SLOVENSKI STANDARD
SIST EN 50155:1998

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Railway applications - Electronic equipment used on rolling stock (IEC 60571-1:1990 + IEC 60571-2:1988 + IEC 60571-3:1990 (Related))

Railway applications - Electronic equipment used on rolling stock

Bahnanwendungen - Elektronische Einrichtungen auf Schienenfahrzeugen

Applications ferroviaires - Équipements électroniques utilisés sur le matériel roulant

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29.280	Elektriļ na vleļ na oprema	Electric traction equipment
45.060.10	Vleļ na vozila	Tractive stock

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English version

Railway applications
Electronic equipment used on rolling stock

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

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FOREWORD

This European Standard, which is based on IEC 571-1, IEC 571-2, and IEC 571-3, was prepared by Working Group 1 of CENELEC Technical Committee TC 9X, Electrical and electronic applications in railways, and by the secretariat of CENELEC TC 9X, further to a decision of the ad hoc BTWG for IEC 571 in 1989, and in accordance with the decisions taken by CENELEC TC 9X during its meeting held in Paris in June 1994.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50155 on 1995-09-20.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-03-01

- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1996-03-01

For products which have complied with the relevant national standard before 1996-03-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2001-03-01.

In this standard annex A is informative, and contains a list of clauses where agreement between the parties (e.g. user and manufacturer) is mentioned.

While the new standards structure is being set up, the review progress will occur more frequently than would be usual. Therefore, before using this standard, the user should check that the latest issue of the standard is known.

Clauses and subclauses subject to future change are indicated in the text by a note referring to this foreword.

Those affected are:

- Clause 2	Environmental service conditions of operation
- Clause 3	Electrical service conditions
- Subclause 10.2.6	Supply related surge and transient susceptibility test
- Subclause 10.2.7	Transient burst susceptibility test
- Subclause 10.2.8	Radio interference test
- Subclause 10.2.11	Vibration, shock and bump test

CONTENTS

1 General

1.1 Scope

This standard applies to all electronic equipment for control, regulation, protection, supply, etc., installed on rail vehicles and associated with:

- either the accumulator battery of the vehicle;
- or a low voltage power supply source with or without a direct connection to the contact system (transformer, potentiometer device, auxiliary supply);

with the exception of electronic power circuits, which conform to EN 50207.

This standard covers the conditions of operation, design, construction, and testing of electronic equipment, as well as basic hardware and software requirements considered necessary for competent, reliable equipment.

Additional requirements in other standards or individual specifications may complement this standard, if they are justified.

Specific requirements related to practices necessary to assure defined levels of functional safety are to be found in EN 50126, EN 50128, and EN 50129.

For the purpose of this standard, electronic equipment is defined as equipment mainly composed of semiconductor devices and recognized associated components. These components will mainly be mounted on printed boards.

NOTE: Sensors (current, voltage, speed, etc.) and firing unit printed board assemblies for power electronic devices are covered by this standard. Complete firing units are covered by EN 50207.

1.2 Normative references

This European standard incorporates by dated or undated references, provisions from other publications.These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 29000-3	Quality management and quality assurance standards Part 3: Guidelines for the application of ISO 9001 to the development, supply and maintenance of software
EN 50121-3-1*)	Railway Applications - Electromagnetic compatibility - Requirements for rolling stock - Vehicles
EN 50121-3-2*)	Railway Applications - Electromagnetic compatibility - Requirements for rolling stock - Apparatus
EN 50125-1*)	Railway Applications - Environmental conditions for equipment - Part 1: Equipment on board rolling stock
EN 50126*)	Railway Applications - Dependability for guided transport systems (RAMS)

*) In preparation

EN 50128*)	Railway Applications - Software for railway control and protection systems
EN 50129*)	Railway Applications - Safety related electronic railway control and protection systems
EN 50163*)	Railway Applications - Supply voltages of traction systems
EN 50207*)	Electronic power convertors for rolling stock
EN 60068 EN 60068-2-1	Environmental testing (IEC 68) Part 2: Tests - Test A: Cold (IEC 68-2-1:1990)
EN 60068-2-2	Part 2: Tests - Test B: Dry heat (IEC 68-2-2:1974)
EN 60068-2-27	Part 2: Tests - Test Ea and guidance: Shock (IEC 68-2-27:1987)
EN 60249 EN 60249-2-5	Base materials for printed circuits Part 2: Specifications - Specification No.5: Epoxide woven glass fabric copper-clad laminated sheet, of defined flammability (vertical burning test) (IEC 249-2-5:1987 + A2:1992)
EN 60249-2-10	Specification No.10: Epoxide non woven/woven glass reinforced copper-clad laminated sheet of defined flammability (vertical burning test) (IEC 249-2-10:1987 + A2:1990)
EN 60249-2-12	Specification No.12: Thin epoxide woven glass fabric copper-clad laminated sheet, of defined flammability, for use in the fabrication of multilayer printed boards (IEC 249-2-12:1987 + A1:1989)
EN 60249-2-15	Specification No.15: Flexible copper-clad polyimide film, of defined flammability (IEC 249-2-15:1987)
EN ISO 9001	Quality systems - Model for quality assurance in design/ development, production, installation and servicing
EN ISO 9002	Quality systems - Model for quality assurance in production and installation
HD 323.3.30 S3	Environmental testing - Part 2: Tests - Test Db and guidance: Damp heat, cyclic (12+12-hour cycle) (IEC 68-2-30:1980)
HD 476 HD 476.1 S1	Solderless connections Part 1: Solderless wrapped connections - General requirements, test methods and practical guidance (IEC 352-1:1983)
HD 476.2 S1	Part 2: Solderless crimped connections - General requirements, test methods and practical guidance (IEC 352-2:1990)
HD 481.3 S1	Electromagnetic compatibility for industrial-process measurement and control equipment - Part 3: Radiated electromagnetic field requirements (IEC 801-3:1984)
HD 493 (series)	Dimensions of mechanical structures of the 482,6 mm (19 in) series (IEC 297, series)

*) In preparation

CECC 23000	Generic specification: Printed boards
CECC 23200	Sectional specification: Single and double sided printed boards with plated through holes
CECC 23300	Sectional specification: Multilayer printed boards
CECC 23400	Flexible printed boards without through connections
CECC 23500	Specification for harmonized system of quality assessment for electronic components - Sectional specification: Flexible printed boards with through connections
CISPR 16	Specification for radio interference measuring apparatus and measurements methods
IEC 77	Rules for electric traction equipment
IEC 113-8	Diagrams, charts, tables - Part 8: Preparation of diagrams for system manuals
IEC 249-3-1	Base materials for printed circuits - Part 3: Special mateirals used in connection with printed circuits - Specification No. 1: Prepreg for use as bonding sheet material in the fabrication of multilayer printed boards
IEC 321	Guidance for the design and use of components intended for mounting on boards with printed wiring and printed circuits
IEC 326	Printed boards
IEC 326-3	Part 3: Design and use of printed boards
IEC 326-7	Part 7: Specification for single and double sided flexible printed boards without through connections
IEC 326-8	Part 8: Specification for single and double sided flexible printed boards with through connections
IEC 605	Equipment reliability testing
IEC 617	Graphical symbols for diagrams
IEC 801-4	Electromagnetic compatibility for industrial-process measurement and control equipment - Part 4: Electrical fast transient/burst requirements
IEC 801-5	Electromagnetic compatibility for electrical and electronic equipment Part 5: Surge immunity requirements

1.3 Definitions

For the purposes of this standard, the following definitions apply:

1.3.1 **printed board:** Base material cut to size containing all holes and bearing at least one conductive pattern.Printed boards are typically subdivided according to:

- their structure (e.g. single and double-sided, multilayers),
- the nature of the base material (e.g. rigid, flexible).

1.3.2 **printed board assembly:** Printed board with electrical and mechanical components and/or other printed boards attached to it with all manufacturing processes, soldering, coating, etc., completed.

1.3.3 **plug-in unit:** A unit which plugs into a subrack and is supported by guides. These units can be of various types, ranging from a printed board with components mounted in a frame or box type unit, designed with a plug-in connection.

1.3.4 **subrack:** A structural unit for housing printed board assemblies and/or plug-in units.

1.3.5 **rack:** A free-standing or fixed structure for supporting electrical or electronic equipment (e.g. subracks).

1.3.6 **cubicle:** Any enclosure for housing electrical and/or electronic equipment.

1.3.7 **line replaceable unit**: A unit designed to be exchanged as a result of on-vehicle fault diagnosis, e.g. a subrack, or plug-in unit.

1.3.8 **performance check**: A performance check is a short form performance test which is carried out during and after environmental tests, sufficient to prove that the equipment is within its operational limits, and that it has survived an environmental test.

1.3.9 **control system voltage supply**: The voltage supply used to power the vehicle control equipment.

The supply may be derived from a vehicle battery. The battery may be charged from battery chargers, auxiliary inverters and motor-alternator or motor-generator sets with associated electronic regulations.

Where the control system voltage supply is derived from a battery, the nominal and rated control system voltages are defined in 3.1. Where no battery is fitted, the nominal control system voltage is the normal controlled level of that voltage.

1.3.10 **vehicle wiring**: Vehicle wiring includes all wiring which can be connected to the control system voltage supply, wherever located, and all other wiring external to the electronic equipment under consideration.

1.3.11 **supply related surge**: An electrical disturbance to the control system voltage supply caused by equipment controlling that supply. A surge will occur as an increase in the level of the control system voltage supply.

1.3.12 **transient**: A non-periodic and relatively short positive or negative (or both) variable (voltage or current) between two steady states.

It may be produced by the normal operation of equipment within the vehicle, caused generally by the discharge of energy when inductive circuits are switched.

It may be present either on the control system voltage supply, or on wiring connected directly to switched inductive circuits, or coupled electrostatically or electromagnetically from such wiring into other wiring.

The effective value of the source impedance of a transient will depend upon the manner of its generation and coupling.

1.3.13 **burst**: Repetitive pulses occurring during a fixed time interval.

It may occur during normal operation of the vehicle, typically resulting from unstable arc conditions.

1.3.14 **failure**: The inability of an item of equipment to continue to perform its intended function.

A temporary malfunction will not be considered a failure provided that both:

a) The equipment will recover normal operation automatically following malfunction

b) The malfunction is not apparent to the vehicle operating staff; for example, fault indicators must not illuminate.

NOTE: Attention is drawn to the possibility of a consequential failure of a second item of equipment resulting from a temporary malfunction of another item of equipment connected to it.

1.3.15 **useful life**: The period from a stated time, during which, under stated conditions, an item has an acceptable failure rate, or until an unrepairable failure occurs.

NOTE: For a repairable item the individual useful life may be ended by a failure which is not considered as repairable for any reason.

2 Environmental service conditions of operation

NOTE: See foreword.

2.1 Normal service conditions

2.1.1 Altitude

The altitude at which the equipment is normally to function does not exceed 1 800 m.

2.1.2 Ambient temperature

Electronic equipment shall be designed and manufactured to meet the full performance specification requirement for the selected temperature categories as stated in table 1.

The design shall take into account temperature rises within cubicles to ensure that the components do not exceed their specified temperature ratings.

In addition, the equipment shall meet the special short-term start up thermal conditions as stated in column 3. In this interval the full performance ratings may be relaxed, but the maximum air temperature surrounding the printed board assembly according to column 4 shall not be exceeded.

Table 1: Ambient temperature

	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
CLASSES	EXTERNAL AMBIENT TEMPERATURE	INTERNAL CUBICLE TEMPERATURE	INTERNAL CUBICLE OVER TEMPERATURE 10 MIN	AIR TEMPERATURE SURROUNDING THE PRINTED BOARD ASSEMBLY
T1	-25 °C to +40 °C	-25 °C to +55 °C	+15 °C	-25 °C to +70 °C
T2	-40 °C to +35 °C	-40 °C to +55 °C	+15 °C	-40 °C to +70 °C
T3	-25 °C to +45 °C	-25 °C to +70 °C	+15 °C	-25 °C to +85 °C
TX	-40 °C to +50 °C	-40 °C to +70 °C	+15 °C	-40 °C to +85 °C

For peripheral units (measuring transducers,etc.), or if the equipment is in a decentralized configuration, then if the above ambient temperature ranges are exceeded, the actual temperatures occurring at the location of the equipment concerned shall be used in the design.

Rapid external ambient temperature variations resulting from running through tunnels shall be taken into account. For this purpose the rate of change of external temperature shall be assumed to be 3 °C/sec, with a maximum variation of 40 °C .

2.1.3 Shock and vibration

The equipment shall be able to withstand, without deterioration or malfunction, vibrations and shocks that occur in service.

In order to provide some reasonable degree of confidence that it will survive the specified useful life under service conditions, it shall be capable of meeting the vibration, shock and bump test as described in 10.2.11.

For these purposes the equipment is specified as having the electronic units installed complete, and supported in their designed fixings, with anti-vibration mounts where fitted.

For the typical values of shocks and vibrations in real service, reference is made to EN 50125-1.

2.1.4 Relative humidity

The equipment shall be designed for the following humidity stresses (limit values) over the relevant range of the external ambient temperature as defined in 2.1.2:

- yearly average ≤ 75% rel. humidity,
- on 30 days in the year continuously = 95% rel. humidity.

In addition, any moisture condensation during operation shall not lead to any malfunction or failure especially when running through tunnels.

For peripheral units (measuring transducers etc.), or if the equipment is in a decentralized configuration, then if the above humidity stresses are exceeded, the actual humidity occurring at the location of the equipment concerned shall be used in the design.

2.2 Special service conditions

Special arrangements shall be agreed between the appropriate parties involved when service conditions can be proved to be different from those mentioned in 2.1 (e.g. electronic equipment mounted on the bogie or integrated within a power converter etc.). Checks of the effectiveness of such arrangements could, if required, form the subject of optional type tests which could be carried out on the vehicle itself in accordance with methods to be agreed between the user and the manufacturer.

2.2.1 Atmospheric pollutants

The equipment may be expected to be exposed throughout its life to various pollutants (e.g. oil mist, salt spray, conductive dust, sulphur dioxide.). The types of pollutants and their concentration should be defined in the tender documents.

3 Electrical service conditions

NOTE: See foreword.

3.1 Power supply

3.1.1 Supply from accumulator battery

The nominal voltage of equipment (U_n) so supplied shall be selected from amongst the following values:

24 V 48 V 72 V 96 V 110 V

NOTE 1: These nominal voltage values are given only as standardising values for the design of equipment. They should not be considered as the off load battery voltages which should be determined as functions of the types of battery, the number of cells and the operating conditions.

NOTE 2: Different voltage variations may be used, following IEC 77. In this case compliance with the requirements should be defined by agreement between manufacturer and user.

3.1.1.1 Variations of voltage supply

Electronic equipment supplied by accumulator batteries without a voltage stabilizing device shall operate satisfactorily for all the values of the supply voltage within the range defined below (measured at the input terminals of the equipment).

The supplier of the electronic equipment shall specify its power consumption in order to enable calculations for the battery cabling.

Minimum voltage	0,7 U_n
Nominal voltage	U_n
Rated voltage	1,15 U_n
Maximum voltage	1,25 U_n

Voltage fluctuations (e.g. during start-up of auxiliary equipment or voltage oscillations of battery chargers) lying between 0,6 U_n and 1,4 U_n and not exceeding 0,1 seconds shall not cause deviation of function.

Voltage fluctuations lying between 1,25 U_n and 1,4 U_n and not exceeding 1 second shall not cause damage: equipment may not be fully functioning during these fluctuations.

In the case of thermal engines, see also 3.1.1.3.

3.1.1.2 Interruptions of voltage supply.

Interruptions of up to 10 ms may occur on input voltage as defined below:

Class S1: No interruptions

Class S2: 10 ms interruptions

This shall not cause any equipment malfunction.

The time values specified are for nominal voltage.

The choice of classes shall be defined by the system designer

3.1.1.3 Variations of voltage supplies for rolling stock powered by thermal engines

At start-up of thermal engines the voltage supply system shall be designed to guarantee the supply to the essential electronic equipment during the whole starting sequence.

3.1.1.4 D.C. ripple factor

All batteries on charge have a pulsating voltage, the d.c. ripple factor of which, unless otherwise stated, shall not be greater than 15% calculated from the equation:

$$\text{d.c. ripple factor} = \frac{U_{max} - U_{min}}{U_{max} + U_{min}} \times 100$$

where U_{max} and U_{min} are the maximum and minimum values, respectively, of the pulsating voltage.

The minimum and maximum voltages as defined in 3.1.1.1 however shall not be exceeded.

3.1.2 Supply by a static converter or a rotating set

In the case of equipment supplied with power from a stabilized source, (e.g. a static converter or a rotating motor-generator set provided with a regulator), Electronic Equipment shall operate satisfactorily for values of the supply voltage lying between 0,9 and 1,1 U_n, where U_n is the nominal voltage and can be either d.c. or a.c.

In addition, for operating equipment, voltage fluctuations lying between 0,7 U_n and 1,25 U_n not exceeding 1 second and also between 0,6 U_n and 1,4 U_n not exceeding 0,1 second are allowed.

3.1.3 Supply change over

In the case of equipment supplied with power alternatively from an accumulator battery and a stabilized source (d.c.), the equipment shall operate satisfactorily under the conditions stated in 3.1.1, 3.1.1.1, 3.1.1.4 and 3.1.2 and

- Class S3: at 0,6 U_n during 100 ms (without interruptions);
- Class S4: during a supply break of 30 ms;

at supply change over.

3.1.4 Supply with contact line voltage

In the case of electronic equipment with a supply derived directly from the overhead line or third rail (e.g. control electronics of a self starting static converter), the equipment shall operate satisfactorily for values of contact line voltage as described in EN 50163 .

3.2 Supply related surge

All connections to electronic equipment capable of being connected to the control system voltage supply shall withstand:

a) the supply surges as specified in 3.1.1.1 and/or 3.1.2 (as appropriate), and

b) the application of voltage surge B as specified in 10.2.6.1.

Surges shall be assumed to be generated with respect to the control system voltage supply return potential and to be present only as an increase to the level of the control system voltage, which shall be assumed to be present before and after the application of the surge.Surges of opposite polarity to the control system voltage supply need not be considered.

Surges exceeding 1.25 U_n longer than 0,1 second shall be assumed to occur only in the case of a failure in the control system voltage supply.

3.3 Installation

It is recommended that the supply to the electronic equipment should be provided by a separate conductor connected as directly as possible to the source. This conductor should be used only for the supply to electronic circuits.

The installation of the electronic equipment shall be arranged so as to reduce, as far as possible,the effects of external electrical disturbances.

Suppression should be provided at the source of electrical interference.

If one pole of the battery of the vehicle is connected to the vehicle body, this shall be specified.

Where several manufacturers supply electronic equipment having common direct connections, a single reference point of equi-potential shall be established by mutual agreement.

3.4 Transients

3.4.1 Requirements

All electronic equipment shall withstand transients, either directly induced or indirectly coupled such that no damage or failure occurs during operation on the vehicle.
It may be assumed that the equipment will be used only for its intended purpose and it will be operated over all representative modes.

In order to provide some reasonable degree of confidence that it will survive the specified useful life under service conditions, the electronic equipment shall be capable of meeting the supply related surge and transient susceptibility test as described in 10.2.6.

Transients may be assumed to be non repetitive and they should not occur at a time interval of less than 10 seconds.

The transients shall be considered to be generated by an ideal voltage source in series with the specified source impedance switched to the electronic equipment by an ideal switch for the specified duration, in place of the normal control system voltage supply, if present. This supply shall not be assumed to be capable of absorbing any of the transient energy. However for certain applications it may be assumed that other loads are connected in parallel with the equipment (See 10.2.6).

Transients shall be assumed to be applied to the electronic equipment at the equipment wiring interface. Where connections to the electronic equipment are made via multipole connectors, such connectors and associated wiring harnesses shall be considered to be part of the electronic equipment.

If separate transient protection equipment is not provided locally (typically within one metre of the equipment), then the requirements of 3.4.2 shall apply.