

SLOVENSKI STANDARD SIST EN IEC 61803:2021

01-februar-2021

Nadomešča: SIST EN 61803:2001 SIST EN 61803:2001/A1:2011 SIST EN 61803:2001/A2:2016

Ugotavljanje močnostnih izgub v visokonapetostnih enosmernih (HVDC) pretvorniških postajah s pretvorniki s komutiranjem (IEC 61803:2020)

Determination of power losses in high-voltage direct current (HVDC) converter stations with line-commutated converters (IEC 61803:2020) PREVIEW

Bestimmung der Leistungsverluste in Hochspannungsgleichstrom-(HGÜ-)Stromrichterstationen mit netzgeführten Stromrichtern (IEC 61803:2020)

https://standards.iteh.ai/catalog/standards/sist/19db871f-8da1-47a9-8d98-

Détermination des pertes en puissance dans les postes de conversion en courant continu à haute tension (CCHT) munis de convertisseurs commutés par la ligne (IEC 61803:2020)

Ta slovenski standard je istoveten z: EN IEC 61803:2020

ICS:

29.200 Usmerniki. Pretvorniki. Stabilizirano električno napajanje

Rectifiers. Convertors. Stabilized power supply

SIST EN IEC 61803:2021

en.fr.de



iTeh STANDARD PREVIEW (standards.iteh.ai)

SIST EN IEC 61803:2021

EUROPEAN STANDARD NORME EUROPÉENNE **EUROPÄISCHE NORM**

EN IEC 61803

December 2020

ICS 29.200

Supersedes EN 61803:1999 and all of its amendments and corrigenda (if any)

English Version

Determination of power losses in high-voltage direct current (HVDC) converter stations with line-commutated converters (IEC 61803:2020)

Détermination des pertes en puissance dans les postes de conversion en courant continu à haute tension (CCHT) munis de convertisseurs commutés par la ligne (IEC 61803:2020)

Bestimmung der Leistungsverluste in Hochspannungsgleichstrom- (HGÜ-)Stromrichterstationen mit netzgeführten Stromrichtern (IEC 61803:2020)

This European Standard was approved by CENELEC on 2020-11-23. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions. SIST EN IEC 61803:2021

https://standards.iteh.ai/catalog/standards/sist/19db871f-8da1-47a9-8d98-

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovakia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 61803:2020 (E)

European foreword

The text of document 22F/563/CDV, future edition 2 of IEC 61803, 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 IEC 61803:2020.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2021-08-23 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2023-11-23 document have to be withdrawn

This document supersedes EN 61803:1999 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice iTeh STANDARD PREVIEW

The text of the International Standard IEC 61803 2020 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

NOTE 1 Where 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: <u>www.cenelec.eu</u>.

Publication	Year <u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60076-1	- Power transformers - Part 1: General	EN 60076-1	-
IEC 60076-6	- Power transformers - Part 6: Reactors	EN 60076-6	-
IEC 60633	- i High-voltage direct Current R(HVDC) E transmission - Vocabulary	EN IEC 60633	-
IEC 60700-1	2015 Thyristor valves for high voltage direct current (HVDC) power transmission - Part 1: https://Electrical.testing.log/standards/sist/19db871f-8da1-47a	EN 60700-1 9-8d98-	2015
IEC 60871-1	- Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V - Part 1: General	EN 60871-1	-



iTeh STANDARD PREVIEW (standards.iteh.ai)



Edition 2.0 2020-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Determination of power losses in high-voltage direct current (HVDC) converter stations with line-commutated converters.iteh.ai)

Détermination des pertes en puissance dans les postes de conversion en courant continu/à haute tension (CCHT) munis de convertisseurs commutés par la ligne dc5667fc5482/sist-en-iec-61803-2021

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.200

ISBN 978-2-8322-8948-8

Warning! Make sure that you obtained this publication from an authorized distributor. Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

 Registered trademark of the International Electrotechnical Commission Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

FC	REWO	RD	4
1	Scop	е	6
2	Norm	ative references	6
3	Terms, definitions and symbols		
	3.1	Terms and definitions	7
	3.2	Symbols	8
4	Overv	/iew	8
	4 1	General	8
	4.2	Ambient conditions	0
	421	General	0
	4.2.2	Outdoor standard reference temperature	9
	4.2.3	Coolant standard reference temperature	9
	4.2.4	Standard reference air pressure	.10
	4.3	Operating parameters	.10
5	Deter	mination of equipment losses	.10
	5 1	Thyristor valve losses	10
	511	General	10
	5.1.2	Thyristor conduction toss per valve D. PREVIEW	.11
	5.1.3	Thyristor spreading loss per valve	.12
	5.1.4	Other conduction losses per valve	.12
	5.1.5	DC voltage-dependent loss per valve	.13
	5.1.6	Damping loss per valve (resistor dependent term), 47-9, 8-192	.14
	5.1.7	Damping loss perlvalve (change of capacitor) energy term)	.14
	5.1.8	Turn-off losses per valve	.15
	5.1.9	Reactor loss per valve	.15
	5.1.1	0 Total valve losses	. 16
	5.1.1	1 Temperature effects	. 16
	5.1.1	2 No-load operation loss per valve	.16
	5.2	Converter transformer losses	.17
	5.2.1	General	. 17
	5.2.2	No-load operation losses	.17
	5.2.3	Operating losses	. 17
	5.2.4	Auxiliary power losses	.18
	5.3	AC filter losses	. 19
	5.3.1	General	. 19
	5.3.2	AC filter capacitor losses	.19
	5.3.3	AC filter reactor losses	.19
	5.3.4	AC filter resistor losses	.20
	5.3.5	Total AC filter losses	.20
	5.4	Shunt capacitor bank losses	.20
	5.5	Shunt reactor losses	. 20
	5.6	DC smoothing reactor losses	.21
	5.7	DC filter losses	.21
	5.7.1	General	.21
	5.7.2	DC filter capacitor losses	.22
	5.7.3	DC filter reactor losses	.22

5.7.4	DC filter resistor losses	23
5.7.5	Total DC filter losses	23
5.8	Auxiliaries and station service losses	23
5.9	Series filter losses	24
5.10	Other equipment losses	25
Annex A ((informative) Calculation of harmonic currents and voltages	31
A.1	Harmonic currents in converter transformers	31
A.2	Harmonic currents in the AC filters	31
A.3	Harmonic voltages on the DC side	32
A.4	DC side harmonic currents in the smoothing reactor	32
Annex B ((informative) Typical station losses	33
Annex C ((informative) HVDC converter station loss evaluation – An illustration	34
C.1	General	34
C.2	Loss evaluation under various cases	35
Bibliograp	bhy	37
Figure 1 -	- Typical high-voltage direct current (HVDC) equipment for one pole	26
Figure 2 -	- Simplified three-phase diagram of an HVDC 12-pulse converter	27
Figure 3 -	- Simplified equivalent circuit of a typical thyristor valve	27
Figure 4 -	- Current and voltage waveforms of a valve operating in a 12-pulse converter	28

 Figure 5 – Thyristor on-state characteristic and s.iteh.ai
 29

 Figure 6 – Conduction current and voltage drop
 29

 Figure 7 – Distribution of commutating inductance between L1 and L2
 30

 Figure 8 – Thyristor current during inductance between L1 and L2
 30

 Figure 8 – Thyristor current during inductance between L2
 30

 State
 30

 State
 30

 State
 30

 Figure 8 – Thyristor current during inductance between Covery
 30

 Co5667fc5482/sist-en-iec-61803-2021
 30

Table B.1 – Typical values of losses33Table C.1 – Conditions for calculation of losses in case D136Table C.2 – Conditions for calculation of losses in Case D236

- 4 -

INTERNATIONAL ELECTROTECHNICAL COMMISSION

DETERMINATION OF POWER LOSSES IN HIGH-VOLTAGE DIRECT CURRENT (HVDC) CONVERTER STATIONS WITH LINE-COMMUTATED CONVERTERS

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 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.
- https://standards.itch.ai/catalog/standards/sist/19db871f-8da1-47a9-8d98 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.
- 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.

International Standard IEC 61803 has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment.

This second edition cancels and replaces the first edition published in 1999, Amendment 1:2010 and Amendment 2:2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

 a) to facilitate the application of this document and to ensure its quality remains consistent, 5.1.8 and 5.8 have been reviewed, taking into consideration that the present thyristor production technology provides considerably less thyristor parameters dispersion comparing with the situation in 1999 when the first edition of IEC 61803 was developed, and therefore the production records of thyristors can be used for the power losses calculation; b) the calculation of the total station load losses (cases D1 and D2 in Annex C) has been corrected.

The text of this International Standard is based on the following documents:

CDV	Report on voting
22F/563/CDV	22F/580A/RVC

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.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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.

iTeh STANDARD PREVIEW (standards.iteh.ai)

- 6 -

IEC 61803:2020 © IEC 2020

DETERMINATION OF POWER LOSSES IN HIGH-VOLTAGE DIRECT CURRENT (HVDC) CONVERTER STATIONS WITH LINE-COMMUTATED CONVERTERS

1 Scope

This document applies to all line-commutated high-voltage direct current (HVDC) converter stations used for power exchange (power transmission or back-to-back installation) in utility systems. This document presumes the use of 12-pulse thyristor converters but can, with due care, also be used for 6-pulse thyristor converters.

In some applications, synchronous compensators or static var compensators (SVC) may be connected to the AC bus of the HVDC converter station. The loss determination procedures for such equipment are not included in this document.

This document presents a set of standard procedures for determining the total losses of an HVDC converter station. The procedures cover all parts, except as noted above, and address no-load operation and operating losses together with their methods of calculation which use, wherever possible, measured parameters.

Converter station designs employing novel components or circuit configurations compared to the typical design assumed in this document, or designs equipped with unusual auxiliary circuits that could affect the losses, are assessed on their own merits.

2 Normative references https://standards.iteh.ai/catalog/standards/sist/19db871f-8da1-47a9-8d98dc5667fc5482/sist-en-iec-61803-2021

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60076-1, Power transformers – Part 1: General

IEC 60076-6, Power transformers – Part 6: Reactors

IEC 60633, *High-voltage direct current (HVDC) transmission – Vocabulary*

IEC 60700-1:2015, Thyristor valves for high voltage direct current (HVDC) power transmission – Part 1: Electrical testing

IEC 60871-1, Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V – Part 1: General

3 Terms, definitions and symbols

For the purposes of this document, the terms and definition given in IEC 60633 and the following apply.

IEC 61803:2020 © IEC 2020

- 7 -

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

Terms and definitions 3.1

3.1.1

auxiliary losses

electric power required to feed the converter station auxiliary loads

Note 1 to entry: The auxiliary losses depend on the number of converter units used and whether the station is in no-load operation or carrying load, in which case the auxiliary losses depend on the load level.

3.1.2

equipment no-load operation losses

losses produced in an item of equipment with the converter station energised but with the converters blocked and all station service loads and auxiliary equipment connected as required for immediate pick-up of load to specified minimum power

3.1.3

load level

direct current, direct voltage, firing angle, AC voltage, and converter transformer tap-changer position at which the converter station is operating ITeh STANDARD PREVIEW

3.1.4

equipment operating losses (standards.iteh.ai)

losses produced in an item of equipment at a given load level with the converter station energised and the converters operating T EN IEC 61803:2021

> https://standards.iteh.ai/catalog/standards/sist/19db871f-8da1-47a9-8d98dc5667fc5482/sist-en-iec-61803-2021

3.1.5 rated load

load related to operation at nominal values of DC current, DC voltage, AC voltage and converter firing angle

Note 1 to entry: The AC system shall be assumed to be at nominal frequency, and its 3-phase voltages are nominal and balanced. The position of the tap-changer of the converter transformer and the number of AC filters and shunt reactive elements connected shall be consistent with operation at rated load, coincident with nominal conditions

3.1.6

total station no-load operation losses

sum of all equipment no-load operation losses (3.1.2) and corresponding auxiliary losses (3.1.1)

3.1.7

total station operating losses

sum of all equipment operating losses (3.1.4) and corresponding auxiliary losses (3.1.1) at a particular load level

Note 1 to entry: An illustrative example using total station operating losses and corresponding loss evaluation is given in Annex C, case D1.

3.1.8

total station load losses

difference between total station operating losses (3.1.7) and total station no-load operation losses (3.1.6)

Note 1 to entry: Such calculated total station load losses are considered as being guantitatively equivalent to load losses as in conventional AC substation practice.