

## **Reactors**

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

Käesolev Eesti standard EVS-EN 60289:2003 sisaldab Euroopa standardi EN 60289:1994+A11:2002 ingliskeelset teksti.

Standard on kinnitatud Eesti Standardikeskuse 15.01.2003 käskkirjaga ja jõustub sellekohase teate avaldamisel EVS Teatajas.

Standard on kättesaadav Eesti standardiorganisatsioonist.

This Estonian standard EVS-EN 60289:2003 consists of the English text of the European standard EN 60289:1994+A11:2002.

This standard is ratified with the order of Estonian Centre for Standardisation dated 15.01.2003 and is endorsed with the notification published in the official bulletin of the Estonian national standardisation organisation.

The standard is available from Estonian standardisation organisation.

ICS 29.180

### Standardite reprodutseerimis- ja levitamiseõigus kuulub Eesti Standardikeskusele

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English version

**Reactors**  
(IEC 289:1988, modified)

Bobines d'inductance  
(CEI 289:1988, modifiée)

Drosselspulen  
(IEC 289:1988, modifiziert)

This European Standard was approved by CENELEC on 1993-09-22. CENELEC members are bound to comply with the requirements of 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 and 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, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, 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 the International Standard IEC 289:1988, prepared by IEC TC 14, Power transformers, together with common modifications prepared by the Technical Committee CENELEC TC 14, Power transformers, was approved by CENELEC as HD 539 S2 on 1992-03-24.

At the request of TC 14 this Harmonization Document was submitted to the formal vote for conversion into a European Standard.

The text of IEC 289:1988 with the common modifications accepted for HD 539 S2 and some editorial modifications was approved by CENELEC as EN 60289 on 1993-09-22.

The following date was fixed:

- latest date of publication of an identical national standard (dop) 1994-07-01

Annexes designated "normative" are part of the body of the standard. In this standard, annex ZA is normative.

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## Endorsement notice

The text of the International Standard IEC 289:1988 was approved by CENELEC as a European Standard with agreed common modifications as given below.

### COMMON MODIFICATIONS

<u>Clause</u>	<u>Modification</u>
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Foreword	<b>Delete.</b>
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Preface	<b>Delete.</b>
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### SECTION ONE — GENERAL

#### 1 Scope

**Replace** the last paragraph and list by:

Where reference is made to specific clauses and subclauses of the various parts of IEC Publication 76, Power Transformers, it is to be understood that the editions are to be as the CENELEC HD 398 in force.

#### 2 Definitions

**Add** the following definition:

##### 2.2.1 *Non-linearity*

Non-linearity of a reactor, at a specific applied voltage, is conventionally defined as the relative difference between the actual peak value of current and a value linearly proportioned, by the voltage, from the crest value of current at rated voltage. Measurement of voltage is, for this purpose, made with a measuring system responsive to mean value of voltage but scaled to read the r.m.s. value of a sinusoidal wave having the same mean value.

NOTE: The deviation is usually expressed in percent of the linearly proportioned current value.

2.3

**Add:**

In certain countries the ambient temperature may temporarily be -30 °C and even lower limits may be agreed upon.

### SECTION TWO — SHUNT REACTORS

#### 4 Definitions

4.7

After the second sentence and before the existing note **add**:

NOTE: The mutual reactance is also expressed by the "coupling factor" being equal to:  
 $k = 100 X_M/X_N$ .

## COMMON MODIFICATIONS

### 8 Tests

8.1 At the end **add**:

The tests shall be carried out with the reactor erected substantially as in service, as far as features affecting the test results are concerned.

8.6 a) **Replace** "The reactance" by "The reactance of single phase reactors".

8.6 b) **Replace** "see IEC Publication 60-2, Sub-clause 7.1" by "see IEC 60-1:1989, subclause 16.1".

8.8 In the note, **replace** "see Sub-clause 7.1 of IEC Publication 60-2" by "see subclause 16.1 of IEC 60-1:1989".

8.10 **Add**:

NOTE: Care should be taken to prevent voltages induced by currents flowing in connecting leads. Details given in subclause 17.5, about this subject, for series reactors, are also applicable.

8.12 **Delete** the last sentence.

**Add**:

NOTE: The magnetic characteristic may also be obtained by processing records from charging or discharging the reactor with d.c. current.

8.13 **Write** "subclause 2.5" instead of "subclause 3.4".

8.14 After "normally on all four sides of ..." procedure **add** "and on the extremities of any equipment mounted on the tank".

After "... maximum value is 200  $\mu\text{m}$ " **add** "for the tank wall".

**Add** new paragraph:

For the equipment mounted on the tank it has to be shown by the manufacturer that the amplitudes have no long-term effect on their stability and performance.

### 9 Tolerances

**Add** new subclause:

9.3 Tolerance on secondary voltage

If a shunt reactor is specified with a secondary winding (see 3.2 "Design") having a continuous rated power, e.g. for station auxiliary supply, the tolerance on its no-load voltage at rated voltage across the main winding is  $\pm 10\%$  of the specified value.

## COMMON MODIFICATIONS

### SECTION THREE — CURRENT-LIMITING REACTORS AND NEUTRAL-EARTHING REACTORS

#### 11 Definitions

11.4 Renumber 11.4 to 11.5 and insert as a new subclause 11.4:

11.4 *Mutual reactance ( $X_M$ ) of a three phase reactor (or coupling factor)*

The ratio between induced voltage in an open phase and the current in an excited phase (in ohms per phase at rated frequency) (see Fig. 3). Mutual reactance is suitably expressed per unit of the rated reactance.

NOTE: The mutual reactance is also expressed by the "coupling factor" being equal to:  
 $k = 100 X_M/X_N$ .

11.5 **Add** at the end of 11.5 (old 11.4):

If the mutual reactance is above 5 % (this will normally be the case in three-phase reactors with common axis, also known as "stacked coils") two different rated impedances should be distinguished: The three-phase rated impedance  $Z_{KN,3}$  and the single-phase rated impedance  $Z_{KN,1}$  as defined in subclauses 11.5.1 and 11.5.2.

11.5.1 *Rated three-phase impedance  $Z_{KN,3}$*

The specified impedance in ohms per phase, at rated frequency and rated three-phase symmetrical short-time current, as an average for the three phases.

11.5.2 *Rated single-phase impedance  $Z_{KN,1}$*

The specified impedance in ohms per phase at rated frequency and rated single-phase short-time current, the other two phases being at zero current.

#### 12 Rating

12.3 **Replace** the first line by:

The standard rated short-time current duration is:

**Add** after a):

NOTE: In special cases, if necessary, longer durations up to 5 s may be specified.

12.4 **Add** a second note:

NOTE 2: The duty on three-phase current-limiting reactors is dependent on system earthing. If there is high impedance system earthing, the duty on the three-phase reactor is to limit symmetrical three-phase fault currents. Only  $Z_{KN,3}$  has to be specified.

If the system is effectively earthed, both single-phase and three-phase system fault currents have to be recognized, and both  $Z_{KN,3}$  and  $Z_{KN,1}$  usually have to be specified. It must be kept in mind that in some cases the reactor design does not allow the individual phase reactances to be symmetrical within both sets of values simultaneously.

The manufacturer will have to provide a suitable compromise in consultation with the purchaser. It should be noted that for this kind of reactor the relative winding senses of the phases and their connections to the system should be such that the mutual inductance between adjacent phases increases the effect of the self-inductance. As a consequence the middle phase will have the opposite winding sense or the ends will be connected in the opposite sense.

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### 17 Tests

#### 17.1 At the end **add**:

The tests shall be carried out with the reactor erected substantially as in service, as far as features affecting the test results are concerned.

#### 17.5 **Add** before the note:

For three-phase reactors with coupling factors higher than 5 % the mutual reactances between each pair of phases shall be measured and their polarities shall be checked. For the method of measurement see figure 3. In the event, that it is not possible to totally shield connecting leads from one another in order to prevent induced voltages, a more rigorous determination of mutual reactances can be obtained by measuring the reactances of each single phase coil and of each pair of phase coils connected in series. The mutual reactances can be derived from the measured results by calculation.

NOTE: It is recommended that an impedance measuring bridge with provisions for compensation of errors introduced by measuring leads be used.

#### 17.6.1 **Replace** the note by:

NOTE: Presence of metal parts in the vicinity around or under reactors without magnetic shield can give rise to considerable measuring errors and should therefore be avoided. However, metal parts which belong to the support structure of the reactor shall not be removed.

#### 17.12 **Write** "subclause 2.5" instead of "subclause 3.4".

## SECTION FOUR — DAMPING REACTORS

### 20 Definitions

#### 20.1 **Add** "which the reactor is designed to carry continuously" at the end of the definition.

### 25 Tests

#### 25 After the first sentence **add**:

The tests shall be carried out with the reactor erected substantially as in service, as far as features affecting the test results are concerned.

## SECTION FIVE — TUNING (FILTER) REACTORS

### 27 General

#### 27.2 After "recognized conditions" (end of third paragraph) **add** "to be stated in the enquiry and order."



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### 28 Definitions

- 28.1 **Replace** the sentence by:  
The r.m.s. value of power frequency current flowing continuously or for a specified period through the reactor.
- 28.2 **Replace** the sentence by:  
The r.m.s. value of power frequency voltage applied continuously or for a specified period across the reactor.
- 28.3 **Replace** the first line by:  
The r.m.s. value of the current of tuning frequency flowing continuously or for a specified period through the reactor.
- 28.4 **Replace** the sentence by:  
The r.m.s. value of the voltage of tuning frequency applied continuously or for a specified period across the reactor.

### 29 Rating

- 29.1 After "applicable" **add** ", and it should be noted that  $I_N$  and  $I_A$  resp.  $U_N$  and  $U_A$  are occurring simultaneously".
- 29.4 **Replace** the text by:  
The frequency spectrum of current and/or voltage in service shall be stated in the enquiry.

### 30 Rating plates

- 30.1 After "Rated power-frequency voltage" **add** "and duration".  
After "Rated tuning-frequency voltage" **add** "and duration".  
After "Rated power-frequency current" **add** "and duration".  
After "Rated tuning-frequency current" **add** "and duration".  
**Add** a new subclause 30.2:  
30.2 Additional information should be given in certain cases: Type of insulating liquid, if not mineral oil.

### 31 Tests

- 31.1 At the end **add**:  
The test shall be carried out with the reactor erected substantially as in service, as far as features affecting the tests results are concerned.
- 31.6 **Replace** the first sentence by:  
The  $Q$ -factor is determined from the measurement of loss (see 31.7) and inductance (see 31.4) at tuning frequency.
- 31.7 **Replace** "signalling" by "tuning".

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### SECTION SIX — EARTHING TRANSFORMERS (NEUTRAL COUPLERS)

#### 34 General

- 34.1 At the end of the second line **replace** "where it is otherwise unearthed" by "where a neutral is not available".

#### 36 Rating

- 36.2 In the second paragraph **replace** the word "short-time" by "rated neutral".  
In the last sentence **add** "rated neutral" before "current".

#### 37 Ability to withstand the rated neutral current

**Add** "for the specified duration as applicable" after "rated neutral current".

#### 38 Temperature rise

**Replace** the text of this clause by:

For rated continuous current the temperature-rise limits given in clause 2 of HD 398.2 and clause 10 of HD 464 apply. For rated neutral current of specified duration up to 10 s the temperature rise limits given for transformer windings under short circuit conditions in subclause 2.1.4 of HD 398.5 apply. In the case of operation together with arc-suppression reactors the temperature rise limits given in clause 47 are applicable.

#### 40 Rating plates

- 40.2 **Add:**  
Type of insulating liquid, if not mineral oil.

#### 41 Tests

- 41.1 At the end **add:**  
The tests shall be carried out with the reactor erected substantially as in service, as far as features affecting the test results are concerned.

- 41.6 **Replace** the subclause by:

*Determination of temperature rise under rated neutral current*

The following cases are to be distinguished:

- In the case of a specified duration of rated neutral current being 10 s or less, the continuous thermal loading is determined by the no-load loss or the combination of no-load and load loss at rated power of the secondary winding. The primary winding is excited at rated voltage in the test. In addition, if a secondary voltage winding is provided, this may be connected to a suitable load giving rated current in that winding. The top oil and winding temperature rises are determined in accordance with clause 3 of HD 398.2. The temperature rise at rated neutral

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current is then determined by calculation in accordance with subclause 2.1.5 of HD 398.5, taking the temperature rise obtained in the test as initial temperature rise.

- In the case of a specified duration being more than 10 s or if rated neutral current is specified as continuous, then measurement shall be made in accordance with clause 3 of HD 398.2, by connecting a single phase supply to give a current in the neutral, equal to rated neutral current. If possible the temperature rise by the no-load loss is to be taken into account by increasing the current in the winding as to dissipate the sum of no-load and load loss in the same way as described for power transformers in HD 398.2.
- Otherwise, calculation or measurement shall be agreed between manufacturer and purchaser.

## SECTION SEVEN — ARC-SUPPRESSION REACTORS

### 43 General

- 43.1 First paragraph, second line:  
**Replace** "insulated" by "isolated".

### 45 Rating

- 45.1 In the first sentence **add** "at rated frequency" after "highest voltage".  
**Delete** the last sentence of 45.1.
- 45.2 In the heading **add** "and duration" after "Rated current".  
After the first paragraph **add** the following note:
- NOTE:** In the system the inductive current for arc suppression may be delivered by more than only one reactor.
- Add** a new subclause:
- 45.3 *Non-linearity*
- Arc suppression reactors shall have a substantially linear characteristic. Non-linearity shall be limited to a maximum value of 5 % up to 110 % of rated voltage, unless otherwise specified by the purchaser.

### 47 Winding temperature rise

- Add** "oil-immersed" before "arc-suppression".
- Delete** "— 120 K for maximum 30 min specified duration of rated current."

### 49 Rating plates

- 49.2 **Add:**
- Type of insulating liquid, if not mineral oil.

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### 50 Tests

50.1 At the end **add**:

The tests shall be carried out with the reactor erected substantially as in service, as far as features affecting the test results are concerned.

## SECTION EIGHT — SMOOTHING REACTORS

### 58 Tests

58.1 At the end **add**:

The tests shall be carried out with the reactor erected substantially as in service, as far as features affecting the test results are concerned.

58.12 **Replace** the first line by "The recommended frequency ranges are:"

### Figures

Figure 4 **Delete** item "R" in the text, since it is absent in the figure.

Figure 5 **Delete** items "B" and "W" in the text, since they are absent in the figure.

## Annex ZA (normative)

### Other international publications quoted in this standard with the references of the relevant 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.

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

IEC Publication	Date	Title	EN/HD	Date
60-2	1973			
superseded by				
60-1	1989	High-voltage test techniques Part 1: General definitions and test requirements	HD 588 S1	1991
70	1967	Power capacitors	-	-
76-1 (mod)	1976	Power transformers - Part 1: General	HD 398.1 S1	1980
76-2 (mod)	1976	Part 2: Temperature rise	HD 398.2 S1 + A1	1980 1988
76-3 (mod)	1980	Part 3: Insulation levels and dielectric tests	HD 398.3 S1	1986
76-5 (mod)	1976	Part 5: Ability to withstand short circuit	HD 398.5 S1* + A1	1983 1988
146	1973	Semiconductor convertors	-	-
551 (mod)	1987	Determination of transformer and reactor sound levels	EN 60551	1992
722	1982	Guide to the lightning impulse and switching impulse testing of power transformers and reactors	-	-
726 (mod)	1982	Dry-type power transformers	HD 464 S1* + A2 + A3	1988 1991 1992

#### Other publications

ISO 3	1973	Preferred numbers - Series of preferred numbers
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\* HD 398.5 S1 includes amendment 1:1979 to IEC 76-5.  
HD 464 S1 includes amendment 1:1986 to IEC 726.

EUROPEAN STANDARD

**EN 60289/A11**

NORME EUROPÉENNE

EUROPÄISCHE NORM

February 2002

ICS 29.180

English version

## **Reactors**

Bobines d'inductance

Drosselspulen

This amendment A11 modifies the European Standard EN 60289:1994; it was approved by CENELEC on 2002-02-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment 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 amendment 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, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, 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

This amendment to the European Standard EN 60289:1994 was prepared by the Technical Committee CENELEC TC 14, Power transformers.

The text of the draft was submitted to the formal vote and was approved by CENELEC as amendment A11 to EN 60289:1994 on 2002-02-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2003-02-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2005-02-01

The reference of clauses, subclauses, notes, figures and annexes which are in addition to those in IEC 60289 is prefixed with the letter Z.

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annex ZB is informative.

Annex ZB has been added by CENELEC.

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The text of EN 60289:1994 is modified as follows:

## 1 Scope

**Add** as second indent in the list of exclusions (end of first paragraph) the following:

- reactors having windings with rated voltage  $U_n$  lower than, or equal to 1 000 V;

**Modify** the second paragraph (Where IEC ... or in part) into a note.

**Add** at the end of section 1 a new clause as follows:

### Z1 Electromagnetic compatibility (EMC)

Reactors under the limits of clause 1 shall be considered as a part of an installation. The EMC requirements are therefore those applicable to the whole installation.

**Add** a new annex:

#### Annex ZB

(Informative)

#### Installation and safety of a reactor

##### ZB.1 Manuals

Instruction manuals concerning installation requirements, transport requirements, erection, maintenance and operation should be given to the purchaser by the supplier, in particular for the supply of a prototype for a given purchaser. Unless otherwise specified in the contract, it is considered a good practice to transmit these manuals in advance, in order to enable the purchaser to check the correctness of the installation and the steps taken to organise transport and erection, if applicable.

##### ZB.2 Installation

###### ZB.2.1 General

Safety in the reactor use can be considered from different points of view:

- a) intrinsic safety of the reactor to be free from dangerous events arising from internal failure;
- b) safety deriving from steps taken in the installation precautions against unavoidable events;
- c) limitation of consequences of external events.

National laws and regulations impose in several countries the steps to be taken to improve safety in b) and c) above.

HD 637 S1 and national standards specify installation requirements to be observed.

NOTE National laws and regulations prevail on the contents of this informative annex.

The following subclauses give some examples on the steps to be taken both by the supplier and the purchaser to assure an acceptable degree of safety.



### **ZB.2.2 Intrinsic safety**

The fulfilment of the requirements contained in this standard gives the necessary reliability against dangerous failures inside the reactor. For the insulation liquids the applicable standards issued by IEC/TC 10 assist, with the exception of IEC 60599. For main fittings the relevant standards are applicable.

The following particular points may be applicable:

- insulation levels and tests;
- maximum heat generation resulting from the guaranteed losses;
- maximum temperature in service;
- systematic maintenance of the reactor, its accessories and protection. The manual should address these points;
- the manual should give guidance on condition based maintenance.

### **ZB.2.3 Installation precautions**

Installation precautions are given in national laws and regulations, in national standards and in HD 637 S1.

Installation designers should consider the following, non exhaustive, list of points:

- the cooling system should be sufficient to keep the temperature of the ambient air and cooling medium below the specified maximum limits;
- adequate protection against transient overvoltages;
- protection on the reactor (gas actuated relay, if applicable, contacts on temperature indicating devices, etc.) and in the installation (relays, fuses, etc.);
- risk and consequences of and precaution against fire with origin in the reactor itself or origin at other place;
- the generation of gases;
- liquid retention means, if applicable;
- restricted access to avoid contact with live parts or hot parts and to limit the presence of persons in the case of failure;
- control of the noise emission outside the installation according the applicable rules, if any;
- control of the emission of magnetic fields outside the installation.

NORME  
INTERNATIONALE  
INTERNATIONAL  
STANDARD

CEI  
IEC  
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Bobines d'inductance

Reactors



Numéro de référence  
Reference number  
CEI/IEC 289: 1988

## Validité de la présente publication

Le contenu technique des publications de la CEI est constamment revu par la CEI afin qu'il reflète l'état actuel de la technique.

Des renseignements relatifs à la date de reconfirmation de la publication sont disponibles auprès du Bureau Central de la CEI.

Les renseignements relatifs à ces révisions, à l'établissement des éditions révisées et aux amendements peuvent être obtenus auprès des Comités nationaux de la CEI et dans les documents ci-dessous:

- **Bulletin de la CEI**
- **Annuaire de la CEI**  
Publié annuellement
- **Catalogue des publications de la CEI**  
Publié annuellement et mis à jour régulièrement

## Terminologie

En ce qui concerne la terminologie générale, le lecteur se reportera à la CEI 50: *Vocabulaire Electrotechnique International* (VEI), qui se présente sous forme de chapitres séparés traitant chacun d'un sujet défini. Des détails complets sur le VEI peuvent être obtenus sur demande. Voir également le dictionnaire multilingue de la CEI.

Les termes et définitions figurant dans la présente publication ont été soit tirés du VEI, soit spécifiquement approuvés aux fins de cette publication.

## Symboles graphiques et littéraux

Pour les symboles graphiques, les symboles littéraux et les signes d'usage général approuvés par la CEI, le lecteur consultera:

- la CEI 27: *Symboles littéraux à utiliser en électrotechnique*;
- la CEI 417: *Symboles graphiques utilisables sur le matériel. Index, relevé et compilation des feuilles individuelles*;
- la CEI 617: *Symboles graphiques pour schémas*;

et pour les appareils électromédicaux,

- la CEI 878: *Symboles graphiques pour équipements électriques en pratique médicale*.

Les symboles et signes contenus dans la présente publication ont été soit tirés de la CEI 27, de la CEI 417, de la CEI 617 et/ou de la CEI 878, soit spécifiquement approuvés aux fins de cette publication.

## Publications de la CEI établies par le même comité d'études

L'attention du lecteur est attirée sur les listes figurant à la fin de cette publication, qui énumèrent les publications de la CEI préparées par le comité d'études qui a établi la présente publication.

## Validity of this publication

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 the date of the reconfirmation of the publication is available from the IEC Central Office.

Information on the revision work, the issue of revised editions and amendments may be obtained from IEC National Committees and from the following IEC sources:

- **IEC Bulletin**
- **IEC Yearbook**  
Published yearly
- **Catalogue of IEC publications**  
Published yearly with regular updates

## Terminology

For general terminology, readers are referred to IEC 50: *International Electrotechnical Vocabulary (IEV)*, which is issued in the form of separate chapters each dealing with a specific field. Full details of the IEV will be supplied on request. See also the IEC Multilingual Dictionary.

The terms and definitions contained in the present publication have either been taken from the IEV or have been specifically approved for the purpose of this publication.

## Graphical and letter symbols

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications:

- IEC 27: *Letter symbols to be used in electrical technology*;
- IEC 417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets*;
- IEC 617: *Graphical symbols for diagrams*;

and for medical electrical equipment,

- IEC 878: *Graphical symbols for electromedical equipment in medical practice*.

The symbols and signs contained in the present publication have either been taken from IEC 27, IEC 417, IEC 617 and/or IEC 878, or have been specifically approved for the purpose of this publication.

## IEC publications prepared by the same technical committee

The attention of readers is drawn to the end pages of this publication which list the IEC publications issued by the technical committee which has prepared the present publication.

NORME  
INTERNATIONALE  
INTERNATIONAL  
STANDARD

CEI  
IEC  
289

Deuxième édition  
Second edition  
1988

**Bobines d'inductance**

**Reactors**

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# COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

## BOBINES D'INDUCTANCE

### PRÉAMBULE

- 1) Les décisions ou accords officiels de la CEI en ce qui concerne les questions techniques, préparés par des Comités d'Etudes où sont représentés tous les Comités nationaux s'intéressant à ces questions, expriment dans la plus grande mesure possible un accord international sur les sujets examinés.
- 2) Ces décisions constituent des recommandations internationales et sont agréées comme telles par les Comités nationaux.
- 3) Dans le but d'encourager l'unification internationale, la CEI exprime le vœu que tous les Comités nationaux adoptent dans leurs règles nationales le texte de la recommandation de la CEI, dans la mesure où les conditions nationales le permettent. Toute divergence entre la recommandation de la CEI et la règle nationale correspondante doit, dans la mesure du possible, être indiquée en termes clairs dans cette dernière.
- 4) La CEI n'a fixé aucune procédure concernant le marquage comme indication d'approbation et sa responsabilité n'est pas engagée quand il est déclaré qu'un matériel est conforme à l'une de ses recommandations.

### PRÉFACE

La présente norme a été établie par le Sous-Comité 14C: Bobines d'inductance, du Comité d'Etudes n° 14 de la CEI: Transformateurs de puissance.

Cette deuxième édition remplace la première édition de la Publication 289 de la CEI, parue en 1968.

Le texte de cette norme est issu des documents suivants:

Règle des Six Mois	Rapports de vote
14C(BC)7 14C(BC)8	14C(BC)9 14C(BC)9

Le rapport de vote indiqué dans le tableau ci-dessus donnent toute information sur le vote ayant abouti à l'approbation de cette norme.

Les publications suivantes sont citées dans la présente norme:

- Publications n°s
- 60-2 (1973): Technique des essais à haute tension: Deuxième partie: Modalités d'essai.
  - 70 (1967): Condensateurs de puissance.
  - 76-1 (1976): Transformateurs de puissance: Première partie: Généralités.
  - 76-2 (1976): Deuxième partie: Echauffement.
  - 76-3 (1980): Troisième partie: Niveaux d'isolement et essais diélectriques.
  - 76-5 (1976): Cinquième partie: Tenue au court-circuit.
  - 146 (1973): Convertisseurs à semi-conducteurs.
  - 551 (1976): Mesures des niveaux de bruit des transformateurs et des bobines d'inductance.
  - 722 (1982): Guide pour les essais au choc de foudre et au choc de manœuvre des transformateurs de puissance et des bobines d'inductance.
  - 726 (1982): Transformateurs de puissance de type sec.

Autre publication citée:

- Norme ISO 3 (1973): Nombres normaux — Série de nombres normaux.

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## REACTORS

## FOREWORD

- 1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
- 2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
- 3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.
- 4) The IEC has not laid down any procedure concerning marking as an indication of approval and has no responsibility when an item of equipment is declared to comply with one of its recommendations.

## PREFACE

This standard has been prepared by Sub-Committee 14C: Reactors, of IEC Technical Committee No. 14: Power Transformers.

This second edition replaces the first edition of IEC Publication 289, issued in 1968.

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

Six Months' Rule	Reports on Voting
14C(CO)7 14C(CO)8	14C(CO)9 14C(CO)9

Full information on the voting for the approval of this standard can be found in the Voting Report indicated in the above table.

The following publications are quoted in this standard:

- Publication Nos. 60-2 (1973): High-voltage test techniques: Part 2: Test procedures.  
 70 (1967): Power capacitors.  
 76-1 (1976): Power transformers: Part 1: General.  
 76-2 (1976): Power transformers: Part 2: Temperature rise.  
 76-3 (1980): Power transformers: Part 3: Insulation levels and dielectric tests.  
 76-5 (1976): Part 5: Ability to withstand short circuit.  
 146 (1973): Semiconductor convertors.  
 551 (1976): Measurement of transformer and reactor sound levels.  
 722 (1982): Guide to the lightning impulse and switching impulse testing of power transformers and reactors.  
 726 (1982): Dry-type power transformers.

Other publication quoted:

- ISO Standard 3 (1973): Preferred numbers—Series of preferred numbers.

# BOBINES D'INDUCTANCE

## SECTION UN — GÉNÉRALITÉS

### 1. Domaine d'application

La présente norme s'applique aux types suivants de bobines d'inductance:

- bobines d'inductance shunt,
- bobines d'inductance de limitation de courant y compris les bobines d'inductance de mise à la terre du neutre,
- bobines d'inductance d'amortissement,
- bobines d'inductance d'accord (de filtrage),
- transformateurs de mise à la terre (bobines d'inductance triphasées de mise à la terre),
- bobines d'inductance d'extinction d'arc,
- bobines d'inductance de lissage.

à l'exception des bobines d'inductance suivantes:

- bobines d'inductance de puissance généralement inférieure à 2 kvar en monophasé et à 10 kvar en triphasé,
- bobines d'inductance de type spécial, telles que bobines d'inductance pour circuits bouchons à haute fréquence ou bobines d'inductance pour matériel roulant.

Lorsque des normes de la CEI n'existent pas pour les bobines d'inductance mentionnées ci-dessus ni pour d'autres bobines d'inductance de type spécial, la présente norme peut s'appliquer en partie ou en totalité.

Lorsqu'on se réfère à des articles et paragraphes spécifiques des diverses parties de la Publication 76 de la CEI: Transformateurs de puissance, les éditions à considérer sont les suivantes:

- |              |                   |                                                                           |
|--------------|-------------------|---------------------------------------------------------------------------|
| 76-1 (1976)  | Première partie:  | Généralités.                                                              |
| 76-2 (1976)  | Deuxième partie:  | Echauffement.                                                             |
| 76-3 (1980)  | Troisième partie: | Niveaux d'isolement et essais diélectriques.<br>Modification n° 1 (1981). |
| 76-4 (1976)  | Quatrième partie: | Prises et connexions.                                                     |
| 76-5* (1976) | Cinquième partie: | Tenue au court-circuit.                                                   |

### 2. Définitions

Les définitions données dans cet article concernent les catégories de bobines d'inductance qui font l'objet des sections deux à huit de la présente norme.

Dans ces sections sont données les définitions complémentaires des termes spécifiques à la catégorie particulière ou qui revêtent une signification particulière quand ils se rapportent à cette catégorie.

\* La deuxième impression (1982) incorpore la Modification n° 1 (1979).

## REACTORS

### SECTION ONE – GENERAL

#### 1. Scope

This standard applies to the following types of reactors:

- shunt reactors,
- current-limiting reactors including neutral-earthing reactors,
- damping reactors,
- tuning (filter) reactors,
- earthing transformers (neutral couplers),
- arc-suppression reactors,
- smoothing reactors,

with the exception of the following reactors:

- small reactors with a rating generally less than 2 kvar single-phase and 10 kvar three-phase,
- reactors for special purposes such as high-frequency line traps or reactors mounted on rolling stock.

Where IEC standards do not exist for such small or special reactors, this standard may be applicable in whole or in part.

Where reference is made to specific clauses and sub-clauses of the various parts of IEC Publication 76: Power transformers, it is to be understood that the editions are as follows:

- |              |                                                                            |
|--------------|----------------------------------------------------------------------------|
| 76-1 (1976)  | Part 1: General.                                                           |
| 76-2 (1976)  | Part 2: Temperature rise.                                                  |
| 76-3 (1980)  | Part 3: Insulation levels and dielectric tests.<br>Amendment No. 1 (1981). |
| 76-4 (1976)  | Part 4: Tappings and connections.                                          |
| 76-5* (1976) | Part 5: Ability to withstand short-circuit.                                |

#### 2. Definitions

The definitions given in this clause concern the categories of reactors which form the subject of Sections Two to Eight of this standard.

Additional definitions are given in those sections of terms which are specific to the particular category or which are given a particular meaning when related to that category.

\* The second impression (1982) incorporates Amendment No. 1 (1979).

A défaut de telles définitions dans cette norme, les termes utilisés ont la signification indiquée dans la Publication 76 de la CEI.

Les autres termes, de nature plus générale, sont définis dans le Vocabulaire Electrotechnique International (VEI).

De fréquentes références sont également faites aux articles techniques de la Publication 76 de la CEI et à d'autres publications concernant les transformateurs et les essais de transformateurs. La terminologie de ces publications a été conservée, même si celle-ci n'est pas strictement applicable aux bobines d'inductance.

Les articles concernant les essais doivent être suivis, s'ils sont applicables, pour les amplitudes, les durées, les séquences d'essais, les mesures et l'évaluation des résultats, même si les branchements d'essai spécifiés ne sont pas réalisables. Par exemple, l'essai par «tension induite» est un essai dans lequel, pour les bobines d'inductance, la tension d'essai appliquée aux bornes de l'enroulement n'est pas «induite» par un autre enroulement, mais est toujours appliquée directement par source extérieure.

## 2.1 Types de bobines d'inductance

### 2.1.1 Bobine d'inductance shunt

Bobine d'inductance destinée à être connectée en dérivation dans un réseau pour compenser le courant capacitif.

### 2.1.2 Bobine d'inductance de limitation de courant

Bobine d'inductance destinée à être connectée en série dans un réseau pour limiter le courant en cas de défaut dans le réseau.

### 2.1.3 Bobine d'inductance de mise à la terre du neutre

Bobine d'inductance monophasée destinée à être connectée entre le neutre d'un réseau et la terre afin de limiter à une valeur modérée le courant phase-terre en cas de défaut à la terre du réseau.

### 2.1.4 Bobine d'inductance d'amortissement

Bobine d'inductance destinée à être connectée en série avec des condensateurs pour limiter le courant d'enclenchement.

### 2.1.5 Bobine d'inductance d'accord (de filtrage)

Bobine d'inductance destinée à être connectée en série ou en parallèle avec des condensateurs afin de réduire, bloquer ou filtrer les harmoniques ou les fréquences de télécommunication.

### 2.1.6 Transformateur de mise à la terre (bobine d'inductance triphasée de mise à la terre)

Transformateur ou bobine d'inductance triphasée destinée à être connectée en dérivation dans un réseau pour former un point neutre.

*Note.* — Les transformateurs de mise à la terre peuvent, en outre, alimenter un réseau auxiliaire local.

### 2.1.7 Bobine d'inductance d'extinction d'arc

Bobine d'inductance monophasée destinée à être connectée entre le neutre d'un réseau et la terre pour compenser essentiellement le courant capacitif ligne-terre dû à un défaut monophasé à la terre (réseau compensé).

### 2.1.8 Bobine d'inductance de lissage

Bobine d'inductance destinée à limiter la circulation des courants harmoniques et les surintensités transitoires dans des réseaux à courant continu.

Unless such definitions are given in this standard, the terms used have the meaning given in IEC Publication 76.

Additional terms of more general nature are defined in the International Electrotechnical Vocabulary (IEV).

There are also frequent references to technical clauses in IEC Publication 76 and other related publications concerning transformers and transformer testing. The terminology of those publications has been maintained although it may not be strictly relevant in the context of reactors.

Test clauses should be followed as applicable concerning amplitudes, durations, test sequences, measurements and evaluation, even though specified test connections may not be applicable. For example “induced overvoltage test” is a test on a reactor where there is a test voltage across the winding although it is not “induced” from another winding, but always applied directly from the test source.

## 2.1 *Types of reactor*

### 2.1.1 *Shunt reactor*

Reactor intended for parallel connection in a system to compensate for capacitive current.

### 2.1.2 *Current-limiting reactor*

Reactor intended for series connection in a system for limiting the current under system fault conditions.

### 2.1.3 *Neutral-earthing current-limiting reactor*

Single-phase reactor intended for connection between the neutral of a system and earth for limiting the line-to-earth current under system earth fault conditions to a moderate value.

### 2.1.4 *Damping reactor*

Reactor intended for series connection with capacitors for limiting the inrush current during switching.

### 2.1.5 *Tuning (filter) reactor*

Reactor intended for series or parallel connection with capacitors for reducing, blocking or filtering harmonics or communication frequencies.

### 2.1.6 *Earthing transformer (neutral coupler)*

Three-phase transformer or reactor intended for parallel connection in a system to provide a neutral.

*Note.* — Earthing transformers may in addition supply a local auxiliary network.

### 2.1.7 *Arc-suppression reactor*

Single-phase reactor intended for connection between the neutral of a system and earth for essentially compensating the capacitive line-to-earth current due to a single-phase earth-fault (resonant-earthed system).

### 2.1.8 *Smoothing reactor*

Reactor intended to reduce the flow of harmonic currents and transient overcurrents in d.c. systems.