Power transformers - Part 1: General

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EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

Käesolev Eesti standard EVS-EN 60076-1:2002 sisaldab Euroopa standardi EN 60076-1:1997+A1:2000+A12:2002 ingliskeelset teksti. Käesolev dokument on jõustatud 18.12.2002 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes. Standard on kättesaadav Eesti standardiorganisatsioonist.	This Estonian standard EVS-EN 60076-1:2002 consists of the English text of the European standard EN 60076-1:1997+A1:2000+A12:2002. This document is endorsed on 18.12.2002 with the notification being published in the official publication of the Estonian national standardisation organisation. The standard is available from Estonian standardisation organisation.

Käsitlusala: This part of International Standard IEC 76 applies to three-phase and single-phase power transformers (including auto-transformers) with the exception of certain categories of small and special transformers such as: single-phase transformers with rated power less than 1 kVA and three-phase transformers less than 5 kVA; instrument transformers; transformers for static convertors; traction transformers mounted on rolling stock; starting transformers; testing transformers; welding transformers.	**Scope:** This part of International Standard IEC 76 applies to three-phase and single-phase power transformers (including auto-transformers) with the exception of certain categories of small and special transformers such as: single-phase transformers with rated power less than 1 kVA and three-phase transformers less than 5 kVA; instrument transformers; transformers for static convertors; traction transformers mounted on rolling stock; starting transformers; testing transformers; welding transformers.

ICS 29.180

Võtmesõnad: definitions, enquiries, general, orders, power transformers, rating plates, service conditions, tests, tolerances

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60076-1

May 1997

ICS 29.180

Supersedes HD 398.1 S1:1980 and HD 398.4 S1:1980

Descriptors: Power transformers, general, service conditions, definitions, rating plates, tolerances, tests, enquiries (requests for proposal), orders

English version

Power transformers
Part 1: General
(IEC 76-1:1993, modified)

Transformateurs de puissance
Partie 1: Généralités
(CEI 76-1:1993, modifiée)

Leistungstransformatoren
Teil 1: Allgemeines
(IEC 76-1:1993, modifiziert)

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

Ref. No. EN 60076-1:1997 E

Foreword

The text of the International Standard IEC 76-1:1993, prepared by IEC TC 14, Power transformers, together with the common modifications prepared by the Technical Committee CENELEC TC 14 was submitted to the formal vote and was accepted by CENELEC as EN 60076-1 on 1997-03-11.

This European Standard supersedes HD 398.1 S1:1980 and HD 398.4 S1:1980.

Technical differences relate mainly to certain measures (e.g. of flexibility in given circumstances) to bring the standard in line with actual requirements of User's specifications.

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) 1997-09-01

- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-09-01

Annexes designated "normative" are part of the body of the standard. Annexes designated "informative" are given for information only. In this standard annexes A, E and ZA are normative and annexes B, C, D and F are informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 76-1:1993 was approved by CENELEC as a European Standard with agreed common modifications as given below.

COMMON MODIFICATIONS

2 Normative references

Delete the year of issue in the references to IEC 76-5 and IEC 606.
Replace the year of issue in the reference to IEC 137 by "1995".

3 Definitions

3.6 **Add** a new definition:

3.6.5 Total harmonic distortion factor:

$$D = \sqrt{\sum_{h=2}^{H} u_h^2}$$

where:

u_h = U_h/U_1

U_h is the rms value of the h^{TH} harmonic
U_1 is the rms value of the fundamental

H may be taken as 7 in practice for the purposes of this standard.

4 Rating

4.1 **Add** at the end of the second paragraph:

if not otherwise agreed between manufacturer and purchaser before an order is placed.

4.2 **Add** at the end of the third paragraph ("In the absence .... IEC 905"):

; however the need for compliance with IEC 354, IEC 905 or other loading conditions shall be stated by the purchaser at tender stage.

4.4 **Add** at the end of the second paragraph:

unless otherwise agreed between manufacturer and purchaser before an order is placed to meet exceptional operational conditions.

9 Tolerances

Add a new paragraph before the last paragraph:

For special cases, where tolerances other than detailed in table 1 are necessary, these shall be subject to agreement between manufacturer and purchaser before an order is placed.

10 Tests

10.1 **Add** a new paragraph after the third paragraph:

Tests on individual units in a group of identical transformers may be subject to agreement between manufacturer and purchaser in respect of choice of test. Type tests and special tests may be carried out on more than one unit in a batch if specified by the purchaser at the time of order. The sequence in which the tests are carried out and the choice of units on which they are performed shall also be subject to agreement at the time of order.

10.4 **Add** a new sentence at the end of the fourth paragraph:

Measurements on additional tap-positions may also be carried out by agreement between manufacturer and purchaser.

10.5 **Amend** the seventh paragraph as follows:

The test voltage shape is satisfactory if:

- the total harmonic distortion factor is ≤ 5%
- the readings U' and U are equal within 3%.

Retain the existing note.

Amend the penultimate paragraph as follows:

If the total harmonic distortion factor is > 5% and/or the difference between the voltmeter readings is larger than 3%, the validity of the test is subject to agreement.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

Publication	Year	Title	EN/HD	Year
IEC 50(421)	1990	International electrotechnical vocabulary Chapter 421: Power transformers and reactors	-	-
IEC 68-3-3	1991	Environmental testing Part 3: Guidance - Seismic test methods for equipments	EN 60068-3-3	1993
IEC 76-2 (mod)	1993	Power transformers Part 2: Temperature rise	EN 60076-2	1997
IEC 76-3 (mod) + A1 (mod)	1980 1981	Part 3: Insulation levels and dielectric tests	HD 398.3 S1	1986
IEC 76-3-1	1987	Part 3: Insulation levels and dielectric tests External clearances in air	-	-
IEC 76-5 (mod) A1	1976[1)] 1979	Part 5: Ability to withstand short-circuit	HD 398.5 S1 A1	1983 1988
IEC 137	1995	Bushings for alternating voltages above 1 kV	EN 60137	1996
IEC 354	1991	Loading guide for oil-immersed power transformers	-	-
IEC 529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May	1991 1993
IEC 551 (mod)	1987	Determination of transformer and reactor sound levels	EN 60551	1992

1) Under revision, latest edition will apply.

Publication	Year	Title	EN/HD	Year
IEC 606	1978[2)]	Application guide for power transformers	-	-
IEC 726 (mod)	1982	Dry-type power transformers	HD 464 S1[3)] + A2 + A3 + A4	1988 1991 1992 1995
IEC 815	1986	Guide for the selection of insulators in respect of polluted conditions	-	-
IEC 905	1987	Loading guide for dry-type power transformers	-	-
ISO 3	1973	Preferred numbers - Series of preferred numbers	-	-
ISO 9001	1987	Quality systems - Model for quality assurance in design/development, production, installation and servicing	EN 29001[4)]	1987

2) Under revision, latest edition will apply.

3) HD 464 S1 includes A1:1986 to IEC 726:1982, mod.

4) EN 29001:1987 is superseded by EN ISO 9001:1994, which is based on ISO 9001:1994.

INTERNATIONAL STANDARD

IEC 60076-1

Edition 2.1
2000-04

Edition 2:1993 consolidated with amendment 1:1999

Power transformers –

Part 1: General

*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.*

Reference number
IEC 60076-1:1993+A1:1999(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site (www.iec.ch)**

- **Catalogue of IEC publications**

  The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

  This summary of recently issued publications (www.iec.ch/online_news/ justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

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INTERNATIONAL STANDARD

IEC 60076-1

Edition 2.1
2000-04

Edition 2:1993 consolidated with amendment 1:1999

Power transformers –

Part 1: General

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International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE X

For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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POWER TRANSFORMERS –

Part 1: General

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

This International Standard has been prepared by IEC by technical committee 14: Power transformers.

This consolidated version of IEC 60076-1 is based on the second edition (1993) [documents 14(CO)75 and 14(CO)77], its amendment 1 (1999) [documents 14/344/FDIS and 14/345/RVD] and its corrigendum of June 1997.

It bears the edition number 2.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

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

Part 1:1993, General.

Part 2:1993, Temperature rise.

Part 3:1980, Insulation levels and dielectric tests.

Part 5:1976, Ability to withstand short circuit.

Annexes A and E form an integral part of this standard.

Annexes B, C, D and F are for information only.

POWER TRANSFORMERS –

Part 1: General

1 Scope and service conditions

1.1 Scope

This part of International Standard IEC 60076 applies to three-phase and single-phase power transformers (including auto-transformers) with the exception of certain categories of small and special transformers such as:

– single-phase transformers with rated power less than 1 kVA and three-phase transformers less than 5 kVA;
– instrument transformers;
– transformers for static convertors;
– traction transformers mounted on rolling stock;
– starting transformers;
– testing transformers;
– welding transformers.

When IEC standards do not exist for such categories of transformers, this part of IEC 60076 may still be applicable either as a whole or in part.

For those categories of power transformers and reactors which have their own IEC standards, this part is applicable only to the extent in which it is specifically called up by cross-reference in the other standard.*

At several places in this part it is specified or recommended that an 'agreement' shall be reached concerning alternative or additional technical solutions or procedures. Such agreement is to be made between the manufacturer and the purchaser. The matters should preferably be raised at an early stage and the agreements included in the contract specification.

1.2 Service conditions

1.2.1 Normal service conditions

This part of IEC 60076 gives detailed requirements for transformers for use under the following conditions:

a) Altitude

A height above sea-level not exceeding 1 000 m (3 300 ft).

b) Temperature of ambient air and cooling medium

A temperature of ambient air not below –25 °C and not above +40 °C. For water-cooled transformers, a temperature of cooling water at the inlet not exceeding +25 °C.

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* Such standards exist for dry-type transformers (IEC 60726), for reactors in general (IEC 60289), for traction transformers and reactors (IEC 60310), and are under preparation for static convertor transformers.

Further limitations, with regard to cooling are given for:

– oil-immersed transformers in IEC 60076-2;

– dry-type transformers in IEC 60726.

c) Wave shape of supply voltage

A supply voltage of which the wave shape is approximately sinusoidal.

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

d) Symmetry of three-phase supply voltage

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

e) Installation environment

An environment with a pollution rate (see IEC 60137 and IEC 60815) that does not require special consideration regarding the external insulation of transformer bushings or of the transformer itself.

An environment not exposed to seismic disturbance which would otherwise require special consideration in the design. (This is assumed to be the case when the ground acceleration level a_g is below 2 m/s.)*

1.2.2 Provision for unusual service conditions

Any unusual service conditions which may lead to special consideration in the design of a transformer shall be stated in the enquiry and the order. These may be factors such as high altitude, extreme high or low temperature, tropical humidity, seismic activity, severe contamination, unusual voltage or load current wave shapes and intermittent loading. They may also concern conditions for shipment, storage and installation, such as weight or space limitations (see annex A).

Supplementary rules for rating and testing are given in other publications for:

– Temperature rise and cooling in high ambient temperature or at high altitude: IEC 60076-2 for oil-immersed transformers, and IEC 60726 for dry-type transformers.

– External insulation at high altitude: IEC 60076-3 and IEC 60076-3-1 for oil-immersed transformers, and IEC 60726 for dry-type transformers.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60076. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60076 are encouraged to investigate the possibility of applying the most recent edition of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

* See IEC 60068-3-3.

IEC 60050(421):1990, *International Electrotechnical Vocabulary – Chapter 421: Power transformers and reactors*

IEC 60068-3-3:1991, *Environmental testing – Part 3: Guidance. Seismic test methods for equipments*

IEC 60076-2:1993, *Power transformers – Part 2: Temperature rise*

IEC 60076-3:1980, *Power transformers – Part 3: Insulation levels and dielectric tests*

IEC 60076-3-1:1987, *Power transformers – Part 3: Insulation levels and dielectric tests. External clearances in air*

IEC 60076-5:1976, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60137:1984, *Bushings for alternating voltages above 1 000 V*

IEC 60354:1991, *Loading guide for oil-immersed power transformers*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60551:1987, *Determination of transformer and reactor sound levels*

IEC 60606:1978, *Application guide for power transformers*

IEC 60726:1982, *Dry-type power transformers*

IEC 60815:1986, *Guide for the selection of insulators in respect of polluted conditions*

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

ISO 3:1973, *Preferred numbers – Series of preferred numbers*

ISO 9001:1987, *Quality systems – Model for quality assurance in design/development, production, installation and servicing*

3 Definitions

For the purpose of this part of IEC 60076, the following definitions shall apply. Other terms use the meanings ascribed to them in the International Electrotechnical Vocabulary (IEV).

3.1 General

3.1.1
power transformer
a static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power [IEV 421-01-01, modified]