SLOVENSKI STANDARD
SIST EN 50160:2011

01-marec-2011

Nadomešča:
SIST EN 50160:2008

Značilnosti napetosti v javnih razdelilnih omrežjih

Voltage characteristics of electricity supplied by public distribution networks

Merkmale der Spannung in öffentlichen Elektrizitätsversorgungsnetzen

iTeh STANDARD PREVIEW

Caractéristiques de la tension fournie par les réseaux publics de distribution

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Ta slovenski standard je istoveten z: **EN 50160:2010**

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ICS:

29.240.01	Omrežja za prenos in distribucijo električne energije na splošno	Power transmission and distribution networks in general

SIST EN 50160:2011 **en,fr,de**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 50160

July 2010

ICS 29.020

Supersedes EN 50160:2007

English version

Voltage characteristics of electricity supplied by public electricity networks

Caractéristiques de la tension fournie par les réseaux publics de distribution

Merkmale der Spannung in öffentlichen Elektrizitätsversorgungsnetzen

This European Standard was approved by CENELEC on 2010-03-01. 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.

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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.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Ref. No. EN 50160:2010 E

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Foreword

This European Standard was prepared by Working Group 1, Physical characteristics of electrical energy, of the Technical Committee CENELEC TC 8X, System aspects of electrical energy supply. It was submitted to the formal vote and was approved by CENELEC as EN 50160 on 2010-03-01.

This document is the result of an intensive cooperation between CENELEC and CEER, with involvement of CEER experts in TC 8X WG1 as well as in related Task Forces.

This document supersedes EN 50160:2007.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

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)	2011-03-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2015-03-01

The main differences from EN 50160:2007 are:

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– new organization of the document by grouping clauses related to events and continuous phenomena;

– modification of some definitions and completion by some new definitions;

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– new Clause 6 relevant to voltage characteristics in high voltage networks.

This work has been deemed so important, that before submission for vote, a CENELEC enquiry has been made, where NCs had the opportunity to respond to the most essential questions resulting from the WG discussions. This enquiry resulted in an extensive number of valuable comments, which have been carefully examined for possible consideration either for the voting draft in particular or for further work within WG1 on some main issues. Following that, the draft has been revised in depth, considering in particular the comments received on:

– the subclauses relevant to supply voltage changes, where a new formulation (capable of encompassing the needs expressed by the vast majority of the NCs) has been introduced,

– the new Clause 6, relevant to voltage characteristics in high voltage networks, where limits for harmonics and unbalance have been changed into indicative values, as new measurement surveys are taking place in several European countries, and it has been recognized as appropriate to wait for the relevant results before considering the setting of limits.

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1 Scope and object

1.1 Scope

This European Standard defines, describes and specifies the main characteristics of the voltage at a network user's supply terminals in public low voltage, medium and high voltage AC electricity networks under normal operating conditions. This standard describes the limits or values within which the voltage characteristics can be expected to remain at any supply terminal in public European electricity networks and does not describe the average situation usually experienced by an individual network user.

NOTE 1 For the definitions of low, medium and high voltage see 3 (Definitions).

This European Standard does not apply under abnormal operating conditions, including the following:

a) a temporary supply arrangement to keep network users supplied during conditions arising as a result of a fault, maintenance and construction work, or to minimize the extent and duration of a loss of supply;

b) in the case of non-compliance of a network user's installation or equipment with the relevant standards or with the technical requirements for connection, established either by the public authorities or the network operator, including the limits for the emission of conducted disturbances;

NOTE 2 A network user's installation may include load and generation.

c) in exceptional situations, in particular,

1) exceptional weather conditions and other natural disasters;

2) third party interference;

3) acts by public authorities;

4) industrial actions (subject to legal requirements);

5) force majeure;

6) power shortages resulting from external events.

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The voltage characteristics given in this standard are not intended to be used as electromagnetic compatibility (EMC) levels or user emission limits for conducted disturbances in public electricity networks.

The voltage characteristics given in this standard are not intended to be used to specify requirements in equipment product standards and in installation standards.

NOTE 3 The performance of equipment might be impaired if it is subjected to supply conditions which are not specified in the equipment product standard.

This standard may be superseded in total or in part by the terms of a contract between the individual network user and the network operator.

NOTE 4 The sharing of complaint management and problem mitigation costs between the involved parties is outside the scope of EN 50160.

Measurement methods to be applied in this standard are described in EN 61000-4-30.

1.2 Object

The object of this European Standard is to define, describe and specify the characteristics of the supply voltage concerning:

a) frequency;

b) magnitude;

c) waveform;

d) symmetry of the line voltages.

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These characteristics are subject to variations during the normal operation of a supply system due to changes of load, disturbances generated by certain equipment and the occurrence of faults which are mainly caused by external events.

The characteristics vary in a manner which is random in time, with reference to any specific supply terminal, and random in location, with reference to any given instant of time. Because of these variations, the values given in this standard for the characteristics can be expected to be exceeded on a small number of occasions.

Some of the phenomena affecting the voltage are particularly unpredictable, which make it very difficult to give useful definite values for the corresponding characteristics. The values given in this standard for the voltage characteristics associated with such phenomena, e.g. voltage dips and voltage interruptions, shall be interpreted accordingly.

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.

EN 60664-1	2007	Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests (IEC 60664-1:2007)
EN 61000-3-3	2008	Electromagnetic compatibility (EMC) – Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection (IEC 61000-3-3:2008)
EN 61000-4-30	2009	Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods (IEC 61000-4-30:2008)
IEC 60364-5-53 + A1	2001 2002	Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control
IEC/TR 61000-2-8	2002	Electromagnetic compatibility (EMC) – Part 2-8: Environment – Voltage dips and short interruptions on public electric power supply systems with statistical measurement results
IEC/TR 61000-3-7	2008	Electromagnetic compatibility (EMC) – Part 3-7: Assessment of emission limits for fluctuating loads in MV and HV power systems

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
conducted disturbance
electromagnetic phenomenon propagated along the line conductors of a supply network

NOTE In some cases an electromagnetic phenomenon is propagated across transformer windings and hence between networks of different voltage levels. These disturbances may degrade the performance of a device, equipment or system or they may cause damage.

3.2
declared supply voltage
***U*c**
supply voltage U_c agreed by the network operator and the network user

NOTE Generally declared supply voltage U_c is the nominal voltage U_n but it may be different according to the agreement between the network operator and the network user.

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3.3
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[IEV 161-08-13]

NOTE Voltage fluctuation cause changes of the luminance of lamps which can create the visual phenomenon called flicker. Above a certain threshold flicker becomes annoying. The annoyance grows very rapidly with the amplitude of the fluctuation. At certain repetition rates even very small amplitudes can be annoying.

3.4
flicker severity
intensity of flicker annoyance evaluated by the following quantities:

– **short term severity** (P_{st}) measured over a period of ten minutes;

– **long term severity** (P_{lt}) calculated from a sequence of twelve P_{st}-values over a two hour interval, according to the following expression:

$$P_{lt} = \sqrt[3]{\sum_{i=1}^{12} \frac{P_{sti}^{\ 3}}{12}}$$

3.5
frequency of the supply voltage
repetition rate of the fundamental wave of the supply voltage measured over a given interval of time

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3.6
harmonic voltage
sinusoidal voltage with a frequency equal to an integer multiple of the fundamental frequency of the supply voltage

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NOTE Application: Harmonic voltages can be evaluated:

– individually by their relative amplitude (u_h) which is the harmonic voltage related to the fundamental voltage u_1, where h is the order of the harmonic;

– globally, for example by the total harmonic distortion factor THD, calculated using the following expression:

$$THD = \sqrt{\sum_{h=2}^{40} (u_h)^2}$$

NOTE Harmonics of the supply voltage are caused mainly by network users' non-linear loads connected to all voltage levels of the supply network. Harmonic currents flowing through the network impedance give rise to harmonic voltages. Harmonic currents and network impedances and thus the harmonic voltages at the supply terminals vary in time.

3.7
high voltage
HV
voltage whose nominal r.m.s. value is 36 kV < $U_n \leq$ 150 kV

NOTE Because of existing network structures, in some countries the boundary between MV and HV can be different.

3.8
interharmonic voltage
sinusoidal voltage with a frequency not equal to an integer multiple of the fundamental

NOTE Interharmonic voltages at closely adjacent frequencies can appear at the same time forming a wide band spectrum.

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3.9
low voltage
LV
voltage whose nominal r.m.s. value is $U_n \leq 1$ kV

3.10
mains signalling voltage
signal superimposed on the supply voltage for the purpose of transmission of information in the public supply network and to network users' premises.

NOTE Classification: three types of signals in the public supply network can be classified:

– **ripple control signals:** superimposed sinusoidal voltage signals in the frequency range 110 Hz to 3 000 Hz;

– **power-line-carrier signals:** superimposed sinusoidal voltage signals in the frequency range 3 kHz to 148,5 kHz;

– **mains marking signals:** superimposed short time alterations (transients) at selected points of the voltage waveform

3.11
medium voltage
MV
voltage whose nominal r.m.s. value is 1 kV < $U_n \leq 36$ kV

NOTE Because of existing network structures, in some countries the boundary between MV and HV can be different.

3.12
network user
party being supplied by or supplying to an electricity supply network

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NOTE In several countries, the term network user includes network operators connected to a supply network with the same or higher voltage level.

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3.13
network operator
party responsible for operating, ensuring the maintenance of, and if necessary developing, the supply network in a given area and responsible for ensuring the long term ability of the network to meet reasonable demands for electricity supply

3.14
nominal frequency
nominal value of the frequency of the supply voltage

3.15
normal operating condition

operating condition for an electricity network, where load and generation demands are met, system switching operations are made and faults are cleared by automatic protection systems, in the absence of exceptional circumstances, i.e.:

a) temporary supply arrangement;

b) in the case of non-compliance of a network user's installation or equipment with the relevant standards or with the technical requirements for connection;

c) exceptional situations, such as:

1) exceptional weather conditions and other natural disasters;

2) third party interference;

3) acts by public authorities;

4) industrial actions (subject to legal requirements);

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5) force majeure;

6) power shortages resulting from external events

3.16
nominal voltage
U_n
voltage by which a supply network is designated or identified and to which certain operating characteristics are referred

3.17
rapid voltage change
single rapid variation of the r.m.s. value of a voltage between two consecutive levels which are sustained for definite but unspecified durations

NOTE For more information see EN 61000-3-3.

3.18
reference voltage (for interruptions, voltage dips and voltage swells evaluation)
a value specified as the base on which residual voltage, thresholds and other values are expressed in per unit or percentage terms

NOTE For the purpose of this standard, the reference voltage is the nominal or declared voltage of the supply system.

3.19
supply interruption
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condition in which the voltage at the supply terminals is lower than 5 % of the reference voltage

NOTE 1 Classification: a supply interruption can be classified as:

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a) **prearranged**, when network users are informed in advance; or

b) **accidental**, caused by permanent or transient faults, mostly related to external events, equipment failures or interference. An accidental interruption is classified as:

1) a long interruption (longer than 3 min);

2) a short interruption (up to and including 3 min).

NOTE 2 Normally, interruptions are caused by the operation of switches or protective devices.

NOTE 3 The effect of a prearranged interruption can be minimized by network users by taking appropriate measures.

NOTE 4 Prearranged interruptions are typically due to the execution of scheduled works on the electricity network.

NOTE 5 Accidental supply interruptions are unpredictable, largely random events.

NOTE 6 For polyphase systems, an interruption occurs when the voltage falls below 5 % of the reference voltage on all phases (otherwise, it is considered to be a dip).

NOTE 7 In some countries, the term Very Short Interruptions (VSI) or transitory interruptions are used to classify interruptions with duration shorter than 1 s to 5 s. Such interruptions are related to automatic reclosing device operation.

3.20
supply terminal
point in a public supply network designated as such and contractually fixed, at which electrical energy is exchanged between contractual partners

NOTE This point can differ from, for example, the electricity metering point or the point of common coupling.

3.21
supply voltage
r.m.s. value of the voltage at a given time at the supply terminal, measured over a given interval

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3.22
transient overvoltage
short duration oscillatory or non-oscillatory overvoltage usually highly damped and with a duration of a few milliseconds or less

[IEV 604-03-13, modified]

NOTE Transient overvoltages are usually caused by lightning, switching or operation of fuses. The rise time of a transient overvoltage can vary from less than a microsecond up to a few milliseconds.

3.23
voltage dip
temporary reduction of the r.m.s. voltage at a point in the electrical supply system below a specified start threshold

NOTE 1 Application: for the purpose of this standard, the dip start threshold is equal to 90 % of the reference voltage.

NOTE 2 Typically, a dip is associated with the occurrence and termination of a short circuit or other extreme current increase on the system or installations connected to it.

NOTE 3 For the purpose of this standard, a voltage dip is a two dimensional electromagnetic disturbance, the level of which is determined by both voltage and time (duration).

3.24
voltage dip duration
time between the instant at which the r.m.s. voltage at a particular point of an electricity supply system falls below the start threshold and the instant at which it rises to the end threshold

NOTE 1 Application: for the purpose of the standard, the duration of a voltage dip is from 10 ms up to and including 1 min.

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NOTE 2 For polyphase events, a dip begins when one voltage falls below the dip start threshold and ends when all voltages are equal to or above the dip end threshold.

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3.25
voltage dip end threshold
r.m.s. value of the voltage on an electricity supply system specified for the purpose of defining the end of a voltage dip

3.26
voltage dip residual voltage
minimum value of r.m.s. voltage recorded during a voltage dip

NOTE For the purpose of this standard, the residual voltage is expressed as a percentage of the reference voltage.

3.27
voltage dip start threshold
r.m.s. value of the voltage on an electricity supply system specified for the purpose of defining the start of a voltage dip

3.28
voltage fluctuation
series of voltage changes or a cyclic variation of the voltage envelope

[IEV 161-08-05]

3.29
voltage swell
temporary power frequency overvoltage

temporary increase of the r.m.s. voltage at a point in the electrical supply system above a specified start threshold

NOTE 1 Application: for the purpose of this standard, the swell start threshold is equal to the 110 % of the reference voltage (see CLC/TR 50422, Clause 3, for more information).

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NOTE 2 For the purpose of this standard, a voltage swell is a two dimensional electromagnetic disturbance, the level of which is determined by both voltage and time (duration).

NOTE 3 Voltage swells may appear between live conductors or between live conductors and earth. Depending on the neutral arrangement, faults to ground may also give rise to overvoltages between healthy phases and neutral.

3.30
voltage swell duration
time between the instant at which the r.m.s. voltage at a particular point of an electricity supply system exceeds the start threshold and the instant at which it falls below the end threshold

NOTE Application: for the purpose of this standard, the duration of a voltage swell is from 10 ms up to and including 1 min.

3.31
voltage swell end threshold
r.m.s. value of the voltage on an electricity supply system specified for the purpose of defining the end of a voltage swell

3.32
voltage swell start threshold
r.m.s. value of the voltage on an electricity supply system specified for the purpose of defining the start of a voltage swell

3.33
voltage unbalance
condition in a polyphase system in which the r.m.s. values of the line-to-line voltages (fundamental component), or the phase angles between consecutive line voltages, are not all equal

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[IEV 161-08-09, modified]

NOTE 1 The degree of the inequality is usually expressed as the ratios of the negative and zero sequence components to the positive sequence component.

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NOTE 2 In this European Standard, voltage unbalance is considered in relation to three-phase systems and negative phase sequence only.

3.34
voltage variation
increase or decrease of r.m.s. voltage normally due to load variations

4 Low-voltage supply characteristics

4.1 General

This clause describes the voltage characteristics of electricity supplied by public low voltage networks. In the following, a distinction is made between

– continuous phenomena, i.e. deviations from the nominal value that occur continuously over time. Such phenomena occur mainly due to load pattern, changes of load or nonlinear loads,

– voltage events, i.e. sudden and significant deviations from normal or desired wave shape. Voltage events typically occur due to unpredictable events (e.g. faults) or to external causes (e.g. weather conditions, third party actions).

For some continuous phenomena, limits are specified [1) 2)]; for voltage events, only indicative values can be given at present (see Annex B).

The standard nominal voltage U_n for public low voltage is U_n = 230 V, either between phase and neutral, or between phases.

– for four-wire three phase systems:
U_n = 230 V between phase and neutral;

[1)] For single rapid voltage changes, only indicative values are given for the time being.

[2)] For some specific parameters, in some national regulations stricter limits may exist.