

INTERNATIONAL STANDARD



Voltage sourced converter (VSC) valves for static synchronous compensator (STATCOM) – Electrical testing

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.200; 29.240.99

ISBN 978-2-8322-4521-7

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
3.1 Insulation co-ordination terms	7
3.2 Power semiconductor terms	8
3.3 Operating states of converter	8
3.4 STATCOM construction terms.....	9
3.5 Valve structure terms.....	10
4 General requirements	11
4.1 Guidelines for the performance of type tests	11
4.1.1 General	11
4.1.2 Dielectric tests	11
4.1.3 Operational tests	11
4.1.4 Electromagnetic interference tests	11
4.1.5 Evidence in lieu	11
4.1.6 Test object.....	12
4.1.7 Test procedure	12
4.1.8 Ambient temperature for testing.....	12
4.1.9 Frequency for testing.....	12
4.1.10 Conditions to be considered in determination of type test parameters	12
4.1.11 Test reports	12
4.2 Atmospheric correction factor	12
4.3 Treatment of redundancy	13
4.3.1 Operational tests	13
4.3.2 Dielectric tests.....	13
4.4 Permissible component failures during type testing	14
5 List of tests.....	14
6 Operational tests	15
6.1 Purpose of tests.....	15
6.2 Test object.....	15
6.3 Test circuit.....	16
6.4 Maximum continuous operating duty test	16
6.5 Maximum temporary overload operating duty test	17
6.6 Minimum start voltage test	17
7 Dielectric tests on valve support	18
7.1 Purpose of tests.....	18
7.2 Test object.....	18
7.3 Test requirements.....	18
7.3.1 Valve support DC voltage test.....	18
7.3.2 Valve support AC voltage test.....	19
7.3.3 Valve support lightning impulse test.....	20
8 Dielectric tests on multiple valve unit (MVU)	20
8.1 General.....	20
8.2 Purpose of tests.....	20
8.3 Test object.....	20

8.4	Test requirements	20
8.4.1	MVU AC voltage test	20
8.4.2	MVU DC voltage test	21
8.4.3	MVU lightning impulse test	21
9	Dielectric tests between valve terminals	21
9.1	Purpose of the test.....	21
9.2	Test object.....	22
9.3	Test methods	22
9.3.1	General	22
9.3.2	Method 1	22
9.3.3	Method 2	23
9.4	Test requirements	23
9.4.1	Valve AC voltage or AC-DC voltage test	23
9.4.2	Valve switching impulse test	25
10	IGBT overcurrent turn-off test	26
10.1	Purpose of test	26
10.2	Test object.....	26
10.3	Test requirements	26
11	Tests for valve insensitivity to electromagnetic disturbance	27
11.1	Purpose of tests.....	27
11.2	Test object.....	27
11.3	Test requirements	27
11.3.1	General	27
11.3.2	Approach 1	27
11.3.3	Approach 2	28
11.3.4	Acceptance criteria	28
12	Short-circuit current test (optional).....	28
12.1	Purpose of tests.....	28
12.2	Test object.....	28
12.3	Test requirements	29
13	Production tests.....	29
13.1	General.....	29
13.2	Purpose of tests.....	29
13.3	Test object.....	29
13.4	Test requirements	29
13.5	Production test objectives	30
13.5.1	Visual inspection	30
13.5.2	Connection check	30
13.5.3	Voltage-grading circuit check.....	30
13.5.4	Control, protection and monitoring circuit checks	30
13.5.5	Voltage withstand check	30
13.5.6	Turn-on/turn-off check	30
13.5.7	Pressure test	30
14	Presentation of type test results	30
Annex A (informative)	Overview of STATCOM valves	32
A.1	General.....	32
A.2	STATCOM applications and operating limits	32
A.3	Overview of STATCOM valve types.....	33

A.4	STATCOMs based on switch type valve	33
A.4.1	General	33
A.4.2	Two-level converter	34
A.4.3	Three-level converters	34
A.4.4	Multi-level converters.....	35
A.5	STATCOMs based on controllable voltage source type valve	36
A.6	Valve switching principles	37
Annex B (informative)	Valve component fault tolerance.....	39
Bibliography	40
Figure A.1	– STATCOM $U-I$ characteristics	33
Figure A.2	– Two-level converter	34
Figure A.3	– Three-level NPC converter.....	35
Figure A.4	– Three-level flying capacitor converter	35
Figure A.5	– Modular multilevel converter	36
Figure A.6	– Single-phase full-bridge converter.....	37
Figure A.7	– Two-level converter output voltage	37
Figure A.8	– Output voltage shape of three-level converter and modular multi-level converter	38
Table 1	– Minimum number of valve levels to be tested as a function of valve levels per valve.....	12
Table 2	– Valve level faults permitted during type tests.....	14
Table 3	– List of type tests	15

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**VOLTAGE SOURCED CONVERTER (VSC) VALVES FOR STATIC
SYNCHRONOUS COMPENSATOR (STATCOM) –
ELECTRICAL TESTING**

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.

International Standard IEC 62927 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 International Standard is based on the following documents:

CDV	Report on voting
22F/412/CDV	22F/431A/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.

A bilingual version of this publication may be issued at a later date.

The contents of the corrigendum of December 2017 have been included in this copy.

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.

VOLTAGE SOURCED CONVERTER (VSC) VALVES FOR STATIC SYNCHRONOUS COMPENSATOR (STATCOM) – ELECTRICAL TESTING

1 Scope

This document applies to self-commutated valves, for use in voltage sourced converter (VSC) for static synchronous compensator (STATCOM). It is restricted to electrical type and production tests.

The tests specified in this document are based on air insulated valves. For other types of valves, the test requirements and acceptance criteria are agreed between the purchaser and the supplier.

2 Normative references

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 60060 (all parts), *High-voltage test techniques*

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60071-1:2006, *Insulation co-ordination – Part 1: Definitions, principles and rules*

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

IEC 62501, *Voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) power transmission – Electrical testing*