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**Železniške naprave – Elektronski močnostni pretvorniki za železniška vozila**

Railway applications - Electronic power converters for rolling stock

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EUROPEAN STANDARD

**EN 50207**

NORME EUROPÉENNE

EUROPÄISCHE NORM

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English version

## **Railway applications - Electronic power converters for rolling stock**

Applications ferroviaires - Convertisseurs  
électroniques de puissance pour matériel  
roulant

Bahnanwendungen - Elektronische  
Stromrichter auf Bahnfahrzeugen

This European Standard was approved by CENELEC on 2000-07-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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# **CENELEC**

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

**Central Secretariat: rue de Stassart 35, B - 1050 Brussels**

## Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50207 on 2000-07-01.

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) 2001-07-01
- latest date by which the national standards conflicting  
with the EN have to be withdrawn (dow) 2001-07-01

Annexes designated "normative" are part of the body of the standard.  
Annexes designated "informative" are given only for information.  
In this standard, annexes A and B informative.

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## 1 Scope

This European-Standard is applicable to power electronic converters mounted on-board railway rolling-stock and intended for supplying:

- traction circuits,
- auxiliary circuits of power vehicles, coaches and trailers.

The application of this standard extends as far as possible to all other traction vehicles, including trolleybuses, for example.

This standard covers the complete converter assembly together with its mounting arrangements containing

- semiconductor device assemblies,
- integrated cooling systems,
- components of the intermediate d.c. link, including any necessary filters associated with the d.c. link,
- semiconductor drive units (SDU) and related sensors,
- incorporated protection circuits.

The following types of power sources are taken into consideration:

- a.c. contact lines,
- d.c. contact lines,
- on-board supplies such as generators, batteries and other electric power sources.

This standard excludes converters which supply the electronic control and Semiconductor Drive Units (SDU).

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NOTE Electronic control equipment of converters and those sensors not related to semiconductor drive units and the printed circuit board assemblies of drive units for power semiconductors (SDU) are covered by EN 50155.

This standard defines terminology, service conditions, general characteristics and test methods of electronic power converters onboard of rolling stock.

## 2 Normative references

This standard incorporates by dated or undated reference, 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 standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN ISO 9000	Quality management and quality assurance standards - Guidelines for selection and use
EN ISO 9001	Quality system - Model for quality assurance in design/development, production, installation and servicing
EN ISO 9002	Quality systems - Model for quality assurance in production, installation and servicing
EN ISO 9003	Quality systems - Model for quality assurance in final inspection and test
EN 50082-1	Electromagnetic compatibility - Generic immunity standard Part 1: Residential, commercial and light industry

EN 50121 series	Railway applications - Electromagnetic compatibility
EN 50121-1	Part 1: General
EN 50121-2	Part 2: Emission of the whole railway system to the outside world.
EN 50121-3-1	Part 3-1: Rolling stock - Train and complete vehicle
EN 50121-3-2	Part 3-2: Rolling stock - Apparatus
EN 50121-4	Part 4: Emission and immunity of the signalling and telecommunications apparatus
EN 50124-1	Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment
EN 50125 series	Railway applications - Environmental conditions for equipment
EN 50125-1	Part 1: Equipment on board rolling stock
EN 50126	Railway applications - The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
EN 50153	Railway applications - Rolling stock - Protective provisions relating to electrical hazards
EN 50155	Railway applications - Electronic equipment used on rolling stock
EN 50163	Railway applications - Supply voltages of traction systems
EN 60146-1-1	Semiconductor convertors - General requirements and line commutated convertors -- Part 1-1 Specifications of basic requirementsGeneral requirements and line commutated convertors (IEC 60146-1-1)
EN 60310	Railway applications <a href="https://standards.gost.org/catalog/standards/sist/ae5dc0dc-15b9-44ec-9daa-d4419c15c370/sist-en-50207-2001">https://standards.gost.org/catalog/standards/sist/ae5dc0dc-15b9-44ec-9daa-d4419c15c370/sist-en-50207-2001</a> Traction transformers and inductors on rolling stock (IEC 60310, mod.)
EN 60529	Degrees of protection provided by enclosures (IP Code) (IEC 60529)
EN 60551	Determination of transformer and reactor sound levels (IEC 60551, mod.)
EN 61373	Railway applications - Rolling stock equipment - Shock and vibration tests
EN 61377	Electric traction - Rolling stock - Combined testing of inverter-fed alternating current motors and their control (IEC 61377)
EN 61881	Railway applications - Rolling stock equipment - Capacitors for power electronics (IEC 61881)
HD 91	Rules for ohmic resistors used in the power circuits of electrically powered vehicles (IEC 60322)
IEC 60050(161)	International Electrotechnical Vocabulary (IEV) Chapter 161: Electromagnetic compatibility
IEC 60050(551)	Chapter 551: Electrical and magnetic devices
IEC 60050(811)	Chapter 811: Electric traction
IEC 60270	Partial discharge measurements
IEC 60349 (series)	Electric traction - Rotating electrical machines for rail and road vehicles
IEC 60349-2	Part 2: Electronic converter-fed alternating current motors
IEC 60384-4	Fixed capacitors for use in electronic equipment Part 4: Sectional specification - Aluminium electrolytic capacitors with solid and non-solid electrolyte
IEC 60664-1	Insulation coordination for equipment within low-voltage systems Part 1: Principles, requirements and tests
IEC 60747 (series)	Semiconductor devices - Discrete devices



IEC 61148	Terminal markings for valve device stacks and assemblies and for power converter equipment
IEC 61287-1	Power converters installed on board rolling stock Part 1: Characteristics and test methods

### 3 Definitions

For the purpose of this standard the definitions given in IEC 60050-551:1998, together with the following additional definitions apply.

#### 3.1 Definitions related to equipment

##### 3.1.1

##### **converter (electronic) (power)**

an electronic device based on power semiconductors which changes one or more of the following parameters: voltage, current, frequency and/or the phase number of the power passing through it

NOTE 1 A converter is defined by the input and output electrical characteristics. The converter may comprise a discrete chopper, inverter, etc. or a combination of these not necessarily in one cubicle.

NOTE 2 The converter is a part of the propulsion (or auxiliary) equipment. The converter may include, for example, a line circuit breaker, filter, transformer, cooling system, etc.

##### 3.1.2

##### **traction converter** [IEC 61287-1] ([standards.iteh.ai](https://standards.iteh.ai))

a converter providing power for the traction motors

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##### 3.1.3

##### **auxiliary converter** [IEC 60050(811-19-03)] (<https://standards.iteh.ai/catalog/standards/sist/ae5dc0dc-15b9-44ec-9daa-5c370/sist-en-50207-2001>)

a converter providing power for auxiliary services e.g. lighting, battery charging, air conditioning, control circuits etc.

##### 3.1.4

##### **direct converter** [IEC 61287-1]

a converter which converts the input energy into the output energy without an intermediate link

##### 3.1.5

##### **indirect converter** [IEC 61287-1]

a converter which converts the input energy into the output energy with an intermediate link

##### 3.1.6

##### **converter system** [IEC 61287-1]

a converter system consists of several converters required to operate connected together, each having different input and/or output characteristics and which also have different functional connections

A converter system is defined by a system specification in addition to the individual specification of each different converter making up the system.

##### 3.1.7

##### **current source intermediate link**

a circuit, linking at least two converters by a reactor connected in series

##### 3.1.8

##### **voltage source intermediate link**

a circuit, linking at least two converters and a capacitor connected in parallel

### 3.1.9

#### **transformer intermediate link**

a transformer which links two converters

### 3.1.10

#### **converter windings**

the windings of a transformer connected to the terminals of the converter

### 3.1.11

#### **auxiliary windings**

the windings of a transformer connected to the terminals of any auxiliary power supply or auxiliary equipment

### 3.1.12

#### **semiconductor device** [EN 60146-1-1]

a device whose essential characteristics are due to the flow of charge carriers within a semiconductor

### 3.1.13

#### **input and output** [IEC 61287-1]

the input side of a converter is the side which absorbs active power in motoring operation, the output side being that side which delivers active power in motoring operation

NOTE Electrical isolation. If individual electrical circuits (e.g. input-, output-, control circuit) are specified as isolated then the circuits are galvanically separated.

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### 3.1.14

#### **port** [EN 50082-1]

particular interface of the specified apparatus with the external electromagnetic environment

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### 3.1.15

#### **enclosure port**

the physical boundary of the apparatus through which electromagnetic fields may radiate or impinge

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### 3.1.16

#### **cable port**

a point at which a conductor or a cable is connected to the apparatus. examples are signal, control and power ports

### 3.1.17

#### **armature converter**

a converter connected to the armature of a d.c. motor to control the current or the voltage of the armature

### 3.1.18

#### **field converter**

a converter connected to the field winding of a d.c. or a synchronous motor to control the current in the field circuit

### 3.1.19

#### **unidirectional chopper**

this type of chopper can transfer the energy only in one direction

### 3.1.20

#### **step-down chopper** [IEC 61287-1]

a step-down chopper is a chopper of which the output voltage is lower than the input voltage

### 3.1.21

#### **step-up chopper** [IEC 61287-1]

a step-up chopper is a chopper of which the output voltage is higher than the input voltage

### 3.1.22

#### **armature chopper** [IEC 61287-1]

a chopper connected with the armature of a d.c. motor to control the current or the voltage of the armature

### 3.1.23

#### **field chopper** [IEC 61287-1]

a chopper connected with the field of a d.c. motor to control the current of the field

### 3.1.24

#### **rheostatic chopper** [IEC 61287-1]

a chopper connected in parallel with all or a part of a rheostat, or in series with a rheostat to control the current of the rheostat

### 3.1.25

#### **line converter with voltage-source intermediate d.c. link**

a converter which transforms the d.c. or a.c. input voltage to a d.c.-voltage

### 3.1.26

#### **line converter with current-source intermediate d.c. link**

a converter which transforms a d.c. or a.c. input voltage into a d.c.- current

### 3.1.27

#### **line converter with transformer intermediate a.c. link**

a converter which transforms a d.c. input voltage into an a.c.-voltage

### 3.1.28

#### **second harmonic filter** <https://standards.iteh.ai/catalog/standards/sist/ae5dc0dc-15b9-44ec-9daa-d449c190376/sist-en-50207-2001>

a filter which absorbs the difference between the power from the a.c. single phase supply (which pulsates with twice the line frequency) and the power supplied to the load (which practically is constant, within several periods of the line current)

## 3.2 Definitions related to electrical parameters

### 3.2.1

#### **full wave control (burst firing control)** [IEC 60050(161-07-07)]

synchronous multi-cycle control in which the starting instant is synchronized at voltage zero, and current flows for an integral number of complete half cycles

### 3.2.2

#### **load profile**

load profile (current versus time) is the repetitive cycle of the load current under specified conditions such as starting or braking

### 3.2.3

#### **maximum instantaneous input current** [IEC 61287-1]

the maximum specified input current which the converter can commutate for a specified voltage

### 3.2.4

#### **maximum instantaneous output current** [IEC 61287-1]

the maximum specified output current which the converter can commutate for a specified voltage

### 3.2.5

#### **transient (adjective or nominative)** [IEC 60050(161-02-01)]

pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest

### 3.2.6

#### **harmonic components** [IEC 60050(161-02-18)]

components of order greater than 1 of the Fourier series of a periodic quantity

### 3.2.7

#### **ripple** [IEC 61287-1]

the function obtained by subtracting the d.c. component from a periodic function

### 3.2.8

#### **total rated apparent power on the line side**

the product of the rated r.m.s line voltage and the total rated r.m.s. line current calculated from the rated average direct current of the converter and allowing also for the load of the auxiliary windings

### 3.2.9

#### **nominal value** [IEC 60050(151)]

a suitable approximate quantity value used to designate or identify a component, device or equipment

### 3.2.10

#### **rated value** [IEC 60050(151)]

a quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device or equipment

### 3.2.11

#### **operating point value**

a quantity value assigned, generally by the user, for a specified operating condition of a component, device or equipment

### 3.2.12

#### **special value**

a quantity value assigned, generally by the user, for expected fault conditions within the supply or the load of a converter

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## 4 Common clauses

### 4.1 General

#### 4.1.1 Design

All design shall proceed according to the regime laid down in EN ISO 9001.

The design process shall be visible and audible.

If the user requires details of this process for tender evaluation, the user shall define this in the tender documents.

#### 4.1.2 Marking

##### 4.1.2.1 Nameplate

The converter shall be provided with a nameplate which shall be readable during the useful life of the converter and on which at least the following is inscribed:

- manufacturers mark;
- number of main drawing and revision number and/or type designation;
- serial number;
- year of manufacture;
- mass.

#### 4.1.2.2 Main terminals

The marking of the main terminals shall comply with the specifications given in IEC 61148

#### 4.1.3 Technical documentation

##### 4.1.3.1 Documentation supplied by the manufacturer

Documentation for use and maintenance of the converter shall be provided by the manufacturer and shall include the following:

- technical specification (including functional description);
- type and routine test specifications including the test conditions;
- results of the specified tests (test certificate);
- commissioning instructions;
- operating instructions;
- maintenance instructions;
- repair instructions;
- description of special tools for maintenance and repair purposes; if any;
- training programme and supporting media, to be detailed by agreement between the manufacturer and the user;
- declaration of materials which must be treated as special waste, when they are removed from service (either alone or with the converter).

##### 4.1.3.2 Documentation to be supplied by the user

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The user shall, if necessary, furnish a specification, which is primarily intended to give details of the agreements listed in Annex B. It is only necessary to enter an item in the specification if it differs from the normal requirement in this standard. The specification may also contain:

- general technical description of the application;
- special service conditions;
- supply system characteristics;
- load characteristics and load profile;
- EMC requirements;
- cooling requirements;
- ambient conditions;
- safety measures including fire behaviour requirements;
- features of electrical and mechanical design;
- details of the available maintenance and repair facilities.

#### 4.1.4 Reliability, availability, maintainability and safety

##### 4.1.4.1 Reliability

The user may require the manufacturer to predict the reliability figure or meet the user's reliability target. The method of calculation shall be agreed between the manufacturer and the user at the time of tendering.

The specification and verification of the reliability requirements shall be in accordance with EN 50126.

##### 4.1.4.2 Availability

The user may require the manufacturer to predict the figure or meet the user's availability target. The method of calculation shall be agreed between the manufacturer and the user at the time of tendering.

The specification the method of calculation and verification shall be in accordance with EN 50126.

#### 4.1.4.3 Maintainability

Maintenance requirements shall be defined by the user at the time of tendering. In addition, the equipment manufacturer shall define what maintenance procedures are necessary or prohibited.

The specification and verification of these requirements shall be in accordance with EN 50126.

#### 4.1.4.4 Safety

Safety requirements shall be defined by the user at the time of tendering.

The specification and verification of the safety requirements shall be in accordance with EN 50126.

#### 4.1.5 Useful life

At the time of tendering the useful life of the converter shall be agreed between the manufacturer and the user. When the manufacturer intends to use components with a known life less than the useful life of the converter, their use and procedures for their regular replacement shall be agreed.

## 4.2 Service conditions

### 4.2.1 General

The classes of service conditions described in EN 50125 shall be applied unless different classes are specified by the user.

### 4.2.2 Altitude

The different classes of altitude above sea level, at which the equipment shall perform as specified, are given in standard EN 50125.

### 4.2.3 Temperature

#### 4.2.3.1 Ambient temperature

The different classes of ambient temperature, at which the equipment shall perform as specified, are in the standard EN 50125.

#### 4.2.3.2 Start up temperatures

This subclause applies for parked vehicles which are not connected to any power source. The initial maximum ambient temperature from which the equipment shall be able to start up without suffering any damage shall be 70<sup>o</sup> C, and the minimum temperature as specified in EN 50125.

Table 1 gives the different classes of start up load characteristics at which the equipment shall perform as specified. There is no preferred class; the class should be chosen to be appropriate to the use of the converter. The choice of class of start up shall be agreed between the manufacturer and the user.

**Table 1: General classes of start up load characteristics**

Load class	Start up power
SU1	rated voltage, no load until within specified temperature range <sup>1)</sup> )
SU2	50% rated power until within specified temperature range <sup>1)</sup>
SU3	100% rated power immediately <sup>2)</sup>
SU4	other specified conditions
1) For example: The traction power of a locomotive may not necessarily be available immediately after connection to the supply. The equipment can be brought to the working temperature by auxiliary equipment.	
2) For example: In some cases auxiliary converters have to perform immediately after connection to the supply.	

#### 4.2.4 Other environmental conditions

The converter shall be designed for the conditions of humidity, snow, rain, hail, ice, solar radiation, lightning and pollution as specified in EN 50125.

#### 4.2.5 Mechanical stress

##### 4.2.5.1 Shocks and vibrations

The converter when supported at its designed fixings (including anti vibration mounts when fitted), shall be able to withstand vibrations and shocks as stated in EN 61373.

##### 4.2.5.2 Other accelerations

When a vehicle is passing through a curve or is stopped on a curve, the allowable net acceleration components acting perpendicularly to the vertical axis of the vehicle shall not exceed the values given in EN 50125. The converter, including the cooling system, shall continue to perform as specified under transverse and longitudinal accelerations as specified in EN 50125.

#### 4.2.6 Load profile characteristics

In view of the fact that the characteristics of the load profile may affect the operating characteristics of a converter or converter component the load profile shall always be specified. These profiles shall be agreed between the manufacturer and the user.

In the case of electric braking, the load becomes a power source.

NOTE The load profile can be a theoretical traction cycle (acceleration, constant speed, braking & stop) or a specified cycle for the vehicle in which the converter is mounted. Generally this cycle is defined for the nominal input voltage for traction and in other cases such as braking at a specified voltage. This profile is used to calculate the worst case conditions for the components involved and to define the conditions for the temperature rise test (4.5.3.11).

#### 4.2.7 Supply system characteristics

The user, in so far as he has knowledge of the system, shall define the characteristics of the supply system, in motoring and in braking operation and under possible fault conditions.

##### 4.2.7.1 A.C. supply systems

###### 4.2.7.1.1 Main characteristics of the a.c. line voltage

The main characteristics of the different a.c. supply systems in use are described in EN 50163. The equipment shall perform as specified when it is used within the system(s) for which it is intended.