IEC 62590

Edition 1.0 2010-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Fixed installations – Electronic power converters for substations

Applications ferroviaires – Installations fixes – Convertisseurs électroniques de puissance pour sous-stations

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub
The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.
- IEC Just Published: www.iec.ch/online_news/justpub
Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.
- Electropedia: www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.
- Customer Service Centre: www.iec.ch/webstore/custserv
If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm
Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.
- Just Published CEI: www.iec.ch/online_news/justpub
Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.
- Electropedia: www.electropedia.org
Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.
- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 62590

Edition 1.0 2010-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Fixed installations – Electronic power converters for substations

Applications ferroviaires – Installations fixes – Convertisseurs électroniques de puissance pour sous-stations

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

ICS 45.060

ISBN 978-2-88912-000-0

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
2 Normative references 8
3 Terms and definitions 9
3.1 Semiconductor devices and combinations 9
3.2 Arms and connections 10
3.3 Controllability of converter arms and quadrants of operation 11
3.4 Commutation, quenching and commutation circuitry 11
3.5 Commutation characteristics 12
3.6 Rated values 15
3.7 Load capabilities 16
3.8 Specific voltages, currents and factors 16
3.9 Definitions related to virtual junction temperature 17
3.10 Cooling 18
3.11 Electromagnetic compatibility and harmonic distortion 19
4 Operation of semiconductor power equipment and valve devices 19
4.1 Classification of traction supply power converters and valves 19
4.1.1 Types of traction supply power converters 19
4.1.2 Purpose of conversion 19
4.1.3 Classification of semiconductor valve devices 19
4.2 Principal letter symbols 20
4.3 Basic calculation factors for line commutated converters 21
4.3.1 Voltage 21
4.3.2 Voltage characteristics and transition current 21
5 Service conditions 22
5.1 Code of identification of cooling method 22
5.1.1 Letter symbols to be used 22
5.1.2 Arrangement of letter symbols 22
5.2 Environmental conditions 23
5.2.1 Ambient air circulation 23
5.2.2 Normal service conditions 23
5.2.3 Special service conditions 24
5.3 Electrical service conditions 25
5.3.1 General 25
5.3.2 Limiting values as basis of rating 25
5.3.3 DC traction supply voltage 26
6 Converter equipment and assemblies 26
6.1 Electrical connections 26
6.2 Calculation factors 28
6.2.1 Current factor on the a.c. side 28
6.2.2 Voltage drop 29
6.3 Losses and efficiency 29
6.3.1 General 29
6.3.2 Included losses 29
6.4 Power factor 29

6.5 Direct voltage harmonic content 30
6.6 Electromagnetic compatibility (EMC) 30
6.7 Rated values for converters 30
6.7.1 General 30
6.7.2 Current values 31
6.7.3 Capability for unsymmetrical load of a 12-pulse converter in parallel connection 33
6.7.4 Semiconductor device failure conditions 33
6.8 Mechanical characteristics 33
6.8.1 General 33
6.8.2 Earthing 34
6.8.3 Degree of protection 34
6.9 Marking 34
6.9.1 Rating plate 34
6.9.2 Main circuit terminals 35
7 Tests 35
7.1 General 35
7.1.1 Performance of tests 35
7.1.2 Test schedule 35
7.2 Test specifications 36
7.2.1 Insulation tests 36
7.2.2 Light load functional test 38
7.2.3 Load test 38
7.2.4 Power loss determination 39
7.2.5 Temperature-rise test 39
7.2.6 Checking of auxiliary devices 40
7.2.7 Checking of the properties of the control equipment 40
7.2.8 Checking of the protective devices 40
7.2.9 Short-time withstand current test 41
7.2.10 Additional tests 41
Annex A (informative) Information required 42
Annex B (informative) Determination of the current capability through calculation of the virtual junction temperature 48
Annex C (informative) Index of definitions 53
Bibliography 55

Figure 1 – Illustration of angles 14
Figure 2 – Voltage drop 21
Figure 3 – AC voltage waveform 26
Figure B.1 – Approximation of the shape of power pulses 49
Figure B.2 – Calculation of the virtual junction temperature for continuous load 50
Figure B.3 – Calculation of the virtual junction temperature for cyclic load 51

Table 1 – Letter symbols for cooling mediums and heat transfer agents 22
Table 2 – Letter symbols for methods of circulation 22
Table 3 – Connections and calculation factors for line commutated converters 28
Table 4 – Standardized duty classes 31

Table 5 – Semiconductor device failure conditions 33
Table 6 – Summary of tests 36
Table 7 – Insulation levels for a.c./d.c. converters 38
Table B.1 – Examples for typical applications 52

INTERNATIONAL ELECTROTECHNICAL COMMISSION

RAILWAY APPLICATIONS – FIXED INSTALLATIONS – ELECTRONIC POWER CONVERTERS FOR SUBSTATIONS

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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
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 62590 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This standard is based on EN 50328.

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

FDIS	Report on voting
9/1387/FDIS	9/1411/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.

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.

INTRODUCTION

Semiconductor converters for traction power supply differ from other converters for industrial use due to special electrical service conditions and due to the large range of load variation and the peculiar characteristics of the load.

For these reasons IEC 60146-1-1 does not fully cover the requirements of railway applications and the decision was taken to have a specific standard for this use.

Converter transformers for fixed installations of railway applications are covered by EN 50329.

Harmonization of the rated values and tests of the whole converter group are covered by IEC 62589.

RAILWAY APPLICATIONS – FIXED INSTALLATIONS – ELECTRONIC POWER CONVERTERS FOR SUBSTATIONS

1 Scope

This International Standard specifies the requirements for the performance of all fixed installations electronic power converters, using controllable and/or non-controllable electronic valves, intended for traction power supply.

The devices can be controlled by means of current, voltage or light. Non-bistable devices are assumed to be operated in the switched mode.

This Standard applies to fixed installations of following electric traction systems:

– railways,
– guided mass transport systems such as: tramways, light rail systems, elevated and underground railways, mountain railways, trolleybusses.

This Standard does not apply to

– cranes, transportable platforms and similar transportation equipment on rails,
– suspended cable cars,
– funicular railways.

This Standard applies to diode rectifiers, controlled rectifiers, inverters and frequency converters.

The equipment covered in this Standard is the converter itself.

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

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

IEC 60146 (all parts), *Semiconductor convertors*

IEC 60146-1-2:1991, *Semiconductor convertors – General requirements and line commutated convertors – Part 1-2: Application guide*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60721 (all parts), *Classification of environmental conditions*

IEC 60850:2007, *Railway applications – Supply voltages of traction systems*

IEC 61000-2-4:2002, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances*

IEC 61000-2-12:2003, *Electromagnetic compatibility (EMC) – Part 2-12: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems*

IEC 61992-7-1:2006, *Railway applications – Fixed installations – DC switchgear – Part 7-1: Measurement, control and protection devices for specific use in d.c. traction systems – Application guide*

IEC 62236 (all parts), *Railway applications – Electromagnetic compatibility*

IEC 62236-5:2008, *Railway applications – Electromagnetic compatibility – Part 5: Emission and immunity of fixed power supply installations and apparatus*

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

EN 50329:2003, *Railway applications – Fixed installations – Traction transformers*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. In this standard, IEV definitions are used wherever possible, particularly those in IEC 60050-551.

The policy adopted is as follows:

a) when a suitable IEV definition exists, the term and the reference are given without repeating the text;

b) when an existing IEV definition needs amplification or additional information, the term, the reference and the additional text are given;

c) when no IEV definition exists, the term and the text are given.

An alphabetical index is given in Annex C.

3.1 Semiconductor devices and combinations

3.1.1
semiconductor device
device whose essential characteristics are due to the flow of charge carriers within a semiconductor

3.1.2
(valve device) stack
[IEV 551-14-12]

3.1.3
(valve device) assembly
[IEV 551-14-13]

3.1.4
electronic power converter
operative unit for power conversion comprising one or more assemblies of semiconductor devices

[IEV 551-12-01, modified]