Irish Standard
I.S. EN 60146-1-1:2010

Semiconductor converters - General requirements and line commutated converters -- Part 1-1: Specification of basic requirements (IEC 60146-1 -1:2009 (EQV))

I.S. EN 60146-1-1:2010

Incorporating amendments/corrigenda issued since publication:

The National Standards Authority of Ireland (NSAI) produces the following categories of formal documents:

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SWiFT xxx: A rapidly developed recommendatory document based on the consensus of the participants of an NSAI workshop.

This document replaces:	*This document is based on:*	*Published:*
EN 60146-1-1:1993	EN 60146-1-1:2010 EN 60146-1-1:1993	9 July, 2010 10 February, 1993

This document was published under the authority of the NSAI and comes into effect on:

19 July, 2010

ICS number:
29.200
29.045

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I.S. EN 60146-1-1:2010

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60146-1-1

July 2010

ICS 29.200;29.045

Supersedes EN 60146-1-1:1993 + A1:1997

English version

Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements

(IEC 60146-1-1:2009)

Convertisseurs à semiconducteurs - Exigences générales et convertisseurs commutés par le réseau - Partie 1-1: Spécification des exigences de base (CEI 60146-1-1:2009)

Halbleiter-Stromrichter - Allgemeine Anforderungen und netzgeführte Stromrichter - Teil 1-1: Festlegung der Grundanforderungen (IEC 60146-1-1:2009)

This European Standard was approved by CENELEC on 2010-07-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Ref. No. EN 60146-1-1:2010 E

Foreword

The text of document 22/146/FDIS, future edition 4 of IEC 60146-1-1, prepared by IEC TC 22, Power electronic systems and equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60146-1-1 on 2010-07-01.

This European Standard supersedes EN 60146-1-1:1993 + A1:1997.

This EN 60146-1-1:200X introduces five main changes:

a) re-edition of the whole standard according to the current directives;

b) correction of definitions and addition of new terms, especially terms concerning EMC, harmonic distortion and insulation co-ordination;

c) the service condition tolerances have been revised according to the EN 61000 series;

d) the insulation tests have been revised considering the insulation co-ordination;

e) addition of three annexes.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-04-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-07-01

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60146-1-1:2009 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60071-1	NOTE	Harmonized as EN 60071-1.
IEC 60071-2	NOTE	Harmonized as EN 60071-2.
IEC 60076-1	NOTE	Harmonized as EN 60076-1.
IEC 60146-1-3	NOTE	Harmonized as EN 60146-1-3.
IEC 60146-2	NOTE	Harmonized as EN 60146-2.
IEC 60664-3	NOTE	Harmonized as EN 60664-3.
IEC 60664-4	NOTE	Harmonized as EN 60664-4.
IEC 60664-5	NOTE	Harmonized as EN 60664-5.
IEC 61287-1	NOTE	Harmonized as EN 61287-1.
IEC 61378-1	NOTE	Harmonized as EN 61378-1.

IEC 61378-2	NOTE	Harmonized as EN 61378-2.
IEC 61439-1	NOTE	Harmonized as EN 61439-1.
IEC/TR 61800-6	NOTE	Harmonized as CLC/TR 61800-6.
IEC 62068-1	NOTE	Harmonized as EN 62068-1.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-101	1998	International Electrotechnical Vocabulary (IEV) - Part 101: Mathematics	-	-
IEC 60050-551	1998	International Electrotechnical Vocabulary (IEV) - Part 551: Power electronics	-	-
IEC 60050-551-20	2001	International Electrotechnical Vocabulary - Part 551-20: Power electronics - Harmonic analysis	-	-
IEC 60364-1	-	Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions	HD 60364-1	-
IEC 60529	-	Degrees of protection provided by enclosures (IP Code)	EN 60529	-
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC 60700-1	-	Thyristor valves for high voltage direct current (HVDC) power transmission - Part 1: Electrical testing	EN 60700-1	-
IEC 61000	Series	Electromagnetic compatibility (EMC)	EN 61000	Series
IEC 61000-2-2	2002	Electromagnetic compatibility (EMC) - Part 2-2: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems	EN 61000-2-2	2002
IEC 61000-2-4	2002	Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances	EN 61000-2-4	2002
IEC 61000-3-2	-	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)	EN 61000-3-2	-

Publication	Year	Title	EN/HD	Year
IEC 61000-3-3	-	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection	EN 61000-3-3	-
IEC 61000-3-11	-	Electromagnetic compatibility (EMC) - Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current ≤ 75 A and subject to conditional connection	EN 61000-3-11	-
IEC 61000-3-12	2004	Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase	EN 61000-3-12	2005
IEC 61000-4-7	-	Electromagnetic compatibility (EMC) - Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto	EN 61000-4-7	-
IEC 61000-6-1	-	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments	EN 61000-6-1	-
IEC 61000-6-2	-	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments	EN 61000-6-2	-
IEC 61000-6-3	-	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments	EN 61000-6-3	-
IEC 61000-6-4	-	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments	EN 61000-6-4	-
IEC 61140	-	Protection against electric shock - Common aspects for installation and equipment	EN 61140	-
IEC 61180-1	1992	High-voltage test techniques for low-voltage equipment - Part 1: Definitions, test and procedure requirements	EN 61180-1	1994
IEC 61204-3	-	Low-voltage power supplies, d.c. output - Part 3: Product EMC standard	EN 61204-3	-
IEC 61204-7	-	Low voltage power supplies, d.c. output - Part 7: Safety requirements	EN 61204-7	-
IEC 61800-3	-	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods	EN 61800-3	-

Publication	Year	Title	EN/HD	Year
IEC 61800-5-1	-	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy	EN 61800-5-1	-
IEC 61954	-	Power electronics for electrical transmission and distribution systems - Testing of thyristor valves for static VAR compensators	EN 61954	-
IEC/PAS 61975	-	System tests for high-voltage direct current (HVDC) installations	-	-
IEC 62040-1	-	Uninterruptible Power Systems (UPS) - Part 1: General and safety requirements for UPS	EN 62040-1	-
IEC 62040-2	-	Uninterruptible power systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements	EN 62040-2	-
IEC 62103	-	Electronic equipment for use in power installations	-	-
IEC 62310-1	-	Static transfer systems (STS) - Part 1: General and safety requirements	EN 62310-1	-
IEC 62310-2	-	Static transfer systems (STS) - Part 2: Electromagnetic compatibility (EMC) requirements	EN 62310-2	-

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR CONVERTERS – GENERAL REQUIREMENTS AND LINE COMMUTATED CONVERTERS –

Part 1-1: Specification of basic requirements

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 60146-1-1 has been prepared by IEC technical committee 22: Power electronic systems and equipment.

This fourth edition cancels and replaces the third edition published in 1991, Corrigendum 1 (1993) and Amendment 1 (1996). This fourth edition constitutes a technical revision.

This fourth edition introduces five main changes:

a) re-edition of the whole standard according to the current directives;
b) correction of definitions and addition of new terms, especially terms concerning EMC, harmonic distortion and insulation co-ordination;
c) the service condition tolerances have been revised according to the IEC 61000 series;
d) the insulation tests have been revised considering the insulation co-ordination;
e) addition of three annexes.

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

FDIS	Report on voting
22/146/FDIS	22/149/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 main purposes of the IEC 60146-1 series are as follows.

Part 1-1, IEC 60146-1-1, Specification of basic requirements:

– to establish basic terms and definitions;
– to specify service conditions which influence the basis of rating;
– to specify test requirements for electronic power converters and assemblies, standard design, (for special design, see IEC/TR 60146-1-2);
– to specify basic performance requirements;
– to give application oriented requirements for semiconductor power converters.

Part 1-2, IEC/TR 60146-1-2, Application guide:

– to give additional information on test conditions and components (for example: semiconductor valve devices), when required for their use in semiconductor power converters, in addition to or as a modification on existing standards;
– to provide useful reference, calculation factors, formulae and diagrams pertaining to power converter practice.

Part 1-3, IEC 60146-1-3, Transformers and reactors:

– to give additional information on characteristics wherein converter transformers differ from ordinary power transformers. In all other respects, the rules specified in IEC 60076 shall apply to converter transformers, insofar as they are not in contradiction with this International Standard.

A list of all parts of the IEC 60146 series, under the general title: *Semiconductor converters*, can be found on the IEC website.

The committee has decided that the contents of this publication 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.

SEMICONDUCTOR CONVERTERS – GENERAL REQUIREMENTS AND LINE COMMUTATED CONVERTERS –

Part 1-1: Specification of basic requirements

1 Scope and object

This International Standard specifies the requirements for the performance of all semiconductor power converters and semiconductor power switches using controllable and/or non-controllable electronic valve devices.

The electronic valve devices mainly comprise semiconductor devices, either not controllable (i.e. rectifier diodes) or controllable (i.e. thyristors, triacs, turn-off thyristors and power transistors). The controllable devices may be reverse blocking or reverse conducting and controlled by means of current, voltage or light. Non-bistable devices are assumed to be operated in the switched mode.

This standard is primarily intended to specify the basic requirements for converters in general and the requirements applicable to line commutated converters for conversion of a.c. power to d.c. power or vice versa. Parts of this standard are also applicable to other types of electronic power converter provided that they do not have their own product standards.

These specific equipment requirements are applicable to semiconductor power converters that either implement power conversion or use commutation (for example semiconductor self-commutated converters) or involve particular applications (for example semiconductor converters for d.c. motor drives) or include a combination of said characteristics (for example direct d.c. converters for electric rolling stock).

This standard is applicable to all power converters not covered by a dedicated product standard, or if special features are not covered by the dedicated product standard. Dedicated product standards for power converters should refer to this International Standard.

NOTE 1 This standard is not intended to define EMC requirements. It covers all phenomena and therefore introduces references to dedicated standards which are applicable according to their scope.

NOTE 2 A large part of this standard, particularly for power transformers, is covered in IEC 61378-1.

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 60050-101:1998, *International Electrotechnical Vocabulary – Part 101: Mathematics*

IEC 60050-551:1998, *International Electrotechnical Vocabulary – Part 551: Power electronics*

IEC 60050-551-20:2001, *International Electrotechnical Vocabulary – Part 551-20: Power electronics – Harmonic analysis*

IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

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