
Zaporedni kondenzatorji za elektroenergetske sisteme - 4. del: Zaporedni kondenzatorji s tiristorskim upravljanjem

Series capacitors for power systems - Part 4: Thyristor controlled series capacitors

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Condensateurs série destinés à être installés sur des réseaux - Partie 4: Condensateurs série commandés par thyristors

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TITRE:

Condensateurs série destinés à être installés sur des réseaux - Partie 4: Condensateurs série commandés par thyristors

DATE DE STABILITÉ PROPOSÉE: 2025

NOTE DES RESPONSABLES DU TC/SC:

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Since this is a second CDV it will be circulated for 8 weeks.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SERIES CAPACITORS FOR POWER SYSTEMS –

107

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Part 4: Thyristor controlled series capacitors

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FOREWORD

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142 rights. IEC shall not be held responsible for identifying any or all such patent rights.

143 IEC 60143-4 has been prepared by IEC technical committee 33: Power capacitors and their
144 applications. It is an International Standard.

145 This second edition cancels and replaces the first edition published in 2010. This edition
146 constitutes a technical revision.

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

149 a) Thyristor valve testing requirements refer to IEC 62823.

150 b) Equation 1 in paragraph 4.2 corrected.

151 c) Hardware-in-the-loop (HIL) Tests, paragraph 7.4.3 replaces previously specified real time
152 protection and control system test with network simulator.

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

Draft	Report on voting
33/XX/FDIS	33/XX/RVD

154
155 Full information on the voting for its approval can be found in the report on voting indicated in
156 the above table.

157 The language used for the development of this International Standard is English.

158 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
159 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
160 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
161 described in greater detail at www.iec.ch/standardsdev/publications.

162 This part of IEC 60143 is to be used in conjunction with the following standards:

- 163 – IEC 60143-1:2015, *Series capacitors for power systems – Part 1: General*
164 – IEC 60143-2:2012, *Series capacitors for power systems – Part 2: Protective equipment for*
165 *series capacitor banks*
166 – IEC 60143-3:2015, *Series capacitors for power systems – Part 3: Internal fuses*

167 This draft was written based on the current standard IEC 60143-4 ED 1.0; changes compared
168 with the aforesaid document are highlighted in red.

169 A list of all parts of IEC 60143 series, under the general title *Series capacitors for power*
170 *systems* can be found on the iec website.

171 The committee has decided that the contents of this document will remain unchanged until the
172 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
173 specific document. At this date, the document will be

- 174 • reconfirmed,
175 • withdrawn,
176 • replaced by a revised edition, or
177 • amended.

178

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180

SERIES CAPACITORS FOR POWER SYSTEMS –

Part 4: Thyristor controlled series capacitors

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187 **1 Scope**

188 This part of IEC 60143 specifies testing of thyristor controlled series capacitor (TCSC)
189 installations used in series with transmission lines. This document also addresses issues that
190 consider ratings for TCSC thyristor valve assemblies, capacitors, and reactors as well as TCSC
191 control characteristics, protective features, cooling system and system operation.

192 **2 Normative references**

193 The following documents are referred to in the text in such a way that some or all of their content
194 constitutes requirements of this document. For dated references, only the edition cited applies.
195 For undated references, the latest edition of the referenced document (including any
196 amendments) applies.

197 NOTE If there is a conflict between this part of IEC 60143 and a standard listed below in Clause 2, this document
198 prevails.

199 IEC 60050-436, *International Electrotechnical Vocabulary (IEV) – Chapter 436: Power*
200 *capacitors*

201 IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Tests B: Dry heat*

202 IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

203 IEC 60076-1, *Power transformers – Part 1: General*

204 IEC 60076-6:2007, *Power transformers – Part 6: Reactors*

205 IEC 60143-1:2015, *Series capacitors for power systems – Part 1: General*

206 IEC 60143-2:2012, *Series capacitors for power systems – Part 2: Protective equipment for*
207 *series capacitor banks*

208 IEC 60143-3:2015, *Series capacitors for power systems – Part 3: Internal fuses*

209 IEC 60255-27, *Electrical relays – Part 5: Insulation coordination for measuring relays and*
210 *protection equipment – Requirements and tests*

211 IEC 60255-21 (all parts), *Electrical relays – Vibration, shock, bump and seismic tests on*
212 *measuring relays and protection equipment*

213 IEC 61000-4 (all parts), *Electromagnetic compatibility (EMC) – Part 4: Testing and*
214 *measurement techniques*

215 IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement*
216 *techniques – Voltage dips, short interruptions and voltage variations immunity tests for*
217 *equipment with input current up to 16 A per phase*

218 IEC 61000-4-29, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement*
 219 *techniques – Voltage dips, short interruptions and voltage variations on d.c. input port immunity*
 220 *tests*

221 *IEC 62823:2015, Thyristor valves for thyristor controlled series capacitors (TCSC) – Electrical*
 222 *testing*
 223 *IEC 62823:2015/AMD1:2019*

224 NOTE Additional useful references, not explicitly referenced in the text, are listed in the Bibliography.

225 **3 Terms, definitions and abbreviated terms**

226 For the purposes of this document, the terms and definitions given in IEC 60143-1, IEC 60143-
 227 2, IEC 60143-3, some taken from IEC 60050-436 and the following apply.

228 ISO and IEC maintain terminological databases for use in standardization at the following
 229 addresses:

- 230 • IEC Electropedia: available at <http://www.electropedia.org/>
- 231 • ISO Online browsing platform: available at <http://www.iso.org/obp>

232 NOTE In some instances, the IEC definitions can be either too broad or too restrictive. In such a case, an additional
 233 definition or note has been included.

234

235 **3.1 Terms and definitions**

236 **3.1.1**

237 **thyristor valve**

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

241 **3.1.2**

242 **bypass current**

243 the current flowing through the bypass switch, protective device, thyristor valve, or other
 244 devices, in parallel with the series capacitor, when the series capacitor is bypassed

245 **3.1.3**

246 **capacitive range**

247 TCSC operation resulting in an effective increase of the power frequency reactance of the series
 248 capacitor (see Figure 5)

249 **3.1.4**

250 **temporary overload**

251 short duration (typically 30 min) overload capability of the TCSC at rated frequency and ambient
 252 temperature range

253 **3.1.5**

254 **dynamic overload**

255 short duration (typically 10 s) overload capability of the TCSC at rated frequency and ambient
 256 temperature range (see Figure 5 and Figure 10)

257 **3.1.6**

258 **platform-to-ground cooling/air-handling insulator**

259 insulator that encloses cooling/air handling paths between platform and ground level

- 260 **3.1.7**
261 **thyristor-controlled series capacitor bank**
262 **TCSC**
263 assembly of thyristor valves, TCSC reactor(s), capacitors, and associated auxiliaries, such as
264 structures, support insulators, switches, and protective devices, with control equipment required
265 for a complete operating installation
- 266 **3.1.8**
267 **valve electronics**
268 **VE**
269 electronic circuits at valve potential(s) that perform control functions
- 270 **3.1.9**
271 **TCSC reactor**
272 one or more reactors connected in series with the thyristor valve (see Figure 1, item 12)
- 273 **3.1.10**
274 **valve varistor**
275 assembly of varistor units that limit overvoltages to a given value
- 276 Note 1 to entry: In the context of TCSCs, the valve varistor is typically defined by its ability to limit the voltage
277 across a thyristor valve to a specified protective level while absorbing energy. The valve varistor is designed to
278 withstand the temporary overvoltages and continuous operating voltage across the thyristor valve.
- 279 **3.1.11**
280 **valve blocking**
281 operation to prevent further firing of a thyristor valve by inhibiting triggering
- 282 **3.1.12**
283 **valve deblocking**
284 operation to permit firing of a thyristor valve by removing valve blocking action
- 285 **3.1.13**
286 **valve base electronics**
287 **VBE**
288 electronic unit, at earth potential, which is the interface between the control system of the TCSC
289 and the thyristor valves
- 290 **3.1.14**
291 **capacitor current**
292 I_C
293 current through the series capacitor (see Figure 2)
- 294 **3.1.15**
295 **line current**
296 I_L
297 power frequency line current (see Figure 2)
- 298 **3.1.16**
299 **rated current**
300 I_N
301 RMS line current (I_L) at which the TCSC should be capable of continuous operation with rated
302 reactance (X_N) and rated voltage (U_N)
- 303 **3.1.17**
304 **valve current**
305 I_V
306 current through the thyristor valve (see Figure 2)

307 **3.1.18**
308 **capacitor voltage**

309 U_C
310 voltage across the TCSC (see Figure 2)

311 **3.1.19**
312 **protective level**

313 U_{PL}
314 magnitude of the maximum peak of the power frequency voltage appearing across the
315 overvoltage protector during a power system fault

316 Note 1 to entry: The protective level may be expressed in terms of the actual peak voltage across a segment or in
317 terms of the per unit of the peak of the rated voltage across the capacitor.

318 **3.1.20**
319 **rated TCSC voltage**

320 U_N
321 power frequency voltage across each phase of the TCSC that can be continuously controlled
322 at **rated** reactance (X_N), rated current (I_N), frequency, and reference ambient temperature range

323 **3.1.21**
324 **apparent reactance**

325 $X(\alpha)$
326 TCSC apparent power frequency reactance as a function of thyristor control angle (α) (see
327 Figure 4)

328 **3.1.22**
329 **nominal frequency**

330 f_N
331 frequency of the system in which the TCSC is intended to be used

332 **3.1.23**
333 **rated capacitance**

334 C_N
335 capacitance value for which the TCSC capacitor has been designed

336 **3.1.24**
337 **physical reactance**

338 X_C
339 power frequency reactance for each phase of the TCSC bank with thyristors blocked and a
340 capacitor internal dielectric temperature of 20 °C

$$341 \quad X_C = 1 / (2\pi f_N \times C_N)$$

342 **3.1.25**
343 **boost factor**

344 k_B
345 ratio of $X(\alpha)$ divided by X_C ; $k_B = X(\alpha) / X_C$

346 **3.1.26**
347 **rated reactance**

348 X_N
349 **rated** power frequency reactance for each phase of the TCSC with rated line I_N and **rated** boost
350 factor