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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Fixed installations – Electronic power converters for substations

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

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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.
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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- withdrawn,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]

3.1.5
trigger equipment (gating equipment)
equipment which provides suitable trigger pulses from a control signal for controllable valve devices in a converter or power switch including timing or phase shifting circuits, pulse generating circuits and usually power supply circuits

3.1.6
system control equipment
equipment associated with a converter equipment or system which performs automatic adjustment of the output characteristics as a function of a controlled quantity

3.2 Arms and connections

3.2.1
(valve) arm
[IEV 551-15-01]

3.2.2
principal arm
[IEV 551-15-02]

3.2.3
converter connection
[IEV 551-15-10]

3.2.4
basic converter connection
[IEV 551-15-11]

3.2.5
single-way connection (of a converter)
[IEV 551-15-12]

3.2.6
double-way connection (of a converter)
[IEV 551-15-13]

3.2.7
uniform connection
[IEV 551-15-15]

3.2.8
non-uniform connection
[IEV 551-15-18]

3.2.9
series connection
connection in which two or more converters are connected in such a way that their voltages add

3.2.10
boost and buck connection
series connection in which the converters are controlled independently

[IEV 551-15-21, modified]

3.2.11
parallel connection
connection in which two or more converters are connected in such a way that their currents add

3.3 Controllability of converter arms and quadrants of operation

3.3.1
controllable arm
converter arm including controllable semiconductor element(s) as valve device(s)

3.3.2
non-controllable arm
converter arm including non-controllable semiconductor element(s) as valve device(s)

3.3.3
quadrant of operation (on the d.c. side)
quadrant of the voltage current plane defined by the d.c. voltage polarity and the current direction

3.3.4
one quadrant converter
[IEV 551-12-34]

3.3.5
two quadrant (single) converter
[IEV 551-12-35]

3.3.6
four quadrant (double) converter
[IEV 551-12-36]

3.3.7
reversible converter
[IEV 551-12-37]

3.3.8
single converter
[IEV 551-12-38]

3.3.9
double converter
[IEV 551-12-39]

3.3.10
converter section of a double converter
[IEV 551-12-40]

3.4 Commutation, quenching and commutation circuitry

3.4.1
commutation
transfer of current from one conducting arm to the next to conduct in sequence, without interruption of the d.c. current. During a finite interval of time both arms are conducting simultaneously

[IEV 551-16-01, modified]

3.4.2
quenching
[IEV 551-16-19]

3.4.3
direct commutation
[IEV 551-16-09]

3.4.4
indirect commutation
[IEV 551-16-10]

3.4.5
external commutation
[IEV 551-16-11]

3.4.6
line commutation
[IEV 551-16-12]

3.4.7
load commutation
[IEV 551-16-13]

3.4.8
self commutation
[IEV 551-16-15]

3.5 Commutation characteristics

3.5.1
commutation circuit
[IEV 551-16-03]

3.5.2
commutating voltage
[IEV 551-16-02]

3.5.3
commutation inductance
total inductance included in the commutation circuit, in series with the commutating voltage

[IEV 551-16-07, modified]

NOTE For line or machine commutated converters the commutation reactance is the impedance of the commutation inductance at the fundamental frequency.

3.5.4
angle of overlap *u*
duration of the commutation interval between a pair of principal arms, expressed in angular measure, where the two arms carry current

[IEV 551-16-05, modified]

3.5.5
commutation notch
periodic voltage transient that can appear in the a.c. voltage of a line or machine-commutated converter due to commutation

[IEV 551-16-06, modified]

3.5.6
commutation repetitive transient
voltage oscillation associated with the commutation notch

3.5.7
commutating group
[IEV 551-16-08]

3.5.8
commutation number q
number of commutations from one principal arm to another, occurring during one period of the alternating voltage in each commutating group

[IEV 551-17-03, modified]

3.5.9
pulse number p
number of non-simultaneous symmetrical direct or indirect commutations from one principal arm to another, during one period of the alternating voltage

[IEV 551-17-01, modified]

3.5.10
trigger delay angle α
time expressed in angular measure by which the trigger pulse is delayed with respect to the reference instant (see Figure 1)

For line, machine or load commutated converters the reference instant is the zero crossing instant of the commutating voltage.

For a.c. controllers it is the zero crossing instant of the supply voltage.

For a.c. controllers with inductive load, the trigger delay angle is the sum of the phase shift and the current delay angle

[IEV 551-16-33, modified]