

Thyristor valves for high voltage direct current (HVDC)
power transmission - Part 1: Electrical testing

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 60700-1:2015 sisaldab Euroopa standardi EN 60700-1:2015 ingliskeelset teksti.	This Estonian standard EVS-EN 60700-1:2015 consists of the English text of the European standard EN 60700-1:2015.
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 25.09.2015.	Date of Availability of the European standard is 25.09.2015.
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

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; koduleht 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; homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee

English Version

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

Valves à thyristors pour le transport d'énergie en courant
continu à haute tension (CCHT) - Partie 1: Essais
électriques
(IEC 60700-1:2015)

Thyristorventile für Hochspannungsgleichstrom-
Energieübertragung (HGÜ) - Teil 1: Elektrische Prüfung
(IEC 60700-1:2015)

This European Standard was approved by CENELEC on 2015-09-01. 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

European foreword

The text of document 22F/341/CDV, future edition 2 of IEC 60700-1, 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 60700-1:2015.

The following dates are fixed:

- latest date by which the document has to be (dop) 2016-06-01
implemented at national level by
publication of an identical national
standard or by endorsement
- latest date by which the national (dow) 2018-09-01
standards conflicting with the
document have to be withdrawn

This document supersedes EN 60700-1:1998.

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 60700-1:2015 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, 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 60060	Series	High-voltage test techniques	EN 60060	Series
IEC 60060-1	-	High-voltage test techniques - Part 1: General definitions and test requirements	EN 60060-1	-
IEC 60071-1	-	Insulation co-ordination - Part 1: Definitions, principles and rules	EN 60071-1	-
IEC 60099	Series	Surge arresters	EN 60099	Series
IEC 60270	-	High-voltage test techniques - Partial discharge measurements	EN 60270	-
IEC 61803 +A1	1999 2010	Determination of power losses in high- voltage direct current (HVDC) converter stations	EN 61803 +A1	1999 2010
ISO/IEC Guide 25 ¹⁾ -		General requirements for the competence - of calibration and testing laboratories		-

¹⁾ Withdrawn publication.

CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions.....	7
3.1 Insulation co-ordination terms.....	8
3.2 Valve construction terms.....	9
3.3 Terms related to type tests.....	10
3.4 Terms related to production tests.....	10
4 General requirements.....	10
4.1 Guidelines for the performance of type tests.....	10
4.1.1 Evidence in lieu.....	10
4.1.2 Test object.....	10
4.1.3 Sequence of tests.....	10
4.1.4 Test procedures.....	11
4.1.5 Ambient temperature for testing.....	11
4.1.6 Frequency for testing.....	11
4.1.7 Test reports.....	11
4.2 Atmospheric correction.....	11
4.3 Treatment of redundancy.....	11
4.3.1 Dielectric tests.....	11
4.3.2 Operational tests.....	11
4.4 Criteria for successful type testing.....	12
4.4.1 General.....	12
4.4.2 Criteria applicable to thyristor levels.....	12
4.4.3 Criteria applicable to the valve as a whole.....	13
5 List of type tests.....	13
6 Dielectric tests on valve support.....	14
6.1 Purpose of tests.....	14
6.2 Test object.....	14
6.3 Test requirements.....	15
6.3.1 General.....	15
6.3.2 Valve support d.c. voltage test.....	15
6.3.3 Valve support a.c. voltage test.....	15
6.3.4 Valve support switching impulse test.....	16
6.3.5 Valve support lightning impulse test.....	16
7 Dielectric tests for multiple valve units (MVU).....	16
7.1 Purpose of tests.....	16
7.2 Test object.....	16
7.3 Test requirements.....	17
7.3.1 MVU d.c. voltage test to earth.....	17
7.3.2 MVU a.c. voltage test.....	18
7.3.3 MVU switching impulse test.....	18
7.3.4 MVU lightning impulse test.....	19
8 Dielectric tests between valve terminals.....	20
8.1 Purpose of tests.....	20
8.2 Test object.....	20

8.3	Test requirements	20
8.3.1	Valve d.c. voltage test	20
8.3.2	Valve a.c. voltage test	21
8.3.3	Valve impulse tests (general)	22
8.3.4	Valve switching impulse test	23
8.3.5	Valve lightning impulse test	23
8.3.6	Valve steep front impulse test	23
8.4	Valve non-periodic firing test	24
8.4.1	Purpose of test	24
8.4.2	Test object	24
8.4.3	Test requirements	24
9	Periodic firing and extinction tests	25
9.1	Purpose of tests	25
9.2	Test object	26
9.3	Test requirements	26
9.3.1	General	26
9.3.2	Maximum continuous operating duty tests	27
9.3.3	Maximum temporary operating duty test ($\alpha = 90^\circ$)	28
9.3.4	Minimum a.c. voltage tests	29
9.3.5	Temporary undervoltage test	30
9.3.6	Intermittent direct current tests	31
10	Tests with transient forward voltage during the recovery period	31
10.1	Purpose of tests	31
10.2	Test object	31
10.3	Test requirements	31
11	Valve fault current tests	33
11.1	Purpose of tests	33
11.2	Test object	33
11.3	Test requirements	33
11.3.1	General	33
11.3.2	One-loop fault current test with re-applied forward voltage	34
11.3.3	Multiple-loop fault current test without re-applied forward voltage	35
12	Tests for valve insensitivity to electromagnetic disturbance	35
12.1	Purpose of tests	35
12.2	Test object	36
12.3	Test requirements	36
12.3.1	General	36
12.3.2	Approach one	36
12.3.3	Approach two	36
12.3.4	Acceptance criteria	37
13	Testing of special features and fault tolerance	37
13.1	Purpose of tests	37
13.1.1	General	37
13.1.2	Circuits to facilitate the proper control, protection and monitoring of the valve	37
13.1.3	Features included in the valve to provide fault tolerance	37
13.2	Test object	37
13.3	Test requirements	38
14	Production tests	38

14.1	General.....	38
14.2	Purpose of tests	38
14.3	Test object.....	38
14.4	Test requirements	38
14.5	Routine test – minimum requirements.....	38
14.5.1	Visual inspection.....	38
14.5.2	Connection check	39
14.5.3	Voltage-grading circuit check	39
14.5.4	Voltage withstand check.....	39
14.5.5	Partial discharge tests.....	39
14.5.6	Check of auxiliaries.....	39
14.5.7	Firing check.....	39
14.5.8	Pressure test	39
15	Method for loss determination	39
16	Presentation of type test results	39
Annex A	(normative) Test safety factors	40
A.1	General.....	40
A.2	Test safety factors for dielectric tests	40
A.2.1	Impulse tests	40
A.2.2	AC and d.c. temporary and long-term voltage tests.....	43
A.3	Test safety factors for operational tests	43
Annex B	(normative) Partial discharge measurements	44
B.1	Measurement of partial discharge.....	44
B.2	Partial discharge during a.c. tests.....	44
B.3	Partial discharge during d.c. tests.....	44
B.4	Composite a.c. plus d.c. voltage stress.....	45
Figure 1	– Steep front impulse test voltage	8
Table 1	– Thyristor level faults permitted during type tests	13
Table 2	– List of type tests	14