

RAUDTEEALASED RAKENDUSED. PÜSIPAIGALDISED JA
VEEREM. ELEKTERVEOSÜSTEEMIDE JA
VEEREVKOOSSEISU VAHELISE KOOSTALITUSVÕIME
SAAVUTAMISE KOOSKÕLASTATUD TEHNILISED
TINGIMUSED. OSA 1: ÜLDOSA

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

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 50388-1:2022 sisaldab Euroopa standardi EN 50388-1:2022 ingliskeelset teksti.	This Estonian standard EVS-EN 50388-1:2022 consists of the English text of the European standard EN 50388-1:2022.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 29.07.2022.	Date of Availability of the European standard is 29.07.2022.
Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 29.280, 45.060.01

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardimis- ja Akrediteerimiskeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardimis-ja Akrediteerimiskeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardimis-ja Akrediteerimiskeskusega: Koduleht www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation and Accreditation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation and Accreditation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation and Accreditation:

Homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee

English Version

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

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

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

This European Standard was approved by CENELEC on 2022-07-04. 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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

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 CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents	Page
European foreword	5
1 Scope	7
2 Normative references	7
3 Terms, definitions and abbreviations	8
3.1 Terms and definitions	8
3.2 Term clarification, coherence and translation.....	11
3.3 Abbreviations and symbols.....	12
4 Periods over which parameters should be averaged or integrated - reference time	12
5 Separation sections	13
5.1 General	13
5.2 System separation sections.....	13
5.3 Phase separation sections	14
6 Power factor of a traction unit	14
6.1 General requirements	14
6.2 Particular conditions	15
6.2.1 Traction	15
6.2.2 Regenerative braking.....	15
6.2.3 Standstill	15
6.2.4 De-icing.....	15
6.3 Acceptance criteria	15
7 Train set current and power limitation function	15
7.1 General	15
7.2 Current limitation in accordance with infrastructure information.....	15
7.3 Automatic current or power limitation as a function of line voltage	16
7.4 Automatic power limitation as a function of frequency variation.....	16
7.5 Acceptance criteria	18
8 Electric traction power supply system performance	18
8.1 Dimensioning study	18
8.1.1 General	18
8.1.2 Traffic conditions.....	18
8.1.3 Parameters relating to the rolling stock and train sets.....	18
8.1.4 Parameters relating to infrastructure	19
8.2 Workflow	19
8.3 Voltage limits	20
8.4 Acceptance criteria	21
9 Type and characterization of electric traction power supply system	21
9.1 Type of electric traction power supply system.....	21
9.2 Characterization of electric traction power supply system	21
10 Harmonic and dynamic effects	21
10.1 General	21
10.2 Common codes of practice.....	22
10.3 Compatibility study.....	22
10.4 Acceptance criteria	23
11 Coordination of protection	23
11.1 General	23
11.2 Short-circuit current levels and its clearance.....	23
11.3 Closing or auto-reclosing of circuit breakers	25
11.4 Maximum inrush current of AC traction unit	27
11.5 DC electrification systems, transient current during closure	27
11.6 Acceptance criteria	27
12 Regenerative braking	28
12.1 General considerations on regenerative braking to the contact line	28

12.2	General conditions and requirements on the use of regenerative braking.....	28
12.2.1	Traction unit	28
12.2.2	Power supply system conditions.....	29
12.3	Acceptance criteria	29
13	Effects of DC operation on AC systems	29
14	Tests	30
15	Test methodology	30
15.1	Separation sections	30
15.1.1	Tests for traction unit	30
15.1.2	Tests for infrastructure	30
15.2	Power factor.....	30
15.2.1	Tests for traction unit	30
15.3	Train set current and power limitation	30
15.3.1	Current or power limitation function of the train set as a function of register of infrastructure information and function of line voltage - Tests for traction unit	30
15.3.2	Power limitation as a function of line frequency - Tests for traction unit	31
15.4	Requirements for performance of power supply - Tests for infrastructure	31
15.5	Coordination of protection.....	31
15.5.1	Short circuit current levels and its clearance	31
15.5.2	Closing or auto-reclosing of circuit breakers.....	32
15.5.3	Maximum inrush current of AC traction unit - Tests for traction unit	32
15.5.4	DC traction units; transient current during closure - Tests for traction unit	32
15.6	Regenerative braking.....	32
15.6.1	Tests for traction unit	32
15.6.2	Tests for Substation	33
	Annex A (informative) Integration periods over which parameters can be averaged.....	34
A.1	General.....	34
A.2	Reference time period over which values can be averaged or integrated	34
	Annex B (informative) Description, calculation and use of mean useful voltage	35
B.1	General.....	35
B.2	Description and methodology	35
B.3	Selection criteria determining the voltage $U_{\text{pantograph}}$ at the pantograph	36
B.4	Values for Minimum Mean Useful Voltage at the pantograph.....	37
B.5	Relation between $U_{\text{mean useful}}$ and U_{min1}.....	38
B.6	Acceptance criteria.....	38
B.7	Testing	38
	Annex C (informative) Sign convention of active and reactive power.....	40
C.1	Sign convention	40
C.2	description of power factor requirements.....	43
	Annex D (informative) Maximum allowable train set current.....	44
	Annex E (informative) Power limitation as a function of line frequency - 15 kV 16,7 Hz systems	46
	Annex F (normative) Maximum traction current and power of a train set against voltage	47
	Annex G (informative) Use of regenerative braking	49
	Annex H (informative) Data related to the compatibility study of harmonics and dynamic effects	50
H.1	Characterization of the electric traction system installations	50
H.2	Characterization of the trains	53
	Annex I (normative) Compatibility study.....	56
	Annex J (normative) Special national conditions	61
	Annex ZZ (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2016/797 aimed to be covered	62
	Bibliography.....	64

European foreword

This document (EN 50388-1:2022) 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 fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-07-04
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2025-07-04

This document supersedes EN 50388:2012 and all of its amendments and corrigenda (if any).

EN 50388-1:2022 includes the following significant technical changes with respect to EN 50388:2012:

- Clause 1: clarification of scope,
- Clause 2: set dated normative references, simplification,
- Clause 3: clarification of definition, renumbering, coherence among terms, addition of abbreviations, withdrawal of terms not used anymore,
- Clause 4: clarification of applicability,
- Clause 5: new structure,
- Clause 6: new drafting taking into account the latest development of traction unit drives,
- Clause 7: new structure taking into account the latest development of traction unit and needs from infrastructure traction power supply system. Addition of power limitation due to frequency variation,
- Clause 8: complete change, giving new parameters to evaluate the capability of the traction power supply system to supply the trains, definition of new indices,
- Previous text of Clause 8 in new Annex B,
- Clause 9: distinction between the table on traction power supply systems and their characterization,
- Clause 10: new structure and text, reference to future EN 50388-2, description of compatibility study process moved to Annex I,
- Clause 11: clarification on the use of this chapter, new information on the sequence of tripping among the circuit breakers, new figure on reclosing sequences, new chapter on maximum inrush current of AC traction unit,
- Clause 12: clarification and improvement, ex Table 8 in new Annex G, new condition for DC systems
- Clause 15: adaptation of the subclauses due to changes in Clauses 5 to 12
- Clause 15.4.1: new text, former Table 10 in Annex B,
- Annex A: improvement on values,
- Annex B, includes part of the previous Clause 8,
- Former Annex C will be located in part 2 of the EN 50388,

- New Annex C on sign convention, includes ex Annex E,
- New Annex D including ex Annex F, on maximum allowable train set current,
- New Annex E on power limitation as a function of line frequency,
- New Annex F on maximum traction and power of a train set against voltage, includes parts of ex Clause 7,
- New Annex G includes ex Table 8 on the use of regenerative braking,
- New Annex H includes former Annex D as long as part 2 of the EN 50388 is not issued,
- New Annex I includes former text from 10.3 on compatibility study
- New Annex J includes former Annex G

This version includes technical changes, clarifications without technical changes and best practises coming from the use of the last version of the document.

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

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

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZZ, which is an integral part of this document.

An additional part 2 is in preparation. In relation to assessment of harmonics and dynamic effects, this document (Part 1) sets out the generic process in Clause 10, and a future part 2 of this standard will give details and acceptance criteria related to known stability, harmonic phenomena and technologies.

EN 50388 “Railway applications – Fixed installations and rolling stock - Technical criteria for the coordination between traction power supply and rolling stock to achieve interoperability” will consist of the following parts:

- EN 50388-1, General
- Future EN 50388-2, Stability and harmonics

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

1 Scope

This document establishes requirements for the electrical aspects to achieve technical compatibility between rolling stock and electric traction systems, limited to:

- co-ordination of protection principles between power supply and traction units, i.e. separation sections, train set current or power limitation, short circuit current discrimination, breaker coordination and use of regenerative braking.
- co-ordination of installed power on the line and the power demand of trains, i.e. traction unit power factor, train set current or power limitation, electric system performance, type and characterization.
- compatibility assessment relating to harmonics and dynamic effects.

Informative values are given for some parts of the existing European railway networks, in annexes.

NOTE For those railways within the scope of EU Interoperability Directive, definitive values are set out in the register of infrastructure published in accordance with Article 49 of Directive (EU) 2016/797, and the list of items included in the register is described in the commission decision (EU) 2019/777.

The following electric traction systems are within the scope of this document:

- railways;
- guided mass transport systems that are integrated with railways;
- material transport systems that are integrated with railways.

Information is given on electrification parameters to enable train operating companies to confirm, after consultation with the rolling stock manufacturers, that risks of non-compatibility are minimized and that there will be no consequential disturbance on the electrification system.

The interaction between pantograph and overhead contact line is dealt with in EN 50367:2020.

The interaction with the control-command and signalling subsystem is not dealt with in this document.

Basic considerations have been included concerning the use of accumulator trains.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 50122-2:2010, *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 50124-1:2017, *Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment*

EN 50163:2004,¹ *Railway applications - Supply voltages of traction systems (with Corrigenda in May 2010 and January 2013)*

IEC 60050-811:2017, *International Electrotechnical Vocabulary (IEV) - Part 811: Electric traction*

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