Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1 000 V – Part 1: General – Performance, testing and rating – Safety requirements – Guide for installation and operation
# CONTENTS

FOREWORD ........................................................................................................................... 5

## SECTION 1: GENERAL

1 Scope and object ............................................................................................................. 7
2 Normative references ...................................................................................................... 8
3 Terms and definitions ..................................................................................................... 8
4 Service conditions .......................................................................................................... 12
   4.1 Normal service conditions ................................................................................ 12
   4.2 Unusual service conditions .............................................................................. 12

## SECTION 2: QUALITY REQUIREMENTS AND TESTS

5 Test requirements .......................................................................................................... 13
   5.1 General ............................................................................................................ 13
   5.2 Test conditions ................................................................................................ 13
6 Classification of tests .................................................................................................... 13
   6.1 Routine tests .................................................................................................... 13
   6.2 Type tests ........................................................................................................ 14
   6.3 Acceptance tests ............................................................................................. 14
7 Capacitance measurement and output calculation ......................................................... 15
   7.1 Measuring procedure ....................................................................................... 15
   7.2 Capacitance tolerances .................................................................................... 15
8 Measurement of the tangent of the loss angle (tan δ) of the capacitor ......................... 15
   8.1 Measuring procedure ....................................................................................... 15
   8.2 Loss requirements ........................................................................................... 16
9 Voltage tests between terminals .................................................................................... 16
   9.1 Routine test ..................................................................................................... 16
   9.2 Type test .......................................................................................................... 16
10 Voltage tests between terminals and container ............................................................ 16
   10.1 Routine test ..................................................................................................... 16
   10.2 Type test ........................................................................................................ 17
11 Test of internal discharge device ................................................................................... 17
12 Sealing test ................................................................................................................... 18
13 Thermal stability test .................................................................................................... 18
14 Measurement of the tangent of the loss angle (tan δ) of the capacitor at elevated temperature ................................................................................................................... 19
   14.1 Measuring procedure ....................................................................................... 19
   14.2 Requirements ................................................................................................. 19
15 Lightning impulse voltage test between terminals and container ................................ 20
16 Discharge test ............................................................................................................... 20
17 Ageing test .................................................................................................................. 21
18 Self-healing test ............................................................................................................ 21
19 Destruction test ............................................................................................................ 21

This is a preview of "S+ IEC 60831-1 Ed. 3...". Click here to purchase the full version from the ANSI store.
SECTION 3: OVERLOADS
20 Maximum permissible voltage ................................................................. 21
20.1 Long-duration voltages ................................................................. 21
20.2 Switching voltages ................................................................. 21
21 Maximum permissible current ................................................................. 22

SECTION 4: SAFETY REQUIREMENTS
22 Discharge device ................................................................................. 22
23 Container connections ............................................................................. 22
24 Protection of the environment ................................................................. 22
25 Other safety requirements ........................................................................ 23

SECTION 5: MARKINGS
26 Marking of the unit .................................................................................. 23
26.1 Rating plate .................................................................................. 23
26.2 Standardized connection symbols ......................................................... 24
26.3 Warning plate ................................................................................ 24
27 Marking of the bank .................................................................................. 24
27.1 Instruction sheet or rating plate .............................................................. 24
27.2 Warning plate ................................................................................ 24

SECTION 6: GUIDE FOR INSTALLATION AND OPERATION
28 General ................................................................................................. 24
29 Choice of the rated voltage ........................................................................ 25
30 Operating temperature ............................................................................. 26
30.1 General ..................................................................................... 26
30.2 Installation .................................................................................. 26
30.3 High ambient air temperature .............................................................. 26
30.4 Evaluation of losses ........................................................................ 26
31 Special service conditions ........................................................................ 26
32 Overvoltages .......................................................................................... 27
33 Overload currents .................................................................................... 28
34 Switching and protective devices and connections ..................................... 28
35 Choice of creepage distance ...................................................................... 29
36 Capacitors connected to systems with audio-frequency remote control .......... 29
37 Electromagnetic compatibility (EMC) ........................................................... 30
37.1 Emission .................................................................................. 30
37.2 Immunity .................................................................................. 30
37.2.1 General ............................................................................... 30
37.2.2 Low-frequency disturbances ......................................................... 30
37.2.3 Conducted transients and high-frequency disturbances .................... 30
37.2.4 Electrostatic discharges .............................................................. 30
37.2.5 Magnetic disturbances ............................................................... 30
37.2.6 Electromagnetic disturbances ........................................................ 31
SHUNT POWER CAPACITORS OF THE SELF-HEALING TYPE FOR A.C. SYSTEMS HAVING A RATED VOLTAGE UP TO AND INCLUDING 1 000 V –

Part 1: General – Performance, testing and rating – Safety requirements – Guide for installation and operation

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

DISCLAIMER

This Redline version is not an official IEC Standard and is intended only to provide the user with an indication of what changes have been made to the previous version. Only the current version of the standard is to be considered the official document.

This Redline version provides you with a quick and easy way to compare all the changes between this standard and its previous edition. A vertical bar appears in the margin wherever a change has been made. Additions and deletions are displayed in red, with deletions being struck through.
International Standard IEC 60831-1 has been prepared by IEC technical committee 33: Power capacitors and their applications.


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

a) Updating of the normative references;
b) Test conditions have been clarified;
c) Thermal stability test has been clarified;
d) Maximum permissible voltage and current have been clarified;
e) The protection of the environment has been amended with safety concerns and plastic quality requirements.

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

<table>
<thead>
<tr>
<th>FDIS</th>
<th>Report on voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>33/543/FDIS</td>
<td>33/550/RVD</td>
</tr>
</tbody>
</table>

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 in the IEC 60831 series, published under the general title Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including, 1 000 V can be found on the IEC website.

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.

The contents of the corrigendum of May 2014 have been included in this copy.
SHUNT POWER CAPACITORS OF THE SELF-HEALING TYPE FOR A.C. SYSTEMS HAVING A RATED VOLTAGE UP TO AND INCLUDING 1 000 V –

Part 1: General – Performance, testing and rating – Safety requirements – Guide for installation and operation

Section 1: General

1 Scope and object

This part of the IEC 60831 series is applicable to both capacitor units and capacitor banks intended to be used, particularly, for power-factor correction of a.c. power systems having a rated voltage up to and including 1 000 V and frequencies of 15 Hz to 60 Hz.

This part of IEC 60831 also applies to capacitors intended for use in power filter circuits. Additional definitions, requirements, and tests for power filter capacitors are given in Annex A.

The following capacitors are excluded from this part of IEC 60831:

- Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 000 V (IEC 60931-1, -2 and -3).
- Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V (IEC 60871-1, -2, -3 and -4).
- Capacitors for inductive heat-generating plants operating at frequencies between 40 Hz and 24 000 Hz (IEC 60110-1 and -2).
- Series capacitors (IEC60143-1, -2, -3 and -4).
- Capacitors for motor applications and the like AC motor capacitors (IEC 60252-1 and -2).
- Coupling capacitors and capacitor dividers (IEC 60358-1).
- Capacitors to be used in for power electronic circuits (IEC 61071).
- Small a.c. capacitors to be used for fluorescent and discharge lamps (IEC 61048 and IEC 61049).
- Capacitors for suppression of radio interference (under consideration).
- Capacitors intended to be used in various types of electrical equipment, and thus considered as components.
- Capacitors intended for use with d.c. voltage superimposed on the a.c. voltage.

Accessories such as insulators, switches, instrument transformers, fuses, etc., should be in accordance with the relevant IEC standards and are not covered by the scope of this part of IEC 60831.

The object of this part of IEC 60831 is to:

a) formulate uniform rules regarding performances, testing and rating;
b) formulate specific safety rules;
c) 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 60060-1:19892010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60110:1973, *Recommendation for capacitors for inductive heat generating plants operating at frequencies between 40 and 24 000 Hz*

IEC 60143:1992, *Series capacitors for power systems*

IEC 60252:1993, *A.C. motor capacitors*

IEC 60269-1:19862006, *Low-voltage fuses – Part 1: General requirements*

IEC 60358:1990, *Coupling capacitors and capacitor dividers*


IEC 60831-2:19952013, *Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1 000 V – Part 2: Ageing test, self-healing test and destruction test*


IEC 60931-1:1996, *Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1000 V – Part 1: General – Performance, testing and rating – Safety requirements – Guide for installation and operation*

IEC 60931-3:1996, *Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1000 V – Part 3: Internal fuses*

IEC 61000-2-2:19902002, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-4-1:19922006, *Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques – Overview of immunity tests – Basic EMC publication Overview of IEC 61000-4 series*

IEC 61048-1991, *Capacitors for use in tubular fluorescent and other discharge lamp circuits – General and safety requirements*

IEC 61049-1991, *Capacitors for use in tubular fluorescent and other discharge lamp circuits – Performance requirements*


---

*According to Amendment 1 (1991).*
CONTENTS

FOREWORD ........................................................................................................................... 5
1 Scope ................................................................................................................................. 7
2 Normative references .................................................................................................... 8
3 Terms and definitions ................................................................................................... 8
4 Service conditions ......................................................................................................... 11
  4.1 Normal service conditions ..................................................................................... 11
  4.2 Unusual service conditions ................................................................................... 12
5 Test requirements ........................................................................................................ 12
  5.1 General ..................................................................................................................... 12
  5.2 Test conditions .......................................................................................................... 13
6 Classification of tests .................................................................................................. 13
  6.1 Routine tests ............................................................................................................. 13
  6.2 Type tests .................................................................................................................. 13
  6.3 Acceptance tests ...................................................................................................... 14
7 Capacitance measurement and output calculation ....................................................... 14
  7.1 Measuring procedure .............................................................................................. 14
  7.2 Capacitance tolerances ............................................................................................ 14
8 Measurement of the tangent of the loss angle (\( \tan \delta \)) of the capacitor ............... 15
  8.1 Measuring procedure .............................................................................................. 15
  8.2 Loss requirements .................................................................................................... 15
9 Voltage tests between terminals ................................................................................. 15
  9.1 Routine test .............................................................................................................. 15
  9.2 Type test .................................................................................................................. 15
10 Voltage tests between terminals and container ......................................................... 16
  10.1 Routine test ............................................................................................................ 16
  10.2 Type test ................................................................................................................ 16
11 Test of internal discharge device .............................................................................. 17
12 Sealing test ................................................................................................................ 17
13 Thermal stability test ................................................................................................. 17
14 Measurement of the tangent of the loss angle (\( \tan \delta \)) of the capacitor at elevated temperature .......................................................... 19
  14.1 Measuring procedure ............................................................................................ 19
  14.2 Requirements .......................................................................................................... 19
15 Lightning impulse voltage test between terminals and container ................................ 19
16 Discharge test .............................................................................................................. 19
17 Ageing test ................................................................................................................ 20
18 Self-healing test .......................................................................................................... 20
19 Destruction test .......................................................................................................... 20
20 Maximum permissible voltage .................................................................................... 20
  20.1 Long-duration voltages ....................................................................................... 20
  20.2 Switching voltages .............................................................................................. 21
21 Maximum permissible current ................................................................................. 21
22 Discharge device ....................................................................................................... 21
23 Container connections .............................................................................................. 22
24 Protection of the environment ................................................................. 22
25 Other safety requirements ................................................................. 22
26 Marking of the unit .............................................................................. 22
26.1 Rating plate .................................................................................... 22
26.2 Standardized connection symbols .................................................. 23
26.3 Warning plate ................................................................................ 23
27 Marking of the bank ........................................................................... 23
27.1 Instruction sheet or rating plate ....................................................... 23
27.2 Warning plate ................................................................................ 23
28 General ............................................................................................. 24
29 Choice of the rated voltage ............................................................... 24
30 Operating temperature ....................................................................... 25
30.1 General ........................................................................................ 25
30.2 Installation ..................................................................................... 25
30.3 High ambient air temperature ....................................................... 25
30.4 Evaluation of losses ....................................................................... 25
31 Special service conditions ............................................................... 26
32 Overvoltages ................................................................................... 26
33 Overload currents ............................................................................. 27
34 Switching and protective devices and connections ......................... 27
35 Choice of creepage distance ............................................................ 28
36 Capacitors connected to systems with audio-frequency remote control 29
37 Electromagnetic compatibility (EMC) ............................................... 29
37.1 Emission ....................................................................................... 29
37.2 Immunity ........................................................................................ 29
37.2.1 General ................................................................................... 29
37.2.2 Low-frequency disturbances .................................................... 29
37.2.3 Conducted transients and high-frequency disturbances .......... 29
37.2.4 Electrostatic discharges ............................................................ 29
37.2.5 Magnetic disturbances ............................................................ 30
37.2.6 Electromagnetic disturbances .................................................. 30
Annex A (normative) Additional definitions, requirements and tests for power filter capacitors .............................................................. 31
A.1 Terms and definitions ..................................................................... 31
A.2 Quality requirements and tests ....................................................... 31
A.2.1 Capacitance tolerance ............................................................... 31
A.2.2 Voltage test between terminals (see Clause 9) ......................... 32
A.2.3 Thermal stability test (see Clause 13) ........................................ 32
A.3 Overloads – Maximum permissible current (see Clause 21) ........ 32
A.4 Markings – Instruction sheet or rating plate (see 27.1) .................... 32
A.5 Guide for installation and operation – Choice of the rated voltage (see Clause 29) .............................................................. 32
Annex B (informative) Formulae for capacitors and installations ........... 33
B.1 Computation of the output of three-phase capacitors from three single-phase capacitance measurements ......................................................... 33
B.2 Resonance frequency ...................................................................... 33
B.3 Voltage rise .................................................................................... 33
B.4 Inrush transient current ................................................................. 34
B.4.1 Switching in of single capacitor ..................................................... 34
B.4.2 Switching of capacitors in parallel with energized capacitor(s) ......... 34
B.4.3 Discharge resistance in single-phase units or in one-phase or polyphase units .............................................................................. 34

Bibliography .......................................................................................................................... 36

Figure B.1 – $k$ values depending on the method of connection of the resistors with the capacitor units ...................................................................................................................... 35

Table 1 – Letter symbols for upper limit of temperature range ......................... 12
Table 2 – Ambient air temperature for the thermal stability test ................................. 18
Table 3 – Admissible voltage levels in service .................................................. 20
SHUNT POWER CAPACITORS OF THE SELF-HEALING TYPE FOR A.C.
SYSTEMS HAVING A RATED VOLTAGE UP TO AND INCLUDING 1 000 V –

Part 1: General – Performance, testing and rating –
Safety requirements – Guide for installation and operation

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60831-1 has been prepared by IEC technical committee 33: Power capacitors and their applications.


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

a) Updating of the normative references;
b) Test conditions have been clarified;
c) Thermal stability test has been clarified;
d) Maximum permissible voltage and current have been clarified;
e) The protection of the environment has been amended with safety concerns and plastic quality requirements.

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

<table>
<thead>
<tr>
<th>FDIS</th>
<th>Report on voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>33/543/FDIS</td>
<td>33/550/RVD</td>
</tr>
</tbody>
</table>

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 in the IEC 60831 series, published under the general title *Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including, 1 000 V* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

The contents of the corrigendum of May 2014 have been included in this copy.
1 Scope

This part of the IEC 60831 series is applicable to both capacitor units and capacitor banks intended to be used, particularly, for power-factor correction of a.c. power systems having a rated voltage up to and including 1 000 V and frequencies of 15 Hz to 60 Hz.

This part of IEC 60831 also applies to capacitors intended for use in power filter circuits. Additional definitions, requirements, and tests for power filter capacitors are given in Annex A.

The following capacitors are excluded from this part of IEC 60831:

- Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 000 V (IEC 60931-, -2 and -3).
- Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V (IEC 60871-1, -2, -3 and -4).
- Capacitors for inductive heat-generating plants operating at frequencies between 40 Hz and 24 000 Hz (IEC 60110-1 and -2).
- Series capacitors (IEC60143-1, -2, -3 and -4).
- AC motor capacitors (IEC 60252-1 and -2).
- Coupling capacitors and capacitor dividers (IEC 60358-1).
- Capacitors for power electronic circuits (IEC 61071).
- Small a.c. capacitors to be used for fluorescent and discharge lamps (IEC 61048 and IEC 61049).
- Capacitors for suppression of radio interference (under consideration).
- Capacitors intended to be used in various types of electrical equipment, and thus considered as components.
- Capacitors intended for use with d.c. voltage superimposed on the a.c. voltage.

Accessories such as insulators, switches, instrument transformers, fuses, etc., should be in accordance with the relevant IEC standards and are not covered by the scope of this part of IEC 60831.

The object of this part of IEC 60831 is to:

a) formulate uniform rules regarding performances, testing and rating;
b) formulate specific safety rules;
c) 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 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60269-1:2006, *Low-voltage fuses – Part 1: General requirements*

IEC 60831-2:2013, *Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1 000 V – Part 2: Ageing test, self-healing test and destruction test*


IEC 61000-4-1:2006, *Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques – Overview of IEC 61000-4 series*