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SLOVENSKI STANDARD
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Železniške naprave - Stabilne naprave električne vleke in voznih sredstev - Tehnična merila za uskladitev med elektronapajalnimi postajami in elektrovlečnimi vozili za doseganje medobratovalnosti - 1. del: Splošno

Railway Applications - Fixed installations and rolling stock - Technical criteria for the coordination between traction power supply and rolling stock to achieve interoperability - Part 1: general

Bahnanwendungen - Ortsfeste Anlagen und Bahnfahrzeuge - Technische Kriterien für die Koordination zwischen Anlagen der Bahnenergieversorgung und Fahrzeugen zum Erreichen der Interoperabilität - Teil 1: Allgemeines

Applications ferroviaires - Installations fixes et matériel roulant - Critères techniques pour la coordination entre les installations fixes de traction électrique et le matériel roulant pour réaliser l'interopérabilité - partie 1 : généralités

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29.280	Električna vlečna oprema	Electric traction equipment
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EUROPÄISCHE NORM

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English Version

Railway Applications - Fixed installations and rolling stock - Technical criteria for the coordination between traction power supply and rolling stock to achieve interoperability - Part 1: general

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This draft European Standard is submitted to CENELEC members for enquiry.
Deadline for CENELEC: 2017-07-07.

It has been drawn up by CLC/SC 9XC.

If this draft becomes a European Standard, 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.

This draft European Standard was established by CENELEC 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 CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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European Committee for Electrotechnical Standardization
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European foreword

This document (prEN 50388-1:2017) has been prepared by CLC/SC 9XC, “Electric supply and earthing systems for public transport equipment and ancillary apparatus (Fixed installations)”, of Technical Committee CLC/TC 9X, “Electrical and electronic applications for railways”. It also concerns the expertise of CLC/SC 9XB, “Electromechanical material on board of rolling stock”.

The following dates are proposed:

• latest date by which the existence of this document has to be announced at national level	(doa)	dor + 6 months
• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	dor + 12 months
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	dor + 36 months (to be confirmed or modified when voting)

This document will partially supersede EN 50388:2012.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive 2008/57/EC, see informative Annex ZZ, which is an integral part of this document.

For TSI lines, modification and amendments should be made within a procedure which is related to the legal status of the TSIs.

1 Scope

This European Standard establishes requirements for the technical compatibility of rolling stock with infrastructure particularly in relation to:

– co-ordination of protection principles between power supply and traction units, especially fault discrimination for short-circuits;

– co-ordination of installed power on the line and the power demand of trains;

– co-ordination of traction unit regenerative braking and power supply receptivity;

– co-ordination of harmonic behaviour (see prEN 50388-2).

This European Standard deals with the definition and quality requirements of the power supply at the interface between traction units and fixed installations.

This European Standard specifies the interface between rolling stock and electrical fixed installations for traction, in respect of the power supply system. The interaction between pantograph and overhead contact line is dealt with in EN 50367. The interaction with the “control-command” subsystem (especially signalling) is not dealt with in this standard.

Values are given for the existing European networks. Furthermore the maximum values that are specified are applicable to the foreseen developments of the infrastructure of the Trans European rail networks.

The following electric traction systems are within scope:

– railways;

– guided mass transport systems that are integrated with railways;

– material transport systems that are integrated with railways.

As far as a migration strategy is not defined in legal documents referring to this standard, this European Standard does not apply retrospectively to rolling stock and infrastructure already in service.

Information is given on electrification parameters such as to enable train operating companies to confirm, after consultation with the rolling stock manufacturers, that there will be no consequential disturbance on the electrification system.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50122-2, *Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 2: Provisions against the effects of stray currents caused by d.c. traction systems*

EN 50122-3, *Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 3: Mutual Interaction of a.c. and d.c. traction systems*

EN 50123-1:2003, *Railway applications - Fixed installations - D.C. switchgear - Part 1: General*

EN 50163:2004[1], *Railway applications - Supply voltages of traction systems*

[1] As impacted by EN 50163:2004/A1:2007, EN 50163:2004/AC:2013 and EN 50163:2004/Corrigendum May 2010.

EN 50367, *Railway applications - Current collection systems - Technical criteria for the interaction between pantograph and overhead line (to achieve free access)*

prEN 50388-2, *Railway Applications - Fixed installations and rolling stock - Technical criteria for the coordination between traction power supply and rolling stock to achieve interoperability - Part 2: Stability and harmonics*

CEN/TS 50535:2010, *Railway applications — Onboard auxiliary power converter systems*

3 Terms and definitions

3.1 Terms and definitions

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

3.1.1
abnormal operating condition
operating condition that is not normal operating condition due to either higher traffic loads or outage of power supply equipment outside the design standard

Note 1 to entry: Under these conditions, traffic may not operate to the design timetable.

3.1.2
classical line
existing line that is not subject to a renewal or upgrading project to bring it into compliance with a TSI

3.1.3
contact line
conductor system for supplying electric energy to vehicles through current-collecting equipment

[SOURCE: IEC 60050-811:1991, 811-33-01]

3.1.4
dimensioning train
train with the lowest mean useful voltage

3.1.5
infrastructure manager
body or undertaking that is responsible in particular for establishing and maintaining railway infrastructure

Note 1 to entry: This may also include the management of infrastructure control and safety systems. The functions of the infrastructure manager on a network or part of a network may be allocated to different bodies or undertakings.

Note 2 to entry: In TSI Energy, this body is referred to as the contracting or adjudicating entity.

3.1.6
maximum line speed
speed for which parts of a route were approved for operation

3.1.7
mean useful voltage at the pantograph ($U_{\text{mean useful}}$)
3.1.7.1
$U_{\text{mean useful}}$ (zone)
voltage giving an indication of the quality of the power supply in a geographic zone during the peak traffic period in the timetable. The zone is a limited part of a route or complex zone not exceeding the length of line supplied by a substation

3.1.7.2
$U_{mean\ useful}$ (train)
voltage identifying the dimensioning train and which enables the effect on its performance to be quantified

3.1.8
new element
new, rebuilt or modified traction-unit or power supply component (hardware or software) having a possible influence on the harmonic behaviour of the power supply system

Note 1 to entry: This new element may be integrated in an existing power supply network with traction units e.g. for fixed installation:

– transformer;

– HV cable;

– filters;

– converter.

3.1.9
normal operating conditions
traffic operating to the design timetable and train formation used for power supply fixed installation design

Note 1 to entry: Power supply equipment is operated according to standard design rules. Rules can vary depending on the infrastructure manager's policy.

3.1.10
overhead contact line

contact line placed above (or beside) the upper limit of the vehicle gauge and supplying vehicles with electric energy through roof–mounted current collection equipment

[SOURCE: IEC 60050-811:1991, 811-33-02]

3.1.11
power factor of the fundamental wave
displacement factor cos φ_1
ratio of the active power of the fundamental components P_1 to the apparent power of the fundamental components S_1 under periodic conditions

$$\text{Ratio } \cos\phi = \frac{active\ \ power\ \ of\ \ the\ \ fundamental\ \ wave}{apparent\ \ power\ \ of\ \ the\ \ fundamental\ \ wave}$$

Note 1 to entry: In this standard, only the fundamental wave is considered

3.1.12
total power factor λ
ratio of the absolute value of the active power P to the apparent power S under periodic conditions

$$\lambda = \frac{\left|active\ \ power\right|}{apparent\ \ power}$$

Note 1 to entry: Deformation factor υ:

$$\upsilon = \frac{\lambda}{\cos\phi}$$

3.1.13
register of infrastructure
<for TSI> single document which compiles, for each section of line, the characteristics of the lines concerned in respect of all subsystems including fixed equipment

Note 1 to entry: The list of items included in the register is described in the commission decision 2011/633/UE.

3.1.14
rolling stock
general term covering all vehicles with or without motors

[SOURCE: IEC 60050-811:1991, 811-02-01]

Note 1 to entry: See also Table 1.

3.1.15
separation or neutral section
section of a contact line provided with a sectioning point at each end to prevent successive electrical sections, differing in voltage, phase or frequency being connected together by the passage of current collectors

3.1.16
(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

3.1.17
traction unit
general term denoting a locomotive, motor coach or train unit

[SOURCE: IEC 60050-811:1991, 811-02-04]

Note 1 to entry: See also Table 1.

3.1.18
train set
combination of vehicles coupled together. It includes banking locomotives

Note 1 to entry: See also Table 1.

3.1.19
train set power at the pantograph
active power of the train taking into account power for traction, regeneration and auxiliaries

3.1.20
TSI line
high speed or conventional rail line being part of the Trans-European Rail Network (TEN) and complying with the requirements of the relevant Technical Specifications for Interoperability (TSI)

3.1.21
type of line
classification of lines as a function of the parameters described in 3.1.6 and 3.1.19

3.1.22
vehicle
general term denoting any single item of rolling stock, e.g. a locomotive, a coach or a wagon

[SOURCE: IEC 60050-811:1991, 811-02-02]

3.1.23
unit
rolling stock which is subject to the application of this TSI, and therefore subject to 'EC' verification

Note 1 to entry: A unit may be composed of several Vehicles, as defined in Directive 2008/57/EC, Article 2(c); considering the scope of this TSI, the use of the term "vehicle" in this TSI is limited to the rolling stock subsystem as defined in Chapter 1.

[SOURCE: TSI LOC&PAS]

3.1.24
train
operational formation consisting of one or more units

Note 1 to entry: A train set is a fixed formation that can operate as a train; it is by definition not intended to be reconfigured, except within a workshop environment or by adding banking locomotive in particular zones It is composed of only motored or of motored and non-motored vehicles.

[SOURCE: TSI LOC&PAS]

3.1.25
locomotive
traction vehicle (or combination of several vehicles) that is not intended to carry a payload and has the ability to be uncoupled in normal operation from a train and to operate independently.

[SOURCE: TSI LOC&PAS]

3.2 Term clarification, coherence and translation

Due to heterogeneous definitions in the bibliography, the following statement in the Table 1 and following text should be considered.

Table 1 – term coherence and translation

Subclause	English term	German term	French term
3.1.22	Vehicle	Fahrzeug	Véhicule
3.1.13	Rolling stock	Bahnfahrzeuge	Matériel roulant
3.1.18	Train set	Zugverband	Train (composition)
3.1.17	Traction unit	Triebfahrzeug	Unité motrice
For information	Train (train path)	Zug (Fahrplantrasse)	Train (circulation)

3.3 Abbreviations

For the purposes of this document, the following abbreviations apply.

EC	European Commission
ERTMS	European Rail Traffic Management System
HV	High Voltage
LRAS	Load Reference-Arrow System
r.m.s.	root mean square
RINF	Register of Infrastructure
TSI	Technical specification for interoperability

4 Periods over which parameters should be averaged or integrated

Where train operators or infrastructure managers use various parameters for their dimensioning computations, protection measures and planning, these are effective only if they are averaged over precisely defined time spans. Guidance and recommendations on these time spans are given in Annex A (informative).

5 Separation sections

5.1 Phase separation sections

Train sets shall be able to move from one section of an AC system to an adjacent section of the same system, through a phase separation section, without bridging the different phases.

Power consumption (traction, auxiliaries and no-load current of the transformer) of the train set taken from overhead line shall be brought to zero before entering the phase separation section.

This can be done for the complete train set or individually and consecutively for each traction unit of the train set.

For lines with speed v ≥ 250 [km/h], this shall be done automatically.

For lines with speed v < 250 [km/h], where required by the infrastructure manager, this shall be done automatically. Otherwise, automatic operation is preferred, but manual on board operation may also be employed.

Where particular circumstances require the lowering of the pantographs this shall be recorded in the register of infrastructure.

For phase separation sections longer than 8 m, the infrastructure manager shall provide adequate means to allow a train set that is gapped underneath the phase separation to be restarted.

EN 50367 describes the characteristics of some designs of phase separation sections.

For other designs of phase separation that allow train sets to pass the section with power running (e.g. automatically switched sections or “change over sections”), the requirements of this clause may not apply if reliability and compatibility with all train sets can be demonstrated.

5.2 System separation sections

5.2.1 General

Train sets shall be able to move from one energy supply system to an adjacent one which uses a different energy supply without bridging the two contact line systems. The necessary actions (opening of the main circuit breaker, lowering of the pantographs, etc.) depend on the type of both supply systems as well as on the arrangement of pantographs on train sets and the running speed.

There are two possibilities for train sets to run through system separation sections:

1) with pantograph raised and touching the contact wire(s) as described in 5.2.2;

2) with pantograph lowered and not touching the contact wire(s) as described in 5.2.3.

The choice between 1) and 2) shall be made by the infrastructure manager.

The requirements for the design of the infrastructure and rolling stock are described in following paragraphs.

EN 50367 describes the design of the system separation sections as well as other functional requirements of the overhead contact line and pantographs.

5.2.2 Pantograph raised

Where the system separation sections are traversed by a train set with pantographs raised to the contact wire(s), the following conditions apply:

- Provisions shall be made in the infrastructure to avoid bridging the contact lines of both adjacent power supply systems if the opening of the on-board circuit breaker(s) fails.

- For lines with speed v ≥ 250 [km/h], an on board, system shall automatically open the circuit breaker before reaching the separation section and shall recognize automatically the voltage of the new power supply system at the pantograph in order to switch the corresponding circuits.

- For Lines with speed v < 250 [km/h], the requirements for lines with speed v ≥ 250 [km/h] may be applied.

5.2.3 Pantograph lowered

Where the system separation sections are traversed with pantographs lowered the following conditions apply:

- The design of separation section between differing energy supply systems shall ensure that, in case of a pantograph unintentionally applied to the contact line, bridging the contact lines of two power supply systems is avoided and switching off both supply systems is triggered immediately, e.g. by detection of short circuits or unintended voltages.

- For lines with speed v ≥ 250 [km/h], at supply system separations which require a lowering of the pantograph, the pantograph shall be lowered without the driver's intervention, triggered by control signals.

- For Lines with speed v < 250 [km/h], the requirements for lines with speed v ≥ 250 [km/h] may be applied.

6 Power factor of a traction unit

6.1 General

The total power factor of a traction unit influences the power supply system performance, i.e. voltage profile, power feeding (active and reactive) and transfer capacity, energy losses, system stability and reliability of protection relays. Hence, requirements to the power factor apply.

The total power factor is composed of the following two elements:

— The displacement power factor related to the phase shift between the fundamental line voltage and fundamental load current (cos); and

— The total harmonic distortion related to load current harmonics.

NOTE 1 No requirement on total harmonic distortion is given in this standard.

The displacement power factor shall be designed as close as possible to unity. More specifically the requirements below apply to traction units in AC systems in quasi-stationary state, i.e. short transients are excluded.

NOTE 2 Infrastructure manager can impose economic conditions when displacement power factor is out of the limits of this chapter 6 and for vehicles not fulfilling the specific requirements (e.g. for retrofitted, existing vehicles) or for vehicles putting special demands on the power supply impose operational or power limiting conditions.

Where a train set comprises multiple traction units, if the requirements of each single traction unit are fulfilled, then they are considered to be fulfilled for the train set,

The requirements apply only to traction units and therefore do not apply to separate loads such as carriages and wagons which are supplied by traction units

For carriages/wagons, the information in CEN/TS 50535:2010, 6.1 applies.

NOTE 3 Annex C gives sign convention on active and reactive power.