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Edition 3.0 2014-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Power converters installed on board rolling stock – Part 1: Characteristics and test methods

Applications ferroviaires – Convertisseurs de puissance embarqués sur le matériel roulant – Partie 1: Caractéristiques et méthodes d'essais

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RAILWAY APPLICATIONS – POWER CONVERTERS INSTALLED ON BOARD ROLLING STOCK –

Part 1: Characteristics and test methods

FOREWORD

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International Standard IEC 61287-1 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision.

This edition includes the following main technical changes with regard to the previous edition: it includes updates as necessary in order to meet the current technical state of the art and to improve clarity. It also takes into account generic railway standards as relevant parts of IEC 62497 and IEC 62498. Especially the clauses considering temperature rise test and auxiliary converter characteristics have been revised.

The text of this standard is based on the following documents:

FDIS	Report on voting
9/1918/FDIS	9/1946/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC series 61287, under the general title *Railway applications – Power converters installed on board rolling stock*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

RAILWAY APPLICATIONS – POWER CONVERTERS INSTALLED ON BOARD ROLLING STOCK –

Part 1: Characteristics and test methods

1 Scope

This part of IEC 61287 defines terminology, service conditions, general characteristics and test methods of electronic power converters onboard of rolling stock.

This International 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 trolley-buses, for example.

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

– semiconductor device assemblies;
– integrated cooling systems;
– integrated components like inductors, capacitors, transformers, resistors, contactors, switches;
– semiconductor drive units (SDU) and related sensors;
– incorporated protection circuits.

The following types of power sources are taken into consideration:

– AC contact lines,
– DC contact lines,
– on-board supplies such as generators, batteries and other electric power sources.

This standard excludes converters which provide the electronic control supply for semiconductor drive units (SDU) and other supplies relevant to the converter operation such as sensors.

NOTE 1 Electronic control equipment of converters and those sensors not related to semiconductor drive units and the printed circuit board assemblies of semiconductor drive units (SDU) are covered by IEC 60571.

NOTE 2 Combined tests with the whole traction system or auxiliary supply system are not within the scope of this standard. E.g. rules for combined tests of a motor fed by a converter are given in the IEC 61377 series.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-551:1998, *International Electrotechnical Vocabulary (IEV) – Part 551: Power electronics*

IEC 60050-811:1991, *International Electrotechnical Vocabulary – Chapter 811: Electric traction*

IEC 60076-10:2001, *Power transformers – Part 10: Determination of sound levels*

IEC 60077-1:1999, *Railway applications – Electric equipment for rolling stock – Part 1: General service conditions and general rules*

IEC 60270, *High-voltage test techniques – Partial discharge measurements*

IEC 60310, *Railway applications – Traction transformers and inductors on board rolling stock*

IEC 60322, *Railway applications – Electric equipment for rolling stock – Rules for power resistors of open construction*

IEC 60349-1, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 1: Machines other than electronic converter-fed alternating current motors*

IEC 60349-2, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 2: Electronic converter-fed alternating current motors*

IEC 60349-4, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 4: Permanent magnet synchronous electrical machines connected to an electronic converter*

IEC 60384-4, *Fixed capacitors for use in electronic equipment – Part 4: Sectional specification – Aluminium electrolytic capacitors with solid (MnO_2) and non-solid electrolyte*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60571, *Railway applications – Electronic equipment used on rolling stock*

IEC 60721-3-5, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 5: Ground vehicle installations*

IEC 60747 (all parts), *Semiconductor devices – Discrete devices*

IEC 60850, *Railway applications – Supply voltages of traction systems*

IEC 61148, *Terminal markings for valve device stacks and assemblies and for power conversion equipment*

IEC 61373, *Railway applications – Rolling stock equipment – Shock and vibration tests*

IEC 61881 (all parts), *Railway applications – Rolling stock equipment – Capacitors for power electronics*

IEC 61991, *Railway applications – Rolling stock – Protective provisions against electrical hazards*

IEC 62236-3-1, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

IEC 62236-3-2, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

IEC 62278, *Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*

IEC 62497-1:2010, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*
IEC 62497-1:2010/AMD1:2013

IEC 62498-1:2010, *Railway applications – Environmental conditions for equipment – Part 1: Equipment on board rolling stock*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-551:1998 and IEC 60050-811:1991, as well as the following, apply.

3.1 General

3.1.1
user
party which is responsible for the specification and the integration of the power converter into the railway vehicle

3.1.2
manufacturer
party which designs and manufactures the power converter

3.1.3
railway authority
organization which allows vehicle operators to operate railway vehicles and defines rules for safe operation

3.1.4
test specification
document that specifies the requirements for one or more tests

Note 1 to entry: For instance test acceptance criteria, test conditions, test methods.

Note 2 to entry: According to the specific terminologies used in the quality management systems of various organisations that perform tests on power converters for rolling stock, this document may have another title e.g. test plan.

3.2 Terms and definitions related to equipment

3.2.1
(electronic) (power) converter
an operative unit for electronic power conversion, comprising one or more electronic valve devices, transformers and filters if necessary and auxiliaries if any

Note 1 to entry: 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 to entry: 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.

[SOURCE: IEC 60050-551:1998, 551-12-01]

3.2.2
traction converter
converter providing traction power

3.2.3
auxiliary converter
converter providing power for auxiliary services

Note 1 to entry: For example, lighting, battery charging, air conditioning, cooling (main service), control circuits, etc.

3.2.4
direct converter
an electronic converter without an intermediate link

3.2.5
indirect converter
an electronic converter with an intermediate link

3.2.6
converter system
system consisting of several converters required to operate connected together, each having different input and/or output characteristics and which also have different functional connections

Note 1 to entry: A converter system is defined by a system specification in addition to the individual specification of each different converter making up the system.

3.2.7
converter windings
windings of a transformer connected to the terminals of the converter

3.2.8
auxiliary winding
a winding or part of a transformer winding which supplies the auxiliary circuits

[SOURCE: IEC 60050-811:1991, 811-26-12]

3.2.9
semiconductor device
device whose essential characteristics are due to the flow of charge carriers within a semi-conductor

Note 1 to entry: The definition includes devices whose essential characteristics are only in part due to the flow of charge carriers in a semiconductor but that are considered as semiconductor devices for the purpose of specification.

[SOURCE: IEC 60050-521:2002, 521-04-01]

3.2.10
input and output
input is the side which absorbs active power in motoring operation, the output side being that which delivers active power in motoring operation

Note 1 to entry: Electrical isolation. If individual electrical circuits (for example, input, output, control circuit) are specified as isolated, then the circuits are galvanically separated.

3.3 Terms and definitions related to electrical parameters

3.3.1
load profile
curve to illustrate the variance of current/power versus time under specified conditions such as

– for traction converter: starting and braking of the vehicle;

– for auxiliary converter: starting and steady state running periods of the auxiliary loads;

the line voltage is also considered

3.3.2
maximum instantaneous current
maximum specified current which the converter can commutate for a specified voltage

3.3.3
transient
pertaining to, or designating, a phenomenon or quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest

[SOURCE: IEC 60050-702:1992, 702-07-78]

3.3.4
harmonic component
sinusoidal component of a periodic quantity having a harmonic frequency

[SOURCE: IEC 60050-551:1998, 551-20-07]

3.3.5
DC ripple factor
the ratio of half the difference between the maximum and minimum value of a pulsating direct current to the mean value of this current

Note 1 to entry: With low values of the DC ripple factor this quantity is approximately equal to the ratio of the difference to the sum of the maximum and the minimum value.

Note 2 to entry: DC ripple factor = $(I_{max} - I_{min}) / 2 \times I_{mean}$

[SOURCE: IEC 60050-551:1998, 551-17-29]

3.3.6
nominal value
value of a quantity used to designate and identify a component, device, equipment, or system

Note 1 to entry: The nominal value is generally a rounded value.

[SOURCE: IEC 60050-151:2001, 151-16-09]

3.3.7
rated value
value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

Note 1 to entry: Generally defined by the manufacturer.

[SOURCE: IEC 60050-151:2001, 151-16-08]

3.3.8
operating point value
quantity value assigned, generally by the user, for a specified operating condition of a component, device or equipment

3.3.9
special value
quantity value assigned, generally by the user, for expected fault conditions within the supply or the load of a converter

4 Common clauses

4.1 General

4.1.1 Design

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:

– manufacturer's 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 about the use and maintenance of the converter shall be provided by the manufacturer and shall include the following:

– device description (including functional description and technical data);
– type and routine test specification (list of tests, test methods, limits, tolerances, test conditions, acceptance criteria);
– 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 are required to 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

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 profile and duty cycles;
– 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.

Requirements shall be clear and univocal.

For example, statements which are not quantified like “Equipment shall not interfere with signalling and telecommunication facilities.” are not acceptable.

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 IEC 62278.

4.1.4.2 Availability

The user may require the manufacturer to predict the availability 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 and the method of calculation and verification shall be in accordance with IEC 62278.

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 maintenance procedure shall be agreed between the manufacturer and the user.

The specification and verification of these requirements shall be in accordance with IEC 62278.