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Železniške naprave – Elektronska oprema na voznih sredstvih

Railway applications – Electronic equipment used in rolling stock

ICS 29.280; 45.060.10

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English version

Railway applications - Electronic equipment used on rolling stock

Applications ferroviaires - Equipements électroniques utilisés sur le matériel roulant

Bahnanwendungen - Elektronische Einrichtungen auf Schienenfahrzeugen

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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 was prepared by the CENELEC Technical Committee TC 9X, Electrical and electronic applications in railways.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50155 on 2000-08-01.

This European Standard supersedes EN 50155:1995.

This second edition of EN 50155 has the purpose to technically align the European Standard to the International Standard IEC 60571:1998, keeping however the reference to the European needs, mainly expressed in the requirements of horizontal European standardisation.

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) 2002-02-01

- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2003-08-01

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given for information only. 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. Annex B is also informative and lists a number of Standard documents which may assist in this standard.

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 (integrity level equal to or higher then one) are to be found in EN 50126, EN 50128, and ENV 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	1998	Quality management and quality assurance standards Part 3: Guidelines for the application of ISO 9001 to the development, supply and maintenance of software (ISO 9000-3:1993)
EN 50121-3-2	2000	Railway Applications - Electromagnetic compatibility Part 3-2: Rolling stock - Apparatus
EN 50126	1999	Railway Applications - Dependability for guided transport systems (RAMS)
EN 50128	2001	Railway Applications - Software for railway control and protection systems
ENV 50129	1998	Railway Applications - Safety related electronic railway control and protection systems
EN 50163	1995	Railway Applications - Supply voltages of traction systems
EN 50207	2000	Electronic power convertors for rolling stock

EN 60068		Environmental testing (IEC 60068 series)
EN 60068-2-1	1993	Part 2: Tests - Test A: Cold (IEC 60068-2-1:1990)
EN 60068-2-2	1993	Part 2: Tests - Test B: Dry heat (IEC 60068-2-2:1974)
EN 60068-2-30	1999	Part 2: Tests - Test Db and guidance: Damp heat, cyclic (12+12 hour cycle) (IEC 60068-2-30:1980 + A1:1985)
EN 60249		Base materials for printed circuits (IEC 60249 series)
EN 60249-2-5	1994	Part 2: Specifications - Specification No.5: Epoxide woven glass fabric copper-clad laminated sheet, of defined flammability (vertical burning test) (IEC 60249-2-5:1987 + A2:1992)
EN 60249-2-10	1994	Specification No.10: Epoxide non woven/woven glass reinforced copper-clad laminated sheet of defined flammability (vertical burning test) (IEC 60249-2-10:1987 + A2:1990)
EN 60249-2-12	1994	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 60249-2-12:1987 + A1:1989)
EN 60249-2-15	1994	Specification No.15: Flexible copper-clad polyimide film, of defined flammability (IEC 60249-2-15:1987)
EN 60297/ HD 493	Series	Dimensions of mechanical structures of the 482,6 mm (19 in) series (IEC 60297, series)
EN 60352		Solderless connections (IEC 60352 series)
EN 60352-1	1997	Part 1: Solderless wrapped connections - General requirements, test methods and practical guidance (IEC 60352-1:1997)
EN 60352-2	1994	Part 2: Solderless crimped connections - General requirements, test methods and practical guidance (IEC 60352-2:1990)
EN 60529	1991	Degrees of protection provided by enclosures (IP Codes) (IEC 60529:1989)
EN 60617	Series	Graphical symbols for diagrams (IEC 60617 series)
EN 61000-4-4	1995	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test (IEC 61000-4-4:1995)
EN 61082	Series	Preparation of documents used in electrotechnology (IEC 61082 series)
EN 61373	1999	Shock and vibration requirements for rolling stock equipment (IEC 61373:1999)
EN 123000	1991	Generic specification - Printed boards
EN 123200	1992	Sectional specification - Single and double sided printed boards with plated-through holes
EN 123300	1992	Sectional specification - Multi-layer printed boards
EN 123400	1992	Sectional specification - Flexible printed boards without through connections
EN 123500	1992	Sectional specification - Flexible printed boards with through connections

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
IEC 60077	1968	Rules for electric traction equipment
IEC 60249-3-1	1981	Base materials for printed circuits - Part 3: Special materials used in connection with printed circuits - Specification No. 1: Prepreg for use as bonding sheet material in the fabrication of multilayer printed boards
IEC 60321	1970	Guidance for the design and use of components intended for mounting on boards with printed wiring and printed circuits
IEC 60326		Printed boards
IEC 60326-3	1991	Part 3: Design and use of printed boards
IEC 60326-7	1981	Part 7: Specification for single and double sided flexible printed boards without through connections
IEC 60326-8	1981	Part 8: Specification for single and double sided flexible printed boards with through connections
IEC 60605 (series)		Equipment reliability testing

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
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
structural unit for housing printed board assemblies and/or plug-in units

1.3.5
rack
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
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
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
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
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 overvoltage
electrical disturbance to the control system voltage supply caused by equipment controlling that supply. A supply overvoltage will occur as an increase in the level of the control system voltage supply

1.3.12
surge
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.

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

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

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

a) The equipment recovers normal operation automatically following malfunction
b) The malfunction is not apparent to the vehicle operating staff; for example, fault indicators do not light up.

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
damage
any change in visual appearance or alteration of mechanical integrity

1.3.16
useful life
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

2.1 Normal service conditions

2.1.1 Altitude

The altitude at which the equipment is normally to function does not exceed 1 200 m. When it exceeds this figure, compliance with the requirements shall be defined by agreement between manufacturer and user.

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
	External ambient temperature °C	Internal cubicle temperature °C	Internal cubicle overtemperature during 10 min °C	Air temperature surrounding the printed board assembly °C
T1	-25 +40	-25 +55	+15	-25 +70
T2	-40 +35	-40 +55	+15	-40 +70
T3	-25 +45	-25 +70	+15	-25 +85
TX	-40 +50	-40 +70	+15	-40 +85

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 61373.

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,
- 30 consecutive days in the year: 95% relative 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 for the effectiveness of such arrangements can, if required, form the subject of optional type tests which can 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

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 since these are determined by the types of battery, the number of cells and the operating conditions.

NOTE 2 Different voltage variations may be used, following IEC 60077. 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 s shall not cause deviation of function.

Voltage fluctuations lying between 1,25 U_n and 1,4 U_n and not exceeding 1 s 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 failure.

The time values specified are for nominal voltage and 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.