BS EN 60831-2:2014

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN 60831-2:2014. It is identical to IEC 60831-2:2014. It supersedes BS EN 60831-2:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/33, Power capacitors.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Supersedes EN 60831-2:1996

English Version

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 60831-2:2014)

Condensateurs shunt de puissance autorégénérateurs pour réseaux à courant alternatif de tension assignée inférieure ou égale à 1 000 V - Partie 2: Essais de vieillissement, d'autorégénération et de destruction (CEI 60831-2:2014)

Selbstheilende Leistungs-Parallelkondensatoren für Wechselstromanlagen mit einer Bemessungsspannung bis 1 000 V - Teil 2: Alterungsprüfung, Selbstheilungsprüfung und Zerstörungsprüfung (IEC 60831-2:2014)

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Foreword

The text of document 33/544/FDIS, future edition 3 of IEC 60831-2, prepared by IEC/TC 33, "Power capacitors and their applications" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60831-2:2014.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-12-19
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-03-19

This document supersedes EN 60831-2:1996.

EN 60831-2:2014 includes the following significant technical changes with respect to EN 60831-2:1996:

a) Updating of the normative references;

b) Discharge cycles before ageing test carried out at ambient temperature;

c) Alternative Self-healing test at d.c. voltage;

d) Modified acceptance conditions after Self-healing test;

e) Modifications to Destruction test.

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

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 60831-2:2014 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

Publication	Year	Title	EN/HD	Year
IEC 60831-1	2014	Shunt power capacitors of the 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	EN 60831-1	2014

CONTENTS

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

1 Scope

This part of IEC 60831 applies to capacitors according to IEC 60831-1 and gives the requirements for the ageing test, self-healing test and destruction test for these capacitors.

NOTE The numbering of the clauses and subclauses in this standard corresponds to that of IEC 60831-1.

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 60831-1:2014, *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*

17 Ageing test

17.1 Conditioning

17.1.1 General

The temperature of the case during the first part (17.2a)) and the third part (17.2c)) of the ageing test shall be the highest mean temperature in 24 h (see Table 1, IEC 60831-1:2014) plus the difference between the measured temperature of the case and the cooling air temperature recorded at the end of the thermal stability test carried out on an identical unit. The second part (17.2b)) of the ageing test should be performed at room temperature.

The two test methods indicated below are intended to ensure that the capacitor case temperature is maintained constant during the test.

The two methods are considered as being equivalent.

The units that are not sealed shall be tested in air, with forced circulation.

17.1.2 Testing in air with forced circulation

The capacitor unit is mounted in an enclosure in which heated air is circulated with an air velocity such that temperature variations at any point of the enclosure do not exceed ± 2 °C. The sensitive element of the thermostat regulating the temperature in the capacitor enclosure shall be located on the surface of the capacitor container, three-quarters of the way up.

The capacitor shall be placed in a vertical position with the terminals upright.

When many capacitors are tested together, they shall be placed with sufficient clearance between them in order to have sufficient temperature uniformity.

After placing the capacitor in the unheated enclosure, the thermostat shall be set at a temperature equal to that indicated in 17.1.1.

Then, without energizing the capacitor, the enclosure shall be brought to thermal stability, which shall be deemed to have been reached when the container temperature of the capacitor has reached the stated temperature with a tolerance of ± 2 °C.

The capacitor shall then be energized at the voltage stated in 17.2a).

17.1.3 Testing in a liquid bath

The capacitor unit is immersed in a container filled with a liquid which, by appropriate heating, is kept at the temperature indicated in 17.1.1 during the whole test.

This temperature is maintained with a permissible change of ± 2 °C.

Care shall be taken to ensure that the temperature in the neighbourhood of the capacitor is within these limits.

The capacitor is not energized until it has reached the temperature of the liquid bath.

The capacitor shall then be energized at the voltage stated in 17.2a).

Where the terminal insulation, or the insulation of cables permanently attached to the capacitor, is of material that might be damaged by the heating liquid, it is permissible for the

capacitors to be positioned in such a manner that these terminals or cables are just above the surface of the liquid.

17.2 Test sequence

Before the test, the capacitance shall be measured as prescribed in 7.1 of IEC 60831-1:2014.

The test sequence is in three parts as follows:

a) The capacitor shall be energized at a voltage equal to 1,25 U_N for 750 h. Taking the tolerances of the supply voltage into account, this test voltage shall be the average voltage for the whole test duration.

b) The capacitor shall then be subjected to 1 000 discharge cycles consisting of:
   - charging the capacitor to a d.c. voltage of 2 U_N;
   - discharging the capacitor through an inductance of:

$$L = \frac{1\,000}{C} \pm 20\,\% \text{ in microhenry } (\mu H)$$

   in which C is the measured capacitance in microfarads (μF).

   The cables used for the external circuit and the inductance shall have a cross-section appropriate to the maximum permissible current (see Clause 21 of IEC 60831-1:2014).

   The duration of each cycle shall be 30 s minimum.

   The connection for this part of the test shall be as described in Clause 16 of IEC 60831-1:2014.

c) Repetition of item a).

During the whole test sequence the temperature of the case shall be maintained equal to that indicated in 17.1.1.

In the case of three-phase capacitors, the first and the third parts of the test sequence (items a) and c)) shall be carried out with all the phases energized at 1,25 U_N. This can be obtained either by using a three-phase source, or by using a monophase source and modifying the internal capacitor connections.

Due to long duration of this test, voltage interruptions may occur unexpectedly. During these interruptions, the capacitor units shall remain in the same test setup and the test time is also interrupted. If power is interrupted to the heating enclosure, the ageing test shall resume with the same starting conditions as described in 17.1.2 or 17.1.3.

17.3 Test requirements

During the test no permanent breakdown, open circuit or flashover shall occur.

At the end of the test the capacitor shall cool down freely to the ambient temperature and the capacitance shall then be measured under the same conditions as before the test.

The maximum permitted variation of capacitance compared to the values measured before the test shall be 3 % averaged over all the phases and 5 % on one phase.

The voltage test between terminals and container shall be carried out with the same procedures as prescribed in 10.1 of IEC 60831-1:2014.

The sealing test shall be repeated as prescribed in Clause 12 of IEC 60831-1:2014.

18 Self-healing test

This test may be carried out on a complete unit, or on a separate element or on a group of elements that are a part of the unit, provided the element or the elements under test are identical to those used in the unit and their conditions are similar to those they have in the unit. The choice is left to the manufacturer.

The capacitor or element shall be subjected for 10 s to an a.c. voltage of 2,15 U_N or to a d.c. voltage of 3,04 U_N (2,15 U_N a.c. peak value).

If fewer than five breakdowns occur during this time, the voltage shall be increased slowly until five breakdowns have occurred since the beginning of the test or until the voltage has reached 3,5 U_N in a.c or 4,95 U_N in d.c.

If fewer than five breakdowns have occurred when the voltage has reached the above stated voltage limit for a time of 10 s, the test shall be finished, if at least one clearing has occurred.

If no breakdown has occurred, the test may be continued until at least one breakdown is obtained or may be interrupted and repeated on another identical unit or element, at the choice of the manufacturer.

Before and after the test, the capacitance and tan δ shall be measured.

No change of the capacitance equal/higher than 0,5 % shall be permitted.

The following formula shall be checked: $\tan \delta \leq 1{,}1 \tan \delta_0 + 1 \times 10^{-4}$, (at 50 or 60 Hz)

Where tan δ is the value after the test and tan δ_0 is the value before the test.

NOTE 1 Breakdown during the test may be detected by an oscilloscope or by an acoustic or a high-frequency test method.

In particular, self-healing breakdown test equipment as shown in Annex A could be used.

NOTE 2 The test carried out on a part of a unit can facilitate the detection of self-healing breakdown.

For polyphase capacitors, the test voltages should be adjusted accordingly.

When comparing the results of capacitance and tan δ measurement obtained before and after the test, two factors should be taken into account:

a) the reproducibility of the measurement;
b) the fact that an internal change in the dielectric may cause a small change in the capacitance without detriment to the capacitor.

19 Destruction test

19.1 Test sequence

The test shall be carried out on a capacitor unit. If necessary the discharge resistors shall be disconnected in order to avoid burning.

A capacitor which has passed the ageing test may be used.

For polyphase units the test shall be carried out between two terminals only. In the case of three-phase delta connection two terminals shall be short-circuited. For star connection no terminals shall be short-circuited.

The principle of the test is to promote failures in the elements by d.c. voltage and subsequently to check the behaviour of the capacitor when an a.c. voltage is applied.

The capacitor shall be mounted in a circulating air oven having a temperature equal to the maximum ambient air temperature of the temperature category of the capacitor.

When all the parts of the capacitor have reached the temperature of the oven the following test sequence shall be performed with the circuit given in Figure 1.

a) With the selector switches H and K in positions 1 and a respectively, the a.c. voltage source is set to 1,3 U_N and the capacitor current is recorded.

b) The d.c. source is set to 10 U_N. The switch H is then set to position 2 and the variable resistor is adjusted to give a d.c. short-circuit current of 300 mA.

c) Switch H is set to position 3 and switch K to position b in order to apply the d.c. test voltage to the capacitor which is maintained until the voltmeter indicates approximately zero for at least 3 s.

   Alternatively, it is also possible to gradually increase the d.c. voltage (to maximum 10 U_N) until a 300 mA short circuit-current is created in the capacitor, and maintained for at least 3 s.

   The capacitor that becomes open circuit after the d.c. conditioning shall be replaced by another sample and not counted.

d) Switch K is then set to position a again in order to apply the a.c. test voltage to the capacitor for a period of 3 min when the current is again noted.

The following conditions may be obtained:

– the ammeter I and the voltmeter U both indicate zero. In this case the fuse-link shall be checked. If it has blown it shall be replaced. Then the a.c. voltage is applied to the capacitor and if the fuse-link blows again the procedure is interrupted. If the fuse-link does not blow the procedure consisting in the application to the capacitor of d.c. and a.c. voltage as prescribed in items c) and d) continues using only the switch K;

– the current indicated by the ammeter I is lower than 66 % of the initial value and the voltmeter U indicates 1,3 U_N. In this case the procedure is interrupted;

– the current indicated by the ammeter I is higher than 66 % of the initial value. In this case the procedure (d.c. – a.c.) continues.

When the procedure is interrupted the capacitor is cooled to the ambient temperature and the voltage test between terminals and container is carried out according to 10.1 of IEC 60831-1:2014 applying an a.c. voltage of 1 500 V.

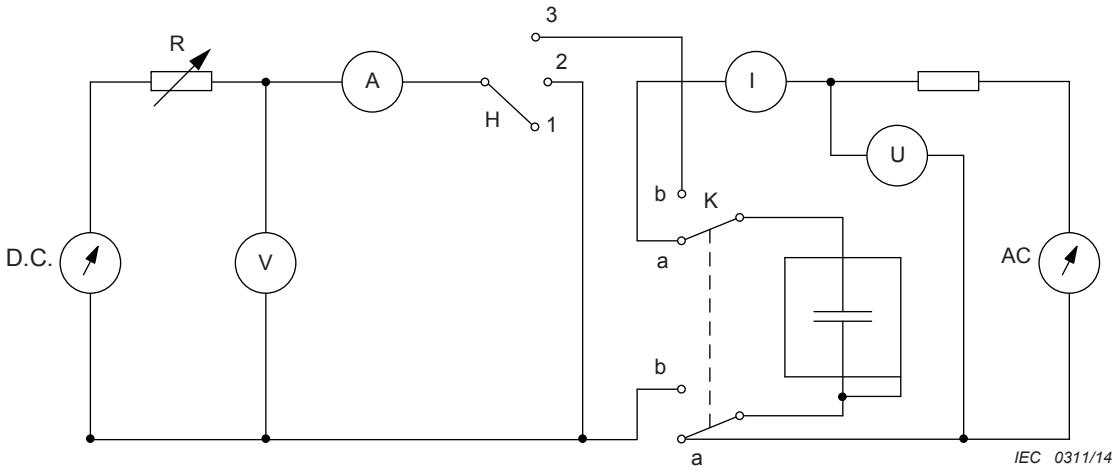

Figure 1 – Circuit to perform the destruction test

The minimum short-circuit current of the a.c. generator shall be 2 000 A at the capacitor terminals.

A time-lag fuse-link for protecting the setup shall be used.

The rated current I_F of the fuse-link shall be obtained by the formula:

$$I_F = KI \pm 10\ \%\ \text{in amperes (A)}$$

where:

$$K = \frac{100}{Q}$$

Q = Q_N in kilovars (kvar), in the case of a single-phase capacitor;

Q = 2/3 Q_N, in kilovars (kvar), in the case of a three-phase delta-connected capacitor with two terminals connected together or three-phase star-connected capacitor with two terminals connected only. (This is because the testing voltage has to be adjusted when performing the test, see following note.);

I = I_N, in amperes (A), in the case of a single phase of star-connected three-phase capacitor;

I = 2/√3(=1,155) I_N, in amperes (A), in the case of a three-phase delta-connected capacitor with two terminals connected together

In any case, K shall be not less than two and not greater than ten.

NOTE For three-phase star-connected capacitors, the single-phase test voltage applied to any two terminals will be adjusted by a single factor of 2/√3 . For a test voltage level of 1,3 U_N the adjusted voltage in this case will be of 2/√3 × 1,3 U_N (about 1,5 U_N).

19.2 Test requirements

At the conclusion of the test the enclosure of each capacitor shall be intact except that normal operation of a vent, or minor damage of a case (e.g. cracks) is permitted provided the following conditions are met:

a) Escaping liquid material may wet the outer surface of the capacitor but shall not fall in drops.

b) The container of the capacitor may be deformed and damaged but not broken.

c) Flames and/or fiery particles shall not be emitted from the openings.

   This may be checked by enclosing the capacitor in gauze (cheesecloth). Burning or scorching of the gauze is then considered to be a criterion of failure.

d) The result of a dielectric test between terminals and container with 1 500 V for 10 s shall be satisfactory.

   NOTE Excessive emanation of fumes during the test could be dangerous.

Annex A
(informative)

Self-healing breakdown test equipment that may be used

Figure A.1 shows an example of self-healing detection equipment that can be used during the self-healing test (Clause 18)

Other methods are acceptable.

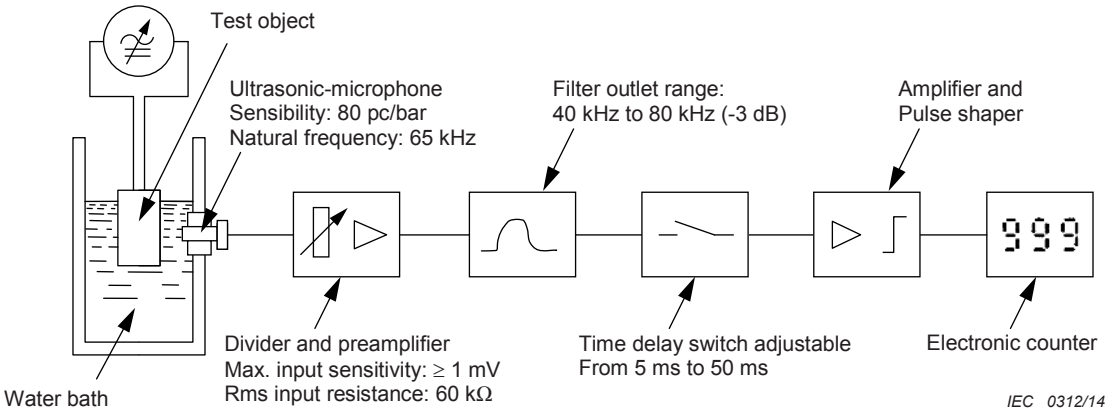

Figure A.1 – Example of self-healing detection equipment

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