SLOVENSKI STANDARD
SIST EN 62751-2:2014/oprA2:2023

01-marec-2023

Ugotavljanje izgub moči v napetostnih pretvorniških ventilih za visokonapetostne enosmerne sisteme - 2. del: Modularni večnivojski pretvorniki - Dopolnilo A2

Amendment 2 - 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 Mehrpunkt-Stromrichter

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

Ta slovenski standard je istoveten z: **EN 62751-2:2014/prA2:2023**

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/oprA2:2023 **en,fr,de**

22F/712/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:
IEC 62751-2/AMD2 ED1

DATE OF CIRCULATION:	CLOSING DATE FOR VOTING:
2023-01-06	**2023-03-31**

SUPERSEDES DOCUMENTS:
22F/689/CD, 22F/701A/CC

IEC SC 22F : POWER ELECTRONICS FOR ELECTRICAL TRANSMISSION AND DISTRIBUTION SYSTEMS

SECRETARIAT:	SECRETARY:
IEC Secretariat	Ms Suzanne Yap
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 115	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:
☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

☒ SUBMITTED FOR CENELEC PARALLEL VOTING

Attention IEC-CENELEC parallel voting

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.

The CENELEC members are invited to vote through the CENELEC online voting system.

☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

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

PROPOSED STABILITY DATE: 2026

NOTE FROM TC/SC OFFICERS:

This document is circulated as a CDV in accordance with the decision taken at the SC 22F plenary meeting held virtually on October 18-20, 2022 (Decision 2022-18 of 22F/711/DL). The Working Draft of the Amendment was developed by SC 22F Maintenance Team 31 (Convenor: Mr. Colin Davidson, UK).

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

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

Part 2: Modular multilevel converters

AMENDMENT 2

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

Amendment 2 to IEC 62751-2:2014 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 Amendment is based on the following documents:

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

The language used for the development of this Amendment is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications/.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

_____

Contents

Add Annex C to the table of contents.

3.1.11
no-load operating state

Add, to the end of Note 1 to entry of the existing definition, modified by IEC 62751-2/AMD1:2019, the following sentence:

"The integration time over which such losses are averaged might need to be longer than during normal operation, so as to obtain the correct weighted average of the losses while blocked and the losses while switching."

4.2 Principles for loss determination

Replace, in the last sentence of the existing first paragraph, modified by IEC 62751-2/AMD1:2019, the text "justify" *with* "explain".

Replace, in the last sentence of the existing third paragraph, modified by IEC 62751-2/AMD1:2019, the text "is now under study in CIGRÉ WG B4-75" *with* "has been studied by CIGRE WG B4-75 and is summarised in Annex C".

Delete, the third sentence of the existing last paragraph, "Care should also be taken to show the propagation of uncertainties from measurements and how they interact with the model.".

4.4 Loss calculation method

Delete, in the third sentence of the existing first paragraph, the following text: "for example valve currents and switching energies".

Replace, in the last sentence of the existing second paragraph, the text "currents" *with* "losses".

Delete, in the existing last paragraph, the text "and justified".

Add, to the end of the existing last paragraph, the following new sentence, and a new paragraph:

"The main benefit of the numerical offline simulation is the determination of the average distribution of the switching events across a cycle.

The remaining calculations can be performed analytically with a reasonable accuracy. If it can be shown by the manufacturer, that the distribution of switching events is reasonably accurate, then the remaining calculations shall be allowed to be performed analytically."

4.5.2 Input data for numerical simulations

Replace, the first dash of the existing first paragraph, with the following new sentence:

"The simulation model shall include a control block which reproduces the correct valve current and switching pattern used in the complete system."

Delete, in the fourth dash of the existing first paragraph, the text "parasitic elements".

Replace, in the fifth dash of the existing first paragraph, the text "with a reduced number of" *with* "using a lumped representation of the".

Replace, the last two dashes of the existing first paragraph, modified by IEC 62751-2/AMD1:2019, by the following new paragraph:

"There are two different approaches/methods which may be applied:

1) Two-stage simulation/calculation method on the basis of simulated input values. In this approach the input parameters required for a calculation are to be simulated using a model which at least represents the on-state characteristics of the converter as well as the switching pattern / control pattern for the switching of the cells. The on-state representation may be chosen on the basis of worst case characteristics (at high junction temperatures) or on-state characteristics for lower junction temperatures. The simulated values (voltages, currents and switching pattern) are to be used as input for the calculations. For the calculations with the simulated values the following two approaches may be used:
   a) The semiconductor parameters are chosen for the rated or worst-case junction temperature condition and the losses are to be calculated on the basis of the rated junction temperature. Please note that due to the assumption of a worst-case temperature condition this calculation will result in higher losses than what can actually be observed in the real application.
   b) Using a thermal model the temperature-dependent semiconductor properties are to be considered to calculate the losses for all semiconductors in the converter. Since only steady state scenarios are the basis for the loss calculation the thermal heat capacitances may be considered as negligible for the thermal model. The temperature dependent loss calculation may be executed in an iterative manner. For the iterative calculation approach with the simulation values input, a steady state condition has to be reached to end the iteration process (as a suggestion +/- 1 K iteration error border).
2) Loss calculation with an exclusive simulation approach. In this approach the junction temperature dependant semiconductor properties, such as on-state voltages, switching and recovery losses are to be included in the simulation model (i.e. a thermal model is to be included in the simulations, as for the mixed calculation and simulation approach the thermal heat capacitances may be neglected for steady state conditions). The simulation model has to represent the switching pattern / control pattern for the switching of the cells. On the basis of the simulations the losses are to be extracted directly from the simulation model for all semiconductors in the converter. Similarly to option 1, it is possible to simplify the model by using semiconductor parameters applicable only to the maximum rated junction temperature, but this will result in a more conservative calculation."

74

75 **4.5.3 Input data coming from numerical simulations**

76 *Add, at the end of the existing second paragraph, modified by IEC 62751-2/AMD1:2019, the*
77 *following sentence:*

78 "The required parameters to be derived from the simulations may vary in dependency of the
79 chosen calculation approach."

80 **4.5.4 Converter station data**

81 *Add, in the second dash of the existing first paragraph,* "if any" *after* "filter configuration".

82 *Add, in the third dash of the existing first paragraph,* "if any" *after* "phase reactor inductance".

83 **4.6 Contents and structure of valve loss determination report**

84 *Add, in the first paragraph 1 of the new subclause 4.6, modified by IEC 62751-2/AMD1:2019,*
85 *between the text,* "…have been determined and" *and* "including a breakdown of the valve
86 losses …"*, the new text* "at the project execution stage,**"**.

87 **5.1 General**

88 *Add, after the new sixth paragraph, modified by IEC 62751-2/AMD1:2019, the following new*
89 *note:*

90 "NOTE: When the rated DC current of the HVDC scheme is significantly lower than the rated current of the IGBT,
91 additional measurement points might be necessary in order to obtain acceptable accuracy."

92 **5.2 IGBT conduction losses**

93 *Add, to the beginning of the existing first paragraph, the text* "Where the piecewise-linear
94 approximation is used," *and replace the immediate text* "The" *with* "the".

95 *Add, to the end of the existing last paragraph, modified by IEC 62751-2/AMD1:2019, the*
96 *following new sentence, and a new paragraph:*

97 "An analytical approach to calculate the current distribution for the individual submodule
98 elements may be acceptable (e.g. use of switching vector derived from simulation).

99 For parallel connected semiconductors the current sharing may be calculated on the basis of
100 the forward characteristics of the semiconductors (usually an equal current sharing)."

101 **5.3 Diode conduction losses**

102 *Add, to the beginning of the existing first paragraph, the text* "Where the piecewise-linear
103 approximation is used," *and replace the immediate text* "The" *with* "the".

104 *Add, to the end of the existing last paragraph, modified by IEC 62751-2/AMD1:2019, the*
105 *following new sentence, and a new paragraph:*

106 "An analytical approach to calculate the current distribution for the individual submodule
107 elements may be acceptable (e.g. use of switching vector derived from simulation).

108 For parallel connected semiconductors the current sharing may be calculated on the basis of
109 the forward characteristics of the semiconductors (usually an equal current sharing)."