SLOVENSKI STANDARD
SIST-TS CLC/TS 50712:2025

01-februar-2025

Železniške naprave - Sistemi za odjem toka - Tehnični kriteriji za interaktivnost med pantografom in nadzemnim voznim vodom na elektrificiranih cestah

Railway applications - Current collection systems - Technical criteria for the interaction between pantograph and overhead contact lines on electrified roads

Bahnanwendungen - Stromabnehmer - Technische Kriterien für das Zusammenwirken zwischen Dachstromabnehmer und Oberleitung auf elektrifizierten Straßen

Applications ferroviaires - Systèmes de captage de courant - Critères techniques d'interaction entre le pantographe et la ligne aérienne de contact sur routes electrifiées

Ta slovenski standard je istoveten z: **CLC/TS 50712:2024**

ICS:

29.280	Električna vlečna oprema	Electric traction equipment
45.060.10	Vlečna vozila	Tractive stock

SIST-TS CLC/TS 50712:2025 **en**

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

CLC/TS 50712

December 2024

ICS 29.280; 45.060.10

English Version

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This Technical Specification was approved by CENELEC on 2024-11-18.

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

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Ref. No. CLC/TS 50712:2024 E

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European foreword

This document (CLC/TS 50712:2024) has been prepared by CLC/TC 9X “Electrical and electronic applications for railways”.

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Introduction

This document will help to establish a common technical base for overhead contact line type electric road systems (ERS) being built in public field trials in different European states. It enables vehicles and likewise infrastructure providers to develop and produce components and systems for interoperable use.

The main aspects being considered are:

— normative references to vehicle and infrastructure standards;

— definition of the pantograph to contact line system interface;

— requirements for safety concepts and provisions in contact line operation;

— requirements for test, operation, and maintenance of pantographs on commercial vehicles;

— distinction of use cases for externally supplied commercial electric road vehicles (informative).

To reduce carbon dioxide and other emissions caused by road traffic, ERS are being widely discussed and tested in public field trials on different European roads and highways. In this document, the pantograph of an overhead contact line type ERS is described. This ERS uses an overhead contact line system, a power supply and a pantograph to draw electrical energy from a static supply system suspended above a highway to power the propulsion and the battery charging of an electric road vehicle while driving.

As road traffic is highly internationalised and standardized, ERS solutions for commercial vehicles need to be standardized to allow interoperable and international vehicle operation.

This document’s scope is limited to pantograph type current collectors for ERS. The electrical power supply of a commercial road vehicle within ERS is achieved through the collection of current from the overhead contact wires with a suitable pantograph system installed on the vehicle.

As the roadway cannot be used as an electrical return conductor, a 2-pole (positive and negative) contact line system and pantograph are employed. The overhead contact line (OCL) system and the connected vehicles form an electric circuit with the feeder system. This allows for electrical power flow between them. This is considered in terms of electrical safety concepts and protective provisions.

The pantograph and the overhead contact line system (OCLS) are separate mechanically oscillating sub-systems. The design of the sliding contact between them ensures continuous contact and allows for minimum wear of both contact partners conductor and pantograph carbon strips.

1 Scope

This document defines the general characteristics applicable to pantographs for ERS, to enable dynamic current collection of road vehicles from an overhead contact line system. It furthermore defines the electrical and mechanical interface between a pantograph and the infrastructure and between a pantograph and the vehicle.

The document also specifies tests for the pantograph. It includes recommendations for a common safety concept that is related to the electric vehicle and power supply infrastructure and gives recommendations for the maintenance of the pantograph.

This document is applicable to:

— Two-pole pantographs on commercial vehicles during operation on electrified public roads and highways.

This document is not applicable to:

— trolley busses and their electric equipment;

— vehicles in private applications on roads in restricted areas such as truck trolley applications in mines;

— commercial freight vehicles or electric busses with static-only charging systems at e.g. loading/unloading facilities or bus stops.

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 50119:2020, *Railway applications — Fixed installations — Electric traction overhead contact lines*

EN 50124-1:2017, *Railway applications — Insulation coordination — Part 1: Basic requirements — Clearances and creepage distances for all electrical and electronic equipment*

EN 50124-2:2017, *Railway applications — Insulation coordination — Part 2: Overvoltages and related protection*

EN 50317:2012, *Railway applications — Current collection systems — Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line*

EN 60068-2-64:2008, *Environmental testing — Part 2-64: Tests — Test Fh: Vibration, broadband random and guidance (IEC 60068-2-64:2008)*

EN 61000-4-2, *Electromagnetic compatibility — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test (IEC 61000-4-2)*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 6469-3:2021, *Electrically propelled road vehicles — Safety specifications — Part 3: Electrical safety*

EN ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests (ISO 9227:2022)*

ISO 10605, *Road vehicles — Test methods for electrical disturbances from electrostatic discharge*

ISO 11452 (all parts), *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy*

ISO 16750-1, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment; Part 1: General*

ISO 16750-2, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment; Part 2: Electrical loads*

ISO 16750-3, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment; Part 3: Mechanical loads*

ISO 16750-4, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment; Part 4: Climatic loads*

ISO 16750-5, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 5: Chemical loads*

ISO 26262-5:2018, *Road vehicles — Functional safety — Part 5: Product development at the hardware level*

3 Terms, definitions, and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following general terms and definitions 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://electropedia.org/

3.1.1
electric road system
ERS
system that enables power transfer to electric road system vehicles whilst they are driving and during standstill

Note 1 to entry: By integrating power transfer technology into existing road infrastructure, the road itself will be accessible to both vehicles that use power transmission and other vehicles.

3.1.2
ERS vehicle
vehicle which is equipped to utilize the power supply of an ERS

Note 1 to entry: The vehicle is compatible with an OCLS type of ERS and contains pantograph, Enable device and VIC (Vehicle Infeed Circuit, Annex A).

3.1.3
ERS route
stretch or road section, which is equipped with an ERS infrastructure, in this case with an OCLS

3.1.4
pantograph
apparatus for collecting current from one or more contact wires, formed of a hinged device designed to allow vertical movement of the pantograph head

Note 1 to entry: Vehicle mounted device to establish an electrical connection with the overhead contact lines. Can be lifted upwards to OCL to transfer current from OCL to vehicle and vice versa.

[SOURCE: IEC 60050-811:2017, 811-32-02, modified – The note 1 to entry has been added]

3.1.5
pantograph collector head
part of the pantograph supported by the frame which includes contact strips, horns and may include a suspension

Note 1 to entry: An ERS pantograph is usually equipped with two collector heads; one for each polarity. Other variants can exist.

3.1.6
enable device
device controlling the use of a pantograph (rising and lowering) depending on various inputs, such as drivers command, vehicle states and data gathered by sensors connected to the enable device

Note 1 to entry: Depending on the enable device's integration into the OEM vehicle, it can be used either as responsible for the functional safety decision whether it is safe to connect and stay connected or not, or as an assistance system to reduce error risks from driver operation.

3.1.7
vehicle infeed circuit
VIC
necessary components to utilize the power transferred from the OCL with the pantograph that are not part of the vehicles usual drive train

Note 1 to entry: See Annex A.

3.1.8
original equipment manufacturer
OEM
manufacturer of the ERS vehicle

Note 1 to entry: Vehicle with or without VIC.

3.1.9
integrator
<of pantograph and/or VIC> entity which integrates pantograph and/or VIC in vehicle

Note 1 to entry: Could be an OEM or a third party.

3.1.10
static contact force
force of one collector head towards its corresponding contact line measured while standstill of the vehicle

3.1.11
dynamic contact force
contact force of one collector head towards contact line during operation measured while vehicle is driving

3.1.12
contact cycle
cycle starting with a pantograph rising from cleared state until it is connected to the OCL in nominal height and ends once the pantograph has returned to its lowest position

Note 1 to entry: Unsuccessful attempts are also covered.

3.1.13
automatic dropping device
ADD
device that initiates immediate lowering of the pantograph in event of contact strip failure

Note 1 to entry: See also EN 50206-1:2010, 4.8.

3.1.14
collector head
part of the pantograph, at least comprised of one contact strip and the respective suspension system for connection to one contact wire

3.1.15
pantograph pole
electrical pole of the pantograph (e.g., positive, or negative)

Note 1 to entry: The pantograph and OCL of the ERS feature at least two electric poles with different electrical potentials.

3.1.16
controller area network bus
CAN bus
communication bus standard (message-based protocol) used for communication between vehicle and pantograph

Note 1 to entry: Definition according to SAE J1939:2018 – ISO 11898.

3.1.17
cleared state
position of the pantograph when fully retracted and ready for operation

3.2 Abbreviations

Abbreviation	Explanation
A	Pantograph Clearance value: Height of the mechanical clearance profile above the idealized road surface
ADD	Automatic Dropping Device
ASIL	Automotive safety integrity level
CAN	Controller Area Network
CSM	Common safety methods
CTI	Comparative Tracking Index
CW	Contact wire, sometime CW1, CW2 as denomination of each wire
CW_{UL}	Contact wire uplift due to pantograph contact force
$CW_{UL, ac}$	Maximum permissible contact wire uplift in case of an accident
$CW_{UL, op}$	Maximum permissible contact wire uplift during regular operation
DC	Direct Current
EMC	Electromagnetic compatibility
ERS	Electric road system
ESD	Electrostatic discharge
FIT	Failure in time
FMEA	Failure Mode and Effects Analysis
GND	Ground (0 V)
$G_{A,v}$	OCL Structure gauge: Category A vertical clearance

Abbreviation	Explanation
$G_{B,v}$	OCL Structure gauge: Category B vertical clearance
$G_{C,v}$	OCL Structure gauge: Category C vertical clearance
$G_{D,v}$	OCL Structure gauge: Category D vertical clearance
HARA	Hazard Analysis and Risk Assessment
$H_{max,\ veh}$	Maximum permitted vehicle height
$H_{clearance}$	Minimum clearance below contact wire
HCW_L	Contact wire height (left)
HCW_{max}	Maximum contact wire height (incl. contact wire uplift CW_{UL})
$HCW_{max,op}$	Maximum operation height of contact wire
$HCW_{max,stat}$	Maximum contact wire height (static, in resting position)
HCW_{min}	Minimum contact wire height (in resting position, non-operational)
HCW_n	Nominal height of contact wire
HCW_{op}	Contact wire height in operation
HCW_{range}	Lifting / lowering range of contact wire
HCW_{safe}	Safety clearance height/safety height of vehicle and pantograph
HCW_{stat}	Static (not connected) contact wire height
HCW_R	Contact wire height (right)
IR	ERS infrastructure required
$I_{max,per}$	Maximum continuous current above 5 km/h
$I_{max,05}$	Permanent current for vehicle velocity 0 km/h to 5 km/h
KP/NTV	Known type of pantograph on new type of vehicle
LC_{max}	Maximum conductive length of a contact strip
L1	Pantograph Clearance value: Radius of clearance area for pantograph at the sides
L2	Pantograph Clearance value: Angle of the clearance profile to the side of the contact wires in any height.
L3	Pantograph Clearance value: Width of the clearance profile to the side of the contact wires in any height
L4	Pantograph Clearance value: Height of the mechanical clearance profile above the contact wires in any height
L5	Pantograph Clearance value: Height of the electrical clearance profile above the mechanical clearance profile
L7	Pantograph Clearance value: Lifted height of the contact wires when in contact to pantograph above the idealized road surface
L8	Pantograph-OCL Clearance value: Distance between the edges of both contact wires CW
NP	New pantograph