

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

Järnvägstillämpningar – Fasta installationer – Krav för validering av simuleringsprogram för dimensionering av banmatningssystem

Railway applications –

Fixed installations –

Requirements for the validation of simulation tools used for the design of electric traction power supply systems

Som svensk standard gäller europastandarden EN 50641:2020. Den svenska standarden innehåller den officiella engelska språkversionen av EN 50641:2020.

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English Version

Railway applications - Fixed installations - Requirements for the validation of simulation tools used for the design of electric traction power supply systems

Applications ferroviaires - Installations fixes - Exigences relatives à la validation des outils de simulation utilisés pour la conception des réseaux d'alimentation de traction

Bahnanwendungen - Ortsfeste Anlagen - Anforderungen für die Validierung von Simulationsprogrammen für die Auslegung von Bahnenergieversorgungssystemen

This European Standard was approved by CENELEC on 2019-11-04. 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, Turkey 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	4
1 Scope.....	5
2 Normative references	6
3 Terms and definitions	6
4 Symbols and abbreviated terms.....	8
5 General	9
6 Test and models description	12
6.1 General.....	12
6.2 Common parameters	12
6.3 Train set descriptions	13
6.3.1 Type of train set and mechanical characteristics.....	13
6.3.2 Traction and braking effort characteristics	14
6.3.3 Current limitation in traction.....	15
6.3.4 Current limitation in regenerative braking	15
6.3.5 Additional information for the train set models	16
6.4 Parameters for DC models	16
6.4.1 Track layout model	16
6.4.2 Train traffic model	17
6.4.3 Electrical infrastructure model	18
6.5 Parameters for AC models	20
6.5.1 Track layout model	20
6.5.2 Train traffic model	21
6.5.3 Electrical infrastructure model	22
6.5.4 Transformer model	22
6.5.5 AC electrical infrastructure complement and multi-conductor model....	24
7 Plausibility of expected outputs	26
7.1 General.....	26
7.2 Validation of driven timetable	26
7.3 Complementary Information on train journeys.....	28
7.4 Complementary Information for substation results	31
8 Verification of expected output	33
8.1 General.....	33
8.2 Train results	34
8.3 Substation results.....	35
9 Validation with simulated values	36
10 Assessment.....	37
Annex A (normative) Substation outage, Train output results: validation boundary value	39
Annex B (normative) Substation outage, Substation output results: validation boundary values	46
Annex C (informative) Determination of reference values and their tolerances	50
C.1 Tolerances for determination of applied boundary values	50
C.2 Determination of reference values	51

Annex D (informative) Individual graphs for each system and operating condition
infrastructure 52

Annex ZZ (informative) Relationship between this European Standard and the Essential
Requirements of Directive (EU) 2016/797 aimed to be covered 68

Bibliography..... 69

European foreword

This document (EN 50641:2020) 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".

The following dates are fixed:

- latest date by which this document has to be (dop) 2020-11-04
implemented at national level by publication of
an identical national standard or by
endorsement
- latest date by which the national standards (dow) 2022-11-04
conflicting with this document have to be
withdrawn

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(s) see informative Annex ZZ, which is an integral part of this document.

Experts representing approximately ten member states worked to draft a complete new document. The results and data are taken from the most well-known representative simulation softwares in Europe and related experts. This document provides a means of assessing simulation tools and provides assurance to anyone who depends upon their output. Future versions will include other cases such as urban traffic.

1 Scope

This document specifies requirements for the acceptance of simulation tools used for the assessment of design of electric traction power supply systems with respect to TSI Energy.

This document is applicable to the simulation of AC and DC electric traction power supply systems, in the frame of assessment required by Directive (EU) 2016/797. The methods and parameters defined in this document are only intended for use in the design of the electric traction power supply system, and hence this document solely considers validation of tools within the TSI energy subsystem for all envisaged railway networks.

This document does not deal with validation of simulation tools by measurement.

This document focuses on the core simulation functions comprising the equations and functions which calculate the mechanical movement of trains and also which calculate the load flow of the electrical traction power supply system. In doing so this document provides all requirements necessary to demonstrate that a simulation tool may be used for the purposes of TSI approval of electric traction power supply systems. Any simulation tool which meets the acceptance requirements of the test cases in this document can be used to determine TSI compatibility for all systems of the same voltage and frequency without any requirement for further validation as part of the TSI assessment process.

This document includes controls for the modification of simulation tools, in particular the limits of applicability of certification when tools are modified. These controls focus on determining whether the core functions of the simulation model are modified.

This document provides only the requirements for demonstration of the algorithms and calculations of core functions. The use of a certified simulation tool in accordance with this document does not, in itself, demonstrate good practice in electric traction power supply system design, neither does it guarantee that the simulation models and data for infrastructure or trains used in the tool are correct for a given application. The choice and application of any models and data, of individual system components, in a design is therefore subject to additional verification processes and not in the Scope of this document. Competent development of design models and full understanding of the limits of design tools remain requirements in any system design. This document does not reduce any element of the need for competent designers to lead the design process.

The test cases and data shown in Clause 6 in this document do not represent an existing network, but these data are used as theoretical/virtual network only for the purpose of verification of the core functionality.

NOTE A new test case will be drafted considering metro, tramways and trolleybuses using DC 600 V or DC 750 V. Until this test case is available, this document can also be applied to subway, tram and trolley bus systems. This test case will also integrate rail systems using DC 750 V.

Additionally, the application of this document ensures that the output data of different simulation tools are consistent when they are using the same set of input data listed in Clause 6.

This document only applies to the simulation of electric traction power supply systems characteristics at their nominal frequency for AC or DC systems. It does not consider harmonic studies, electrical safety studies (e.g. rail potential), short circuit or electromagnetic compatibility studies over a wide frequency spectrum. This document does not mandate the use of a particular simulation tool in order to validate the design of an electric traction power supply system.

This document does not consider complex models with active components such as static frequency converters.

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 50163:2004, *Railway applications - Supply voltages of traction systems*

EN 50388:2012, *Railway Applications - Power supply and rolling stock - Technical criteria for the coordination between power supply (substation) and rolling stock to achieve interoperability*