SLOVENSKI STANDARD
SIST EN 61642:2001

01-september-2001

Industrial a.c. networks affected by harmonics - Application of filters and shunt capacitors

Industrial a.c. networks affected by harmonics - Application of filters and shunt capacitors

Von Oberschwingungen beeinflußte industrielle Wechselstromnetze - Anwendung von Filtern und Parallelkondensatoren

Réseaux industriels à courant alternatif affectés par les harmoniques - Emploi de filtres et de condensateurs shunt

Ta slovenski standard je istoveten z: **EN 61642:1997**

ICS:

31.060.99	Drugi kondenzatorji	Other capacitors
31.160	Električni filtri	Electric filters

SIST EN 61642:2001 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61642

October 1997

ICS 31.060.99; 31.160

Descriptors: Capacitors, shunts, power capacities, alternating current, electric filters, definitions, generalities

English version

Industrial a.c. networks affected by harmonics Application of filters and shunt capacitors (IEC 61642:1997)

Réseaux industriels à courant alternatif affectés par les harmoniques - Emploi de filtres et de condensateurs shunt (CEI 61642:1997)

Von Oberschwingungen beeinflußte industrielle Wechselstromnetze Anwendung von Filtern und Parallelkondensatoren (IEC 61642:1997)

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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 document 33/255/FDIS, future edition 1 of IEC 61642, prepared by IEC TC 33, Power capacitors, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61642 on 1997-10-01.

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) 1998-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1998-07-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annex A is informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61642:1997 was approved by CENELEC as a European Standard without any modification.

In the official version, for annex A, Bibliography, the following notes have to be added for the standards indicated:

IEC 60110	NOTE: Harmonized as HD 207 S1:1977 (not modified).
IEC 60143	NOTE: Harmonized in the EN 60143 series.
IEC 60358	NOTE: Harmonized as HD 597 S1:1992 (not modified).
IEC 60252	NOTE: Harmonized as EN 60252:1994 (modified).
IEC 61048	NOTE: Harmonized, together with its corrigendum 1992, as EN 61048:1993 (modified).
IEC 61049	NOTE: Harmonized, together with its corrigendum 1992, as EN 61049:1993 (modified).
IEC 60056	NOTE: Harmonized, together with its amendments 1:1992 and 2:1995, as HD 348 S6:1995.
IEC 60255-6	NOTE: Harmonized as EN 60255-6:1994 (modified).
IEC 60265-1	NOTE: Harmonized, together with its amendments 1:1984 and 2:1994, as HD 355.1 S3:1995 (not modified).
IEC 60265-2	NOTE: Harmonized, together with its corrigendum 1990, as EN 60265-2:1993 (not modified).
IEC 60269	NOTE: Harmonized in the EN 60269 series and in the HD 630 series.
IEC 60282	NOTE: Harmonized as EN 60282-1:1996 (not modified) and as HD 636 S1:1996 (not modified).
IEC 60289	NOTE: Harmonized as EN 60289:1994 (modified).

IEC 60831-1 NOTE: Harmonized as EN 60831-1:1996 (not modified).

IEC 60871-1 NOTE: Harmonized as HD 525.1 S1:1989 (not modified).

IEC 60871-2 NOTE: Harmonized as HD 525.2 S1:1989 (not modified).

IEC 60931-1 NOTE: Harmonized as EN 60931-1:1996 (not modified).

IEC 61000-2-2 NOTE: Harmonized as ENV 61000-2-2:1993 (modified).

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 60050(131)	1978	International Electrotechnical Vocabulary (IEV) Chapter 131: Electric and magnetic circuits	-	-
IEC 60050(161)	1990	Chapter 161: Electromagnetic compatibility	-	-

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
61642

Première édition
First edition
1997-09

Réseaux industriels à courant alternatif affectés par les harmoniques – Emploi de filtres et de condensateurs shunt

Industrial a.c. networks affected by harmonics – Application of filters and shunt capacitors

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE U

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL AC NETWORKS AFFECTED BY HARMONICS – APPLICATION OF FILTERS AND SHUNT CAPACITORS

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 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.

International Standard IEC 61642 has been prepared by IEC technical committee 33: Power capacitors.

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

FDIS	Report on voting
33/255/FDIS	33/274/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.

Annex A is for information only.

INDUSTRIAL AC NETWORKS AFFECTED BY HARMONICS – APPLICATION OF FILTERS AND SHUNT CAPACITORS

1 General

1.1 *Scope and object*

This International Standard gives guidance for the use of passive a.c. harmonic filters and shunt capacitors for the limitation of harmonics and power factor correction intended to be used in industrial applications, at low and high voltages. The measures proposed in this standard are applicable to harmonic orders greater than 1 and up to and including 25.

The following capacitors are excluded from this standard:

– capacitors for inductive heat generating plants, operating at frequencies between 40 Hz and 24 000 Hz (see IEC 60110 [1]*);

– series capacitors for power systems (see IEC 60143 [2]);

– coupling capacitors and capacitor dividers (see IEC 60358 [3]);

– power electronic capacitors (see IEC 61071 [4]);

– AC motor capacitors (see IEC 60252 [5]);

– capacitors for use in tubular fluorescent and other discharge lamp circuits (see IEC 61048 [6] and IEC 61049 [7]);

– capacitors for the suppression of radio interference;

– capacitors intended to be used in various types of electric equipment and thus considered as components;

– capacitors intended for use with d.c. voltage superimposed on a.c. voltage;

– capacitors intended for use with arc furnaces.

The object of this standard is to identify problems and give recommendations for general applications of capacitors and a.c. harmonic filters in a.c. power systems affected by the presence of harmonic voltages and currents.

1.2 *Normative references*

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

IEC 60050(131):1978, *International Electrotechnical Vocabulary (IEV) – Chapter 131: Electric and magnetic circuits*

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* Figures in square brackets refer to the bibliography given in annex A.

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

1.3 *Definitions*

For the purpose of this International Standard, the following definitions apply.

1.3.1 **harmonic**: The component of the Fourier-series decomposition of a voltage or current periodic wave. [IEV 161-02-18 modified]

1.3.2 **harmonic order, *h***: The ratio of the frequency of a harmonic (f_h) to the fundamental (rated) network frequency (f_1). [IEV 161-02-19 modified]

1.3.3 **characteristic harmonics**: Those harmonics produced by static converters in the course of theoretically ideal operation. The characteristic-harmonic order of static a.c./d.c. converters is given by $h = mp \pm 1$, where p is the pulse number of the converter and m is any integer. For example, the six-pulse converter circuit has characteristic harmonics with order numbers h = 5, 7, 11, 13, 17, 19....

1.3.4 **non-characteristic harmonics**: Those harmonics which are produced as a result of imbalance in the a.c. power system or asymmetrical delay of firing angle of the converter. They are also produced by other non-linear, time-varying devices, for example frequency changers, fluorescent lamps, arc furnaces, electric welding machines, etc.

1.3.5 **power factor**: The ratio of the active power to the apparent power. [IEV 131-03-20]

1.3.6 **displacement factor**: The ratio of the active power of the fundamental wave to the apparent power of the fundamental wave. [IEV 131-03-21 modified]

1.3.7 **distortion factor**: The ratio of the root-mean-square value of the harmonic content to the root-mean-square value of the fundamental quantity, expressed as a percentage of the fundamental. [IEV 131-03-04 modified]

$$DF = \frac{(\text{sum of the squares of r.m.s values of the harmonics})^{1/2}}{\text{r.m.s. value of the fundamental}} \quad 100\ \%$$

1.3.8 **filter**: An equipment generally constituted of reactors, capacitors and resistors if required, tuned to present a known impedance over a given frequency range.

1.3.9 **tuning frequency**: The frequency for which the filter impedance, calculated from the rated values, has a minimum or maximum value.

1.3.10 **tuned filter**: A filter with a tuning frequency which differs by no more than 10 % from the frequency which is to be filtered.

1.3.11 **detuned filter**: A filter with a tuning frequency more than 10% below the lowest harmonic frequency with considerable current/voltage amplitude.

1.3.12 **damped filter**: A filter with low, predominantly resistive, impedance over a wide band of frequencies.

1.3.13 **ripple control installation**: An installation to inject audio-frequency signals into the high voltage (HV) network in order to control receivers on the low voltage (LV) network.

1.3.14 **reference voltage**: The voltage to which the impedance calculations are referred.

1.4 *General considerations*

1.4.1 *AC harmonics*

Harmonic currents in power networks are produced, in general, when the loads are non-linear or time-varying. One of the main sources of harmonics in industrial networks are static converters.

There are two groups of converter a.c. current harmonics: characteristic and non-characteristic. The characteristic harmonics correlate strongly with the converter circuit and have a constant frequency spectrum. Their magnitude is approximately in inverse proportion to the harmonic number.

The main sources of non-characteristic harmonics are frequency changers, although small amounts of non-characteristic harmonics can result from system imbalances (voltage and impedance) and imbalance in the converter firing angle.

The rectifiers for d.c. drives produce mostly characteristic harmonics.

The effect of non-linear and time-varying loads can be amplified under certain conditions of the electrical supply-network, for example by resonances. Depending on the network conditions and on the amplification effect of the resonances, the supply voltage can be distorted even in electrical installations where non-linear and time-varying loads are absent or represent a small part of the total utility power.

Harmonics increase the losses in power networks and may affect the correct operation of various equipments, in particular electronic circuits.

To keep the harmonic disturbances to an acceptable level, local requirements and national and international standards may specify limits for the harmonic distortion. For the reduction of harmonic distortion, filters can be used.

1.4.2 *Reactive power*

In general, the reactive power flowing in networks is caused by inductive loads and static converters.

In a network the power factor is determined by the most economical use of the distribution system or is imposed by the utility. Penalties may be imposed through the tariff structure for poor power factor. It is therefore advisable to compensate the inductive reactive power by fitting suitable compensating equipments.

For power factor correction shunt capacitors are normally used. If there are harmonics in the network, unwanted overvoltages and/or overcurrents can appear. In addition, ripple control installations may be disturbed. In these cases, filters can be used in place of shunt capacitors alone.