SLOVENSKI STANDARD
SIST EN 62751-2:2014

01-december-2014

Ugotavljanje izgub moči v napetostnih pretvorniških ventilih za visokonapetostne enosmerne sisteme - 2. del: Modularni večnivojski pretvorniki (IEC 62751-2:2014)

Determination of power losses in voltage sourced converter (VSC) valves for high voltage direct current (HVDC) systems - Part 2: Modular multilevel converters

Bestimmung der Leistungsverluste in Spannungszwischenkreis-Stromrichtern (VSC) für Hochspannungsgleichstrom(HGÜ)-Systeme -- Teil 2: Modulare Mehrstufen-Stromrichter

Determination des pertes de puissance dans les valves à convertisseur de source de tension (VSC) des systemes en courant continu a haute tension (CCHT) -- Partie 2: Convertisseurs multiniveaux modulaires

Ta slovenski standard je istoveten z: EN 62751-2:2014

ICS:

29.200	Usmerniki. Pretvorniki. Stabilizirano električno napajanje	Rectifiers. Convertors. Stabilized power supply
29.240.01	Omrežja za prenos in distribucijo električne energije na splošno	Power transmission and distribution networks in general

SIST EN 62751-2:2014 **en**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 62751-2

October 2014

ICS 29.200; 29.240

English Version

Power losses in voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) systems - Part 2: Modular multilevel converters (IEC 62751-2:2014)

Pertes de puissance dans les valves à convertisseur de source de tension (VSC) des systèmes en courant continu à haute tension (CCHT) - Partie 2: Convertisseurs multiniveaux modulaires (CEI 62751-2:2014)

Bestimmung der Leistungsverluste in Spannungszwischenkreis-Stromrichtern (VSC) für Hochspannungsgleichstrom(HGÜ)-Systeme - Teil 2: Modulare Mehrstufen-Stromrichter (IEC 62751-2:2014)

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CENELEC

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 62751-2:2014 E

Foreword

The text of document 22F/303/CDV, future edition 1 of IEC 62751-2, 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 62751-2:2014.

The following dates are fixed:

– latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-07-01
– latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-10-01

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The text of the International Standard IEC 62751-2:2014 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61803:1999 NOTE Harmonised as EN 61803:1999.

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 60633	-	Terminology for high-voltage direct current (HVDC) transmission	EN 60633	-
IEC 62747	-	Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems	EN 62747	-
IEC 62751-1	2014	Determination of power losses in voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) systems -- Part 1: General requirements	EN 62751-1	2014
ISO/IEC Guide 98-3	-	Uncertainty of measurement -- Part-3: Guide to the expression of uncertainty in measurement (GUM:1995)	-	-

IEC 62751-2

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Power losses in voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) systems – Part 2: Modular multilevel converters

Pertes de puissance dans les valves à convertisseur de source de tension (VSC) des systèmes en courant continu à haute tension (CCHT) – Partie 2: Convertisseurs multiniveaux modulaires

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POWER LOSSES IN VOLTAGE SOURCED CONVERTER (VSC) VALVES FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS –

Part 2: Modular multilevel converters

FOREWORD

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International Standard IEC 62751-2 has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment.

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

CDV	Report on voting
22F/303/CDV	22F/322A/RVC

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.

A list of all parts in the IEC 62751series, published under the general title *Power losses in voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

POWER LOSSES IN VOLTAGE SOURCED CONVERTER (VSC) VALVES FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS –

Part 2: Modular multilevel converters

1 Scope

This part of IEC 62751 gives the detailed method to be adopted for calculating the power losses in the valves for an HVDC system based on the "modular multi-level converter", where each valve in the converter consists of a number of self-contained, two-terminal controllable voltage sources connected in series. It is applicable both for the cases where each modular cell uses only a single turn-off semiconductor device in each switch position, and the case where each switch position consists of a number of turn-off semiconductor devices in series (topology also referred to as "cascaded two-level converter"). The main formulae are given for the two-level "half-bridge" configuration but guidance is also given in Annex A as to how to extend the results to certain other types of MMC building block configuration.

The standard is written mainly for insulated gate bipolar transistors (IGBTs) but may also be used for guidance in the event that other types of turn-off semiconductor devices are used.

Power losses in other items of equipment in the HVDC station, apart from the converter valves, are excluded from the scope of this standard.

This standard does not apply to converter valves for line-commutated converter HVDC systems.

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 60633, *Terminology for high-voltage direct-current (HVDC) transmission*

IEC 62747, *Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems*

IEC 62751-1:2014, *Power losses in voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) systems – Part 1: General* requirements

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 60633, IEC 62747, IEC 62751-1, as well as the following apply.

3.1 Terms and definitions

3.1.1
modular multi-level converter
MMC
multi-level converter in which each VSC valve consists of a number of MMC building blocks connected in series

Note 1 to entry: This note applies to the French language only.

3.1.2
MMC building block
self-contained, two-terminal controllable voltage source together with d.c. capacitor(s) and immediate auxiliaries, forming part of a MMC

3.1.3
IGBT-diode pair
arrangement of IGBT and free-wheeling diode connected in inverse parallel

3.1.4
switch position
semiconductor function which behaves as a single, indivisible switch

Note 1 to entry: A switch position may consist of a single IGBT-diode pair or, in the case of the cascaded two level converter, a series connection of multiple IGBT-diode pairs.

3.1.5
cascaded two-level converter
CTL
modular multi-level converter in which each switch position consists of more than one IGBT-diode pair connected in series

Note 1 to entry: This note applies to the French language only.

3.1.6
submodule
MMC building block where each switch position consists of only one IGBT-diode pair

3.1.7
cell
MMC building block where each switch position consists of more than one IGBT-diode pair connected in series

3.1.8
turn-off semiconductor device
controllable semiconductor device which may be turned on and off by a control signal, for example an IGBT

3.1.9
insulated gate bipolar transistor
IGBT
turn-off semiconductor device with three terminals: a gate terminal (G) and two load terminals emitter (E) and collector (C)

Note 1 to entry: This note applies to the French language only.

3.1.10
operating state
condition in which the HVDC substation is energized and the converters are de-blocked

Note 1 to entry: Unlike line-commutated converter, VSC can operate with zero active/reactive power output.

3.1.11
no-load operating state
condition in which the HVDC substation is energized but the IGBTs are blocked and all necessary substation service loads and auxiliary equipment are connected

3.1.12
idling operating state
condition in which the HVDC substation is energized and the IGBTs are de-blocked but with no active or reactive power output at the point of common connection to the a.c. network

Note 1 to entry: The “idling operating” and “no-load” conditions are similar but from the no-load state, several seconds may be needed before power can be transmitted, while from the idling operating state, power transmission may be commenced almost immediately (less than 3 power frequency cycles).

Note 2 to entry: In the idling operating state, the converter is capable of actively controlling the d.c. voltage, in contrast to the no-load state where the behavior of the converter is essentially “passive”.

Note 3 to entry: Losses will generally be slightly lower in the no-load state than in the idling operating state, therefore this operating mode is preferred where the arrangement of the VSC system permits it.

3.1.13
modulation index of PWM converters
M
ratio of the peak line to ground a.c. converter voltage, to half of the converter d.c. terminal to terminal voltage

$$M = \frac{\sqrt{2} \cdot U_{c1}}{\sqrt{3} \cdot \frac{U_{dc}}{2}}$$

where

U_{c1} is the r.m.s value of the fundamental frequency component of the line-to-line voltage U_c;

U_c is the output voltage of one VSC phase unit at its a.c. terminal;

U_{dc} is the output voltage of one VSC phase unit at its d.c. terminals.

Note 1 to entry: Some sources define modulation index in a different way such that a modulation index of 1 refers to a square-wave output, which means that the modulation index can never exceed 1. The modulation index according to that definition is given simply by $M \cdot (\pi/4)$. However, that definition is relevant mainly to two-level converters using PWM.

3.2 Symbols and abbreviated terms

3.2.1 Valve and simulation data

N_{tc} number of MMC building blocks per valve

N_c number of series-connected semiconductor devices per switch position

N_{sr} total number of series resistive elements contributing to conduction losses in the valve, other than in the IGBTs and diodes

N_{cv} number of d.c. capacitors in the valve

N_s number of switching cycles (on or off) experienced by each VSC valve level during the integration time t_i

N_{pr} total number of parallel resistive elements contributing to d.c. voltage dependent losses in the valve

N_{sn} number of snubber circuits per valve

t_i integration time used in the simulation