

Terminology for high-voltage direct current (HVDC) transmission

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Foreword

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The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee PEL/22, Power electronics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English version

Terminology for high-voltage direct current (HVDC) transmission

(IEC 60633:1998)

Terminologie pour le transport d'énergie en
courant continu à haute tension (CCHT)
(CEI 60633:1998)

Terminologie für
Hochspannungsgleichstromübertragung
(HGÜ)
(IEC 60633:1998)

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CENELEC

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

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Foreword

The text of document 22F/49/FDIS, future edition 2 of IEC 60633, prepared by SC 22F, Power electronics for electrical transmission and distribution systems, of IEC TC 22, Power electronics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60633 on 1999-01-01.

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Annexes designated “normative” are part of the body of the standard.

In this standard, Annex ZA is normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60633:1998 was approved by CENELEC as a European Standard without any modification.

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

IEC 60076	NOTE Harmonized as HD 398 (modified) series and as EN 60076 (modified) series.
IEC 60099	NOTE Harmonized in the EN 60099 (modified) series.
IEC 60146-1-3	NOTE Harmonized as EN 60146-1-3:1993 (not modified).
IEC 60617-4	NOTE Harmonized as EN 60617-4:1996 (not modified).
IEC 60617-7	NOTE Harmonized as EN 60617-7:1996 (not modified).

Foreword to amendment A1

The text of document 22F/153/CDV, future amendment 1 to IEC 60633:1998, prepared by SC 22F, Power electronics for electrical transmission and distribution systems, of IEC TC 22, Power electronic systems and equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60633:1999 on 2009-09-01.

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Endorsement notice

The text of amendment 1:2009 to the International Standard IEC 60633:1998 was approved by CENELEC as an amendment to the European Standard without any modification.

Foreword to amendment A2

The text of document 22F/340/CDV, future IEC 60633:1998/A2, prepared by SC 22F “Power electronics for electrical transmission and distribution systems” of IEC/TC 22 “Power electronic systems and equipment” was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60633:1999/A2:2015.

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-09-02

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Annex ZA (normative)**Normative references to international publications with their corresponding European publications**

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

Publication	Year	Title	EN/HD	Year
IEC 60027	Series	Letter symbols to be used in electrical technology	EN 60027	Series
IEC 60050-551	-	International Electrotechnical Vocabulary (IEV) - Part 551: Power electronics	-	-
IEC 60146-1-1	-	Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements	EN 60146-1-1	-
IEC 60617-5	-	Graphical symbols for diagrams - Part 5: Semiconductors and electron tubes	EN 60617-5	-
IEC 60617-6	-	Graphical symbols for diagrams - Part 6: Production and conversion of electrical energy	EN 60617-6	-

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1 Scope

This International Standard defines terms for high-voltage direct current (HVDC) power transmission systems and for HVDC substations using electronic power converters for the conversion from a.c. to d.c. or vice versa.

This standard is applicable to HVDC substations with line commutated converters, most commonly based on three-phase bridge (double way) connections (see Figure 2) in which unidirectional electronic valves, e.g. semiconductor valves, are used.

2 Normative references

 The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. 

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*.

IEC 60050-551  text deleted , *International Electrotechnical Vocabulary — Part 551: Power electronics*.

IEC 60146-1-1  text deleted , *General requirements and line commutated convertors — Part 1-1: Specifications of basic requirements*.

IEC 60617-5  text deleted , *Graphical symbols for diagrams — Part 5: Semiconductors and electron tubes*.

IEC 60617-6  text deleted , *Graphical symbols for diagrams — Part 6: Production and conversion of electrical energy*.

3 Symbols and abbreviations

The list covers only the most frequently used symbols. For a more complete list of the symbols which have been adopted for static converters see IEC 60027 and other standards listed in the normative references and the bibliography.

3.1 List of letter symbols

U_d	direct voltage (any defined value)
U_{d0}	 nominal  no-load direct voltage
U_{di0}	ideal no-load direct voltage
U_{dN}	rated direct voltage
U_L	line-to-line voltage on line side of converter transformer, r.m.s. value including harmonics

U_{LN}	rated value of U_L
U_{v0}	no-load phase-to-phase voltage on the valve side of transformer, r.m.s. value excluding harmonics
I_d	direct current (any defined value)
I_{dN}	rated direct current
I_L	current on line side of converter transformer, r.m.s. value including harmonics
I_{LN}	rated value of I_L
I_v	current on valve side of transformer, r.m.s. value including harmonics
α	(trigger) delay angle
β	(trigger) advance angle
γ	extinction angle
μ	overlap angle
p	pulse number
q	commutation number

3.2 List of subscripts

0 (zero)	at no load
N	rated value or at rated load
d	direct current or voltage
i	ideal
L	line side of converter transformer
v	valve side of converter transformer
max	maximum
min	minimum
n	pertaining to harmonic component of order n

3.3 List of abbreviations

The following abbreviations are always in capital letters and without dots.

HVDC	high-voltage direct current
MVU	multiple valve (unit) (see 6.3.2)
SCR	short-circuit ratio (see 7.32)
ESCR	effective short-circuit ratio (see 7.33)
MTDC	multiterminal HVDC transmission system (see 8.2.2)
MRTB	metallic return transfer breaker (see 9.12)
ERTB	earth return transfer breaker (see 9.13)
VDCOL	voltage dependent current order limit (see 12.9)
 SSTI	sub-synchronous torsional interaction (see 10.10) 

4 Graphical symbols

Figure 1 shows the specific graphical symbols which are defined only for the purposes of this standard. For a more complete list of the graphical symbols which have been adopted for static converters, see IEC 60617-5 and IEC 60617-6.

5 General terms related to converter circuits

For the purposes of this standard, the following terms and definitions apply.

NOTE For a more complete list of the terms which have been adopted for static converters, see IEC 60050(551) and IEC 60146-1-1.

5.1 conversion

in the context of HVDC, the transfer of energy from a.c. to d.c. or vice versa, or a combination of these operations

5.2 converter connection

electrical arrangement of arms and other components necessary for the functioning of the main power circuit of a converter

5.3 bridge (converter connection)

 double-way connection as illustrated on Figure 2, comprising six converter arms such that the centre terminals are the phase terminals of the a.c. circuit, and that the outer terminals of like polarity are connected together and are the d.c. terminals 

NOTE The term “bridge” may be used to describe either the circuit connection or the equipment implementing that circuit (see 6.2).

5.3.1 uniform bridge

bridge where all converter arms are either controllable or non-controllable

5.3.2 non-uniform bridge

bridge with both controllable and non-controllable converter arms

5.4 (converter) arm

 part of a bridge connecting two points of different potentials within a bridge, for example, between an AC terminal and a DC terminal 

5.4.1 controllable converter arm

converter arm in which the start of forward conduction may be determined by an externally applied signal

5.4.2 non-controllable converter arm

converter arm in which the start of forward conduction is determined solely by the voltage applied to its terminals

5.5 by-pass path

low resistance path between the d.c. terminals of one or several bridges excluding the a.c. circuit

NOTE The by-pass path may either constitute a unidirectional path, e.g. a by-pass arm (see 5.5.1), or a by-pass pair (see 5.5.2), or it may constitute a bidirectional path, e.g. a by-pass switch (see 6.20).

5.5.1 by-pass arm

unidirectionally conducting by-pass path connected only between d.c. terminals, commonly used with mercury arc valve technology (not shown in Figure 2)

5.5.2 by-pass pair

two converter arms of a bridge connected to a common a.c. terminal and forming a by-pass path (see Figure 2)

5.6 commutation

transfer of current between any two paths with both paths carrying current simultaneously during this process

NOTE Commutation may occur between any two converter arms, including the connected a.c. phases, between a converter arm and a by-pass arm, or between any two paths in the circuit.

5.6.1 line commutation

method of commutation whereby the commutating voltage is supplied by the a.c. system

5.7 commutating group

group of converter arms which commute cyclically and independently from other converter arms, i.e. the commutations are normally not simultaneous (see Figure 2)

NOTE In the case of a bridge, a commutating group is composed of the converter arms connected to a common d.c. terminal. In certain cases, e.g. when large currents and/or large commutation inductances are involved, the commutation in the two commutating groups belonging to the same bridge need not be independent.

5.8 commutation inductance

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

5.9

pulse number p

characteristic of a converter connection expressed as the number of non-simultaneous symmetrical commutations occurring during one cycle of the a.c. line voltage

NOTE The pulse number of a bridge converter connection defined in 5.3 is always $p = 6$.

5.10

commutation number q

number of commutations during one cycle of the a.c. line voltage occurring in each commutating group

NOTE In a bridge converter connection, each commutating group has a commutation number $q = 3$.

A1 5.11

capacitor commutated converter

converter in which series capacitors are included between the converter transformer and the valves (see Figure 13a)

5.12

controlled series capacitor converter

converter in which series capacitors are inserted between the a.c. filter bus and the a.c. network (see Figure 13b) **A1**

A2 5.13

commutating voltage

voltage which causes the current to commute

[SOURCE: IEC 60500-551:1998, 551-16-02]

5.14

controlled capacitor commutated converter

converter in which controlled series capacitors are included between the converter transformer and the valves

5.15

series capacitor converter

converter in which fixed series capacitors are inserted between the AC filter bus and the AC network **A2**

6 Converter units and valves

6.1

A1 converter (unit) **A1**

A2 indivisible operative unit comprising all equipment between the point of common coupling on the AC side (see 8.24) and the point of common coupling DC side (see 8.25), essentially one or more converter bridges, together with one or more converter transformers, converter unit control equipment, essential protective and switching devices and auxiliaries, if any, used for conversion (see Figure 3) **A2**

6.2

(converter) bridge

equipment used to implement the bridge converter connection and the by-pass arm, if used

NOTE The term “bridge” may be used to describe either the circuit connection or the equipment implementing that circuit (see 5.3).

6.2.1

anode (cathode) valve commutating group

equipment used to implement the converter arms of one commutating group of a bridge with interconnected anode (cathode) terminals

6.3

valve

complete operative controllable or non-controllable valve device assembly, normally conducting in only one direction (the forward direction), which can function as a converter arm in a converter bridge

A2 text deleted **A2**

6.3.1

single valve (unit)

single structure comprising only one valve

6.3.2

multiple valve (unit) (MVU)

single structure comprising more than one valve

NOTE Examples of multiple valve units are double valves, quadrivalves and octovalves with two, four and eight series-connected valves respectively.

6.4

main valve

valve in a converter arm

6.5

by-pass valve

valve in a by-pass arm

6.6

thyristor module

A2 part of a valve comprising a mechanical assembly of thyristors with their immediate auxiliaries but without valve reactors

Note 1 to entry: Thyristor modules may be elements in the construction of a valve, and/or be interchangeable for maintenance purposes. **A2**

6.7

reactor module

part of a valve, being a mechanical assembly of one or more reactors, used in some valve designs

NOTE Reactor modules may be elements in the construction of a valve.