



SLOVENSKI STANDARD
oSIST prEN IEC 61954:2021
01-april-2021

Statični kompenzatorji jalove energije (var) - Preskušanje tiristorskih elektronk

Static var compensators (SVC) - Testing of thyristor valves

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

Ta slovenski standard je istoveten z: prEN IEC 61954:2021

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ICS:

29.240.99	Druga oprema v zvezi z omrežji za prenos in distribucijo električne energije	Other equipment related to power transmission and distribution networks
31.080.20	Tiristorji	Thyristors

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22F/608/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: IEC 61954 ED3	
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IEC SC 22F : POWER ELECTRONICS FOR ELECTRICAL TRANSMISSION AND DISTRIBUTION SYSTEMS	
SECRETARIAT: Russian Federation	SECRETARY: Mr Lev Travin
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 115	PROPOSED HORIZONTAL STANDARD: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: <input type="checkbox"/> EMC <input type="checkbox"/> ENVIRONMENT <input type="checkbox"/> QUALITY ASSURANCE <input type="checkbox"/> SAFETY	
<input checked="" type="checkbox"/> SUBMITTED FOR CENELEC PARALLEL VOTING	<input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING
<p>Attention IEC-CENELEC parallel voting</p> <p>The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.</p> <p>The CENELEC members are invited to vote through the CENELEC online voting system.</p>	

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TITLE:

Static var compensators (SVC) - Testing of thyristor valves

PROPOSED STABILITY DATE: 2026

NOTE FROM TC/SC OFFICERS:

As the plenary meeting of SC 22F was cancelled in 2020 due to COVID-19 pandemic (see 22F/591/INF), comments and proposals of National Committees on 22F/589/CD contained in 22F/600/CC were discussed by correspondence by a group consisting of Mr. Huigao Zhou, the Chair of SC 22F, Mr. Lev Travin, SC 22F secretary, Mr. Marcio de Oliveira, the convenor of SC 22F/MT 10 and MT 10 members.

The decision to develop the current CDV, based on the results of this discussion was taken by Mr. Huigao Zhou, the Chair of SC 22F (supported by Mr. Lev Travin, SC 22F secretary).

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**STATIC VAR COMPENSATORS (SVC) –
TESTING OF THYRISTOR VALVES**
FOREWORD

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International Standard IEC 61954 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 third edition cancels and replaces the second edition published in 2011-04 [documents 22F/217/CDV and 22F/231A/RVC], Amendment 1:2013-04 [documents 22F/274/CDV and 22F/287A/RVC] and Amendment 2:2017-04 [documents 22F/409/CDV and 22F/418A/RVC]. The technical content is identical to the base edition and its amendments. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition - important clarifications were made in 4.4.1.2, 5.1.2.2, 5.1.3.2, 5.2.3.2, 6.1.3.2 and 9.3.2

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

FDIS	Report on voting
22F/XX/FDIS	22F/XX/RVD

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154 Full information on the voting for the approval of this International Standard can be found in the report
155 on voting indicated in the above table.

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

157 The committee has decided that the contents of this document will remain unchanged until the stability
158 date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific
159 document. At this date, the document will be

- 160 • reconfirmed,
- 161 • withdrawn,
- 162 • replaced by a revised edition, or
- 163 • amended.

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STATIC VAR COMPENSATORS (SVC) – TESTING OF THYRISTOR VALVES

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1 Scope

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

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

2 Normative references

193 The following referenced documents are indispensable for the application of this document. For dated
194 references, only the edition cited applies. For undated references, the latest edition of the referenced
195 document (including any amendments) applies.

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

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

198 IEC 60060-2, *High-voltage test techniques – Part 2: Measuring systems*

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

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

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

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

3 Terms and definitions

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

3.1

thyristor level

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

3.2

thyristor (series) string

212 series connected thyristors forming one direction of a thyristor valve

3.3

valve reactor

215 reactor incorporated within some valves for limitation of stresses

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

217 **3.4**
218 **valve section**

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

222 **3.5**
223 **thyristor valve**

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

227 **3.6**
228 **valve structure**

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

231 **3.7**
232 **valve base electronics**
233 **VBE**

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

236 **3.8**
237 **multiple valve unit**
238 **MVU**

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

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241 **3.9**
242 **redundant thyristor levels**

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

247 **3.10**
248 **voltage breakover (VBO) protection**

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

250

251 **4 General requirements for type, production and optional tests**252 **4.1 Summary of tests**

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

254 **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 or valve section

256 4.2 Objectives of tests

257 4.2.1 General

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

263 4.2.2 Dielectric tests

264 4.2.2.1 General

265 Tests for the following dielectric stresses are specified:

- 266 – a.c. voltage;
- 267 – combined a.c. and d.c. voltage (TSC only);
- 268 – impulse voltages.

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

272 4.2.2.2 Tests on valve structure

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

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

280 4.2.2.3 Tests between valve terminals

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

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

289 4.2.3 Operational tests

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

- 293 – the valve functions properly;
- 294 – the turn-on and turn-off voltage and current stresses are within the capabilities of the thyristors and
295 other internal circuits;
- 296 – the cooling provided is adequate and no component is overheated;

- 297 – the overcurrent withstand capability of the valve is adequate.

298 **4.2.4 Electromagnetic interference tests**

299 The principal objective of these tests is to demonstrate the immunity of the valve to electromagnetic
300 interference from within the valve and from outside the valve. Generally, immunity to electromagnetic
301 interference is demonstrated by monitoring of the valve during other tests.

302 **4.2.5 Production tests**

303 The objective of tests is to verify proper manufacture. The production tests shall demonstrate that

- 304 – all materials, components and sub-assemblies used in the valve have been correctly installed;
- 305 – the valve equipment functions as intended, and predefined parameters are within prescribed
306 acceptance limits;
- 307 – thyristor levels and valve or valve sections have the necessary voltage withstand capability;
- 308 – consistency and uniformity in production is achieved.

309 **4.2.6 Optional tests**

310 Optional tests are additional tests which may be performed, subject to agreement between the
311 purchaser and the supplier. The objectives are the same as for the operational tests specified in 4.2.3.
312 The test object is normally one valve or appropriate equivalent number of valve sections.

313 **4.3 Guidelines for the performance of type and optional tests**

314 The following principles shall apply: (standards.iteh.ai)

- 315 – type tests shall be performed on at least one valve or on an appropriate number of valve sections,
316 as indicated in Table 1 (see 4.1), to verify that the valve design meets the specified requirements.
317 All type tests shall be performed on the same valve(s) or valve section(s);
- 318 – provided that the valve is demonstrably similar to one previously tested, the supplier may submit a
319 certified report of any previous type test, at least equal to the requirements specified in the
320 contract, in lieu of the type test;
- 321 – for type tests performed on valve sections, the total number of thyristor levels subjected to such
322 type tests shall be at least equal to the number of thyristor levels in a valve;
- 323 – the valve or valve sections used for type tests shall first pass all production tests. On completion of
324 the type test programme, the valve or valve sections shall be checked again for compliance with
325 the production test criteria;
- 326 – material for the type tests shall be selected at random;
- 327 – the dielectric tests shall be performed in accordance with IEC 60060-1 and IEC 60060-2 where
328 applicable;
- 329 – individual tests may be performed in any order.

330 NOTE Tests involving partial discharge measurement may provide added confidence if performed at the end of the dielectric
331 type test programme.

332 **4.4 Test conditions**

333 **4.4.1 General**

334 **4.4.1.1 Dielectric test objects**

335 Dielectric tests shall be performed on completely assembled valves, whereas some operational tests
336 may be performed on either complete valves or valve sections.

337 The valve shall be assembled with all auxiliary components except for the valve arrester, if used.
338 Unless otherwise specified, the valve electronics shall be energized. The cooling and insulating fluids