

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Static var compensators (SVC) – Testing of thyristor valves

Compensateurs statiques de puissance réactive (SVC) – Essais des valves à thyristors

IEC 61954:2011

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CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions	7
4 General requirements for type, production and optional tests.....	9
4.1 Summary of tests	9
4.2 Objectives of tests.....	10
4.2.1 General	10
4.2.2 Dielectric tests	10
4.2.3 Operational tests.....	10
4.2.4 Electromagnetic interference tests	11
4.2.5 Production tests.....	11
4.2.6 Optional tests	11
4.3 Guidelines for the performance of type and optional tests.....	11
4.4 Test conditions.....	12
4.4.1 General	12
4.4.2 Valve temperature at testing	13
4.4.3 Redundant thyristor levels.....	13
4.5 Permissible component failures during type testing.....	14
4.6 Documentation of test results	14
4.6.1 Test reports to be issued.....	14
4.6.2 Contents of a type test report	15
5 Type tests on TCR and TSR valves.....	15
5.1 Dielectric tests between valve terminals and earth.....	15
5.1.1 General	15
5.1.2 AC test	16
5.1.3 Lightning impulse test	16
5.2 Dielectric tests between valves (MVU only).....	17
5.2.1 General	17
5.2.2 AC test	17
5.2.3 Lightning impulse test	18
5.3 Dielectric tests between valve terminals	18
5.3.1 General	18
5.3.2 AC test	18
5.3.3 Switching impulse test.....	20
5.4 Operational tests.....	21
5.4.1 Periodic firing and extinction test.....	21
5.4.2 Minimum a.c. voltage test	22
5.4.3 Temperature rise test.....	23
6 Type tests on TSC valves	23
6.1 Dielectric tests between valve terminals and earth.....	23
6.1.1 General	23
6.1.2 AC-DC test	24
6.1.3 Lightning impulse test	26
6.2 Dielectric tests between valves (for MVU only).....	26
6.2.1 General	26

6.2.2	AC-DC test	26
6.2.3	Lightning impulse test	28
6.3	Dielectric tests between valve terminals	29
6.3.1	General	29
6.3.2	AC-DC test	29
6.3.3	Switching impulse test.....	31
6.4	Operational tests.....	32
6.4.1	Overcurrent tests	32
6.4.2	Minimum a.c. voltage test	35
6.4.3	Temperature rise test.....	36
7	Electromagnetic interference tests	36
7.1	Objectives.....	36
7.2	Test procedures	36
7.2.1	General	36
7.2.2	Switching impulse test.....	37
7.2.3	Non-periodic firing test.....	37
8	Production tests.....	37
8.1	General.....	37
8.2	Visual inspection	37
8.3	Connection check.....	37
8.4	Voltage-dividing/damping circuit check.....	38
8.5	Voltage withstand check.....	38
8.6	Check of auxiliaries.....	38
8.7	Firing check	38
8.8	Cooling system pressure test	38
8.9	Partial discharge tests.....	38
9	Optional tests on TCR and TSR valves.....	38
9.1	Overcurrent test.....	38
9.1.1	Overcurrent with subsequent blocking	38
9.1.2	Overcurrent without blocking.....	39
9.2	Positive voltage transient during recovery test	39
9.2.1	Objectives.....	39
9.2.2	Test values and waveshapes	39
9.2.3	Test procedures.....	40
9.3	Non-periodic firing test	40
9.3.1	Objectives.....	40
9.3.2	Test values and waveshapes	40
9.3.3	Test procedures.....	42
10	Optional tests on TSC valves	42
10.1	Positive voltage transient during recovery test	42
10.1.1	Test objective	42
10.1.2	Test values and waveshapes	42
10.1.3	Test procedures.....	42
10.2	Non-periodic firing test	43
10.2.1	Objectives.....	43
10.2.2	Test values and waveshapes	43
10.2.3	Test procedures.....	44
	Figure 1 – TSC branch	33

Figure 2 – One-loop overcurrent..... 34
Figure 3 – Two-loop overcurrent..... 35

Table 1 – List of tests..... 9
Table 2 – Number of thyristor levels permitted to fail during type tests 15

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STATIC VAR COMPENSATORS (SVC) – TESTING OF THYRISTOR VALVES

FOREWORD

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IEC 61954 edition 2.2 contains the second edition (2011-04) [documents 22F/217/CDV and 22F/231A/RVC], its amendment 1 (2013-04) [documents 22F/274/CDV and 22F/287A/RVC] and its amendment 2 (2017-04) [documents 22F/409/CDV and 22F/418A/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 61954 has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronics.

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

- a) Definitions of terms “thyristor level”, “valve section”, “valve base electronics” and “redundant thyristor levels” have been changed for clarification.
- b) Conditions of testing thyristor valve sections instead of a complete thyristor valve have been defined.
- c) The requirement has been added that if, following a type test, one thyristor level has become short-circuited, then the failed level shall be restored and this type test repeated.
- d) The time period of increasing the initial test voltage from 50 % to 100 % during type a.c. dielectric tests on TSC, TCR or TSR valves has been set equal to approximately 10 s.
- e) The duration of test voltage U_{ts2} during type a.c.-d.c. dielectric tests between TSC valve terminals and earth as well as the duration of test voltage U_{tvv2} during dielectric tests between TSC valves (for MVU only) has been changed from 30 min to 3 h.
- f) The reference on the number of pulses per minute of the periodic partial discharge recorded during a.c.-d.c. dielectric tests on TSC valves and exceeding the permissible level has been deleted.

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

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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STATIC VAR COMPENSATORS (SVC) – TESTING OF THYRISTOR VALVES

1 Scope

This International Standard defines type, production and optional tests on thyristor valves used in thyristor controlled reactors (TCR), thyristor switched reactors (TSR) and thyristor switched capacitors (TSC) forming part of static VAR compensators (SVC) for power system applications. The requirements of the standard apply both to single valve units (one phase) and to multiple valve units (several phases).

Clauses 4 to 7 detail the type tests, i.e. tests which are carried out to verify that the valve design meets the requirements specified. Clause 8 covers the production tests, i.e. tests which are carried out to verify proper manufacturing. Clauses 9 and 10 detail optional tests, i.e. tests additional to the type and production tests.

2 Normative references

The following referenced documents are indispensable for the application 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 60060-2, *High-voltage test techniques – Part 2: Measuring systems*

IEC 60071 (all parts), *Insulation co-ordination*

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

IEC 60071-1:2006/AMD1:2010

IEC 60270, *High-voltage test techniques – Partial discharge measurements*

IEC 60700-1:2008/2015, *Thyristor valves for high-voltage direct current (HVDC) power transmission – Part 1: Electrical testing*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1

thyristor level

part of a thyristor valve comprising a thyristor, or thyristors connected in parallel or antiparallel, together with their immediate auxiliaries and reactor, if any

3.2

thyristor (series) string

series connected thyristors forming one direction of a thyristor valve

3.3

valve reactor

reactor incorporated within some valves for limitation of stresses

NOTE For testing purposes it is considered an integral part of the valve.

3.4

valve section

electrical assembly, comprising a number of thyristors and other components, which exhibits pro-rated electrical properties of a complete thyristor valve but only a portion of the full voltage blocking capability of the thyristor valve and which can be used for tests

3.5

thyristor valve

electrically and mechanically combined assembly of thyristor levels, complete with all connections, auxiliary components and mechanical structures, which can be connected in series with each phase of the reactor or capacitor of a SVC

3.6

valve structure

physical structure which insulates the valves to the appropriate level above earth potential and from each other

3.7

valve base electronics

VBE

electronic unit, at earth potential, which is the interface between the control system of the SVC and the thyristor valves

3.8

multiple valve unit

MVU

assembly of several valves in the same physical structure which cannot be separated for test purposes (e.g. three-phase valves)

3.9

redundant thyristor levels

the maximum number of thyristor levels in the thyristor valve that may be short-circuited, externally or internally, during service without affecting the safe operation of the thyristor valve as demonstrated by type tests; and which if and when exceeded, would require either the shutdown of the thyristor valve to replace the failed thyristors, or the acceptance of increased risk of failures

3.10

voltage breakover (VBO) protection

means of protecting the thyristors from excessive voltage by firing them at a predetermined voltage

4 General requirements for type, production and optional tests

4.1 Summary of tests

Table 1 lists the tests given in the following clauses and subclauses.

Table 1 – List of tests

Test	Clause or subclause		Test object
	TCR/TSR	TSC	
Dielectric tests between valve terminals and earth (type tests)			
AC test	5.1.2		Valve
AC-DC test		6.1.2	Valve
Lightning impulse test	5.1.3	6.1.3	Valve
Dielectric tests between valves (MVU only) (type tests)			
AC test	5.2.2		MVU
AC-DC test		6.2.2	MVU
Lightning impulse test	5.2.3	6.2.3	MVU
Dielectric tests between valve terminals (type tests)			
AC test	5.3.2		Valve
AC-DC test		6.3.2	Valve
Switching impulse test	5.3.3	6.3.3	Valve
Operational tests (type tests)			
Periodic firing and extinction test	5.4.1		Valve or valve section
Overcurrent test		6.4.1	Valve or valve section
Minimum a.c. voltage test	5.4.2	6.4.2	Valve or valve section
Temperature rise test	5.4.3	6.4.3	Valve or valve section
Electromagnetic interference tests (type tests)			
Switching impulse test	7.2.2	7.2.2	Valve
Non-periodic firing test	7.2.3	7.2.3	Valve
Production tests			
Visual inspection	8.2	8.2	
Connection check	8.3	8.3	
Voltage dividing/damping circuit check	8.4	8.4	
Voltage withstand check	8.5	8.5	
Check of auxiliaries	8.6	8.6	
Firing check	8.7	8.7	
Cooling system pressure test	8.8	8.8	
Partial discharge tests	8.9	8.9	
Optional tests			
Overcurrent test	9.1		Valve or valve section
Positive voltage transient during recovery test	9.2	10.1	Valve or valve section
Non-periodic firing test	9.3	10.2	Valve

4.2 Objectives of tests

4.2.1 General

The tests described apply to the valve (or valve sections), the valve structure and those parts of the coolant distribution system and firing and monitoring circuits which are contained within the valve structure or connected between the valve structure and earth. Other equipment, such as valve control and protection and valve base electronics may be essential for demonstrating the correct function of the valve during the tests but are not in themselves the subject of the tests.

4.2.2 Dielectric tests

4.2.2.1 General

Tests for the following dielectric stresses are specified:

- a.c. voltage;
- combined a.c. and d.c. voltage (TSC only);
- impulse voltages.

In the interest of standardization with other equipment, lightning impulse tests between valve terminals and earth and between phases of an MVU are included. For tests between valve terminals, the only impulse test specified is a switching impulse.

4.2.2.2 Tests on valve structure

Tests are defined for the voltage withstand requirements between a valve (with its terminals short-circuited) and earth, and also between valves for MVU. The tests shall demonstrate that

- sufficient clearances have been provided to prevent flashovers;
- there is no disruptive discharge in the insulation of the valve structure, cooling ducts, light guides and other insulation parts of the pulse transmission and distribution systems;
- partial discharge inception and extinction voltages under a.c. and d.c. conditions are above the maximum steady-state operating voltage appearing on the valve structure.

4.2.2.3 Tests between valve terminals

The purpose of these tests is to verify the design of the valve with respect to its capability to withstand overvoltages between its terminals. The tests shall demonstrate that

- sufficient internal insulation has been provided to enable the valve to withstand specified voltages;
- partial discharge inception and extinction voltages under a.c. and d.c. conditions are above the maximum steady-state operating voltage appearing between valve terminals;
- the protective overvoltage firing system (if provided) works as intended;
- the thyristors have adequate du/dt capability for in-service conditions. (In most cases the specified tests are sufficient; however in some exceptional cases additional tests may be required).

4.2.3 Operational tests

The purpose of these tests is to verify the valve design for combined voltage and current stresses under normal and abnormal repetitive conditions as well as under transient fault conditions. They shall demonstrate that, under specified conditions:

- the valve functions properly;