SLOVENSKI STANDARD

SIST EN 60076-5:2006

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Močnostni transformatorji – 5. del: Kratkostična zmogljivost (IEC 60076-5:2006)

Power transformers – Part 5: Ability to withstand short-circuit (IEC 60076-5:2006)

ICS 29.180

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SIST EN 60076-5:2006(en)

EUROPEAN STANDARD

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EN 60076-5

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ICS 29.180

Supersedes EN 60076-5:2000

English version

Power transformers
Part 5: Ability to withstand short-circuit
(IEC 60076-5:2006)

Transformateurs de puissance
Partie 5: Tenue au court-circuit
(CEI 60076-5:2006)

Leistungstransformatoren
Teil 5: Kurzschlussfestigkeit
(IEC 60076-5:2006)

This European Standard was approved by CENELEC on 2006-04-01. 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, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the 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

Ref. No. EN 60076-5:2006 E

Foreword

The text of document 14/518/FDIS, future edition 3 of IEC 60076-5, prepared by IEC TC 14, Power transformers, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60076-5 on 2006-04-01.

This European Standard supersedes EN 60076-5:2000.

This European Standard includes the following significant technical changes with respect to EN 60076-5:2000:

a) introduction of Annex A (informative) "Theoretical evaluation of the ability to withstand the dynamic effects of short circuit", in place of previous Annex B (normative) "Calculation method for the demonstration of the ability to withstand short circuit" (blank);

b) introduction of Annex B (informative) "Definition of similar transformer", in place of previous Annex A (informative) "Guidance for the identification of a similar transformer".

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)	2007-01-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2009-04-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60076-5:2006 was approved by CENELEC as a European Standard without any modification.

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 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 60076-1 (mod) + corr. June + A1	1993 1997 1999	Power transformers - Part 1: General	EN 60076-1 + A1 + A11 + A12	1997 2000 1997 2002
IEC 60076-3 + corr. December	2000 2000	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air	EN 60076-3	2001
IEC 60076-8	1997	Power transformers - Part 8: Application guide	-	-
IEC 60076-11	2004	Power transformers - Part 11: Dry-type transformers	EN 60076-11	2004

INTERNATIONAL STANDARD

IEC 60076-5

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Power transformers –

Part 5:
Ability to withstand short circuit

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Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER TRANSFORMERS –

Part 5: Ability to withstand short circuit

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 60076-5 has been prepared by IEC technical committee 14: Power transformers.

This third edition cancels and replaces the second edition published in 2000. This third edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) introduction of Annex A (informative) – "Theoretical evaluation of the ability to withstand the dynamic effects of short circuit", in place of previous Annex B (normative) – "Calculation method for the demonstration of the ability to withstand short circuit" (blank);
b) introduction of Annex B (informative) – "Definition of similar transformer", in place of previous Annex A (informative) – "Guidance for the identification of a similar transformer".

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

FDIS	Report on voting
14/518/FDIS	14/523/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 the 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
Part 8: Application guide
Part 10: Determination of sound levels
Part 10-1: Determination of sound levels – Application guide
Part 11: Dry-type transformers
Part 12: Loading guide for dry-type power transformers[1]
Part 13: Self-protected liquid-filled transformers
Part 14: Design and application of liquid-immersed power transformers using high-temperature insulation materials
Part 15: Gas-filled-type power tranformers[1]

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

[1] Under consideration.

POWER TRANSFORMERS –

Part 5: Ability to withstand short circuit

1 Scope

This part of IEC 60076 identifies the requirements for power transformers to sustain without damage the effects of overcurrents originated by external short circuits. It describes the calculation procedures used to demonstrate the thermal ability of a power transformer to withstand such overcurrents and both the special test and the theoretical evaluation method used to demonstrate the ability to withstand the relevant dynamic effects. The requirements apply to transformers as defined in the scope of IEC 60076-1.

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 60076-1:1993, *Power transformers – Part 1: General*
Amendment 1 (1999)[2]

IEC 60076-3:2000, *Power Transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-8:1997, *Power transformers – Part 8: Application guide*

IEC 60076-11:2004, *Power transformers – Part 11: Dry-type transformers*

3 Requirements with regard to ability to withstand short circuit

3.1 General

Transformers together with all equipment and accessories shall be designed and constructed to withstand without damage the thermal and dynamic effects of external short circuits under the conditions specified in 3.2.

External short circuits are not restricted to three-phase short circuits; they include line-to-line, double-earth and line-to-earth faults. The currents resulting from these conditions in the windings are designated as overcurrents in this part of IEC 60076.

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2 There exists a consolidated edition 2.1 (2000) that includes edition 2.0 and its amendment.

3.2 Overcurrent conditions

3.2.1 General considerations

3.2.1.1 Application conditions requiring special consideration

The following situations affecting overcurrent magnitude, duration, or frequency of occurrence require special consideration and shall be clearly identified in transformer specifications:

- regulating transformers with very low impedance that depend on the impedance of directly connected apparatus to limit overcurrents;
- unit generator transformers susceptible to high overcurrents produced by connection of the generator to the system out of synchronism;
- transformers directly connected to rotating machines, such as motors or synchronous condensers, that can act as generators to feed current into the transformer under system fault conditions;
- special transformers and transformers installed in systems characterized by high fault rates (see 3.2.6);
- operating voltage higher than rated maintained at the unfaulted terminal(s) during a fault condition.

3.2.1.2 Current limitations concerning booster transformers

When the combined impedance of the booster transformer and the system results in short-circuit current levels for which the transformer cannot feasibly or economically be designed to withstand, the manufacturer and the purchaser shall mutually agree on the maximum allowed overcurrent. In this case, provision should be made by the purchaser to limit the overcurrent to the maximum value determined by the manufacturer and stated on the rating plate.

3.2.2 Transformers with two separate windings

3.2.2.1 For the purpose of this standard, three categories for the rated power of three-phase transformers or three-phase banks are recognized:

- category I: 25 kVA to 2 500 kVA;
- category II: 2 501 kVA to 100 000 kVA;
- category III: above 100 000 kVA.

3.2.2.2 In the absence of other specifications, the symmetrical short-circuit current (for the r.m.s. value, see 4.1.2) shall be calculated using the measured short-circuit impedance of the transformer plus the system impedance.

For transformers of category I, the contribution of the system impedance shall be neglected in the calculation of the short-circuit current if this impedance is equal to, or less than, 5 % of the short-circuit impedance of the transformer.

The peak value of the short-circuit current shall be calculated in accordance with 4.2.3.

3.2.2.3 Commonly recognized minimum values for the short-circuit impedance of transformers at the rated current (principal tapping) are given in Table 1. If lower values are required, the ability of the transformer to withstand short circuit shall be subject to agreement between the manufacturer and the purchaser.

Table 1 – Recognized minimum values of short-circuit impedance for transformers with two separate windings

Short-circuit impedance at rated current	
Rated power kVA	**Minimum short-circuit impedance** %
25 to 630	4,0
631 to 1 250	5,0
1 251 to 2 500	6,0
2 501 to 6 300	7,0
6 301 to 25 000	8,0
25 001 to 40 000	10,0
40 001 to 63 000	11,0
63 001 to 100 000	12,5
above 100 000	>12,5

NOTE 1 Values for rated power greater than 100 000 kVA are generally subject to agreement between manufacturer and purchaser.

NOTE 2 In the case of single-phase units connected to form a three-phase bank, the value of rated power applies to three-phase bank rating.

3.2.2.4 The short-circuit apparent power of the system at the transformer location should be specified by the purchaser in his enquiry in order to obtain the value of the symmetrical short-circuit current to be used for the design and tests.

If the short-circuit apparent power of the system is not specified, the values given in Table 2 shall be used.

Table 2 – Short-circuit apparent power of the system

Highest voltage for equipment, U_m kV	**Short-circuit apparent power** MVA	
	Current European practice	**Current North American practice**
7,2; 12; 17,5 and 24	500	500
36	1 000	1 500
52 and 72,5	3 000	5 000
100 and 123	6 000	15 000
145 and 170	10 000	15 000
245	20 000	25 000
300	30 000	30 000
362	35 000	35 000
420	40 000	40 000
525	60 000	60 000
765	83 500	83 500

NOTE If not specified, a value between 1 and 3 should be considered for the ratio of zero-sequence to positive-sequence impedance of the system.