IEC 60633

Edition 2.1 2009-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Terminology for high-voltage direct current (HVDC) transmission

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

IEC 60633:1998+A1:2009

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INTERNATIONAL
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COMMISSION

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INTERNATIONALE

ICS 29.200

ISBN 978-2-88910-240-2

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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TERMINOLOGY FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) TRANSMISSION

FOREWORD

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International Standard IEC 60633 has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronics.

This consolidated version of IEC 60633 consists of the second edition (1998) [documents 22F/49/FDIS and 22F/53/RVD] and its amendment 1 (2009) [documents 22F/153/CDV and 22F/163/RVC].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 2.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

The committee has decided that the contents of the base publication and its amendments 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- withdrawn,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.

TERMINOLOGY FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) TRANSMISSION

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

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

IEC 60146-1-1:1991, *General requirements and line commutated convertors – Part 1-1: Specifications of basic requirements*

IEC 60617-5:1996, *Graphical symbols for diagrams – Part 5: Semiconductors and electron tubes*

IEC 60617-6:1996, *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}	conventional 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)

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 an operative circuit used for conversion which is connected between an a.c. terminal and a d.c. terminal, with the ability to conduct current in only one direction, defined as the forward direction (see 7.3)

NOTE The main function of a converter arm is conversion; it may also perform additional functions such as voltage limiting, damping, etc.

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 commutate 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 $q = 3$.

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)

6 Converter units and valves

6.1
converter (unit)
operative unit comprising 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)

NOTE If a converter unit comprises two converter bridges with a phase displacement of 30°, then the converter unit forms a 12-pulse unit (see figure 7). The term “12-pulse group” is also used.

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

NOTE An example of a non-controllable valve device assembly is a semiconductor diode valve. An example of a controllable valve device assembly is a thyristor valve.

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
part of a valve comprised of a mechanical assembly of thyristors with their immediate auxiliaries, and reactors, if used

NOTE 1 Thyristor modules may be elements in the construction of a valve, and/or be interchangeable for maintenance purposes.

NOTE 2 The deprecated term “valve module” has been used with an equivalent meaning.