



SLOVENSKI STANDARD oSIST prEN 50388:2008

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Power supply and rolling stock - Technical criteria for the coordination between power supply (substation) and rolling stock to achieve interoperability

Railway applications - Power supply and rolling stock - Technical criteria for the coordination between power supply (substation) and rolling stock to achieve interoperability

STANDARD PREVIEW
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Bahnanwendungen - Bahnenergieversorgung und Fahrzeuge - Technische Kriterien für die Koordination zwischen Anlagen der Bahnenergieversorgung und Fahrzeugen zum Erreichen der Interoperabilität

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Applications ferroviaires - Alimentation électrique et matériel roulant - Critères techniques pour la coordination entre le système d'alimentation (sous-station) et le matériel roulant pour réaliser l'interopérabilité

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- 29.280 Elektrická trakční zařízení Electric traction equipment
- 45.060.01 Železniška vozila na splošno Railway rolling stock in general

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EUROPEAN STANDARD
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ICS

Will supersede EN 50388:2005

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**Railway applications -
Power supply and rolling stock -
Technical criteria for the coordination between power supply (substation)
and rolling stock to achieve interoperability**

Applications ferroviaires -
Alimentation électrique et matériel roulant -
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le système d'alimentation (sous-station)
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Bahnanwendungen -
Bahnenergieversorgung und Fahrzeuge -
Technische Kriterien für die Koordination
zwischen Anlagen der Bahnenergieversorgung
und Fahrzeugen zum Erreichen der
Interoperabilität

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This draft European Standard is submitted to CENELEC members for CENELEC enquiry.
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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.

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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

1

Foreword

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

6 This document will supersede EN 50388:2005.

7 For TSI lines, modification and amendments shall be made within a procedure which is related to the legal
8 status of the HS and CR TSIs.

9 This draft European Standard has been prepared under a mandate given to CENELEC by the European
10 Commission and the European Free Trade Association and covers essential requirements of EC Directives
11 96/48/EC ¹⁾ and 2001/16/EC ²⁾. See Annex ZZ.

12

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¹⁾ Council Directive 96/48/EC of 23 July 1996 on the interoperability of the trans-European high speed rail system, O.J. L 235, 17/09/1996, p. 6 – 24

²⁾ Directive 2001/16/EC of the European Parliament and of the Council of 19 March 2001 on the interoperability of the trans-European conventional rail system, O.J. L 110, 20/04/2001, p. 1 – 27

13

Contents

14	1	Scope	5
15	2	Normative references	6
16	3	Terms and definitions.....	6
17	4	Periods over which parameters can be averaged or integrated.....	10
18	5	Neutral sections	10
19	5.1	AC phase separation sections.....	10
20	5.2	System separation sections.....	10
21	5.3	Acceptance criteria	11
22	6	Power factor of a train	11
23	6.1	General.....	11
24	6.2	Inductive power factor.....	11
25	6.3	Capacitive power factor	12
26	6.4	Acceptance criteria	12
27	7	Train current limitation.....	13
28	7.1	Maximum train current.....	13
29	7.2	Automatic regulation.....	15
30	7.3	Power or current limitation device	16
31	7.4	Acceptance criteria	16
32	8	Requirements on performance of power supply.....	16
33	8.1	General.....	16
34	8.2	Description.....	16
35	8.3	Values for $U_{\text{mean useful}}$ at the pantograph.....	17
36	8.4	Relation between $U_{\text{mean useful}}$ and U_{min1}	17
37	8.5	Acceptance criteria	17
38	9	Type of line and electrification system.....	18
39	10	Harmonics and dynamic effects.....	18
40	10.1	General.....	18
41	10.2	Acceptance procedure for new element.....	20
42	10.3	Compatibility study.....	20
43	10.4	Methodology and acceptance criteria.....	24
44	11	Coordination of protection.....	24
45	11.1	General.....	24
46	11.2	Protection toward short-circuits	24
47	11.3	Auto-reclosing of one or more substation circuit breakers	25
48	11.4	Effect of loss of line voltage and re-energisation on the traction unit.....	25
49	11.5	DC electrification systems, transient current during closure	25
50	11.6	Acceptance criteria	26
51	12	Regenerative braking	26
52	12.1	General conditions on the use of regenerative braking.....	26
53	12.2	Use of regenerative braking.....	26
54	12.3	Acceptance criteria	28
55	13	Effects of d.c. operation on a.c. systems	28
56	14	Tests.....	28
57	15	Test methodology	29
58	15.1	Neutral sections.....	29
59	15.2	Power factor.....	29
60	15.3	Train current limitation	29
61	15.4	Quality index of the power supply.....	29
62	15.5	Harmonics and dynamic effects	31
63	15.6	Coordination of protections.....	31
64	15.7	Regenerative braking.....	31

65	Annex A (informative) Integration periods over which parameters can be averaged	33
66	A.1 General	33
67	A.2 Reference time period over which it can be averaged or integrated	33
68	Annex B (informative) Selection criteria determining the voltage at the pantograph for high speed	
69	trains	34
70	Annex C (informative) Investigation of harmonic characteristics and related overvoltages.....	36
71	C.1 General	36
72	C.2 Stability	36
73	C.3 Overvoltages generated by harmonics.....	37
74	Annex D (informative) Data related to the compatibility study of harmonics and dynamic effects	38
75	D.1 Characterisation of the traction power supply fixed installations.....	38
76	D.2 Characterisation of the trains.....	41
77	Annex E (informative) Inductive and capacitive power factor.....	43
78	Annex F (normative) Special national conditions	45
79	Annex ZZ (informative) Coverage of Essential Requirements of EC Directives.....	47
80	Bibliography.....	48
81	Figures	
82	Figure 1 – Maximum train current against voltage	15
83	Figure 2 – Procedure for compatibility study of harmonics and dynamic effects	21
84	Figure E.1 – Allowed power factor versus drawn active and reactive power (P and Q) by the train	43
85	Tables	
86	Table 1 – Total inductive power factor λ of a train	12
87	Table 2 – Maximum allowable train current.....	14
88	Table 3 – Value of factor a	15
89	Table 4 – Minimum $U_{\text{mean useful}}$ at pantograph.....	17
90	Table 5 – Electrification systems in function of the type of lines	18
91	Table 6 – Description of steps	22
92	Table 7 – Maximum contact line – Rail short-circuit level	24
93	Table 8 – Action on circuit breakers at an internal fault within a traction unit	25
94	Table 9 – di/dt when closure of traction unit circuit breaker	26
95	Table 10 – Use of regenerative braking	27
96	Table 11 – Tests	28
97	Table 12 – $U_{\text{mean useful}}$ (zone).....	29
98	Table 13 – $U_{\text{mean useful}}$ (train).....	30
99	Table 14 – Relation between $U_{\text{mean useful}}$ and U_{min1}	30
100	Table A.1 – Integration period	33
101	Table D.1 – Characterization of a.c. electrified lines	39
102	Table D.2 – Characterisation of d.c. electrified lines	40
103	Table D.3 – Characterisation of one a.c. train with respect to impedances, harmonics and stability	41
104	Table D.4 – Characterisation of one d.c. train with respect to impedances, harmonics and stability	42
105	Table ZZ.1 – Correspondence between this European Standard and Directives 96/48/EC and	
106	2001/16/EC	47
107		
108		

109 1 Scope

110 This European Standard is intended to be used to set up the requirements for the acceptance of rolling stock
111 on infrastructure in the field of

- 112 – co-ordination of protection principles between power supply and traction units, especially fault
113 discrimination for short-circuits,
- 114 – co-ordination of installed power on the line and power demand of the trains,
- 115 – co-ordination of traction unit regenerative braking and power supply receptivity,
- 116 – co-ordination of harmonic behaviour.

117 This standard deals with the definition and quality requirements of the power supply at the interface between
118 traction unit and fixed installations.

119 The standard specifies the interface between rolling stock and electrical fixed installations for traction, in the
120 frame "supply system". The interaction between pantograph and overhead line is dealt with in EN 50367.
121 The interaction with subsystem "control-command" (especially signalling) is not dealt with in the standard.

122 Requirements are given for the following categories of line:

- 123 – TSI lines (high speed and conventional);
- 124 – classical lines.

125 For classical lines, values, if any, are given for the existing European networks. A set of values is also
126 specified for the future network, which is named "target" network.

127 The following electric traction systems are concerned:

- 128 – railways;
- 129 – guided mass transport systems that are integrated with the railways;
- 130 – material transport systems that are integrated with the railways.

131 This standard does not apply retrospectively to rolling stock already accepted by infrastructure managers.
132 However, on new infrastructure, existing rolling stock may be accepted by the infrastructure manager,
133 provided there is an agreement.

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

137 2 Normative references

138 The following referenced documents are indispensable for the application of this document. For dated
139 references, only the edition cited applies. For undated references, the latest edition of the referenced
140 document (including any amendments) applies.

141 EN 50122-2:1998, *Railway applications – Fixed installations – Part 2: Protective provisions against the*
142 *effects of stray currents caused by d.c. traction systems*

143 EN 50122-2³⁾, *Railway applications – Fixed installations – Electrical safety, earthing and bonding –*
144 *Part 2: Provisions against the effects of stray currents caused by d.c. traction systems*

145 EN 50122-3³⁾, *Railway applications – Fixed installations – Electrical safety, earthing and bonding –*
146 *Part 3: Mutual interaction of a.c. and d.c. traction systems*

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

148 EN 50163:2004 + A1:2007, *Railway applications – Supply voltages of traction systems*

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

151 IEC 60050-811, *International Electrotechnical vocabulary (IEV) – Chapter 811: Electric traction*

152 EN ISO 3166-1:1997⁴⁾, *Codes for the representation of names of countries and their subdivisions –*
153 *Part 1: Country codes (ISO 3166-1:1997)*

154 3 Terms and definitions

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

156 3.1

157 TSI line

158 line defined as part of the Trans European High-Speed rail network for the High Speed Technical
159 Specification for Interoperability, HS TSI, (see Directive 96/48/EC) or line defined as conventional as part of
160 TEN Trans European Network in the conventional TSI, CR TSI, (see Directive 2001/16/EC).

161 It includes for the HS TSI:

- 162 – category I: specially built high-speed lines equipped for speeds generally equal to or greater than
163 250 km/h;
- 164 – category II: specially upgraded high-speed lines equipped for speeds of the order of 200 km/h;
- 165 – category III: specially upgraded high-speed lines which have special features as a result of
166 topographical, relief or town planning constraints on which the speed must be adapted to each case.

167 It includes for the CR TSI:

- 168 – category IV: New Core TEN LINE:
 - 169 – passenger and mixed traffic: 200 km/h max.;
 - 170 – freight traffic: 140 km/h max.;

³⁾ At draft stage.

⁴⁾ Superseded by EN ISO 3166-1:2006, *Codes for the representation of names of countries and their subdivisions – Part 1: Country codes (ISO 3166-1:2006)*.

- 171 – category V: Upgraded Core TEN LINE:
- 172 – passenger and mixed traffic: 160 km/h max.;
- 173 – freight traffic: 100 km/h max.;
- 174 – category VI: New Other TEN LINE:
- 175 – passenger and mixed traffic: 140 km/h max.;
- 176 – freight traffic: 100 km/h max.;
- 177 – category VII: Upgraded Other TEN LINE:
- 178 – passenger and mixed traffic: 120 km/h max.;
- 179 – freight traffic: 100 km/h max.

180 **3.2**

181 **classical line**

182 line which does not belong to the TSI lines.

183 It includes

- 184 – information on European networks named with their national country code (see EN ISO 3166-1) and
- 185 – future target network named as "target", see 3.25

186 **3.3**

187 **type of line**

188 classification of lines as a function of the parameters described in 3.4 to 3.6

189 **3.4**

190 **train power at the pantograph**

191 active power of the train taking into account power for traction, regeneration and auxiliary

192 **3.5**

193 **minimum possible headway**

194 interval at which trains can run as allowed by the signalling system

195 **3.6**

196 **maximum line speed**

197 speed for which the line was approved for operation

198 **3.7**

199 **contact line**

200 conductor system for supplying electric energy to vehicles through current-collecting equipment

201 [IEC 60050-811-33-01]

202 **3.8**

203 **overhead contact line**

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

206 [IEC 60050-811-33-02]

207 **3.9**

208 **(traction) substation**

209 installation, the main function of which is to supply a contact line system, at which the voltage of a primary
210 supply system, and in certain cases the frequency, is converted to the voltage and frequency of the contact
211 line

212 **3.10**
213 **total power factor λ**

$$214 \quad \lambda = \frac{\text{active power}}{\text{apparent power}}$$

215 **3.11**
216 **deformation factor ν**

$$217 \quad \nu = \frac{\lambda}{\cos \varphi}$$

218 **3.12**
219 **power factor**

$$220 \quad \cos \varphi = \frac{\text{active power of the fundamental wave}}{\text{apparent power of the fundamental wave}}$$

221 In this standard, only fundamental wave is considered

222 NOTE This is also the displacement factor $\cos \varphi$.

223 **3.13**
224 **neutral section**

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

228 [IEC 60050-811-36-16]

229 **3.14**
230 **vehicle**

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

232 [IEC 60050-811-02-02]

233 **3.15**
234 **traction unit**

235 general term covering a locomotive, motor coach or train unit

236 [IEC 60050-811-02-04]

237 **3.16**
238 **rolling stock**

239 general term covering all vehicles with or without motors

240 [IEC 60050-811-02-01]

241 **3.17**
242 **train**

243 any combination of rolling stock coupled together. It includes banking locomotives

244 **3.18**
245 **normal operating conditions**

246 traffic operating to the design timetable and train formation used for power supply fixed installation design

247 Power supply equipment is operated according to standard design-rules

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

- 249 **3.19**
 250 **abnormal operating conditions**
 251 either higher traffic loads or outage of power supply equipment outside the design standard
- 252 NOTE Under these conditions, traffic may not operate to the design timetable.
- 253 **3.20**
 254 **mean useful voltage at the pantograph ($U_{\text{mean useful}}$)**
- 255 **3.20.1**
 256 $U_{\text{mean useful}}$ (**zone**)
 257 voltage giving an indication of the quality of the power supply in a geographic zone during the peak traffic
 258 period in the timetable
- 259 **3.20.2**
 260 $U_{\text{mean useful}}$ (**train**)
 261 voltage identifying the dimensioning train and enables the effect on its performance to be quantified
- 262 **3.21**
 263 **dimensioning train**
 264 train with the lowest mean useful voltage
- 265 **3.22**
 266 **register of infrastructure**
 267 for TSI, a single document which compiles, for each section of line of the trans-European high speed rail or
 268 conventional network systems, the characteristics of the lines concerned for all subsystems that include fixed
 269 equipment.
 270 This register of infrastructure should be drawn up by the infrastructure manager or its authorised
 271 representative.
 272 For other lines, a single document which compiles, for each section of line, the characteristics of the lines
 273 concerned for all subsystems that include fixed equipment.
- 274 **3.23**
 275 **infrastructure manager**
 276 any body or undertaking that is responsible in particular for establishing and maintaining railway
 277 infrastructure. This may also include the management of infrastructure control and safety systems. The
 278 functions of the infrastructure manager on a network or part of a network may be allocated to different bodies
 279 or undertakings
- 280 NOTE In TSI Energy, this body is referred to as the contracting or adjudicating entity.
- 281 **3.24**
 282 **new element**
 283 generally, any new, rebuilt or modified (hardware or software) traction-unit or power supply component
 284 having a possible influence on the harmonic behaviour of the power supply system.
 285 This new element will be integrated in an existing power supply network with traction units e.g. for fixed
 286 installation side:
- 287 – transformer;
 - 288 – HV cable;
 - 289 – filters;
 - 290 – converter
- 291 **3.25**
 292 **target network**
 293 network whose design allows the requirements of European interoperability and should avoid later costly
 294 investments

295 **4 Periods over which parameters can be averaged or integrated**

296 This clause is informative and refers to Annex A.

297 The train operators or infrastructure managers use parameters for

- 298 – their dimensioning computations,
- 299 – protection measures,
- 300 – planning;
- 301 – etc.

302 These are effective only if they are averaged over precisely defined time spans.

303 Annex A gives, for information, the periods over which those parameters should be averaged.

304 **5 Neutral sections**

305 **5.1 AC phase separation sections**

306 The train shall be able to move from one section to an adjacent one without bridging the two phases.

307 Power consumption of the train (traction, auxiliaries and no-load current of the transformer) shall be brought
308 to zero when entering the phase separation section.

309 For HS TSI lines, this shall be done automatically.

310 For Conventional Rail TSI lines and for classical lines, automatic operation is preferred; however manual on
311 board operation is also permitted.

312 Lowering of the pantographs is not necessary.

313 The infrastructure manager shall provide adequate means to allow a train that is gapped underneath the
314 phase separation to be restarted.

315 NOTE For other designs of phase separation to be considered allowing the train to pass the section with power running e.g.
316 automatically switched sections or “change over sections” if reliability and compatibility with all trains can be demonstrated, some
317 requirements of this clause may not apply.

318 EN 50367 describes the design of phase separation sections.

319 **5.2 System separation sections**

320 **5.2.1 General**

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

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

- 326 1) with pantograph raised and touching the contact wire(s) as described in 5.2.2;
- 327 2) with pantograph lowered and not touching the contact wire(s) as described in 5.2.3.

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

329 The requirements for the design of the infrastructure and rolling stock are:

330 **5.2.2 Pantograph raised**

331 If the system separation sections are negotiated with pantographs raised to the contact wire(s), provisions
332 shall be made in the infrastructure to avoid bridging the contact lines of both adjacent power supply systems
333 when the opening of the on-board circuit breaker(s) fails.

334 – For categories I, II and III lines, on rolling stock, devices shall open automatically the circuit breaker
335 before reaching the separation section and recognise automatically the voltage of the new power supply
336 system at the pantograph in order to switch the corresponding circuits.

337 – For categories IV to VII lines and for classical lines, these requirements for categories I, II and III lines
338 may be applied.

339 **5.2.3 Pantograph lowered**

340 If the system separation sections are negotiated with pantographs lowered the following conditions apply:

341 the design of separation section between differing energy supply systems shall ensure that, in case of a
342 pantograph unintentionally applied to the contact line, bridging the contact lines of two power supply systems
343 is avoided and switching off both supply sections is triggered immediately. If a system separation section is
344 traversed with pantographs lowered, it shall be designed so as to avoid the bridging by an unintentionally
345 raised pantograph. Equipment shall be provided to switch off both power supply systems should a
346 pantograph remain raised, e.g. by detection of short circuits or unintended voltages.

347 – For categories I, II and III lines, at supply system separations which require a lowering of the pantograph,
348 the pantograph shall be lowered without the driver's intervention, triggered by control signals.

349 – For categories IV to VII lines and for classical lines, these requirements for categories I, II and III lines
350 may be applied. <https://standards.iteh.ai/catalog/standards/sist/72579b52-50c6-47a3-81e3-7ac484c62bb3/osist-pr-en-50388-2008>

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

353 **5.3 Acceptance criteria**

354 Infrastructure, traction units and control command designers shall comply with the requirements of 5.1
355 and 5.2.

356 **6 Power factor of a train**

357 **6.1 General**

358 The higher the power factor of a train, the better is the power supply performance, therefore the rules below
359 apply.

360 Capacitive or inductive power from a train can be utilised to change the overhead contact line voltage.

361 **6.2 Inductive power factor**

362 This clause deals only with inductive power factor and power consumption over the range of voltage from,
363 $U_{\min 1}$ to $U_{\max 1}$ defined in EN 50163.

364 Table 1 gives the total inductive power factor λ of a train. For the calculation of λ , only the fundamental of the
365 voltage at pantograph is taken into account.

366

Table 1 – Total inductive power factor λ of a train

	Category I and II of HS TSI lines ^a	TSI line category III; IV; V;VI; VII and Classical lines
MW		
$P > 2$	$\geq 0,95$	$\geq 0,95$
$0 \leq P \leq 2$	b	b

For yards or depot, the power factor of the fundamental wave shall be equal or higher to 0,8 (see the Note below) under the following conditions: the train is hotelling with traction power switched off and all auxiliaries running and the active power being drawn is greater than 200 kW.

The calculation of overall average λ for a train journey, including the stops, is taken from the active energy W_P (MWh) and reactive energy W_Q (MVarh) given by a computer simulation of a train journey or metered on an actual train:

$$\lambda = \frac{1}{\sqrt{1 + \left(\frac{W_Q}{W_P}\right)^2}}$$

NOTE Higher power factors than 0,8 will result in better economic performance due to a reduced requirement for fixed equipment provision.

^a Applicable to trains in conformity with the HS TSI "rolling stock"

^b In order to control the total power factor of the auxiliary load of a train during the coasting phases, the overall average λ (traction and auxiliaries) defined by simulation and/or measurement shall be higher than 0,85 over a complete timetable journey (typical journey between two stations including commercial stops).

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368 During regeneration, inductive power factor is allowed to decrease freely in order to keep voltage within
369 limits.

370 NOTE 1 Another representation of Table 1 in a graphic form is given in Annex E.

371 NOTE 2 On line categories III to VII, for rolling stock existing before publication of this standard, the infrastructure manager may
372 impose conditions e.g. economic, operating, power limitation for acceptance of interoperable trains having power factors below the
373 value specified in Table 1.

374 6.3 Capacitive power factor

375 During traction mode and standstill, capacitive power factor is allowed in order to keep voltage within limits:

- 376 – within the range of voltage from $U_{\min 1}$ to $U_{\max 1}$ defined in EN 50163, capacitive power factors are not
377 limited;
- 378 – within the range of voltage from $U_{\max 1}$ to $U_{\max 2}$ defined in EN 50163, a train shall not behave like a
379 capacitor.

380 During regenerative mode, capacitive power factor is not allowed.

381 NOTE Capacitive power factors could lead to overvoltages and/or dynamic effects and should be treated according to Clause 10.

382 6.4 Acceptance criteria

383 The power factor is acceptable if the values given in Table 1 and requirement given in 6.3 are achieved.

384 **7 Train current limitation**

385 **7.1 Maximum train current**

386 The maximum allowable train current including auxiliary is given in Table 2. The levels apply both in tractive
387 and regenerative modes. Higher or lower values of train current shall be given in the register of infrastructure
388 (see 7.3) for each line when required.

389 NOTE In order to prevent the energy subsystem from over sizing, the values given in Table 2 are given for rolling stock and not for
390 the design of the energy sub system for continuous load.

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