

This is a preview - click here to buy the full publication



IEC 62590

Edition 2.0 2019-08

# INTERNATIONAL STANDARD

---

**Railway applications – Fixed installations – Electronic power converters for substations**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 45.060.01

ISBN 978-2-8322-7066-0

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## 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 .....	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 .....	17
3.9 Definitions related to virtual junction temperature .....	18
3.10 Cooling .....	18
3.11 Electromagnetic compatibility and harmonic distortion .....	19
4 Symbols .....	19
5 Operation of semiconductor power equipment and valve devices .....	21
5.1 Classification of traction supply power converters and valves .....	21
5.1.1 Types of traction supply power converters .....	21
5.1.2 Purpose of conversion .....	21
5.1.3 Classification of semiconductor valve devices .....	21
5.2 Basic calculation factors for line commutated converters .....	22
5.2.1 Voltage .....	22
5.2.2 Voltage characteristics and transition current .....	22
6 Service conditions .....	23
6.1 Code of identification of cooling method .....	23
6.1.1 Letter symbols to be used .....	23
6.1.2 Arrangement of letter symbols .....	24
6.2 Environmental conditions .....	24
6.2.1 Ambient air circulation .....	24
6.2.2 Normal service conditions .....	25
6.2.3 Special service conditions .....	26
6.3 Electrical service conditions .....	26
6.3.1 General .....	26
6.3.2 Limiting values as basis of rating .....	26
6.3.3 DC traction supply voltage .....	28
7 Converter equipment and assemblies .....	28
7.1 Losses and efficiency .....	28
7.1.1 General .....	28
7.1.2 Included losses .....	28
7.2 Power factor .....	28
7.3 Electromagnetic compatibility (EMC) .....	29
7.4 Rated values for converters .....	29
7.4.1 General .....	29

7.4.2	Current values .....	29
7.4.3	Capability for unsymmetrical load of a 12-pulse converter in parallel connection .....	31
7.4.4	Semiconductor device failure conditions .....	32
7.5	Mechanical characteristics .....	32
7.5.1	General .....	32
7.5.2	Earthing .....	32
7.5.3	Degree of protection .....	33
7.6	Insulation coordination .....	33
7.7	Specifics of line commutated rectifiers .....	33
7.7.1	Electrical connections .....	33
7.7.2	Calculation factors .....	35
7.7.3	Direct voltage harmonic content .....	35
8	Tests .....	35
8.1	General .....	35
8.1.1	Overview .....	35
8.1.2	Performance of tests .....	36
8.1.3	Test schedule .....	36
8.2	Test specifications .....	36
8.2.1	Insulation tests .....	36
8.2.2	Light load functional test .....	38
8.2.3	Load test .....	38
8.2.4	Power loss determination .....	39
8.2.5	Temperature-rise test .....	39
8.2.6	Checking of auxiliary devices .....	40
8.2.7	Checking of the properties of the control equipment .....	40
8.2.8	Checking of the protective devices .....	41
8.2.9	Short-time withstand current test .....	41
8.2.10	EMC test .....	41
8.2.11	Additional tests .....	41
9	Marking .....	41
9.1	Rating plate .....	41
9.2	Main circuit terminals .....	42
Annex A (informative)	Information required .....	43
A.1	General .....	43
A.2	Diode rectifiers .....	43
A.2.1	Procurement specification .....	43
A.2.2	Supplier's tender specification .....	44
A.2.3	Information and data to be given by the supplier during the delivery stage .....	44
A.3	Controlled converters and inverters .....	45
A.3.1	Procurement specification .....	45
A.3.2	Supplier's tender specification .....	46
A.4	Frequency converters (direct and DC link converters) .....	46
A.4.1	Procurement specification .....	46
A.4.2	Supplier's tender specification .....	47
A.5	DC converters .....	48
A.5.1	Procurement specification .....	48
A.5.2	Supplier's tender specification .....	49

Annex B (informative) Determination of the current capability through calculation of the virtual junction temperature.....	51
B.1 General.....	51
B.2 Approximation of the shape of power pulses applied to the semiconductor device.....	51
B.3 Superposition method for the calculation of temperature.....	52
B.4 Calculation of virtual junction temperature for continuous load.....	53
B.4.1 General.....	53
B.4.2 Calculation of mean value of virtual junction temperature.....	53
B.4.3 Calculation of maximum instantaneous virtual junction temperature.....	53
B.5 Calculation of virtual junction temperature for cyclic loads.....	54
B.6 Examples for typical applications.....	55
Annex C (informative) Index of definitions.....	57
Bibliography.....	59
Figure 1 – Illustration of angles.....	14
Figure 2 – Voltage regulation.....	23
Figure 3 – AC voltage waveform.....	27
Figure B.1 – Approximation of the shape of power pulses.....	52
Figure B.2 – Calculation of the virtual junction temperature for continuous load.....	53
Figure B.3 – Calculation of the virtual junction temperature for cyclic load.....	54
Table 1 – Letter symbols for cooling mediums and heat transfer agents.....	23
Table 2 – Letter symbols for methods of circulation.....	23
Table 3 – Standardized duty classes.....	30
Table 4 – Semiconductor device failure conditions.....	32
Table 5 – Insulation levels for AC/DC and DC converters.....	33
Table 6 – Connections and calculation factors for line commutated converters.....	34
Table 7 – Summary of tests.....	36
Table 8 – Insulation levels for AC/DC and DC converters.....	38
Table B.1 – Examples for typical applications.....	55

## 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.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Incorporation of DC converters.
- b) Correction of the clearances and withstand voltages due to erroneous use of PD in former edition.
- c) Adaption to current ISO/IEC directive part 2, adaption of structure, adaption of vocabulary, removal of unused term and abbreviations.

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

FDIS	Report on voting
9/2502/FDIS	9/2516/RVD

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

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

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

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

A bilingual version of this publication may be issued at a later date.

## 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 IEC 62695.

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 document 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 document applies to fixed installations of the following electric traction systems:

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

This document does not apply to:

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

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

The equipment covered in this document is the converter itself.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-811:2017, *International electrotechnical vocabulary – Part 811: Electric traction*

IEC 60146 (all parts), *Semiconductor convertors*

IEC TR 60146-1-2:2011, *Semiconductor converters – General requirements and line commutated converters – 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 60721-3-3:1994, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 3: Stationary use at weatherprotected locations*

AMD1:1995

AMD2:1996



IEC 60721-3-4:1995, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 4: Stationary use at non-weatherprotected locations*  
AMD1:1996

IEC 60850:2014, *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 DC traction systems – Application guide*

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

IEC 62236-5:2018, *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*