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Edition 2.1 2021-09
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Series capacitors for power systems – Part 2: Protective equipment for series capacitor banks

Condensateurs série destinés à être installés sur des réseaux – Partie 2: Matériel de protection pour les batteries de condensateurs série

IEC 60143-2:2012-12+AMD1:2021-09 CSV(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SERIES CAPACITORS FOR POWER SYSTEMS –

Part 2: Protective equipment for series capacitor banks

FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60143-2 edition 2.1 contains the second edition (2012-12) [documents 33/517/FDIS and 33/521/RVD] and its amendment 1 (2021-09) [documents 33/660/FDIS and 33/664/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. 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 60143-2 has been prepared by IEC technical committee 33: Power capacitors and their applications.

This second edition constitutes a technical revision.

The main changes with respect to the previous edition are:

- updated with respect to new and revised component standards;
- updates with respect to technology changes. Outdated technologies have been removed, i.e. series capacitors with dual self-triggered gaps. New technologies have been added, i.e. current sensors instead of current transformers;
- the testing of spark gaps has been updated to more clearly specify requirements and testing procedures. A new bypass making current test replaces the old discharge current test;
- Clause 5, Guide, has been expanded with more information about different damping circuits and series capacitor protections

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

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

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under 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 2: Protective equipment for series capacitor banks

1 Scope

This part of IEC 60143 covers protective equipment for series capacitor banks, with a size larger than 10 Mvar per phase. Protective equipment is defined as the main circuit apparatus and ancillary equipment, which are part of a series capacitor installation, but which are external to the capacitor part itself. The recommendations for the capacitor part are given in IEC 60143-1:2004. The protective equipment is mentioned in Clause 3 and 10.6 of IEC 60143-1:2004.

The protective equipment, treated in this standard, comprises the following items listed below:

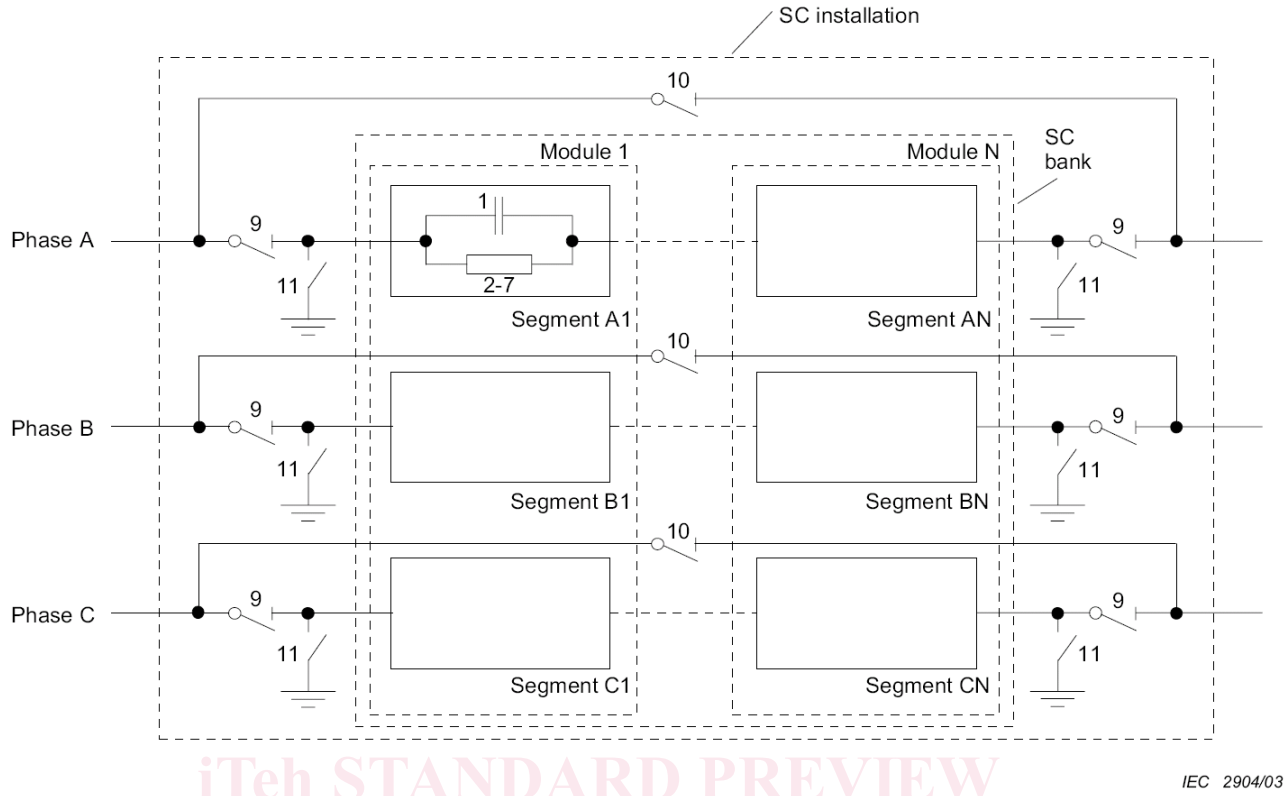
– overvoltage protector,
– protective spark gap,
– varistor,
– bypass switch,
– disconnectors and earthing switches,
– discharge current-limiting and damping equipment,
– voltage transformer,
– current sensors,
– coupling capacitor,
– signal column,
– fibre optical platform links,
– relay protection, control equipment and platform-to-ground communication equipment.

See Figure 1.

Principles involved in the application and operation of series capacitors are given in Clause 5.

Examples of fault scenarios are given in Clause 5.

Examples of protective schemes utilizing different overvoltage protectors are given in 4.1.



Key

1 assembly of capacitor units
2-7 main protective equipment
9 isolating disconnector
10 bypass disconnector
11 earth switch

Figure 1 – Typical nomenclature of a series capacitor installation

NOTE Most series capacitors are configured with a single module, unless the reactance and current requirements result in a voltage across the bank that is impractical for the supplier to achieve with one module. Normally each module has its own bypass switch but a common bypass switch can be used for more than one module. See 10.2.3 of IEC 60143-1:2004 for additional details.

The object of this standard is:

– to formulate uniform rules regarding performance, testing and rating,
– to illustrate different kinds of overvoltage protectors,
– to provide a guide for installation and operation.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60044 (all parts), *Instrument transformers*

IEC 60044-1, *Instrument transformers – Part 1: Current transformers*

IEC 60044-8, *Instrument transformers – Part 8: Electronic current transformers*

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

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

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

IEC 60099-4:2009, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

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

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

IEC 60255-21, *Electrical relays – Part 21: Vibration, shock, bump and seismic test on measuring relays and protection equipment – Section One – Vibration tests (sinusoidal)*

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

IEC 60358-1, *Coupling capacitors and capacitor dividers – Part 1: General rules*

IEC 60358-2, *Coupling capacitors and capacitor dividers – Part 2: AC or DC single-phase coupling capacitor connected between line and ground for power line carrier frequency (PLC) application*[1]

IEC 60794-1-1, *Optical fibre cables - Part 1: Generic specification – General*

IEC 60794-2, *Optical fibre cables - Part 2: Indoor cables – Sectional specification*

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 61109, *Insulators for overhead lines – Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1 000 V – Definitions, test methods and acceptance criteria*

IEC 61300-3-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examinations and measurements – Attenuation*

IEC 61869-3, *Instrument transformers – Part 3: Additional requirements for inductive voltage transformers*

IEC 61869-5, *Instrument transformers – Part 5: Additional requirements for capacitor voltage transformers*

IEC 62271-1, *High-voltage switchgear and controlgear – Part 1: Common specifications*

IEC 62271-102:2001, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC 62271-109:2008, *High-voltage switchgear and controlgear – Part 109: Alternating current series capacitor bypass switches*

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1 To be published.

IEC 62823, *Thyristor valves for thyristor controlled series capacitors (TCSC) – Electrical testing*

NOTE No standard exists for varistors for series capacitors (SC). The relevant tests for series capacitors varistors are therefore dealt with in this standard.

3 Terms and definitions

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

NOTE The definitions of capacitor parts and accessories in this standard are in accordance with IEC 60143-1:2004.

3.1
back-up gap
supplementary gap which may be set to spark over at a voltage level higher than the protective level of the primary protective device, and which is normally placed in parallel with the primary protective device

3.2
bank protection
general term for all protective equipment for a capacitor bank, or part thereof

3.3
bypass current
current flowing through the bypass switch or spark gap in parallel with the series capacitor

3.4
bypass switch
device such as a switch or a circuit-breaker used in parallel with a series capacitor and its overvoltage protector to shunt line current for a specified time, or continuously

Note 1 to entry: Besides bypassing the capacitor, this device may also have the capability of inserting the capacitor into a circuit and carrying a specified current.

Note 2 to entry: This device shall also have the capability of bypassing the capacitor during specified power system fault conditions. The operation of the device is initiated by the capacitor control, remote control or an operator. The device may be mounted on the platform or on the ground near the platform.

3.5
bypass disconnector
device to short-circuit the series capacitor after it is bypassed by the bypass switch

Note 1 to entry: Installed to keep the line in service while the bypass switch or series capacitor bank are maintained.

3.6
bypass fault current
current flowing through the bypassed series capacitor bank caused by a fault on the line

Note 1 to entry: See also “through fault current” and “partial fault current”.

3.7
bypass gap (protective gap)
gap, or system of gaps, to protect either the capacitor (type K) against overvoltage or the varistor (type M) against overload by carrying load or fault current around the protected parts for a specified time

3.8
bypass interlocking device
device that requires all three poles of the bypass switch to be in the same open or closed position

3.9
capacitor unbalance protection
device to detect unbalance in capacitance between capacitor groups within a phase, such as that caused by blown capacitor fuses or faulted capacitor elements, and to initiate an alarm or the closing of the bypass switch, or both

3.10
capacitor platform
structure that supports the capacitor/rack assemblies and all associated equipment and protective devices, and is supported on insulators compatible with phase-to-earth insulation requirements

3.11
continuous operating voltage
COV
MCOV of a varistor
(maximum) continuous operating voltage, COV is the designated permissible r.m.s. value of power frequency voltage that may be applied continuously between the varistor terminals

Note 1 to entry: COV of the series capacitor varistor is usually equal to the rated voltage of the series capacitor. This definition is different from the definition of COV (U_c) for a ZnO arrester according to IEC 60099-4:2009.

Note 2 to entry: In IEC 60099-4:2009 U_c is used to designate “continuous operating voltage”. However, in this standard, COV is used to designate “continuous operating voltage”. The reason is that U_C is used to designate “capacitor voltage” in the IEC 60143 series.

Note 3 to entry: Consideration of short-time overvoltages of the series capacitor, such as voltages produced by swing currents and overload currents, should be taken into account when the protective level of the varistor is determined.

3.12
discharge current-limiting and damping equipment
reactor or reactor with a parallel connected resistor to limit the current magnitude and frequency and to provide a sufficient damping of the oscillation of the discharge of the capacitors upon operation of the bypass gap or the bypass switch

3.13
external fault
line fault occurring outside the protected line section containing the series capacitor bank

3.14
fault-to-platform protection
device to detect insulation failure on the platform that results in current flowing from normal current-carrying circuit elements to the platform and to initiate the closing of the bypass switch

3.15
forced-triggered bypass gap
bypass gap that is designed to operate on external command on quantities such as MOV energy, current magnitude, or rate of change of such quantities

Note 1 to entry: The sparkover of the gap is initiated by a trigger circuit. After initiation, an arc is established in the power gap. Forced-triggered gaps typically operate only during internal faults.

3.16
insertion
opening of the bypass switch to place the series capacitor in service

3.17
insertion current
r.m.s. current that flows through the series capacitor bank after the bypass switch has opened

Note 1 to entry: This current may be at the specified continuous, overload or swing current magnitudes.

3.18
insertion voltage
peak voltage appearing across the series capacitor bank upon the interruption of the bypass current with the opening of the bypass switch

3.19
internal fault
line fault occurring within the protected line section containing the series capacitor bank

3.20
isolating disconnector
devices to connect or disconnect the bypassed series capacitor from the line

SEE: Figure 1.

3.21
leakage current (of a varistor)
continuous current flowing through the varistor when energized at a specified power-frequency voltage

Note 1 to entry: At COV, and at a varistor element temperature equal to normal ambient temperature, the leakage current is usually mainly capacitive.

3.22
limiting voltage
maximum peak of the power frequency voltage occurring between capacitor unit terminals immediately before or during operation of the overvoltage protector, divided by $\sqrt{2}$

Note 1 to entry: This voltage appears either during conduction of the varistor or immediately before ignition of the spark gap. See IEC 60143-1:2004 for details.

3.23
loss-of-control power protection
means to initiate the closing of the bypass switch upon the loss of normal control power

3.24
main gap
part of the protective spark gap, that shall carry the fault current during a specified time, comprising two or more heavy-duty electrodes

3.25
minimum reference voltage (of a varistor)
$U_{\mathbf{MRef}}$
minimum permissible reference voltage for a complete varistor or varistor unit measured at a specified temperature, typically (20 ± 15) °C

Note 1 to entry: See Figure 4 and comments in Clause 5.