partial discharge test for a three-phase transformer	39
Figure 3 – Voltage application for routine partial discharge test	41
Figure 4 – Voltage application for special partial discharge test	41
Figure 5 – Example of back-to-back method – Single phase.	47
Figure 6 – Example of back-to-back method – Three-phase	47
Figure 7 – Test chamber	69
Figure 8 – Test chamber details	71
Table 1 – Letter symbols	25
Table 2 – Winding temperature-rise limits	27
Table 3 – Insulation levels based on European practice	29
Table 4 – Insulation levels based on North American practice	29
Table 5 – sequence of tests	33
Table 6 – Dimensions of test chamber (see Figures 7 and 8)	61

(standards.iteh.ai)

SIST EN 60076-11:2005

<https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005>

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

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

STANDARD PREVIEW
(standards.iteh.ai)

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

- reconfirmed; [SIST EN 60076-11:2005](https://standards.iteh.ai/catalog/standards/sist/93bc8038-698a-49cd-8627-a3e3e1ef257b/sist-en-60076-11-2005)
- withdrawn;
- replaced by a revised edition, or
- amended.

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.

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*