

**NORME
INTERNATIONALE
INTERNATIONAL
STANDARD**

**CEI
IEC
60571**

Edition 2.1

2006-12

Edition 2:1998 consolidée par l'amendement 1:2006
Edition 2:1998 consolidated with amendment 1:2006

**Equipements électroniques utilisés
sur les véhicules ferroviaires**

Electronic equipment used on rail vehicles



Numéro de référence
Reference number
CEI/IEC 60571:1998+A1:2006

Numérotation des publications

Depuis le 1er janvier 1997, les publications de la CEI sont numérotées à partir de 60000. Ainsi, la CEI 34-1 devient la CEI 60034-1.

Editions consolidées

Les versions consolidées de certaines publications de la CEI incorporant les amendements sont disponibles. Par exemple, les numéros d'édition 1.0, 1.1 et 1.2 indiquent respectivement la publication de base, la publication de base incorporant l'amendement 1, et la publication de base incorporant les amendements 1 et 2.

Informations supplémentaires sur les publications de la CEI

Le contenu technique des publications de la CEI est constamment revu par la CEI afin qu'il reflète l'état actuel de la technique. Des renseignements relatifs à cette publication, y compris sa validité, sont disponibles dans le Catalogue des publications de la CEI (voir ci-dessous) en plus des nouvelles éditions, amendements et corrigenda. Des informations sur les sujets à l'étude et l'avancement des travaux entrepris par le comité d'études qui a élaboré cette publication, ainsi que la liste des publications parues, sont également disponibles par l'intermédiaire de:

- **Site web de la CEI (www.iec.ch)**
- **Catalogue des publications de la CEI**

Le catalogue en ligne sur le site web de la CEI (www.iec.ch/searchpub) vous permet de faire des recherches en utilisant de nombreux critères, comprenant des recherches textuelles, par comité d'études ou date de publication. Des informations en ligne sont également disponibles sur les nouvelles publications, les publications remplacées ou retirées, ainsi que sur les corrigenda.

- **IEC Just Published**

Ce résumé des dernières publications parues (www.iec.ch/online_news/justpub) est aussi disponible par courrier électronique. Veuillez prendre contact avec le Service client (voir ci-dessous) pour plus d'informations.

- **Service clients**

Si vous avez des questions au sujet de cette publication ou avez besoin de renseignements supplémentaires, prenez contact avec le Service clients:

Email: custserv@iec.ch
Tél: +41 22 919 02 11
Fax: +41 22 919 03 00

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site (www.iec.ch)**
- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications (www.iec.ch/online_news/justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: custserv@iec.ch
Tel: +41 22 919 02 11
Fax: +41 22 919 03 00

CONTENTS

FOREWORD.....	7
1 General.....	11
1.1 Scope.....	11
1.2 Normative references.....	11
1.3 Definitions.....	15
2 Environmental service conditions of operation.....	19
2.1 Normal service conditions.....	19
2.2 Special service conditions.....	21
3 Electrical service conditions.....	21
3.1 Power supply.....	21
3.2 Supply overvoltages.....	25
3.3 Installation.....	25
3.4 Surges and electrostatic discharge.....	27
3.5 Electromagnetic compatibility.....	29
4 Reliability, maintainability and expected useful life.....	29
4.1 Equipment reliability.....	29
4.2 Useful life.....	29
4.3 Maintainability.....	29
4.4 Maintenance levels.....	31
4.5 Built-in diagnostics.....	31
4.6 Automatic test equipment.....	33
4.7 Alternative methods for fault diagnosis.....	33
4.8 Purpose-built test equipment and special tools.....	33
5 Design.....	33
5.1 General.....	33
5.2 Detailed practices – Hardware.....	35
5.3 Detailed practices – Software.....	39
5.4 Equipment features.....	43
6 Components.....	45
6.1 Procurement.....	45
6.2 Application.....	47
7 Construction.....	47
7.1 Equipment construction.....	47
7.2 Component mounting.....	49
7.3 Electrical connections.....	51
7.4 Internal flexible wiring (electrical and optical).....	51
7.5 Flexible printed wiring.....	53
7.6 Printed boards – flexible and rigid.....	53
7.7 Protective coatings for printed board assemblies.....	55
7.8 Identification.....	55
7.9 Mounting.....	57
7.10 Cooling and ventilation.....	57
7.11 Materials and finishes.....	57

8	Safety	59
8.1	General	59
8.2	Functional safety	59
8.3	Personnel safety	59
9	Documentation	59
9.1	Supply and storage of documentation	59
9.2	Hardware and software documentation	59
9.3	Documentation requirements	61
10	Testing	65
10.1	Categories of test	65
10.2	List of tests	67
Annex A (informative) List of subclauses in which agreement between the parties (e.g. user and manufacturer) is mentioned		93
Figure 1 – System interfacing with the typical EMC areas A, B and C		37
Figure 2 – Supply overvoltage		77
Figure 3 – Alternative test for supply overvoltage		79
Figure 4 – Capacitor discharge surge test		81
Table 1 – Ambient temperature		19
Table 2 – List of tests		67

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRONIC EQUIPMENT USED ON RAIL VEHICLES

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60571 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This consolidated version of IEC 60571 is based on the second edition (1998) [documents 9/425/FDIS and 9/463/RVD] and its amendment 1 (2006) [documents 9/917/FDIS and 9/933/RVD].

It bears the edition number 2.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

Annex A is for information only.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result 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.

ELECTRONIC EQUIPMENT USED ON RAIL VEHICLES

1 General

1.1 Scope

This International 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 IEC 61287-1.

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 determined in accordance with 4.6.3.1 and 4.6.3.2 of IEC 62278 and its informative Annex A.

Software safety integrity level of 1 or higher shall only be considered when it is shown that a residual safety risk remains and that it has to be carried by the software driven programmable electronic system. In such a case (i.e. software safety integrity level 1 or higher), IEC 62279 is applicable.

For the purposes 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 IEC 61287-1.

1.2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-30:1980, *Environmental testing – Part 2: Tests – Test Db and guidance: Damp heat, cyclic (12+12-hour cycle)*

- IEC 60077-1, *Rules for electric traction equipment*
- IEC 60297 (all parts), *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series*
- IEC 60321, *Guidance for the design and use of components intended for mounting on boards with printed wiring and printed circuits*
- IEC 60352-1, *Solderless connections – Part 1: Solderless wrapped connections – General requirements, test methods and practical guidance*
- IEC 60352-2, *Solderless connections – Part 2: Solderless crimped connections – General requirements, test methods and practical guidance*
- IEC 60529, *Degrees of protection provided by enclosures (IP Code)*
- IEC 60605 (all parts), *Equipment reliability testing*
- IEC 60617 – DB: 20011, *Graphical symbols for diagrams*
- IEC 60850, *Supply voltages of traction systems*
- IEC 61000-4-4:1995, *Electromagnetic Compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test – Basic EMC publication*
- IEC 61000-4-5, *Electromagnetic Compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*
- IEC 61082 (all parts), *Preparation of documents used in electrotechnology*
- IEC 61188-5 (all parts), *Printed boards and printed board assemblies – Design and use – Attachment (land/joint) considerations*
- IEC 61249, *Materials for printed boards and other interconnecting structures*
- IEC 61287-1, *Power convertors installed on board rolling stock – Part 1: Characteristics and test methods*
- IEC 61373, *Electrical railway equipment – Rolling stock – Shock and vibration requirements*
- IEC 62236-3-2:2003, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*
- IEC 62278:2002, *Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*
- IEC 62279, *Railway applications – Communications, signalling and processing systems – Software for railway control and protection systems*
- ISO 9000-3, *Quality management and quality assurance standards – Part 3: Guidelines for the application of ISO 9001 to the development, supply and maintenance of software*
- ISO 9001, *Quality systems – Model for quality assurance in design, development, production, installation and servicing*
- ISO 9002, *Quality systems – Model for quality assurance in production, installation and servicing*

¹ “DB” refers to the IEC on-line database.

1.3 Definitions

For the purpose of this International 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 to a box type unit

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 (LRU)

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 surge 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 is not 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 one 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 unreparable 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.