SLOVENSKI STANDARD
SIST EN 50728:2025

01-februar-2025

Železniške naprave - Vozna sredstva - Preskušanje elektromagnetne združljivosti s tirnimi tokokrogi

Railway applications - Rolling stock - Testing for electromagnetic compatibility with track circuits

Bahnanwendungen - Fahrzeuge - Prüfung der elektromagnetischen Verträglichkeit mit Gleisstromkreisen

Applications ferroviaires - Matériel roulant - Essais pour la compatibilité électromagnétique avec les circuits de voie

Ta slovenski standard je istoveten z: **EN 50728:2024**

ICS:

29.280	Električna vlečna oprema	Electric traction equipment
33.100.01	Elektromagnetna združljivost na splošno	Electromagnetic compatibility in general
45.060.10	Vlečna vozila	Tractive stock

SIST EN 50728:2025 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 50728

December 2024

ICS 29.280; 45.060.10

English Version

Railway applications - Rolling stock - Testing for electromagnetic compatibility with track circuits

Applications ferroviaires - Matériel roulant - Essais pour la compatibilité électromagnétique avec les circuits de voie

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CENELEC

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

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Ref. No. EN 50728:2024 E

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European foreword

This document (EN 50728:2024) has been prepared by CLC/SC 9XB “Electromechanical material on board rolling stock” of CLC/TC 9X “Electrical and electronic applications for railways”.

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)	2025-12-31
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2027-12-31

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For the relationship with EU Legislation, see informative Annex ZZ, which is an integral part of this document.

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.

Introduction

This document defines the testing, measurement and evaluation methods for rolling stock interference current emissions to demonstrate compatibility with track circuits. The evaluation is done at the interface between rolling stock and infrastructure (the total interference current of the IU), and not at the receiver of a track circuit.

In the context of European interoperability, interference current limits for rolling stock are defined in the TSI Interface document ERA/ERTMS/033281.

Outside European interoperability, individual limits and summation rules are defined in other documents such as NNTRs and PD CLC/TS 50238-2. In specific application cases outside the scope of Interoperability Regulations, limit values can be notified by the track circuit manufacturer, according to the process defined in EN 50617-1.

Proof of compliance of rolling stock with the interference current limits is done in three main steps. First, a test specification is defined, based on the specific characteristics of rolling stock to be tested (see Clause 4). This ensures that the final results give sufficient confidence in the level of compliance. Then the tests are performed according to the specification. Finally, the results are processed under a defined set of rules, in order to demonstrate compliance with the given limits (see Clause 5).

Tests for the demonstration of vehicle compatibility are type tests and are performed before the first unit is put into regular service. When completed in accordance with this document, it is the goal to perform measurements only once per electric traction power supply system voltage and frequency.

As far as possible, common requirements are defined for both AC and DC systems. However, these differ in several aspects. In AC systems, the impedance of the electric traction power supply system is small compared with the impedance of the vehicle, but resonance effects need to be considered. The main source of interference is the rolling stock. In DC systems, the impedance and, therefore, the distance from substations, is important, but resonance effects are largely neglectable. Rectifier substations have a significant contribution to the total interference current in DC systems, and also the traction and auxiliary systems of DC rolling stock are normally different from those of AC. Where necessary or appropriate, this document differentiates between AC and DC systems. If requirements are not clearly indicated as relevant to AC or DC systems then they are relevant to both AC and DC.

In order to limit the influence from static converters (AC) and substations (DC) on track circuits, a minimum rolling stock impedance is required. This document defines how to prove conformity with such requirements as well.

1 Scope

This document defines the measurement and evaluation methods of rolling stock interference current emissions to demonstrate compatibility with track circuits. This includes rolling stock with or without traction equipment. The established limits for compatibility are defined in ERA/ERTMS/033281, PD CLC/TS 50238-2 or NNTRs as current flowing between the vehicle and the electric traction power supply system that can disturb the track circuit receiver, as part of the track circuit system. Additionally, the referred documents can define a minimum rolling stock impedance in order to guarantee compatibility between the electric traction power supply system and track circuits.

This document is relevant to the interference current limits defined in the “frequency management” for track circuits as defined in ERA/ERTMS/033281. It is also applicable to the demonstration of compatibility with all other types of track circuits which have established compatibility according to EN 50617-1. Finally, the methodology defined in this document can also be applied to other track circuit types, including those for which the only requirements are defined in NNTRs.

NOTE 1 Interface parameters between rolling stock and track circuits other than interference currents and impedance are out of the scope of this document.

NOTE 2 For track circuits prone to wrong side failures additional precautions might be needed to mitigate safety risks. The necessary precautions and safety considerations are outside the scope of this document, but can be found in NNTRs.

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 50388-1:2022, *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*

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

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

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

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

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

3.1.1
beating
interference pattern between two or more slightly different frequencies, perceived as a periodic variation in amplitude with a rate dependent on the differences in frequencies

[1] As impacted by EN 50163:2004/A1:2007, EN 50163:2004/corrigendum May 2010, EN 50163:2004/AC:2013, EN 50163:2004/A2:2020, EN 50163:2004/A3:2022.

3.1.2
controlled impedance
increase of impedance by appropriate control of a connected converter

Note 1 to entry: The resulting controlled impedance is equal to the frequency response of the small signal ratio voltage divided by current.

Note 2 to entry: The increased impedance can be a result of controlling other quantities, e.g. active interference current suppression.

3.1.3
degraded mode
mode of operation of rolling stock with a reduced number of ES or IIS, which has been anticipated in the design

Note 1 to entry: Degraded modes (failure modes) are operating modes which can be activated in order to isolate a defect and continue the operation of the rolling stock. When operating in a degraded mode the system performance might be reduced. Examples of degraded modes are deactivated traction motors or traction converters that have an impact on the remaining ones, such as increasing power and / or traction, changing the interlacing strategy or switching frequency.

[SOURCE: IEC 60050-811:2017, 811-01-52, modified – The term “degraded modes” has been replaced with “degraded mode” and “have been” with “has been”; “in the presence of faults” has been replaced with “of rolling stock with a reduced number of ES or IIS,”; “of the signalling system or the rolling stock” has been deleted; the Note 1 to entry has been added.]

3.1.4
electric traction power supply system
railway electric distribution network used to provide energy for rolling stock

Note 1 to entry: The system includes

— contact line systems,

— return circuit of electric traction systems,

— running rails of non-electric traction systems, which are in the vicinity of, and conductively connected to the running rails of an electric traction system,

— electric installations, which are supplied from contact lines either directly or via a transformer,

— electric installations in power plants and substations, which are utilized solely for generation and distribution of power directly to the contact line,

— electric installations of switching stations.

[SOURCE: IEC 60050-821:2017, 821-36-21, modified – “power supply” has been added in the term]

3.1.5
electrical subsystem
ES
smallest unit which is practicably accessible for interference current measurements

Note 1 to entry: See Figure 1 and Figure 2.

Note 2 to entry: An ES is fed from the line voltage via distribution lines inside a TU. Internally, an ES can consist of one or several interference sources (such as traction and / or auxiliary converters) which cannot practicably be evaluated individually.

Note 3 to entry: An ES can be an IIS, however it can also consist of multiple IISs.

3.1.6
individual interference source
IIS
smallest subset of an electrical subsystem that can be identified and characterised as an interference current source

Note 1 to entry: The individual interference source is the basis for evaluation, in DC systems, of the total interference current produced by an influencing unit, but it might not always be practicable to measure at IIS level.

Note 2 to entry: Individual interference sources can be various types of components and their control.

3.1.7
influencing unit
IU
rolling stock influencing the train detection system

Note 1 to entry: One influencing unit comprises all coupled / connected vehicles, e.g. complete train with single or multiple traction, single vehicle, multiple connected / coupled vehicles and wagons, e.g. one complete passenger train, consisting of one or more TUs and coaches.

Note 2 to entry: The influencing unit can consist of several “Traction Units“ (TU).

See Figure 1 and Figure 2 for clarification.

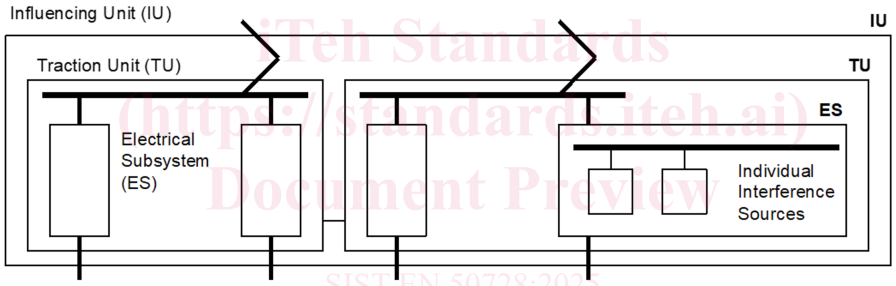

Figure 1 — Definition of IU, TU and Electrical Subsystem (ES)

[SOURCE: CLC/TS 50238-2:2020, 3.1.2, modified – The Note 1 to entry and Note 2 to entry have been modified. The note 3 to entry has been omitted. The Figure 1 has been replaced.]

3.1.8
infrastructure
all fixed railway installations

Note 1 to entry: In the given context it includes the electric traction power supply system and train detection systems.

3.1.9
integration time
window size over which the root mean square (RMS) of the output of the bandpass filter is calculated

[SOURCE: CLC/TS 50238-2:2020, 3.1.3]

3.1.10
interference current
undesired frequency content in the line current, which is in the operating frequency range of the track circuits

3.1.11
interference current budget
part of the interference current limit, based on the summation rules, which can be used by an IU, TU, ES or IIS

3.1.12
interference current limit
maximum interference current which an influencing unit is allowed to produce at a given frequency to remain compatible with a track circuit

Note 1 to entry: Interference current limits are defined in ERA/ERTMS/033281, NNTRs or PD CLC/TS 50238-2.

Note 2 to entry: Interference current limits are defined by a number of evaluation parameters, such as FFT parameters, or bandpass filter centre frequency and bandwidth and integration time.

3.1.13
interference current monitor
system or function that monitors the interference current production of an influencing unit, traction unit or electrical subsystem

Note 1 to entry: The interference current monitor is not part of the test specification as given in this document. It might, however, be one of the safety measures required.

Note 2 to entry: In case interference currents can result in a wrong side failure, an interference current monitor which is able to switch off an interference current source is a possible mitigation measure.

3.1.14
line current
current that flows from the contact line via the pantograph(s) (or current collectors) through the IU, TU or ES to the return circuit

Note 1 to entry: In this document, line current is used in a more general sense and not only to the pantograph current to one TU.

3.1.15
normal operating mode
mode of operation of rolling stock with all electrical subsystems in fault-free working configuration

3.1.16
number of tests
number of times that a condition defined in the test specification is met

Note 1 to entry: This is not necessarily equal to the number of test runs.

3.1.17
right side failure
RSF
mode of failure which does not directly compromise the safe operation of trains but can reduce availability

3.1.18
small input filter
low pass passive input filter for DC supplied vehicle with a cut-off frequency which is higher than 1/3 of the centre frequency f_0 of the considered track circuit

Note 1 to entry: 1/3 is set so that the filter cut-off frequency is well below the lowest track circuit centre frequency.

Note 2 to entry: For an LC filter the cut-off frequency is $\frac{1}{2\pi\sqrt{LC}}$

3.1.19
steady state
operating condition of a system in which the system state variables can be considered to be constant compared to time interval of interest

Note 1 to entry: For example, a varying speed should be considered as potentially constant if a train can stay at a certain speed for a longer time than the time interval of interest.

[SOURCE: IEC 60050-603:1986, 603-02-06, modified – “conditions” has been replaced with “condition”. “network” has been replaced with “system”. “are” has been replaced with “can be”. “sensibly constant” has been replaced with “constant compared to time interval of interest”. The Note 1 to entry has been added.]

3.1.20
substation
<in electric traction> installation which supplies a contact line

Note 1 to entry: The voltage of a primary supply system, and in certain cases the frequency, is converted by the substation to the voltage and frequency of the contact line.

3.1.21
summation rule
calculation method to scale a set of measurements on traction unit or electrical subsystem level to the maximum interference current for an IU with a specified confidence level

3.1.22
traction unit
TU
locomotive, motor coach or train-unit

Note 1 to entry: Each TU is fed from one pantograph or collector (or UIC busbar in case of coaches / wagons). A TU contains at least one ES. One TU can be:

— one locomotive;

— one electric multiple unit, with one or several Electrical Subsystems (ES) in one or several cars;

Note 2 to entry: A TU does not have to have traction equipment.

See Figure 2 for examples. This Figure is not exhaustive.