

Semiconductor converters —

Part 2: Self-commutated semiconductor converters including direct d.c. converters

The European Standard EN 60146-2:2000 has the status of a
British Standard

ICS 29.200

National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/22, Power electronics, which has the responsibility to:

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Convertisseurs à semiconducteurs
Partie 2: Convertisseurs autocommutés
à semiconducteurs y compris les
convertisseurs à courant continu directs
(CEI 60146-2:1999)

Halbleiter-Stromrichter
Teil 2: Selbstgeführte
Halbleiter-Stromrichter einschließlich
Gleichstrom-Direktumrichter
(IEC 60146-2:1999)

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European Committee for Electrotechnical Standardization
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Foreword

The text of document 22B/126/FDIS, future edition 2 of IEC 60146-2, prepared by SC 22B, Semiconductor converters, of IEC TC 22, Power electronics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60146-2 on 2000-01-01.

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Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annex A is informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60146-2:1999 was approved by CENELEC as a European Standard without any modification.

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SEMICONDUCTOR CONVERTERS –

Part 2: Self-commutated semiconductor converters including direct d.c. converters

1 Scope

This part of IEC 60146 applies to all types of semiconductor converters of the self-commutated type including power converters which contain at least one part of a self-commutated type, for example a.c. converters, indirect d.c. converters, direct d.c. converters.

The requirements of IEC 60146-1-1 apply also to self-commutated converters as far as they are not in contradiction with this standard. For some special applications, for example, uninterruptible power systems, variable speed a.c. and d.c. drives and electric traction equipment, additional standards may apply.

NOTE Test restrictions may apply to special applications, for example high-power reactive power converters.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60146. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60146 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

IEC 60050-101:1998, *International Electrotechnical Vocabulary (IEV) – Part 101: Mathematics*

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electro-magnetic compatibility*

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

IEC 60146-1-1:1991, *Semiconductor converters – General requirements and line commutated converters – Part 1-1: Specifications of basic requirements*
Amendment 2¹⁾

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

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

¹⁾ To be published.

IEC 60747-1:1983, *Semiconductor devices – Discrete devices – Part 1: General*
Amendment 3 (1996)

IEC 61000-2-2:1990, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 2: Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-2-4:1994, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 4: Compatibility levels in industrial plants for low-frequency conducted disturbances*

IEC 61000-4 (all parts), *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques*

IEC 61010-1:1990, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
Amendment 1 (1992)

3 Definitions

For the purpose of this part of IEC 60146, the terms and definitions given in IEC 60146-1-1, in IEC 60050-551 (some of which are repeated below for convenience) and the following apply.

3.1 Functions of converters

3.1.1

(electronic) (power) conversion

change of one or more of the characteristics of an electric power system essentially without appreciable loss of power by means of electronic valve devices

[IEV 551-11-02]

NOTE Characteristics are, for example, voltage, number of phases and frequency including zero frequency.

3.1.2

(electronic) a.c./d.c. (power) conversion

electronic conversion from a.c. to d.c. or vice versa

[IEV 551-11-05]

3.1.3

(electronic) (power) rectification

electronic conversion from a.c. to d.c.

[IEV 551-11-06]

3.1.4

(electronic) (power) inversion

electronic conversion from d.c. to a.c.

[IEV 551-11-07]

3.1.5

(electronic) a.c. (power) conversion

electronic conversion from a.c. to a.c.

[IEV 551-11-08]

3.1.6

(electronic) d.c. (power) conversion

electronic conversion from d.c. to d.c.

[IEV 551-11-09]

3.1.7

direct (power) conversion

electronic conversion without a d.c. or a.c. link

[IEV 551-11-10]

3.1.8

indirect (power) conversion

electronic conversion with one or more d.c. or a.c. link(s)

[IEV 551-11-11]

3.1.9

commutation

in an electronic power converter the transfer of current from one conducting arm to the next to conduct in sequence, without interruption of the current, both arms conducting simultaneously during a finite time interval

[IEV 551-16-01]

3.1.10

commutating voltage

the voltage which causes the current to commute

[IEV 551-16-02]

3.1.11

line commutation

an external commutation where the commutating voltage is supplied by the line

[IEV 551-16-12]

3.1.12

self-commutation

a commutation where the commutating voltage is supplied by components within the converter or the electronic switch

[IEV 551-16-15]

3.1.13

phase control

the process of varying the instant within the cycle at which current conduction in an electronic valve device or a valve arm begins

[IEV 551-16-23]

3.1.14

pulse control

the process of varying the starting or termination instants or both of a repeated current conduction in a principal arm

[IEV 551-16-27]

3.1.15

pulse duration control

pulse control at variable pulse duration and fixed frequency

[IEV 551-16-28]

3.1.16

pulse frequency control

pulse control at variable frequency and fixed pulse duration

[IEV 551-16-29]

3.1.17

pulse width modulation control

PWM control (abbreviation)

pulse control in which the pulse width or frequency or both are modulated within each fundamental period to produce a certain output waveform

[IEV 551-16-30]

3.1.18

triggering

the control action to achieve firing of a latching valve device or an arm consisting of such devices

[IEV 551-16-61]

3.1.19

firing

the establishment of current in the conducting direction in a latching valve device or an arm consisting of such devices

[IEV 551-16-62]

3.2 Types of converters

3.2.1

(electronic) (power) converter

an operative unit for electronic power conversion, comprising one or more electronic valve devices, transformers and filters if necessary and auxiliaries if any

[IEV 551-12-01]

3.2.2

self-commutated converter

a converter in which at least one part uses self-commutation

NOTE Similar terms are used for specific kinds of self-commutated converters, for example self-commutated a.c./d.c. converter, self-commutated inverter, etc., if the property of self-commutation is to be emphasized.

3.2.3

a.c./d.c. converter

an electronic converter for rectification or inversion or both

[IEV 551-12-02]

3.2.4

voltage stiff a.c./d.c. converter

an electronic a.c./d.c. converter having an essentially smooth voltage on the d.c. side provided e.g. by a low impedance path for the harmonic currents

[IEV 551-12-03]

3.2.5

current stiff a.c./d.c. converter

an electronic a.c./d.c. converter having an essentially smooth current on the d.c. side provided e.g. by means to reduce the harmonic currents

[IEV 551-12-04]

3.2.6

rectifier

an a.c./d.c. converter for rectification

[IEV 551-12-07]

3.2.7

inverter

an a.c./d.c. converter for inversion

[IEV 551-12-10]

3.2.8

voltage source inverter

voltage fed inverter

a voltage stiff inverter

[IEV 551-12-11]

3.2.9

current source inverter

current fed inverter

a current stiff inverter

[IEV 551-12-12]

3.2.10

line-interactive converter

a.c./d.c. converter operating in parallel to the line to condition the energy supplied to one or more power consumer(s) or reversely by absorbing, storing and/or refeeding energy

3.2.11

reactive power converter

a converter for reactive power compensation that generates or consumes reactive power without the flow of active power except for the power losses in the converter

[IEV 551-12-15]

3.2.12

a.c. converter

a converter for a.c. conversion

[IEV 551-12-17]

3.2.13

direct a.c. converter

an a.c. converter without a d.c. link

[IEV 551-12-18]

3.2.14

indirect a.c. converter

an a.c. converter with a d.c. link

[IEV 551-12-19]

3.2.15

d.c. converter

a converter for d.c. conversion

[IEV 551-12-27]

3.2.16

direct d.c. converter

d.c. chopper

a d.c. converter without an a.c. link

[IEV 551-12-28]

3.2.17

indirect d.c. converter

a d.c. converter with an a.c. link

[IEV 551-12-29]

3.3 Converter circuit components

3.3.1

electronic device

a device the function of which is based on charge carriers moving through a semiconductor, a high vacuum or a gas discharge

[IEV 551-14-01]

3.3.2

electronic valve device

an indivisible electronic device for electronic power conversion or electronic power switching, comprising a single non-controllable or bistably controlled unidirectionally conducting current path

NOTE 1 Typical electronic valve devices are thyristors, power rectifier diodes, power switching bipolar and field effect transistors and insulated-gate bipolar transistors (IGBTs).

NOTE 2 Two or more electronic valve devices may be integrated on a common semiconductor chip (examples: a thyristor and a rectifier diode in a reverse conducting thyristor, a power switching field effect transistor with its inverse diode) or packaged in a common case (semiconductor power module). These combinations are to be considered as consisting of separate electronic valve devices.

[IEV 551-14-02]

3.3.3

valve device stack

a single structure of one or more electronic valve devices with its (their) associated mounting(s) and auxiliaries if any

[IEV 551-14-12]

3.3.4

valve device assembly

an electrically and mechanically combined assembly of electronic valve devices or stacks, completed with all its connections and auxiliaries in its own mechanical structure

NOTE Similar terms are applied to stacks and assemblies comprising specific electronic valve devices, e.g. diode stack (rectifier diodes only), thyristor assembly (thyristors only or in combination with rectifier diodes).

[IEV 551-14-13]

3.3.5

converter assembly

electrical and mechanical arrangement of arms and other components essential for the function of the main power circuit of a converter, especially the d.c. link capacitors, reactors and gate drivers. Usually the control equipment is not included

3.3.6

(valve) arm

a part of the circuit of an electronic power converter or switch bounded by any two a.c. or d.c. terminals and including one or more simultaneously conducting electronic valve devices connected together and other components if any

[IEV 551-15-01]

3.3.7

snubber (circuit)

a subcircuit connected to one or more electronic valve devices in order to relieve it (them) of stress as for instance overvoltage transients, switching losses, high rate of rise of current or voltage, etc.

NOTE Specified terms as for instance RC snubber, parallel snubber, a.c. side snubber, etc. are in use.

[IEV 551-14-17]

3.4 Important properties of converters and electronic valve devices

3.4.1

fundamental power

the active power determined by the fundamental components of voltage and current

[IEV 551-17-08]

3.4.2

d.c. power

the product of the direct voltage and the direct current (mean values)

[IEV 551-17-09]

3.4.3

conversion factor (in general)

the ratio of the fundamental output active power or d.c. output power to the fundamental input active power or d.c. input power

[IEV 551-17-10]

3.4.4

total power factor

ratio of the active power to the apparent power

[IEC 60146-1-1:1991, definition 1.5.26.1]

3.4.5

displacement factor

ratio of the active power of the fundamental components to the apparent power of the fundamental components

[IEC 60146-1-1:1991, definition 1.5.26.2]

3.4.6

deformation factor

ratio of the total power factor to the displacement factor

[IEC 60146-1-1:1991, definition 1.5.26.3 modified]

3.4.7

(power) efficiency

ratio of the output active power to the input active power of the converter

[IEC 60146-1-1:1991, definition 1.5.24.2]

3.4.8

virtual junction temperature (of an electronic valve device)

virtual temperature of the junction of a semiconductor device

[IEC 60747-1, amendment 3, definition 5.2.5]

3.4.9

transient thermal impedance (of an electronic valve device)

generic term denoting the quotient of

- 1) the change in temperature difference between two specified points or regions at the end of a time interval
by
- 2) the step-function change in power dissipation beginning at that time interval and causing the change in temperature difference

[IEC 60747-1, amendment 3, definition 5.3.7]

3.5 Disturbances and electromagnetic compatibility

3.5.1

electrical disturbance

any variation of an electrical quantity, beyond specified limits, which may be the cause of a loss of performance or an interruption of service or damage

[IEC 60146-1-1:1991, definition 1.5.31]