
Zaporedni kondenzatorji za elektroenergetske sisteme - 4. del: Zaporedni kondenzatorji s tiristorskim upravljanjem (IEC 60143-4:2010)

Series capacitors for power systems - Part 4: Thyristor controlled series capacitors (IEC 60143-4:2010)

Reihen Kondensatoren für Starkstromanlagen - Teil 4: Thyristorgesteuerte Reihen Kondensatoren (IEC 60143-4:2010)

Condensateurs série destinés à être installés sur des réseaux - Partie 4: Condensateurs série commandés par thyristors (CEI 60143-4:2010)

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Ta slovenski standard je istoveten z: EN 60143-4:2010

ICS:

31.060.70 Močnostni kondenzatorji Power capacitors

SIST EN 60143-4:2011

en

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60143-4

December 2010

ICS 29.240.99; 31.060.70

English version

**Series capacitors for power systems -
Part 4: Thyristor controlled series capacitors
(IEC 60143-4:2010)**

Condensateurs série destinés à être
installés sur des réseaux -
Partie 4: Condensateurs série
commandés par thyristors
(CEI 60143-4:2010)

Reihencondensatoren für
Starkstromanlagen -
Teil 4: Thyristorgesteuerte
Reihencondensatoren
(IEC 60143-4:2010)

iTeh STANDARD PREVIEW

This European Standard was approved by CENELEC on 2010-12-01. 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.

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Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 33/472/FDIS, future edition 1 of IEC 60143-4, prepared by IEC TC 33, Power capacitors, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60143-4 on 2010-12-01.

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

- EN 60143-1:2004, *Series capacitors for power systems – Part 1: General*
- EN 60143-2:1994, *Series capacitors for power systems – Part 2: Protective equipment for series capacitor banks*
- EN 60143-3:1998, *Series capacitors for power systems – Part 3: Internal fuses*

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2011-09-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2013-12-01

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60143-4:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

- | | | |
|-------------------|------|-----------------------------|
| [1] IEC 60068-1 | NOTE | Harmonized as EN 60068-1. |
| [2] IEC 60721-1 | NOTE | Harmonized as EN 60721-1. |
| [3] IEC 60068-3-3 | NOTE | Harmonized as EN 60068-3-3. |
| [4] IEC 60060-2 | NOTE | Harmonized as EN 60060-2. |
| [5] IEC 61000-4-2 | NOTE | Harmonized as EN 61000-4-2. |

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-436	-	International Electrotechnical Vocabulary (IEV) - Chapter 436: Power capacitors	-	-
IEC 60060-1	-	High-voltage test techniques - Part 1: General definitions and test requirements	EN 60060-1	-
IEC 60068-1	-	Environmental testing - Part 1: General and guidance	EN 60068-1	-
IEC 60068-2-2	-	Environmental testing - Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	-
IEC 60068-2-78	-	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	-
IEC 60071-1	-	Insulation co-ordination - Part 1: Definitions, principles and rules	EN 60071-1	-
IEC 60071-2	-	Insulation co-ordination - Part 2: Application guide	EN 60071-2	-
IEC 60076-1	1993	Power transformers - Part 1: General	EN 60076-1	1997
IEC 60076-6	2007	Power transformers - Part 6: Reactors	EN 60076-6	2008
IEC 60143-1	2004	Series capacitors for power systems - Part 1: General	EN 60143-1	2004
IEC 60143-2	1994	Series capacitors for power systems - Part 2: Protective equipment for series capacitor banks	EN 60143-2	1994
IEC 60143-3	1998	Series capacitors for power systems - Part 3: Internal fuses	EN 60143-3	1998

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60255-5	-	Electrical relays - Part 5: Insulation coordination for measuring relays and protection equipment - Requirements and tests	EN 60255-5	-
IEC 60255-21	Series	Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment	EN 60255-21	Series
IEC 60270	-	High-voltage test techniques - Partial discharge measurements	EN 60270	-
IEC 61000-4-29	-	Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests	EN 61000-4-29	-
IEC 61954	1999	Power electronics for electrical transmission and distribution systems - Testing of thyristor valves for static VAR compensators	EN 61954	1999

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IEC 60143-4

Edition 1.0 2010-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Series capacitors for power systems –
Part 4: Thyristor controlled series capacitors**

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

XA

ICS 29.240.99; 31.060.70

ISBN 978-2-88912-242-4

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SERIES CAPACITORS FOR POWER SYSTEMS –**Part 4: Thyristor controlled series capacitors**

FOREWORD

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

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

- IEC 60143-1:2004, *Series capacitors for power systems – Part 1: General*
- IEC 60143-2:1994, *Series capacitors for power systems – Part 2: Protective equipment for series capacitor banks*
- IEC 60143-3:1998, *Series capacitors for power systems – Part 3: Internal fuses*

The text of this standard is based on the following documents:

FDIS	Report on voting
33/472/FDIS	33/478/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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

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

NOTE This standard contains excerpts reproduced from IEEE Std 1534-2002. IEEE Std 1534-2002 IEEE Recommended Practice for Specifying Thyristor-Controlled Series Capacitors. Reprinted with permission from IEEE, 3 Park Avenue, New York, NY 10016-5997 USA, Copyright 2002 IEEE.

The committee has decided that the contents of this publication 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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SERIES CAPACITORS FOR POWER SYSTEMS –

Part 4: Thyristor controlled series capacitors

1 Scope

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

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.

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

IEC 60050-436, *International Electrotechnical Vocabulary – Chapter 436: Power capacitors*

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

IEC 60068-1, *Environmental Testing – Part 1: General and guidance*
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IEC 60068-2-2, *Basic environmental testing procedures – Part 2-2: Tests – Tests B: Dry heat*

IEC 60068-2-78, *Basic environmental testing procedures – Part 2-78: Tests – Tests C: Damp heat, steady state*

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

IEC 60071-2, *Insulation co-ordination – Part 2: Application guide*

IEC 60076-1:1993, *Power transformers – Part 1: General*

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

IEC 60143-1:2004, *Series capacitors for power systems – Part 1: General*

IEC 60143-2:1994, *Series capacitors for power systems – Part 2: Protective equipment for series capacitor banks*

IEC 60143-3:1998, *Series capacitors for power systems – Part 3: Internal fuses*

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

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

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

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

IEC 61954:1999, *Power electronics for electrical transmission and distribution systems – Testing of thyristor valves for static VAR compensators*

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

3 Terms, definitions and abbreviations

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

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

3.1 Abbreviations

ETT	Electrically triggered thyristors
FACTS	Flexible ac transmission systems
FSC	Fixed series compensation
LTT	Light-triggered thyristors
MC	Master control
MTBF	Mean time between failure
MTTR	Mean time to repair
POD	Power oscillation damping
RAM	Reliability, availability, and maintainability
RIV	Radio influence voltage
RTU	Remote terminal unit
SCADA	Supervisory control and data acquisition
ER	Events recorder
FR	Fault recorder
RTDS	Real time digital simulation
SSR	Sub synchronous resonance
SVC	Static var compensator
TCR	Thyristor-controlled reactor
RMS	Root mean square

3.2 Terms and definitions

3.2.1 thyristor valve

electrically 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 TCSC

3.2.2**bypass current**

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

3.2.3**capacitive range**

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

3.2.4**temporary overload**

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

3.2.5**dynamic overload**

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

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

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

3.2.7**thyristor-controlled series capacitor bank
TCSC**

an assembly of thyristor valves, TCSC reactor(s), capacitors, and associated auxiliaries, such as structures, support insulators, switches, and protective devices, with control equipment required for a complete operating installation

3.2.8**valve electronics****VE**

electronic circuits at valve potential(s) that perform control functions

3.2.9**TCSC reactor**

one or more reactors connected in series with the thyristor valve (see NOTE This figure contains material reproduced from IEEE Std 1534-2002. IEEE Std 1534-2002 IEEE Recommended Practice for Specifying Thyristor-Controlled Series Capacitors, Copyright 2002 IEEE. All rights reserved.

Figure 1, item 12)

3.2.10**thyristor valve enclosure**

a platform-mounted enclosure containing thyristor valve(s) with associated valve cooling and electronic hardware

3.2.11**valve varistor**

an assembly of varistor units that limit overvoltages to a given value. In the context of TCSCs, the valve varistor is typically defined by its ability to limit the voltage across a thyristor valve to a specified protective level while absorbing energy. The valve varistor is designed to withstand the temporary overvoltages and continuous operating voltage across the thyristor valve

3.2.12**valve blocking**

an operation to prevent further firing of a thyristor valve by inhibiting triggering

3.2.13**valve deblocking**

an operation to permit firing of a thyristor valve by removing valve blocking action

3.2.14**valve base electronics****VBE**

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

3.2.15**voltage breakover protection****VBO**

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

3.2.16**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

3.2.17**capacitor current** I_C

current through the series capacitor (see Figure 2)

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3.2.18**line current** I_L

power frequency line current (see Figure 2)

3.2.19**rated current** I_N

the RMS line current (I_L) at which the TCSC should be capable of continuous operation with rated reactance (X_N) and rated voltage (U_N)

3.2.20**valve current** I_V

current through the thyristor valve (see Figure 2)

3.2.21**capacitor voltage** U_C

voltage across the TCSC (see Figure 2)

3.2.22**protective level** U_{PL}

magnitude of the maximum peak of the power frequency voltage appearing across the overvoltage protector during a power system fault