

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

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 62751-1:2014 sisaldab Euroopa standardi EN 62751-1:2014 inglisekeelset teksti.	This Estonian standard EVS-EN 62751-1:2014 consists of the English text of the European standard EN 62751-1:2014.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 31.10.2014.	Date of Availability of the European standard is 31.10.2014.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 29.200, 29.240

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Aru 10, 10317 Tallinn, Eesti; www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:
Aru 10, 10317 Tallinn, Estonia; www.evs.ee; phone 605 5050; e-mail info@evs.ee

ICS 29.200; 29.240

English Version

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

Pertes de puissance dans les valves à convertisseur de
source de tension (VSC) des systèmes en courant continu
à haute tension (CCHT) - Partie 1: Exigences générales
(CEI 62751-1:2014)

Bestimmung der Leistungsverluste in
Spannungszwischenkreis-Stromrichtern (VSC) für
Hochspannungsgleichstrom(HGÜ)-Systeme - Teil 1:
Allgemeine Anforderungen
(IEC 62751-1:2014)

This European Standard was approved by CENELEC on 2014-10-01. 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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, 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: Avenue Marnix 17, B-1000 Brussels

Foreword

The text of document 22F/302/CDV, future edition 1 of IEC 62751-1, 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 62751-1:2014.

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

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

Endorsement notice

The text of the International Standard IEC 62751-1:2014 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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60633	-	Terminology for high-voltage direct current (HVDC) transmission	EN 60633	-
IEC 60747-2	-	Semiconductor devices - Discrete devices and integrated circuits -- Part 2: Rectifier diodes	-	-
IEC 60747-9	2007	Semiconductor devices - Discrete devices - Part 9: Insulated-gate bipolar transistors (IGBTs)	-	-
IEC 62747	2014	Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems	EN 62747	2014

CONTENTS

FOREWORD	4
1 Scope	6
2 Normative references	6
3 Terms and definitions	7
3.1 Converter types	7
3.2 Semiconductor devices	7
3.3 Converter operating states	8
3.4 Device characteristics	9
3.5 Other definitions	9
4 General conditions	10
4.1 General	10
4.2 Causes of power losses	11
4.3 Categories of valve losses	11
4.4 Operating conditions	12
4.4.1 General	12
4.4.2 Reference ambient conditions	12
4.4.3 Reference a.c. system conditions	12
4.4.4 Converter operating states	12
4.4.5 Treatment of redundancy	12
4.5 Use of real measured data	13
4.5.1 General	13
4.5.2 Routine testing	13
4.5.3 Characterisation testing	13
5 Conduction losses	14
5.1 General	14
5.2 IGBT conduction losses	16
5.3 Diode conduction losses	16
5.4 Other conduction losses	17
6 D.C. voltage-dependent losses	17
7 Losses in d.c. capacitors	18
8 Switching losses	18
8.1 General	18
8.2 IGBT switching losses	19
8.3 Diode switching losses	20
9 Other losses	21
9.1 Snubber circuit losses	21
9.2 Valve electronics power consumption	21
10 Total valve losses per converter substation	22
Annex A (informative) Determination of power losses in other HVDC substation equipment	25
A.1 General	25
A.2 Guidance for calculating losses in each equipment	25
A.2.1 Circuit breaker	25
A.2.2 Pre-insertion resistor	25
A.2.3 Line side harmonic filter	26

A.2.4	Line side high frequency filter	26
A.2.5	Interface transformer	26
A.2.6	Converter side harmonic filter	27
A.2.7	Converter side high frequency filter	27
A.2.8	Phase reactor	27
A.2.9	VSC unit	27
A.2.10	VSC d.c. capacitor	27
A.2.11	D.C. harmonic filter	27
A.2.12	Dynamic braking system	27
A.2.13	Neutral point grounding branch	28
A.2.14	D.C. reactor	28
A.2.15	Common mode blocking reactor	28
A.2.16	D.C. side high frequency filter	28
A.2.17	D.C. cable or overhead transmission line	28
A.3	Auxiliaries and station service losses	29
Bibliography		30
Figure 1 – On-state voltage of an IGBT or diode		14
Figure 2 – Piecewise-linear representation of IGBT or diode on-state voltage		15
Figure 3 – IGBT switching energy as a function of collector current		19
Figure 4 – Diode recovery energy as a function of current		20
Figure A.1 – Major components that may be found in a VSC substation		26
Table 1 – Matrix indicating the relationship of data needed for calculation of losses and the type of valve losses (1 of 2)		23