

Semiconductor power convertors — Adjustable speed electric drive systems — General requirements —

Part 1: Rating specifications, particularly for d.c. motor drives

The European Standard EN 61136-1:1995 has the status of a
British Standard

ICS 29.200

National foreword

This British Standard is the English language version of EN 61136-1:1995. It was derived by CENELEC from IEC 1136-1:1992.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a sideline in the margin.

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

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 35 and a back cover.

Amendments issued since publication

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English version

**Semiconductor power converters
Adjustable speed electric drive systems
General requirements - Part 1: Rating specifications,
particularly for d.c. motor drives
(IEC 1136-1:1992, modified)**

Convertisseurs de puissance à
semiconducteurs
Entraînements électriques à vitesse
variable - Prescriptions générales
Partie 1: Spécifications de
dimensionnement, en particulier
pour les entraînements à moteurs
à courant continu
(CEI 1136-1:1992, modifiée)

Halbleiter-Stromrichter
Regelbare elektrische Antriebssysteme
Allgemeine Anforderungen
Teil 1: Nennwerte, insbesondere für
Gleichstromantriebe
(IEC 1136-1:1992, modifiziert)

This European Standard was approved by CENELEC on 1994-10-04. 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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of the International Standard IEC 1136-1:1992, prepared by SC 22G: Semiconductor power convertors for adjustable speed electric drive systems, of IEC TC 22, Power electronics, together with the common modifications prepared by the German National Committee was submitted to the formal vote and approved by CENELEC as EN 61136-1 on 1994-10-04.

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) 1995-10-15
- latest date by which national standards conflicting
with the EN have to be withdrawn (dow) 1995-10-15

For products which have complied with the relevant national standard before 1995-10-15, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2000-10-15.

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 annexes A and B are informative.

Annex ZA has been added by CENELEC.

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SEMICONDUCTOR POWER CONVERTORS – ADJUSTABLE SPEED ELECTRIC DRIVE SYSTEMS – GENERAL REQUIREMENTS

Part 1: Rating specifications, particularly for d.c. motor drives

1 General

1.1 Scope and object

This International Standard provides alternative methods for specifying ratings for semiconductor power convertors for adjustable speed electric drive systems, particularly for d.c. motor drives.

It has been established with respect to, but is not restricted to, convertors of line- or machine-commutated type. It is not intended to cover adjustable speed drives for traction purposes.

This standard is an extension of, and an addition to, IEC 146. General information on convertors for adjustable speed d.c. motor drives is contained in IEC 146.

The term semiconductor, as used in this standard, principally means reverse blocking triode thyristor. When applicable, this standard also applies to convertors with other types of semiconductor devices (e.g. bi-directional thyristors).

1.2 Normative references

NOTE : Normative references to international publications are listed in annex ZA (normative).

IEC 146, *Semiconductor convertors*.

IEC 721, *Classification of environmental conditions*.

2 Definitions

For the purpose of this standard the relevant definitions given in IEC 146 apply. The following are additional definitions.

2.1 semiconductor convertor equipment (thyristor convertor unit or thyristor convertor): Functional unit for power conversion comprising one or more semiconductor assemblies together with convertor transformers, essential switching devices and other auxiliary equipment, if any. It may include the gating equipment.

2.2 *Classification of semiconductor convertors*

The following designations are intended to describe the functional characteristics of convertors, but not necessarily the circuits or components used.

NOTE - The figures refer only to the convertors. The rotational direction of motors may be changed by field or armature reversal.

2.3 reversible convertor: Convertor in which the flow of d.c. power is reversible.

2.4 non-reversible convertor: Convertor in which the flow of d.c. power is not reversible.

2.5 semi-convertor (one quadrant convertor): Non-reversible convertor for connection to a d.c. circuit in which there is only one possible voltage polarity and current direction (see figure 1).

2.6 single convertor: Reversible convertor connected to a d.c. circuit such that the direct current supplied by the convertor can only flow in one direction (see figure 2).

2.7 double convertor: Reversible convertor connected to a d.c. circuit such that energy can be accepted from or returned to the a.c. supply system and the direct current supplied by the convertor can flow in either direction (see figure 3).

A double convertor usually consists of two sections, one for each direction of current flow.

NOTE - The convertor sections may be supplied from common windings, from separate windings on a common transformer, or from separate transformers.

2.8 semiconductor convertor section: Those parts of a semiconductor convertor unit, containing the power semiconductors together with their auxiliaries (including individual fuses, individual transformers or windings and individual circulating current reactors if any), in which the main direct current when viewed from the convertor unit d.c. terminals always flows in the same direction.

A semiconductor convertor section is capable of operating as an independent unit but components such as fuses, reactors, snubbers and/or heat sinks may be common to the two sections.

2.8.1 forward section (of a double convertor unit): That portion of a semiconductor convertor which operates in voltage-current quadrants 1 and 4 (see figure 2).

2.8.2 reverse section (of a double convertor unit): That portion of a semiconductor convertor which operates in voltage-current quadrants 2 and 3 (see figure 3).

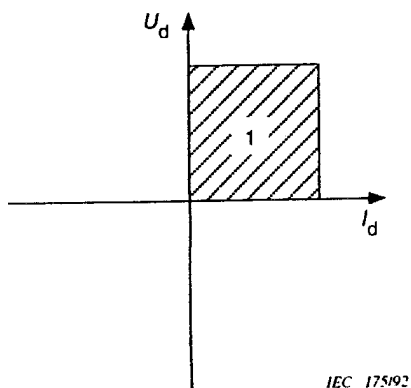


Figure 1 – Semi-converter in which the direct current can flow in one direction only and which is not capable of returning energy from the load to the alternating current supply.
This form of converter operates in quadrant 1 only.

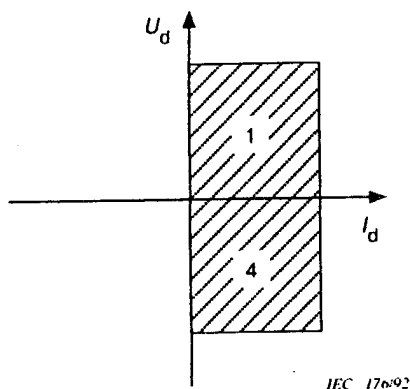


Figure 2 – Single converter in which the direct current can flow in one direction only and which is capable of returning energy from the load to the alternating current supply.
This form of converter operates in quadrants 1 and 4 only.

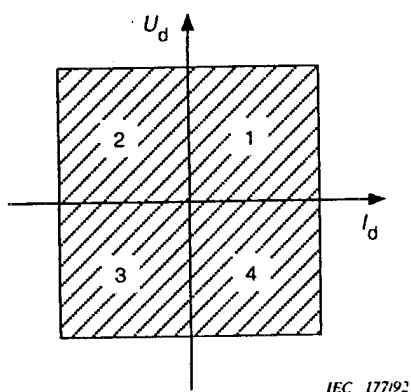


Figure 3 – Double converter in which the direct current can flow in either direction and which is capable of returning energy from the load to the alternating current supply.
This form of converter operates in quadrants 1, 2, 3 and 4.

NOTE - Quadrant 1 implies motoring torque in the agreed forward direction of motor rotation.

2.9 converter transformer: Main transformer equipment of a semiconductor converter including one or more transformers or transformer windings, used to provide the desired a.c. voltages and converter circuit configuration together with all the transformer auxiliary equipment.

2.10 common convertor transformer: Common transformer feeding two or more individual convertor assemblies which may be individually or simultaneously energized through common or separate windings.

2.11 equilibrium temperature: Steady-state temperature reached by a component of a convertor under specified conditions of load and cooling.

NOTE - Steady-state temperatures are in general different for different components. The times necessary to establish the steady state are also different and proportional to thermal time constants.

2.12 rated direct current (I_{dN}): Mean value of the direct current specified by the manufacturer for specified load and service conditions. It may be referred to as the base value to which other values of direct current are compared.

NOTE - Rated continuous direct current (I_{dNM}) as defined in IEC 146 is not always applicable to convertors for adjustable speed drives.

2.13 rated direct voltage: Specified value at rated direct current of the direct voltage between the d.c. terminals of the assembly or equipment. This is the mean value of the d.c. voltage.

2.14 rated a.c. voltage: The rated r.m.s. value of the a.c. supply voltage at the supply terminals of the convertor equipment, including the transformer if one is supplied. It may be referred to as the base value to which other values of a.c. supply voltage are compared.

2.15 current-time load chart: Record of load current with respect to time.

2.16 uniform load duty: Duty for which a convertor equipment carries a direct current of fixed value for an interval sufficiently long for the components of the convertor to reach equilibrium temperatures corresponding to the said value of current. Figure 4 illustrates this kind of duty.

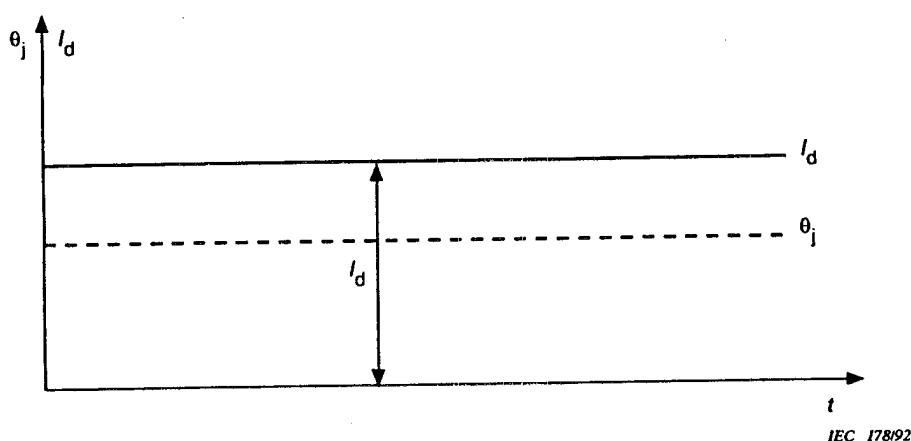


Figure 4 – Typical current-time chart for uniform load duty

2.17 Intermittent peak load duty: Type of duty for which loads of high magnitude and short duration are applied following no-load periods such that thermal equilibrium is reached between successive applications of the load. Figure 5 illustrates this type of duty.

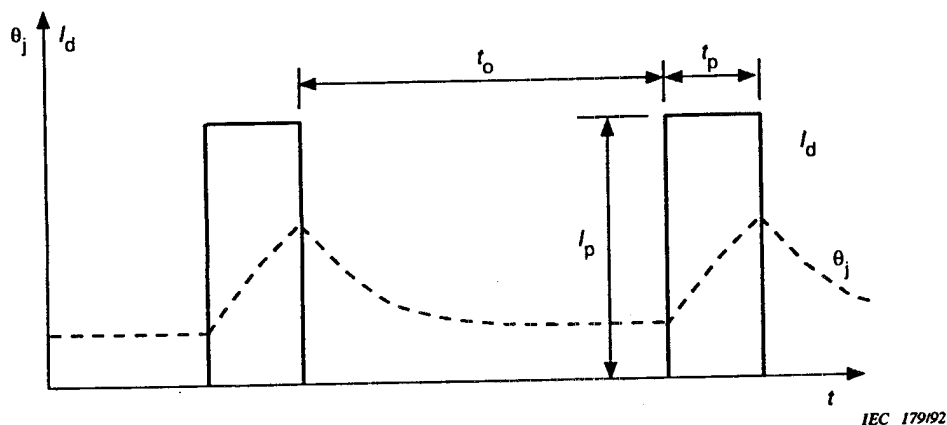


Figure 5 – Typical current-time chart for intermittent peak load duty

2.18 Intermittent load duty: Type of duty for which intermittent loads are superimposed onto a constant base load such that thermal equilibrium is reached between successive applications of the intermittent load. Figure 6 illustrates this type of duty.

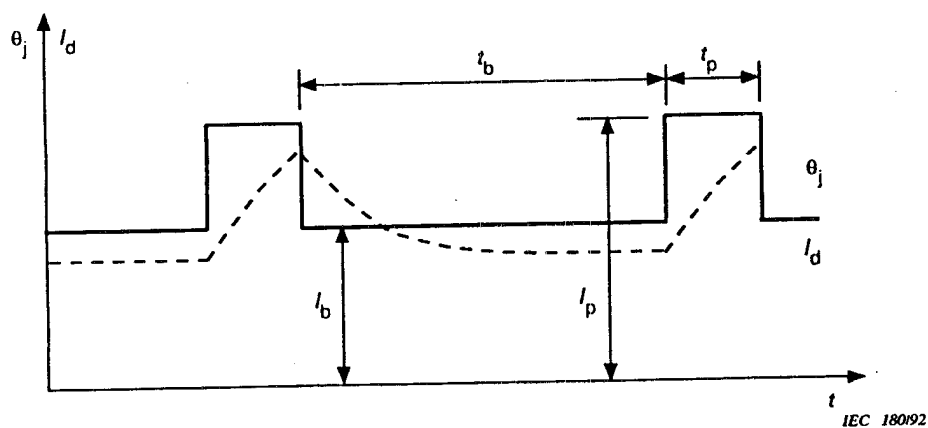


Figure 6 – Typical current-time chart for intermittent load duty

2.19 repetitive load duty: Type of duty for which loads are cyclically variable such that thermal equilibrium is not reached within the cycle period. Figure 7 illustrates this type of duty.

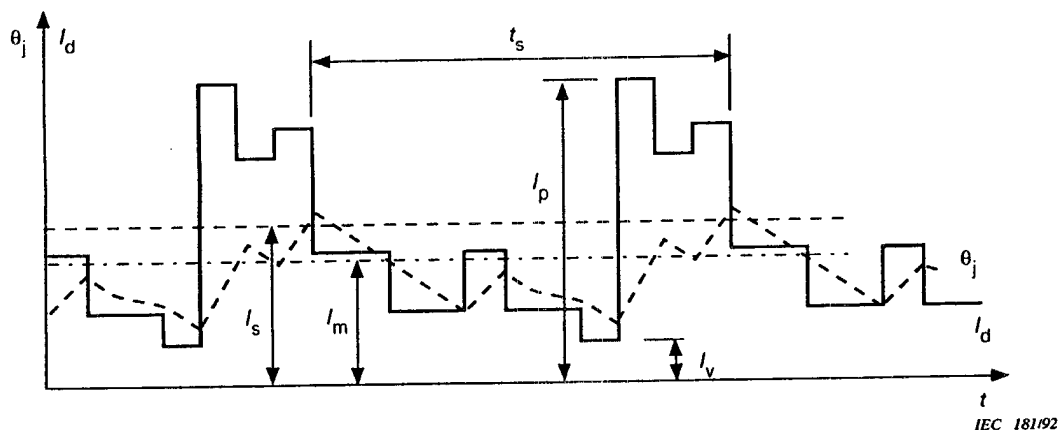


Figure 7 – Typical current-time chart for repetitive load duty

2.20 non-repetitive load duty: Type of duty for which a peak load is applied at the end of a constant load period during which thermal equilibrium is reached. Figure 8 illustrates this kind of duty.

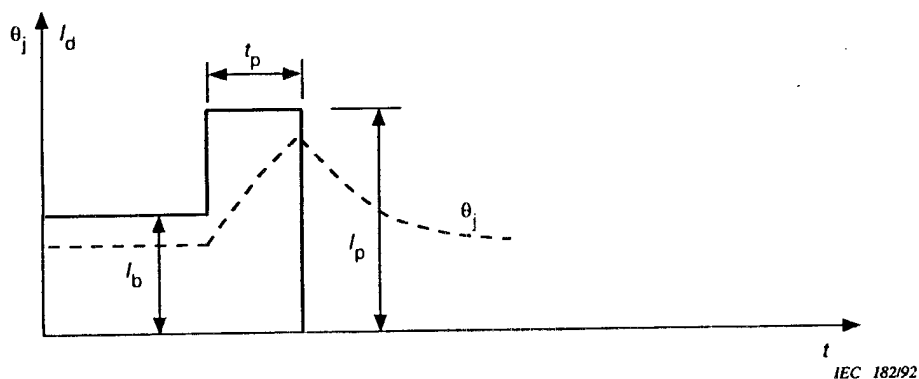


Figure 8 – Typical current-time chart for non-repetitive load duty

Table 1 – List of symbols

t_b	= base load interval
t_s	= load cycle period (duration)
t_o	= no-load interval
t_p	= peak load duration
t	= time
I_b	= base load current value
I_p	= peak load current value
I_v	= minimum load current value for period t_s
I_m	= average load current value for period t_s
I_s	= r.m.s. load current value for period t_s
I_{dN}	= rated direct current
I_d	= direct current output of convertor section
θ_j	= temperature of the convertor under consideration. This is usually taken to be the junction temperature of the semiconductor device
I_{PM}	= rated peak current for equivalent repetitive load duty (see 3.5.4.2)
I_{PMO}	= rated peak current for equivalent repetitive load duty with $I_v = 0$ (see 3.5.4.2)
r_n	= factor which is used to evaluate the per-unit average semiconductor junction power loss as a function of the per-unit direct current, it is given by:

$$r_N = \frac{R_o I_{dN}}{V_o}$$

where

R_o	= resistance value of the on-state characteristic of the semiconductor device
V_o	= threshold value of the on-state characteristic of the semiconductor device

3 Rated values

3.1 General

The ratings defined in this clause are to be applied to complete semiconductor convertor equipments, including such components as conductors, switchgear, reactors and transformers as defined in 2.1.

The basis of the rating of a reversible convertor shall be such that the convertor operating either as a rectifier or as an inverter shall be capable of meeting in either case all the specified load conditions.

The thermal time constants of semiconductors (including their cooling devices) are much shorter than those for convertor transformers and drive motors. For this reason, the high short-time peak currents that occur in normal load duties of various types of adjustable speed d.c. motor drives are of greater significance for the semiconductor convertor itself than for the convertor transformers and motors.

Short-time peak currents tend to cause faster and relatively higher temperature rises in the semiconductor than in the transformers and motors.

For a semiconductor device the manufacturer's maximum junction temperature is the critical temperature above which loss of control, failure or deterioration may occur.