SLOVENSKI STANDARD
SIST EN 17997:2025

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Železniške naprave - Zavore - Opredelitev parametrov zavorne krivulje ETCS za vlake Gamma

Railway applications - Braking - Definition of ETCS brake curve parameters for Gamma trains

Bahnanwendungen - Bremsen - Bestimmung der ETCS-Bremskurvenparameter für Gamma-Züge

Applications ferroviaires - Freinage - Détermination des paramètres des courbes de freinage ETCS pour les trains Gamma

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Railway applications - Braking - Definition of ETCS brake curve parameters for Gamma trains

Applications ferroviaires - Freinage - Détermination des paramètres des courbes de freinage ETCS pour les trains Gamma

Bahnanwendungen - Bremsen - Bestimmung der ETCS-Bremskurvenparameter für Gamma-Züge

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European foreword

This document (EN 17997:2025) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2025, and conflicting national standards shall be withdrawn at the latest by July 2025.

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Introduction

European Train Control System (ETCS) specifications have become part of, or are referred to the Technical Specifications for Interoperability (TSI) for railway control-command systems, as part of the European legislation, managed by the European Union Agency for Railways (ERA).

The Braking model specification in this document is based on the definition in the System Requirements Specification (SRS) SUBSET-026, Version 3.6.0 of 13/05/2016 [11], published by the European Union Agency for Railways: ETCS B3 R2 GSM-R B1 [10].

Based on a generic “brake system architecture model” a procedure is described to design a train specific software model which is applied for calculating the rolling stock correction factors and a method for determination of the nominal emergency and service braking deceleration for normal and degraded modes is described. Furthermore, the derivation of all the required traction and braking model parameters is specified.

This document describes the different steps to define ETCS emergency and service brake parameters for ETCS gamma braking model trains intended to operate on lines equipped with ETCS Baseline 3 [10].

1 Scope

This document specifies the methodology to define the train related braking model and required emergency and service brake on-board parameters to enable speed and distance monitoring for trains equipped and operated on railway lines using ETCS Baseline 3.

This document is only applicable for ETCS Gamma braking model trains (i.e. the train is said to be a "gamma" train). This document does not specify the way these parameters are transferred to and can be used by the ETCS on-board system (e.g. during start of mission - SoM).

The ETCS "conversion models" are not covered by this document and are described in EN 16834:2019, Annex F. The ETCS "conversion models" are intended for use with trains where the braking performance is expressed using braked weight percentages ("lambda" train).

Any trackside related input parameters, including national values, are not covered in this document. Information can be found in the SUBSET-026 (see [11]).

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 15595:2018+A1:2023, *Railway applications — Braking — Wheel slide protection*

EN 16834:2019, *Railway applications - Braking - Brake performance*

EN 17343:2023, *Railway applications - General terms and definitions*

EN 50126-2, *Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 2: Systems Approach to Safety*

EN ISO 24478:2024, *Railway applications — Braking — General vocabulary (ISO 24478:2023)*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 17343:2023, EN ISO 24478:2024 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
base unit
smallest considered unit of a certain system on the lowest level of the level model

3.1.2
building block
validated information for the characteristics of a brake sub-system (e.g. Magnetic Track Brake), that is derived from the difference between test results of configurations with and without the brake sub-system

3.1.3
highly improbable event
event which is extremely unlikely to occur and can be neglected

Note 1 to entry: See also EN 50126-1:2017, Table C.1 [5].

3.1.4
brake system architecture model
calculation model for some ETCS brake parameters which can be applied for K_{dry} definition with Monte Carlo simulation

3.1.5
level model
model that enables the consideration of structural information of the vehicle in the brake system architecture model

3.1.6
technical function
function, which can be generated by a single component or a complete system

Note 1 to entry: The technical function of the brake system is to generate braking force.

3.1.7
structural information
information about the levels, units and structure used in a brake system

3.1.8
statistical information
information that describes the failure or/and the deviation behaviour of a technical function

3.1.9
failure coefficient
coefficient that represents the effect of the failure of a technical function on the braking force of a brake unit/group of brake units and is linked to the probability of failure of the technical function

3.1.10
deviation coefficient
coefficient that represents the effect of the deviation of a technical function on the braking force of a brake unit/group of brake units and is linked to the statistical distribution of deviation of the technical function

3.1.11
normal mode
operating condition with all expected brakes available and performing as specified

[SOURCE: ISO 24221:2024, 3.6]

3.1.12
degraded mode
operating condition where some of the brakes are not available and/or not performing as specified (e.g. equipment failure, leakage)

[SOURCE: ISO 24221:2024, 3.7]

3.1.13
car
type of vehicle (e.g. trailer car, motor car)

Note 1 to entry: A trailer car can be a coach or a wagon, a motor car can be a locomotive.

3.2 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in Table 1 apply.

Table 1 — Symbols and abbreviated terms

Symbol	Definition	Unit
$A_{\text{brake safe}}(C,V,EBCL)$	safe emergency brake deceleration, also called A_brake_safe in SUBSET-026–3 [11]	m/s^2
$A_{\text{brake safe dry}}$ (C,V,EBCL)	safe emergency brake deceleration on dry rails	m/s^2
$A_{\text{nominal}}(C,V)$	nominal deceleration in emergency brake, also called A_brake_emergency in SUBSET-026–3 [11]	m/s^2
$A_{\text{nominalSB}}(C,V)$	nominal deceleration in service brake, also called A_brake_service in SUBSET 026-3 [11]	m/s^2
$A_{\text{normal}}(C,V)$	normal service brake deceleration, also called A_brake_ normal_service in SUBSET-026–3 [11]	m/s^2
C	identification of the configuration of the brakes (combination of special brake, degraded modes with brakes isolated, multiple unit operation, etc.)	—
F	braking force	N
$K_{\text{dry}}(C,V,EBCL)$	correction factor, also called Kdry_rst in SUBSET-026–3 [11]	—
$K_i(C,V)$	correction factor for one random selected combination “i” (also called case “i”) of parameters (influencing braking force and failure behaviour) for calculation of deceleration	—
$K_n(V)$	speed dependent correction factors for gradient on the normal service brake; split in $K_{n+}(V)$ (uphill) and $K_{n-}(V)$ (downhill)	—
$K_{\text{wet}}(C,V)$	correction factor, also called Kwet_rst in SUBSET-026–3 [11]	—
P	probability of failure	—
$t_{\text{eEB}}(C)$	equivalent emergency brake response time, also called T_brake_emergency (for emergency brake) in SUBSET-026–3 [11]	s
$t_{\text{eSB}}(C)$	equivalent service brake response time, also called T_brake_service (for service brake) in SUBSET-026–3 [11]	s
$t_{\text{tco}}(C)$	traction cut-off time, also called T_traction_cut_off in SUBSET-026–3 [11], 3.13.2.2.2	s
V	identification of the speed interval	—
V_{max}	maximum design speed of the train	—
α	weighting factor representing the part of a brake unit/group of brake units/brake type force in the total braking force	—

Symbol	Definition	Unit
α'	ratio of the maximum force generated by a traction unit compared to the total braking force at train level	—
β	factor representing the product of the impact of all deviations and failure impacting the braking force of a brake unit	—
β'	factor representing the impact of possible traction cut-off failures leading to a reduction of total braking force by generation of a traction force	—
BCU	brake control unit	—
DBU	disc brake unit	—
EBCL	emergency brake confidence level	—
ECB	eddy current brake	—
ED	electro-dynamic brake	—
ETCS	European Train Control System	—
FIT	failures in time	—
MTB	magnetic track brake	—
Rnd	function providing a random value depending on a distribution type and on parameters	—
B	Bernoulli distribution	—
N	Normal distribution	—
U	Uniform distribution	—
TBU	tread brake unit	—
WSP	wheel slide protection	—

4 ETCS on-board brake model parameters

4.1 ETCS on-board emergency brake model parameters

4.1.1 Nominal emergency brake deceleration $A_{nominal}$

$A_{nominal}(C,V)$ is the established deceleration during an emergency braking for a given configuration of the train for a defined speed interval (see SUBSET-026-3 [11] and SUBSET-040 [12]). The determination of $A_{nominal}$ is described in 7.2.

4.1.2 Correction factor $K_{dry}(C,V,EBCL)$

$K_{dry}(C,V,EBCL)$ is a rolling stock correction factor that, applied to $A_{nominal}$, gives the safe emergency brake deceleration for a given configuration of the train, on dry rails in accordance with the required confidence level, and for a defined speed interval (see SUBSET-026-3 [11] and SUBSET-040 [12]).

$$A_{\text{brake safe dry}}\left(C,V,EBCL\right) = K_{\text{dry}}\left(C,V,EBCL\right) \times A_{\text{nominal}}\left(C,V\right) \quad (1)$$

The determination of $K_{dry}(C,V,EBCL)$ is described in 7.3.

4.1.3 Correction factor K_{wet}(C,V)

K_{wet}(C,V) is a rolling stock correction factor that considers in a limited way the loss of deceleration with regards to emergency braking on dry rails, when the emergency brake is applied on low adhesion rails, in accordance with wheel/rail adhesion reference conditions, and for a defined speed interval (see SUBSET-026-3 [11] and SUBSET-040 [12]).

$$A_{\text{brake safe}}\left(\text{C},\text{V},\text{EBCL}\right)=\left(K_{\text{wet}}\left(\text{C},\text{V}\right)+M_{\text{NVAVADH}}\times\left(1-K_{\text{wet}}\left(\text{C},\text{V}\right)\right)\right)\times A_{\text{brake safe dry}}\left(\text{C},\text{V},\text{EBCL}\right) \quad (2)$$

NOTE $M_{NVAVADH}$ is a trackside ETCS parameter and is not in the scope of this document.

The determination of K_{wet}(C,V) is described in 7.4.

4.1.4 Emergency brake response time

The equivalent emergency brake response time t_{eEB} (see 7.5) is used to model the transition between the emergency brake demand and the fully established emergency braking force (see SUBSET-026-3 [11] and SUBSET-040 [12]).

4.1.5 Traction cut-off time

The traction cut-off time t_{tco} (see 7.6) is used to model the transition between the emergency brake demand or traction cut-off demand and the moment the acceleration due to traction (A_traction) is zero after a trainwide control signal for an emergency brake application.

4.2 ETCS on-board service brake model parameters

4.2.1 General

The service brake performance is not safety relevant. Therefore, no worst-case conditions (e.g. correction factors, adhesion conditions) are considered for its calculation.

4.2.2 Nominal service brake deceleration $A_{nominalSB}$

$A_{nominalSB}$(C,V) is the established deceleration during a full service braking for a given configuration of the train for a defined speed interval (see SUBSET-026-3 [11]).

The determination of $A_{nominalSB}$ is described in 8.2.

4.2.3 Service brake response time

The equivalent service brake response time t_{eSB} (see 8.3) is used to model the transition between the full service brake demand and the fully established service brake braking force (see SUBSET-026-3 [11]).

4.2.4 Normal service brake deceleration and correction factors K_n

The normal service brake deceleration A_{normal}(C,V) is used in combination with the speed dependent on-board correction factors for gradient K_n+(V) and K_n-(V) to calculate $A_{normal\_service}$(V,d). This deceleration is used to calculate the guidance curve (GUI), which is an optional braking curve in ETCS (see SUBSET-026-3 [11]).

Recommendations for determining A_{normal} are described in 8.4.