# SLOVENSKI STANDARD

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**Železniške naprave – Napajalne napetosti sistemov električne vleke**

Railway applications - Supply voltages of traction systems



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# Railway applications – Supply voltages of traction systems

Applications ferroviaires – Tensions d'alimentation des réseaux de traction

Bahnanwendungen – Speisespannungen von Bahnnetzen

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CENELEC

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

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## Foreword

This European Standard was prepared by SC 9XC, Electric supply and earthing systems for public transport equipment and ancillary apparatus (fixed installations), of the Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways. It also concerns the expertise of SC 9XB, Electromechanical material on board of rolling stock.

For TSI lines, modifications and amendments should be made within a process frame which is related to the legal status of the TSI.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50163 on 2004-07-06.

This European Standard supersedes EN 50163:1995.

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) | 2005-07-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2007-07-01 |

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directives. See Annex ZZ.

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## 1 Scope

This European Standard specifies the main characteristics of the supply voltages of traction systems, such as traction fixed installations, including auxiliary devices fed by the contact line, and rolling stock, for use in the following applications :

– railways;

– guided mass transport systems such as tramways, elevated and underground railways mountain railways, and trolleybus systems;

– material transportation systems.

This European Standard does not apply to

– mine traction systems in underground mines,

– cranes, transportable platforms and similar transportation equipment on rails, temporary structures (e.g. exhibition structures) in so far as these are not supplied directly or via transformers from the contact line system and are not endangered by the traction power supply system,

– suspended cable cars,

– funicular railways.

This European Standard deals with long term overvoltages as shown in the Annex A.

## 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 50119 | Railway applications – Fixed installations - Electric traction overhead contact lines |
| EN 50122-1:1997 | Railway applications – Fixed installations – Part 1: Protective provisions relating to electrical safety and earthing |
| EN 50160:1999 | Voltage characteristics of electricity supplied by public distribution systems |
| EN 50215:1999 | Railway applications – Testing of rolling stock after completion of construction and before entry into service |
| EN 50388 [1)] | Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock to achieve interoperability |
| IEC 60050-811 | International Electrotechnical vocabulary - Chapter 811: Electric traction |



1) At draft stage.

## 3 Definitions

For the purposes of this European Standard, the terms and definitions given in EN 50122-1, EN 50160 and the following apply.

**3.1**
**electric traction system**
railway electrical distribution network used to provide energy for rolling stock

NOTE The system may comprise

- contact line systems,
- return circuit of electric traction systems,
- running rails of non-electric traction systems, which are in the vicinity of, and conductively connected to the running rails of an electric traction system,
- electrical installations, which are supplied from contact lines either directly or via a transformer,
- electrical installations in power plants and substations, which are utilized solely for generation and distribution of power directly to the contact line,
- electrical installations of switching stations.

[EN 50122–1]

**3.2**
**voltage *U***
potential at the train's current collector or elsewhere on the contact line, measured between the contact line and the return circuit.

The values considered in this European Standard are the mean value of d.c. voltage or the r.m.s. value of the fundamental a.c. voltage

**3.3**
**nominal voltage $U_n$**
designated value for a system

**3.4**
**highest permanent voltage $U_{max1}$**
maximum value of the voltage likely to be present indefinitely

**3.5**
**highest non permanent voltage $U_{max2}$**
maximum value of the voltage likely to be present as highest non permanent voltage for a limited period of time



**3.6**
**highest long term overvoltage $U_{max3}$**
Voltage defined as the highest value of the long-term overvoltage for $t$ = 20 ms. This value is independent from frequency



**3.7**
**lowest permanent voltage $U_{min1}$**
minimum value of the voltage likely to be present indefinitely

**3.8**
**lowest non permanent voltage $U_{min2}$**
minimum value of the voltage likely to be present for a limited period of time

**3.9**
**long-term overvoltage**
overvoltage higher than $U_{max2}$ lasting typically more than 20 ms, due to low impedance phenomena e.g. a rise in substation primary voltage

NOTE Such overvoltages are independent of line load and may be described by a voltage-time curve only. See Annex A for information on this curve.

**3.10**
**voltage variation**
increase or decrease of voltage normally due to variation of the total load of a distribution system or a part of it

NOTE Adapted from EN 50160.

**3.11**
**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 Adapted from EN 50160.

**3.12**
**supply voltage dip**
sudden reduction of the supply voltage to a value less than $U_{min2}$, followed by a voltage recovery after a short period of time. Conventionally the duration of a voltage dip is between 10 ms and 1 min. The depth of a voltage dip is defined as the difference between the minimum r.m.s. voltage during the voltage dip and the nominal voltage $U_n$. Voltage changes which do not reduce the supply voltage to less than $U_{min2}$ are not considered to be dips

**3.13**
**supply interruption**
condition in which the voltage at the supply-terminals is lower than 1 % of the nominal voltage $U_n$. A supply interruption can be classified as

- prearranged, when consumers are informed in advance, to allow the execution of scheduled works on the distribution systems, or
- accidental, caused by permanent or transient faults, mostly related to external events, equipment failures or interference. An accidental interruption is classified as
  - a long interruption (longer than 3 min) caused by a permanent fault,
  - a short interruption (up to 3 min) caused by a transient fault (see EN 50160).



**3.14**
**contact line**
conductor system for supplying electric energy to vehicles through current-collecting equipment [IEC 60050-811-33-01]



NOTE Contact line covers overhead contact line and conductor rail as defined in EN 50119 and EN 50122-1.

**3.15**
**(traction) substation**
installation, the main function of which is to supply a contact line system, at which the voltage of a primary supply system, and in certain cases the frequency, is converted to the voltage and frequency of the contact line

**3.16**
**normal operating conditions**
traffic operating to the design timetable and train formation used for power supply fixed installation design. Power supply equipment is operated according to standard rules.

NOTE Standard rules may vary depending on the infrastructure manager's policy.

**3.17**
**abnormal operating conditions**
either higher traffic loads or outage of power supply equipment outside the standard rules

NOTE Under these conditions, traffic may not operate to the design timetable.

# 4 Voltages and frequencies of traction systems

## 4.1 Voltages

The characteristics of the main voltage systems (overvoltages excluded) are specified in Table 1 below.

**Table 1 – Nominal voltages and their permissible limits in values and duration**

| Electrification system | Lowest non-permanent voltage $U_{min2}$ V | Lowest permanent voltage $U_{min1}$ V | Nominal voltage $U_n$ V | Highest permanent voltage $U_{max1}$ V | Highest non-permanent voltage $U_{max2}$ V |
|---|---|---|---|---|---|
| d.c. (mean values) | 400 | 400 | 600 [a] | 720 | 800 |
| | 500 [c] | 500 | 750 | 900 [c] | 1 000 |
| | 1 000 | 1 000 | 1 500 | 1 800 [c] | 1 950 |
| | 2 000 | 2 000 | 3 000 | 3 600 | 3 900 [b] |
| a.c. (r.m.s. values) | 11 000 | 12 000 | 15 000 | 17 250 | 18 000 |
| | 17 500 [c] | 19 000 [c] | 25 000 | 27 500 [c] | 29 000 |
| Special national conditions for France, see Annex B. | | | | | |

[a] Future d.c. traction systems for tramways and local railways should conform with system nominal voltage of 750 V, 1 500 V or 3 000 V.

[b] Special national conditions for Belgium, see Annex B.

[c] Special national conditions for United Kingdom, see Annex B.



The following requirements shall be fulfilled:



a) the duration of voltages between $U_{min1}$ and $U_{min2}$ shall not exceed 2 min;

b) the duration of voltages between $U_{max1}$ and $U_{max2}$ shall not exceed 5 min;

c) the voltage of the busbar at the substation at no load condition shall be less than or equal to $U_{max1}$. For d.c. substations it is acceptable to have this voltage at no load condition less than or equal to $U_{max2}$, knowing that when a train is present, the voltage at this train's pantograph (s) shall be in accordance with Table 1 and its requirements;

d) under normal operating conditions, voltages shall lie within the range $U_{min1} \leq U \leq U_{max2}$;