

**SLOVENSKI
STANDARD**

SIST EN 60289:1997

prva izdaja
oktober 1997

Reactors (IEC 289:1988 modified)

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ICS 29.180

Referenčna številka
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UDC 621.314.228.1

Supersedes HD 539 S2:1992

Descriptors: Reactor, definition, rating plate, insulation level, temperature rise, test, measurement

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.

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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>
Foreword	Delete.
Preface	Delete.

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.

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SECTION TWO — SHUNT REACTORS

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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 μm " **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.

COMMON MODIFICATIONS

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.

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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."

COMMON MODIFICATIONS

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".
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Add a new subclause 30.2:
30.2 Additional information should be given in certain cases: Type of insulating liquid, if not mineral oil.

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- 31 **Tests** <https://standards.iteh.ai/catalog/standards/sist/5b1cfd8b-2cfd-4dc0-a078-211a4d5021c0/sist-en-60289-1997>

- 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".**

COMMON MODIFICATIONS

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:** [SIST EN 60289:1997](https://standards.iteh.ai/catalog/standards/sist/5b1cfd8b-2cfd-4dc0-a078-110001000000/en-60289-1994)
<https://standards.iteh.ai/catalog/standards/sist/5b1cfd8b-2cfd-4dc0-a078-110001000000/en-60289-1994>
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

- [SIST EN 60289:1997](http://standards.iteh.ai/SIST/EN/60289/1997)
<http://standards.iteh.ai/standards/sist/5b1cfd8b-2cfd-4dc0-a078-211a4d5021c0/sist-en-60289-1997>
- 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.

COMMON MODIFICATIONS

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.

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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.

<u>IEC Publication</u>	<u>Date</u>	<u>Title</u>	<u>EN/HD</u>	<u>Date</u>
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 <http://standards.iso.org/iso/5797/211a4d5021c0/sist-en-60289-1997> 1973 Preferred numbers Series of preferred numbers

[SIST EN 60289:1997](http://standards.iso.org/iso/5797/211a4d5021c0/sist-en-60289-1997)

* HD 398.5 S1 includes amendment 1:1979 to IEC 76-5.
HD 464 S1 includes amendment 1:1986 to IEC 726.

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