IEC 62590

Edition 2.0 2019-08

INTERNATIONAL STANDARD

Railway applications - Fixed installations - Electronic power converters for substations

ICS 45.060.01

ISBN 978-2-8327-0982-5

IEC 62590:2019-08(en)

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, trolleybusses.

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

Bibliography

IEC 60050-151:2001, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*

IEC 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

IEC 60050-521:2002, *International Electrotechnical Vocabulary (IEV) – Part 521: Semiconductor devices and integrated circuits*

IEC 60050-601:1985, *International Electrotechnical Vocabulary (IEV) – Chapter 601: Generation, transmission and distribution of electricity – General*

IEC 60146-2:1999, *Semiconductor converters – Part 2: Self-commutated semiconductor converters including direct d.c. converters*

IEC 60747 (all parts), *Semiconductor devices*

IEC 62589:2010, *Railway applications – Fixed installations – Harmonisation of the rated values for converter groups and tests on converter groups*

IEC 62695:2014, *Railway applications – Fixed installations – Traction transformers*

_____