

CONSOLIDATED VERSION

VERSION CONSOLIDÉE



Auxiliaries for lamps – Capacitors for use in tubular fluorescent and other discharge lamp circuits – General and safety requirements

Appareils auxiliaires pour lampes – Condensateurs destinés à être utilisés dans les circuits de lampes tubulaires à fluorescence et autres lampes à décharge – Prescriptions générales et de sécurité



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**AUXILIARIES FOR LAMPS –
CAPACITORS FOR USE IN TUBULAR FLUORESCENT AND
OTHER DISCHARGE LAMP CIRCUITS –
GENERAL AND SAFETY REQUIREMENTS**

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In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.

This International Standard has been prepared by subcommittee 34C: Auxiliaries for lamps, of IEC technical committee 34: Lamps and related equipment.

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

In this standard, the following print types are used:

- requirements proper: in roman type;
- *test specifications: in italic type*;
- notes: in smaller roman type.

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INTRODUCTION

This International Standard covers general and safety requirements for certain capacitors for use in tubular fluorescent and other discharge lamp circuits.

Performance requirements for these capacitors are the subject of IEC 61049.

NOTE Safety requirements ensure that electrical equipment constructed in accordance with these requirements, does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was intended.

AUXILIARIES FOR LAMPS – CAPACITORS FOR USE IN TUBULAR FLUORESCENT AND OTHER DISCHARGE LAMP CIRCUITS – GENERAL AND SAFETY REQUIREMENTS

1 Scope

This International Standard states the requirements for both self-healing and non-self-healing continuously rated a.c. capacitors of up to and including 2,5 kVAr, and not less than 0,1 μ F, having a rated voltage not exceeding 1 000 V, which are intended for use in discharge lamp circuits operating at 50 Hz or 60 Hz and at altitudes up to 3 000 m.

NOTE These lamps and associated ballasts are covered by IEC 60081, IEC 60901, IEC 60188, IEC 60192, IEC 60662, and IEC 61167 and by IEC 61347-2-8 and IEC 61347-2-9, respectively.

It covers capacitors intended for connection in shunt or in series with the lamp circuit or an effective combination of these.

It covers only impregnated or unimpregnated capacitors, having a dielectric of paper, plastic film or a combination of both, either metallized or with metal foil electrodes.

This standard does not cover radio-interference suppressor capacitors the requirements for which are found in IEC 60384-14.

Tests given in this standard are type tests. Requirements for testing individual capacitors during production are not included.

Particular requirements for built-in capacitors having an insulation equivalent to double or reinforced insulation are given in Annex E.

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.

IEC 60269 (all parts), *Low-voltage fuses*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60598-1, *Luminaires – Part 1: General requirements and tests*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle flame method – Apparatus, confirmatory test arrangement and guidance*

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

ISO 4046-4:2002, *Paper, board, pulps and related terms – Vocabulary – Paper and board grades and converted products*

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1

rated voltage

U_n

r.m.s. value of the sinusoidal voltage, marked on the capacitor

3.2

rated maximum temperature

t_c

temperature, in degrees Celsius, which must not be exceeded by the hottest part of the capacitor surface during operation

NOTE The internal losses in a capacitor, though small, result in the surface temperature being above ambient air temperature and due allowance for this should be made.

3.3

rated minimum temperature

temperature, in degrees Celsius, of any part of the surface of the capacitor below which the capacitor must not be energized

3.4

discharge resistor

resistor connected across the terminals of a capacitor to reduce shock hazard from the charge stored in the capacitor

3.5

tangent of loss angle

$\tan \delta$

power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of rated frequency

3.6

self-healing

process by which the electrical properties of the capacitor, after a local breakdown of the dielectric, are rapidly and essentially restored to the values before the breakdown

3.7

type test

test or series of tests, made on a type test sample for the purpose of checking compliance of the design of a given product with the requirements of the relevant specification

3.8

type test sample

sample consisting of one or more similar units submitted by the manufacturer or the responsible vendor for the purpose of a type test

3.9

capacitor of type A

self-healing parallel capacitor not necessarily including an interrupting device

3.10

capacitor of type B

self-healing capacitor used in series lighting circuits or a self-healing parallel capacitor, containing an interrupter device

4 General requirements

Capacitors shall be so designed that in normal use they function safely and cause no danger to persons or surroundings.

All exposed metal parts shall be constructed of non-ferrous material or shall be protected against rusting. Visible rust shall not occur. The test of Clause 15 will show whether the capacitor is sufficiently protected against rust.

Tests for checking the mechanical robustness are under consideration.

Compliance with the requirements of Clauses 4 to 11 is checked by measurement, inspection and by carrying out all the tests specified in this standard.

NOTE In Japan an additional capacitor type is permitted, details of which are to be found in JIS C 4908. Inclusion of the requirements for these capacitors in this standard is under consideration.

5 General notes on tests

Tests according to this standard are type tests, (Annex C excluded).

NOTE The requirements and tolerances permitted by this standard are related to testing of a type test sample submitted for that purpose. Compliance of the type test sample does not ensure compliance of the whole production of a manufacturer with this safety standard. Conformity of production is the responsibility of the manufacturer and includes routine tests and quality assurance in addition to type testing.

Capacitors shall be subjected to the tests detailed in Clause 12.

Unless otherwise specified, tests shall be carried out at a temperature of $(20 \pm 5) ^\circ\text{C}$, using where appropriate a voltage source as detailed in Annex A.

Test temperatures specified in particular clauses shall be subject to a tolerance of $\pm 2 ^\circ\text{C}$, unless otherwise stated.

Unless otherwise specified, the type shall be deemed to comply with any one clause or subclause if not more than one failure occurs in the test of that clause or subclause. If three or more failures occur, the type shall be rejected. If two failures occur in any one test, that test, and any preceding tests which may have influenced the test results, shall be repeated on the same quantity of capacitors and if any further failures occur, the type shall be rejected.

NOTE A repeat test may be permitted only once in a series of tests according to the requirements of this standard. A repeat test is not permitted in the destruction test, Clause 18, in the case of a catastrophic failure.

For a range of capacitors of the same construction, rated voltage and cross-sectional shape, each group referred to in Clause 12 shall contain as nearly as possible equal numbers of capacitors of the highest capacitance and the lowest capacitance in that range.

Moreover, the manufacturer shall provide data on the ratio of capacitance per area outer total surface of the container of each capacitance value in the range. The capacitor with the maximum capacitance per unit surface area shall also be tested if this ratio exceeds that of the maximum capacitance value in the range by 10 % or greater. Similarly, the capacitor with the minimum capacitance per unit area shall also be tested if the ratio is less than that of the minimum capacitance value in the range by 10 % or greater.

"Area" denotes total outer surface area of capacitor enclosure ignoring small protrusions, terminals and fixing studs.

With this procedure the tests qualify all intermediate values of capacitance in the range.

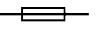
NOTE 1 The "same construction" is that which is declared by the manufacturer to be the same dielectric material, the same dielectric thickness, the same type of case (metal or plastic), the same generic family of filler or impregnating liquid, the same type of safety device and the same type of metallization (e.g. zinc or aluminium).

NOTE 2 "Cross-sectional shape" means: round, rectangular, oval, etc.

6 Marking

6.1 Required marking

Capacitors shall be legibly marked as follows:

- a) name or trade mark of the manufacturer or responsible vendor;
- b) manufacturer's catalogue number and/or model reference;
- c) rated capacitance and tolerance;
- d) rated voltage;
- e) when a discharge resistor is fitted, the symbol  ;
- f) when a current fuse is fitted, the symbol  ;
- g) rated frequency or frequency range;
- h) rated minimum and maximum temperatures, for example $-10\text{ }^{\circ}\text{C}/70\text{ }^{\circ}\text{C}$;
- i) if the capacitor is self-healing, the symbol  ;
- j) if a non-self-healing capacitor is exclusively intended for series operation the symbol  ;

This symbol shall not appear on capacitors bearing the self-healing symbol.

NOTE This type of capacitor is not intended to be connected across the mains supply.

- k) type A or B as applicable.

6.2 Additional information

- a) Declaration of value of discharge resistor, if fitted.
- b) Declaration whether the capacitor does not contain substances which are liquid at $(t_c + 10)\text{ }^{\circ}\text{C}$.

6.3 Durability and legibility of marking

Marking shall be durable and legible.

Compliance is checked by inspection and by trying to remove the marking by rubbing lightly, for 15 s each, with one piece of cloth soaked with water and another with petroleum spirit. The marking shall be legible after the test.

NOTE The petroleum spirit used should consist of a solvent hexane with a content of aromatics of maximum 0,1 volume percentage, a kauri-butanol value of 29, an initial boiling point of approximately $65\text{ }^{\circ}\text{C}$, a dry-point of approximately $69\text{ }^{\circ}\text{C}$ and a density of approximately $0,68\text{ g/cm}^3$.

7 Terminations

7.1 Terminations shall be provided by means of either cables (tails) or terminals (screw, screwless, solder tag or the like). Terminations shall be capable of accepting the size and number of conductors appropriate to the rating and application of the capacitor. Cables (tails) shall be suitable for the rating of the capacitor, but in no case shall they be smaller than $0,5\text{ mm}^2$ and their insulation shall be appropriate to the capacitor rated voltage and temperatures.

Screw terminals shall comply with section 14 of IEC 60598-1.

Screwless terminals shall comply with section 15 of IEC 60598-1.

7.2 The capacitor case, if of metal, shall either be fitted with an earthing terminal or be capable of being earthed (or connected to other metal parts, if any, of the luminaire) by clamping or by an appropriate fixing bracket. The part of the case to which such a clamp is fitted or the fixing bracket attached shall be free from paint or other non-conducting covering in order to ensure the maintenance of good electrical contact.

Compliance is checked by inspection and the following test:

A current of at least 10 A, derived from a source with a no-load voltage not exceeding 12 V, shall be passed between the earthing terminal or earthing contact and each of the accessible metal parts in turn. The voltage drop between the case and the clamping means or fixing bracket shall be measured and the resistance calculated from the current and the voltage drop.

In no case shall the resistance exceed 0,5 Ω .

The requirements of the previous paragraph do not apply to metal-cased capacitors completely covered in an insulating material, because these are tested according to 14.2.

8 Creepage distances and clearances

The creepage distances over external surfaces of terminal insulation and the clearances between the exterior parts of terminal connections or between such live parts and the metal case of the capacitor, if any, shall be not less than the minimum values given in Table 1.

These minimum distances shall apply to the terminals with or without the external wiring connected.

They are not intended to apply to internal distances and clearances.

Compliance is checked by measurement.

Table 1 – Minimum creepage distances and clearances

Rated voltage	Up to and including 24 V mm	Above 24 V up to and including 250 V mm	Above 250 V up to and including 500 V mm	Above 500 V up to and including 1 000 V mm
<i>Creepage distance</i>				
1) between live parts of different polarity	2	3 (2) ^a	5	6
2) between live parts and accessible metal parts which are permanently fixed to the capacitor, including screws of devices for fixing covers or fixing the capacitor to its support	2	4 (2) ^a 3 ^b	6 3 ^b	7
<i>Clearances</i>				
3) between live parts of different polarity	2	3 (2) ^a	5	6
4) between live parts and accessible metal parts which are permanently fixed to the capacitor, including screws or devices for fixing covers or fixing the capacitors to its support	2	4 (2) ^a 3 ^b	6 3 ^b	7
5) between live parts and a flat supporting surface or a loose metal cover, if any, if the construction does not ensure that the values of Item 4) above are maintained under the most unfavourable conditions	2	6	10	12
^a The values in brackets apply to creepage distances and clearances protected against pollution. For permanently sealed-off or compound-filled enclosures, creepage distances and clearances are not checked.				
^b For glass or other insulation with equivalent tracking qualities.				

The contribution to the creepage distances of any groove less than 1 mm wide shall be limited to its width.

Any air-gap of less than 1 mm shall be ignored in computing the total air path.

Creepage distances are distances in air, measured along the surface of insulating material.

9 Voltage rating

Capacitors shall be capable of withstanding for prolonged periods a voltage not exceeding 110 % of their rated voltage within the temperature ratings.

Compliance is checked by the test given in Clause 14.

NOTE This requirement is intended to cover variations in voltage due to supply fluctuations.

10 Fuses

Where an internal current fuse is fitted, it shall be adequately protected, enclosed and insulated so as to prevent flashover to, or contact with, a metal container in normal service in the event of the operation of the fuse.

Compliance is checked by inspection and by the tests given in 14.2 and 16.

NOTE In establishing the design of any internal fuse, the possibility of short circuits occurring external to the capacitor should be taken into account.

11 Discharge resistors

Capacitors may have a discharge resistor permanently connected across their terminals. If fitted, this discharge resistor shall have a value such that it will discharge the capacitor from the peak of the a.c. voltage applied to it, to a voltage not exceeding 50 V, within 1 min. Allowance shall be made for a voltage which is 10 % above its rated value.

The manufacturer shall declare the resistor value and tolerance.

Compliance is checked by measurement.

NOTE 1 Within the overall lamp circuit, it is essential that a discharge path be provided for any capacitor. It is recommended that this should be by means of a resistor integral with the capacitor, but other arrangements are possible.

NOTE 2 In certain cases, for example luminaires connected by plugs, a discharge to 50 V within 1 min may not be acceptable, see subclause 8.2.7 of IEC 60598-1.

12 Testing sequence

A total of 50 self-healing capacitors or 20 non-self-healing capacitors are taken and divided into groups as indicated below.

NOTE For capacitors above 1 kVAr, the quantities for testing can be agreed between manufacturer and testing authority.

The following initial tests are applied to all the capacitors in the order given:

- a) *sealing and heating test, if required, in accordance with Clause 13;*
- b) *high-voltage test between terminals in accordance with 14.1;*
- c) *high-voltage test between terminals and container in accordance with 14.2.*

The first group of 10 capacitors is subjected to a series of tests that are designed to check the ability of the capacitor design to withstand adverse operating conditions. Details of these tests are described in Clause 15. In addition, tests to check resistance to heat and fire are carried out in accordance with Clause 16.

The second group of 40 self-healing capacitors shall provide the samples for the tests of Clauses 17 and 18. Ten capacitors are submitted to the self-healing test and no subsequent testing. The remainder are used for the destruction test.

13 Sealing and heating test

13.1 Sealing and heating test for type A capacitors

Capacitors containing substances which are liquid at $(t_c + 10)^\circ\text{C}$ shall be adequately sealed and have adequate resistance to heating.

Compliance is checked by the following test.

The unenergized capacitors are placed in an oven in the position most conducive to the leakage of impregnant or filling material and heated throughout to 10°C above their rated maximum temperature (t_c). They are maintained at this temperature for 1 h.

Leakage of impregnant or filling material shall not occur during this test. The capacitor shall not become open-circuited during this test.

NOTE This test does not apply to any capacitor where the manufacturer declares that the capacitor does not contain substances which are liquid at $(t_c + 10)^\circ\text{C}$.

13.2 Sealing and heating test for type B capacitors

The sealing of the capacitors is a requirement for the safety device with overpressure. This test shall be carried out as a random test and a type-test.

Capacitors whose fillers have a dropping point above t_c and capacitors without fillers shall be tested as follows:

After the capacitors have been degreased they shall be placed in a vessel which can be hermetically sealed and which is filled with liquid up to such a level that the liquid surface is at least 10 mm above the test-piece.

The liquid is, for example, degassed water at 20 °C. The liquid shall be at room temperature. After the vessel has been closed it shall be evacuated within 1 min to 160 mbar and this vacuum shall be maintained for at least 1 min. The test specimens are observed through a window in the test vessel. Leakage points in the capacitor container are indicated by rising air bubbles.

In this test it shall be noted that some designs have hollows outside the seal of the capacitor. Air bubbles which rise from these outer cavities at the start of the test shall not be taken into account. If necessary, the test shall be lengthened for these capacitors.

During the test no bubbles shall be visible.

14 High-voltage test

Capacitors shall withstand high voltages.

Compliance is checked by the tests of 14.1 and 14.2.

14.1 High-voltage test between terminals

Non-self-healing capacitors shall withstand, at room temperature, an a.c. test voltage of $2,15 U_n$ applied between terminals for a period of 60 s.

Self-healing capacitors shall withstand, at room temperature, an a.c. test voltage of $2 U_n$ applied between terminals for a period of 60 s.

In Japan and North America, self-healing capacitors shall withstand, at room temperature, an a.c. test voltage of $1,75 U_n$ applied between terminals for a period of 10 s.

For self-healing capacitors, self-healing breakdowns (clearings) are allowed during the test.

Initially, not more than half the test voltage is applied, following which it shall be raised gradually to the full value.

14.2 High-voltage test between terminals and case

Each capacitor shall withstand at 50 Hz or 60 Hz, as appropriate, the following a.c. test voltage for a period of 1 min.

Capacitor rated voltage	Test voltage
Up to and including 250 V	2 000 V r.m.s.
Greater than 250 V	2 500 V r.m.s.

Initially not more than half the test voltage is applied, following which it is raised gradually to the full value.

For capacitors having cases of insulating material, the test voltage is applied between the terminals and a metal foil in close contact with the surface of the case, with a clearance of not less than 4 mm between metal foil and terminals.

15 Resistance to adverse operating conditions

The capacitor shall have adequate resistance to adverse operating conditions.

Compliance is checked by the tests of 15.1 and 15.2.

Capacitors are required to meet a humidity test with voltage applied, followed by a current (discharge) test. This is to demonstrate reliability of operation under damp conditions and on "dirty" mains supplies that can subject the capacitor to current surges due to non-sinusoidal wave forms.

If the capacitor design has a self-contained fuse element internally fitted, the fuse element may be short-circuited for the purpose of the tests described in 15.1 and 15.2. The manufacturer shall clearly specify which samples have been prepared in this way. Capacitor designs which have fuse wire directly connected to the capacitor winding shall not be modified for these tests.

Ten capacitors are subjected to the test described in 15.1, followed by the test described in 15.2.

15.1 Humidity test with voltage applied

Ten capacitors shall be measured for capacitance and tangent of loss angle at a frequency of 1 kHz.

For the purpose of this test, leads or terminals shall not exceed 30 mm in length.

The test cabinet shall be capable of maintaining the temperature at $(40 \pm 2)^{\circ}\text{C}$, and the relative humidity between 90 % and 95 % in the region where the capacitors are placed. The air in the cabinet shall be circulated and the cabinet shall be so designed that mist or water droplets cannot fall on the capacitors.

The test samples are placed in the humidity cabinet and connected to an a.c. supply. A voltage of U_n shall be applied to all the samples after the humidity conditions have been reached.

The voltage and humidity is maintained for a period of 240 h.

At the end of the test period the capacitors shall be permitted to recover at room temperature for a period of 1 h to 2 h, after which the following conditions of compliance are checked:

- change of capacitance shall be less than 1 %;*
- tangent of loss angle change shall be less than 50 % when measured at 1 kHz;*
- no failures are permitted.*

15.2 Current (discharge) test

The same 10 capacitors that have completed the test of 15.1 shall be individually subjected to a current test at room temperature. The test shall be maintained for 15 min at the following conditions using an appropriate discharge circuit.

Capacitance	Peak current
$\leq 10 \mu\text{F}$	30 A/ μF (30 V/ μs) $\pm 10 \%$
$> 10 \mu\text{F}, \leq 25 \mu\text{F}$	25 A/ μF (25 V/ μs) $\pm 10 \%$
$> 25 \mu\text{F}$	20 A/ μF (20 V/ μs) $\pm 10 \%$

- During the test, the RMS current should be 1,5 A/ μF or 16 A, whichever is the less, and the peak -to-peak voltage 600V $\pm 10 \%$.

The relevant voltage and current waveform are given in Figure 4.

A typical circuit for creating the required test conditions is given in Figure 5.

Alternative circuit arrangements may be used, provided that the required waveforms are produced.

A guide for calculating equipment settings for tests is given in Annex D.

Conditions of compliance are checked using the final measurement after the test of 15.1 as the initial measurement for the test of 15.2.

At room temperature the samples shall meet the following requirements:

- change of capacitance shall be less than 1 %;
- tangent of loss angle change shall be less than 50 % when measured at 1 kHz;
- no failures are permitted.

In addition, all capacitors are required to meet a high-voltage test between terminals and case as given in 14.2.

16 Resistance to heat, fire and tracking

16.1 External parts of insulating material retaining terminals in position, shall be sufficiently resistant to heat.

For materials other than ceramic, compliance is checked by subjecting the parts to the ball-pressure test in accordance with IEC 60598-1, Section 13.

16.2 External parts of insulating material retaining terminals in position and other parts of insulating material providing protection against electric shock, shall be resistant to flame and ignition.

For materials other than ceramic, compliance is checked by the tests of 16.2.1 or 16.2.2 as appropriate.

16.2.1 *External parts of insulating material providing protection against electric shock shall be subjected to the glow-wire test in accordance with IEC 60695-2-11, subject to the following details:*

- the test sample is one specimen;
- the test specimen is a complete component;

- the temperature of the tip of the glow-wire is 650 °C;
- any flame or glowing of the specimen shall extinguish within 30 s of withdrawing the glow-wire and any flaming drops shall not ignite a piece of five-layer tissue-paper, specified in 4.187 of ISO 4046-4, spread out horizontally 200 mm ± 5 mm below the test specimen.

The manufacturer shall declare whether the test shall be carried out on a complete capacitor or on the individual components forming the housing and supplied specially by the manufacturer for this test.

16.2.2 Parts of insulating material retaining terminals in position shall be subjected to the needle flame test in accordance with IEC 60695-11-5, subject to the following details:

- the test sample is one specimen;
- the test specimen is a complete component. If it is necessary to take away parts of the capacitor to perform the test, care must be taken to ensure that the test conditions are not significantly different from those occurring in normal use;
- the test flame is applied to the centre of the surface to be tested;
- the duration of application is 10 s;
- any self-sustaining flame shall extinguish within 30 s of removal of the gas flame and any flaming drops shall not ignite a piece of five-layer tissue-paper, specified in 4.187 of ISO 4046-4, spread out horizontally 200 mm ± 5 mm below the test specimen.

16.3 Tracking test

Outer insulating parts of capacitors for use in luminaires, other than ordinary luminaires, which retain live parts in position or are in contact with such parts, shall be of material resistant to tracking.

NOTE Capacitors not complying with this requirement when being tested can only be approved for use in ordinary luminaires.

Compliance is checked by carrying out the tracking test specified in IEC 60598-1, Section 13, on relevant parts.

17 Self-healing test

Capacitors marked with the symbol  (see 6.1 i) shall be self-healing).

Compliance is checked by the following test.

The manufacturer shall specify whether the capacitors require to be preconditioned by the endurance test of 18.1.1.

The capacitors shall be subjected to an a.c. voltage of 1,25 U_n which is increased at a rate of not more than 200 V/min until five clearings have occurred since the beginning of the test or until the voltage has reached 3,5 U_n . (A higher voltage may be specified by the manufacturer.)

The voltage shall be decreased to 0,8 times the value at which the fifth clearing occurs or 0,8 times 2,15 U_n whichever is lower and maintained for 10 s.

One additional clearing in each capacitor is permitted during this period.

A total of 25 or more clearings (self-healing breakdowns) shall be obtained from the 10 capacitors tested but if any capacitor shows more than five clearings, only five shall be used in calculating the total.

If insufficient clearings are achieved, in consultation with the manufacturer, the maximum voltage may be increased and the same capacitors retested.

Any additional clearings shall be added to the previous total, subject to the maximum number attributed to any one capacitor being five.

The capacitors shall be deemed to have passed the test if the change of capacitance measured before and after the test is not greater than 0,5 %.

If 25 clearings do not occur, the type shall be rejected.

No further tests shall be applied to capacitors which have been tested for self-healing.

NOTE Self-healing breakdowns during the test may be detected by an oscilloscope or by acoustic or high frequency test methods (see Figure 3).

18 Destruction test

Capacitors shall have adequate resistance against destructive failure.

Self-healing capacitors shall be tested in accordance with either of the test procedures in 18.1 and 18.2. A summary of the test procedures is given in Figure 4. For parallel lighting capacitors, the manufacturer shall specify which test route to follow, test A or test B. Non-self-healing capacitors shall be tested in accordance with 18.3.

18.1 Test A

This test procedure is intended for parallel lighting capacitors not necessarily relying on the operation of a pressure interrupter device, i.e. type A capacitors.

18.1.1 Endurance test

Twenty-one samples are tested in accordance with the requirements of IEC 61049, Clause 8, the voltage and time being selected from Table 2:

Table 2 – Voltage and test duration for endurance test, first test sequence

Voltage (U_n)	Time h
1,15	8 500
1,25	4 000
1,3	2 500
1,35	2 000

Test temperature = t_c

Compliance shall be checked by the requirements of IEC 61049, subclause 8.6.

NOTE If agreed between the manufacturer and the test house this test may be carried out by the manufacturer under the supervision of the test house.

18.1.2 *Twenty samples that have met the requirements of 18.1.1 are wrapped in tissue paper complying with 4.187 of ISO 4046-4 and subjected to the following additional test requirements.*

Maximum rated temperature (t_c).

Voltage and time shall be chosen by the manufacturer from Table 3.

The test voltage shall be agreed between the test house and the manufacturer.

However, the initial value shall not be higher than $1,3 \times U_n$ and then increased successively to the chosen value.

Table 3 – Voltage and test duration for endurance test, second test sequence

Voltage (U_n)	Time h
1,6	2 500
1,8	850
2,0	330

Where the total current drawn by all the 20 capacitors has not decreased to 50 % of the initial value, the manufacturer may specify a longer test time to destroy capacitance. The test time shall not exceed 2 500 h. The test is concluded if the current drawn by the 20 capacitors has decreased to 50% or less of the initial value.

The capacitors are wrapped closely with tissue paper complying with 4.187 of ISO 4046-4 and mounted in an oven or test cabinet at room temperature.

If, at the end of the specified time, the current decrease has not been achieved, the capacitors are checked to see how many have become open circuit (inoperative). The remaining capacitors are tested one at a time in the following order: one at room temperature, the next at a temperature of $(t_c + 10)^\circ\text{C}$, and so on, as specified in 18.1.2.1. The test is complete when the total of 10 inoperatives has been obtained.

Compliance is checked by the requirements of 18.1.4. One failure is permitted for a), b) and d). No failures are permitted for c).

18.1.2.1 Preparation for conditioning

This procedure is only to be carried out if the total current drawn by the 20 capacitors has not decreased to 50% or less of the initial value as specified in 18.1.2

The capacitors are wrapped closely with tissue paper complying with 4.187 of ISO 4046-4 and mounted in an oven or test cabinet at room temperature.

The capacitors are connected individually and successively to a d.c. conditioning circuit as shown in Figure 2, where the variable d.c. source is capable of supplying a current of 50 mA and a voltage of $10 U_n$ d.c.

A high-power a.c. source and time-lag fuses shall also be available as described in 18.2.2, connected as shown in Figure 1.

The conditioning procedure is as follows:

- using the circuit illustrated in Figure 2 and with the switch in position 1, the d.c. supply is adjusted so that the voltmeter reads $10 U_n$;*
- using the circuit illustrated in Figure 2 and with the switch in position 2, the variable resistor R is adjusted so that the ammeter reads 50 mA;*

- c) *using the circuit illustrated in Figure 2 the switch is moved to position 3, and shortly afterwards the reading will assume a stable position. The voltage of the d.c. source shall then be reduced to zero;*
- d) *as soon as possible, and with the capacitor at the same temperature, an a.c. voltage of $1,3 U_n$ is applied to the capacitor for a period of 5 min using the circuit of Figure 1. A blown fuse indicates a short-circuit. A current of less than 10 % of the expected reading of an ammeter indicates an open circuit.*

18.1.2.2 Conditions for identifying whether a capacitor has become inoperative

During the procedure of 18.1.2.1 d) the capacitor is monitored to see if the following requirements are met. If they are met, then the capacitors shall be allowed to cool to room temperature and are tested to see that they meet the requirements of 18.1.2.3.

If the following requirements are not met, then the whole procedure of 18.1.2.1 is repeated.

If the current through any capacitor falls to less than 10 % of the value which would be expected from the rated capacitance and the test voltage applied, this will be due to one of the following reasons:

- a) the capacitor has become short-circuited and the fuse has blown;
- b) the capacitor has become open-circuited or has lost most of its capacitance;
- c) the fuse has blown without the capacitor being short-circuited, due to changed electrical conditions in the capacitor.

By replacing the fuse twice (both of which have to operate) it will be established that the capacitor is stable and meets the conditions a) or c) above. Condition b) can be detected by the ammeter, in Figure 1, showing very low or no current. The capacitor having become inoperative shall then be removed from the oven, allowed to cool to room temperature, and tested to see if it meets the requirements of 18.1.4.

18.1.2.3 Conditions of compliance for capacitors having become inoperative

Each capacitor having become inoperative shall meet the requirements of 18.1.4.

18.1.3 High r.m.s. current test

Type A capacitors shall also meet the requirements of the following test.

Ten samples shall be tested.

Tests shall be carried out at room temperature using capacitor elements (completed windings from the production line).

The manufacturer shall prepare the samples by attaching wire of sufficient cross-sectional area to withstand the high r.m.s. current.

Before carrying out the high r.m.s. current test, the prepared samples shall be subjected to the test of Clause 17. The samples shall then be wrapped with tissue paper complying with 4.187 of ISO 4046-4.

Conditions to be applied to the test samples are as follows:

- f = frequency of current waveform = 10 kHz $\pm$ 10 %
- I_c = peak current = 15 A/ μ F $\pm$ 10 %
- I = r.m.s. current = 3 A/ μ F $\pm$ 10 %

I to be limited to 48 A maximum.

Duration of test = 15 min

Repetition frequency of the voltage – *F* – may be derived from the following equation:

$$\frac{I_c}{I\sqrt{2}} = \sqrt{\frac{f}{F}}$$

Conditions of compliance are to be in accordance with 18.1.4 c).

The relevant voltage and current waveform are given in Figure 4.

A typical circuit for creating the required test conditions is given in Figure 5.

Alternative circuit arrangements may be used, provided that the required waveforms are produced.

A guide for calculating equipment settings for tests is given in Annex D.

18.1.4 Conditions of compliance

Each capacitor shall meet the following requirements:

- a) *escaping liquid materials may wet the outer surface of the capacitor, but not fall away in drops;*
- b) *internal live parts shall not be accessible to the standard test finger (see Figure 1 of IEC 60529);*
- c) *burning or scorching of the tissue paper shall not be evident, since this would indicate that flames or fiery particles had been emitted from the openings;*
- d) *the capacitor shall withstand the test of 14.2, the test voltage being reduced by 500 V.*

18.2 Test B

This test option is intended for self-healing capacitors used in series lighting circuits and self-healing parallel capacitors including a pressure interrupter device, i.e. type B capacitors. It demonstrates that the interrupter device functions reliably.

Testing the behaviour of a capacitor on destruction is intended to demonstrate that a type of capacitor will fail without harmful consequences, e.g. ignition or mechanical damage to neighbouring parts.

Capacitors of type B shall be so designed that their destruction is followed by short-circuiting or interruption of the circuit.

The test is carried out on capacitors which have passed the initial tests detailed in items a) to c) of Clause 12. In addition, the capacitance shall be measured before the test (see Clause 6 of IEC 61049).

18.2.1 Test specimens

The following test shall be carried out on 20 capacitors which are operative at the completion of the endurance test described in IEC 61049 and 20 of the "new" samples that have not been through the preconditioning.

18.2.2 Test arrangement

The capacitors shall be still closely wrapped in tissue paper and shall be mounted in an oven.

In series with each capacitor there is a time-lag fuse complying with the electrical characteristics specified in IEC 60269. The rating of the fuse shall be 20 A or 10 times the rated current of the capacitor to which it is connected, whichever is greater.

The capacitors are connected to a high-power a.c. supply capable of passing a fault current of 300 A or 10 times the rated current of the highest rated current of the fuse in use in the test circuit.

The cases of capacitor with metal case shall be connected with one pole of the voltage source.

The test circuit is given in Figure 1.

18.2.3 Test procedure

18.2.3.1 Preparation for conditioning

The capacitors shall be wrapped closely with tissue paper complying with 4.187 of ISO 4046-4 and mounted in a test cabinet.

To prepare the test samples, they shall be loaded with their rated voltage U_n for 2 h at temperature $(t_c + 10) ^\circ\text{C}$. No open circuit or short-circuit shall occur in the capacitor. Then 20 capacitors which have passed the endurance test of Clause 8 of IEC 61049, shall be exposed to a highly resistive d.c. voltage source ($I_{\text{max}} < 50 \text{ mA}$) in the test oven at the temperature $(t_c + 10) ^\circ\text{C}$, with increasing voltage until breakdown occurs. The 20 "new" capacitors shall be tested at room temperature as the preconditioned capacitors.

NOTE The short conditioning with the rated voltage ($2 \text{ h}/U_n/t_c + 10$) is evidence for the operation of the capacitors.

18.2.3.2 Destruction of the capacitors

Immediately after preparation, the capacitors shall be loaded with a voltage of $1,25 U_n$ a.c. while the d.c. conditioning temperature is maintained.

Each test sample, after a loading period of 20 h, may, in accordance with details provided by the manufacturer, be connected to a voltage of $10 U_n$ until breakdown will occur.

The current in this case shall be limited to less than 50 mA. Loading shall be terminated when the d.c. voltage breaks down.

Subsequently, the voltage of $1,25 U_n$ a.c. shall be applied to the capacitors.

This procedure may be repeated at intervals of 4 h until destruction of the 40 test samples occurs when the voltage of $1,25 U_n$ is applied. The destruction of the capacitors shall not occur at the d.c. conditioning.

NOTE The capacitors will be subjected to a d.c. and a.c. voltage alternatively until failure occurs.

18.2.3.3 Conditions of identifying a capacitor having become inoperative

In the case of self-healing capacitors, the constructive measures to ensure interrupting shall have been operated.

This can be detected by the ammeter, in Figure 1, showing no current. When the capacitor has become inoperative, it shall be removed from the oven, allowed to cool to room temperature, and tested to see if it meets the requirements of 18.2.3.4 and 18.2.3.5.

18.2.3.4 Conditions of compliance

Each capacitor shall meet the following requirements:

- a) *escaping liquid materials may wet the outer surface of the capacitor, but not fall away in drops;*
- b) *the capacitor shall not have burst and the case of the capacitor shall not have melted;*
- c) *burning or scorching of the tissue paper shall not be evident, since this would indicate that flames or fiery particles had been emitted from the openings.*

18.2.3.5 Testing safety in the failed state

Each capacitor becoming inoperative shall pass the following test.

- a) *High-voltage test between the terminals at a voltage of $2,00 U_n$ and at room temperature for a period of 1 min. No flash-over shall occur at the point of interruption.*
In case of doubt, the manufacturer shall demonstrate that the constructive measures to ensure interruption of the current have operated.
- b) *The capacitors shall withstand the high-voltage test between the terminals and the case in accordance with 14.2.*

NOTE After the destruction test, a high-voltage test between the terminals is carried out to obtain evidence of interruption. In addition a high-voltage test between case and terminal is made for safety.

18.2.3.6 Evaluation of the test

All capacitors becoming inoperative shall fulfil the requirements of 18.2.3.4 b) and c).

If one of the test specimens does not satisfy the criteria according to 18.2.3.4 a) and 18.2.3.5 a) and b), the test may be repeated once on a further 40 samples. However, all the capacitors shall pass the repeat test.

If more than one capacitor does not satisfy the criteria according to 18.2.3.4 a) and 18.2.3.5 a) and b), the test shall be regarded as having failed.

18.3 Non-self-healing capacitors

The test is carried out on 10 capacitors, all of which have passed the initial tests detailed in items a) to c) of Clause 12.

18.3.1 Preparation for conditioning

Ten capacitors which are operative at the completion of the conditioning in 18.3 and are still closely wrapped in tissue-paper are mounted in an oven.

The capacitors are connected individually and successively to a variable d.c. voltage source with a resistance in series to limit the current to a maximum of 3 mA, as shown in Figure 2.

A high-power a.c. source and time-lag fuses shall be available as described in 18.2.2, connected as shown in Figure 1.

The capacitors are heated throughout to a temperature of $(t_c + 10) ^\circ\text{C}$ and individually broken down using a steadily increasing d.c. voltage source where the breakdown current does not exceed 3 mA.

Breakdown will be indicated by the voltmeter reading dropping to effectively 0 V.

The test proceeds as follows.

a) For capacitors marked with the symbol 

An a.c. voltage of $1,3 U_n$ is applied for a period of 8 h using the circuit of Figure 1 except that there is a choke or resistor in series with the short-circuited capacitor. The impedance of the choke or resistor is such that with $1,3 U_n$ applied to the circuit, the current flowing through the circuit is limited to 1,5 times the rated value ($1,5 U_n \omega C$) of the capacitor.

b) For all other capacitors

As soon as possible after breakdown, and with the capacitor at the same temperature, an a.c. voltage of $1,3 U_n$ is applied to the capacitor for a period of 5 min using the circuit of Figure 1.

18.3.2 Conditions for identifying whether a capacitor has become inoperative

After cooling, all inoperatives shall meet the requirements of 18.2.2 and a) to d) of 18.1.4. Operative capacitors shall be repeat tested according to the whole procedure of 18.3.1.

Further repeat tests are made until all capacitors are inoperative.

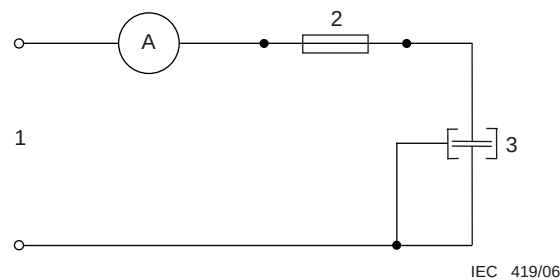


Figure 1 – AC conditioning circuit

Key

- 1 A.C. supply
- 2 Fuse
- 3 Capacitor case

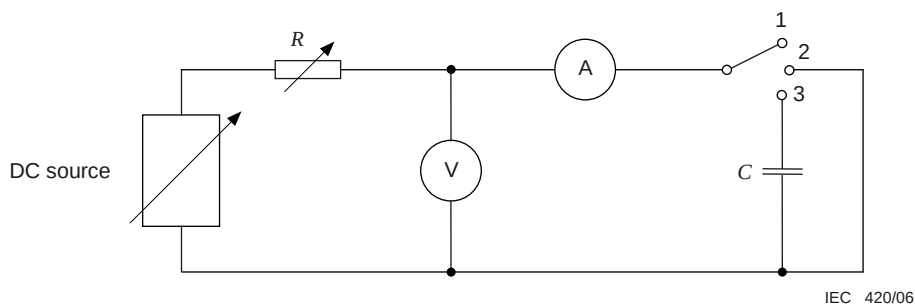
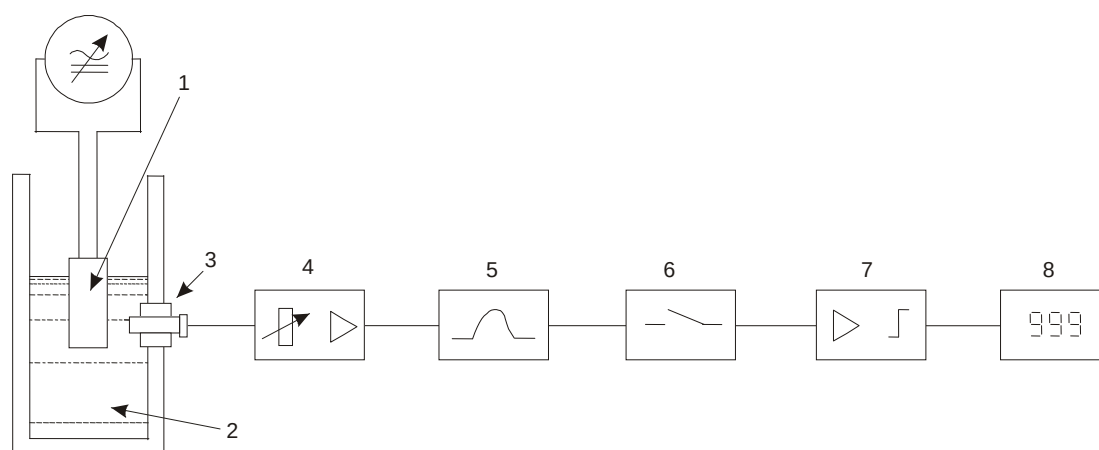


Figure 2 – DC conditioning circuit

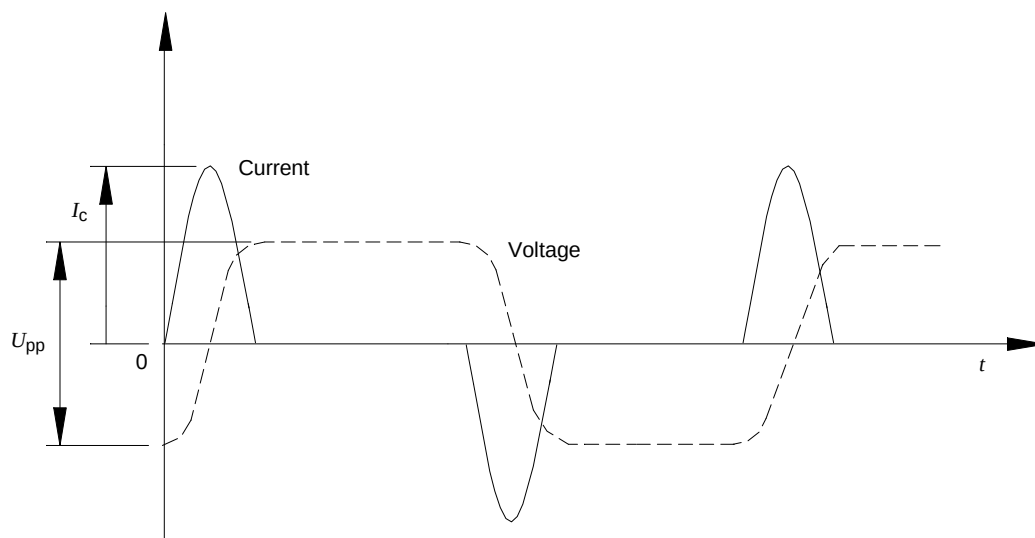


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Figure 3 – Self-healing breakdown test equipment

Key

- 1 Test object
- 2 Water bath
- 3 Ultrasonic microphone; sensitivity: 80 pc/bar; natural frequency: 65 kHz
- 4 Divider and preamplifier; max. input sensitivity ≥ 1 mV r.m.s.; input resistance ≈ 60 k Ω
- 5 Filter; outlet range: 40 kHz to 80 kHz (- 3 dB)
- 6 Deadtime switch; adjustable from 5 ms to 50 ms
- 7 Amplifier and pulse shaper
- 8 Electronic counter



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Voltage and frequency (of the voltage) shall be adjustable

Key

Symbols

U_{pp} = peak to peak voltage	(V)
I_c = peak current	(A)
I = r.m.s. current per μF	(A/ μF)
I_T = total r.m.s. current	(A)
C = capacitance	(μF)

$\frac{dV}{dt}$ = slope of voltage wave, numerically equivalent to the peak current (A/ μF)
per unit capacitance

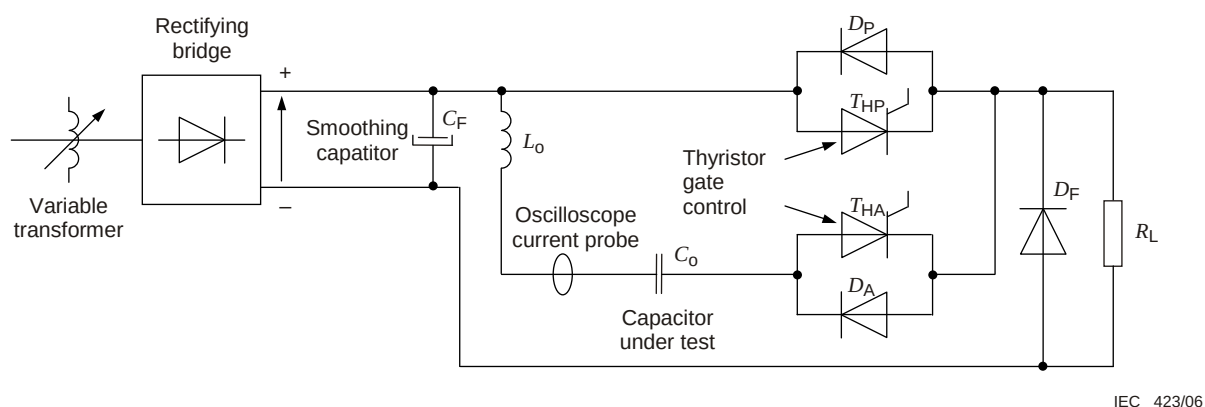
$$I_C = C \cdot \frac{dV}{dt} = \text{peak current} \quad (\text{A})$$

L = inductance of the coil in series with the capacitor (μH)

f = frequency of the current waveform (Hz)
(commutation frequency)

F = frequency of the voltage waveform (Hz)
(fundamental frequency)

Figure 4 – Voltage and current waveform for the tests in 15.2 and 18.1.3



Key

Circuit components:

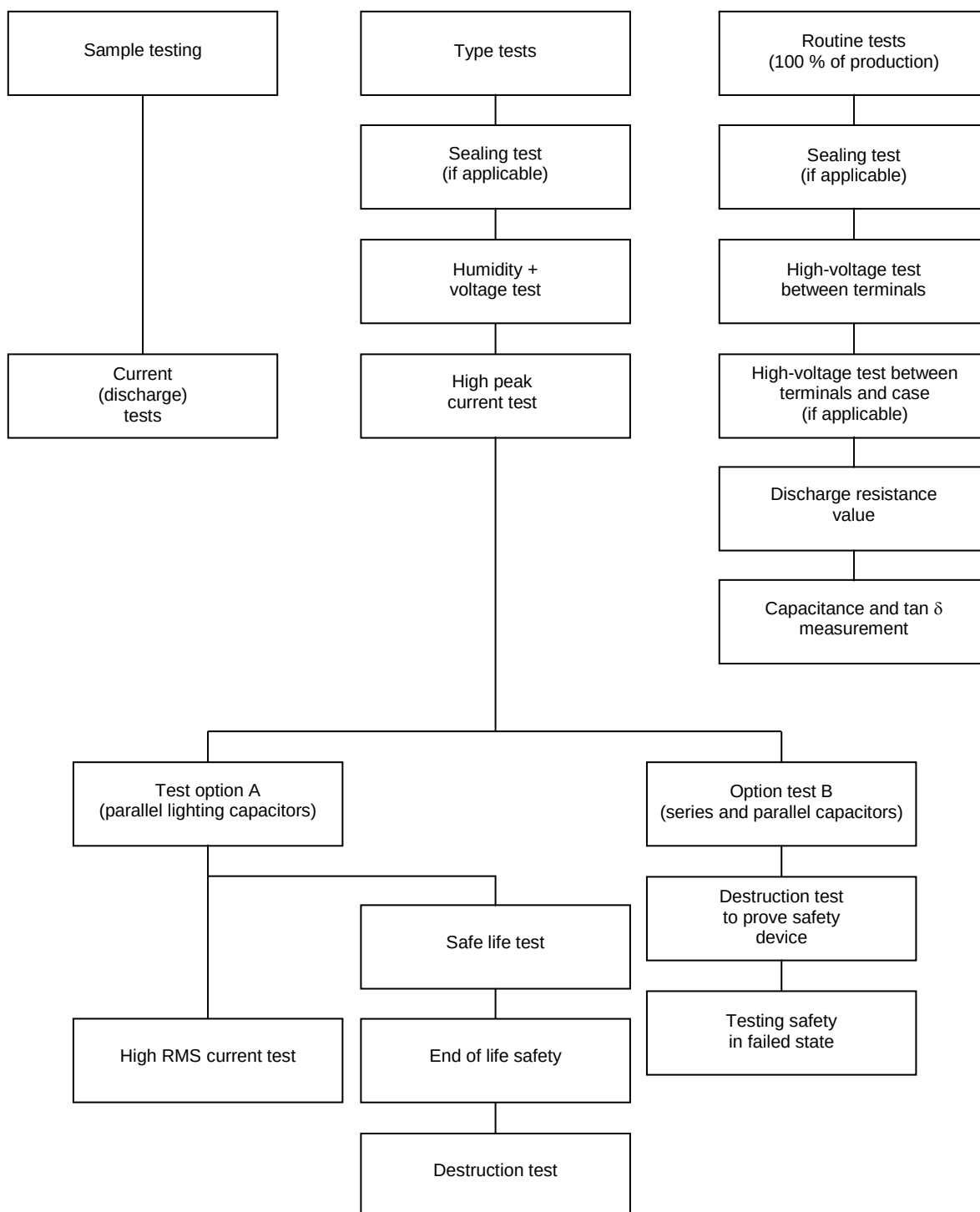
- Variable three phases transformer intended for an output voltage ranging from 0 V to 450 V
- Graetz diodes rectifying bridge
- Smoothing capacitor $C_F = 640 \mu F$
- 2 fast thyristors (1 500 V, 200 A, $t_q = 20 \mu s$)
- 2 fast diodes D_P and D_A (1 500 V, 200 A)
- 1 fast diode D_F (1 500 V, 50 A)
- 1 adjustable air inductance L_o (peak current 700 A)
- 1 slightly inductive resistive load (FP=0.8) withstanding 5 A under 0,5 Vs voltage.

Variable transformer allows adjustment of voltage applied to capacitor(s) under test; current is adjusted thanks to chopper frequency F .

T : chopper period
 F : chopper frequency
 F_o : free running oscillator frequency L_o , C_o with:

$$F_o = \frac{1}{T_o} = \frac{1}{2 \cdot \pi \cdot \sqrt{L_o \cdot C_o}}$$

Figure 5 – Typical test circuit for the tests in 15.2 and 18.1.3



IEC 424/06

Figure 6 – Summary of test procedure

Annex A (normative)

Test voltage

Voltage tests shall be carried out with either an a.c. or a d.c. source as specified in the relevant clauses. The source shall be adequate to maintain, over any specified test period, the test voltage required, subject to a tolerance of $\pm 2,5$ %.

AC voltage tests shall be made using a 50 Hz or 60 Hz frequency, as appropriate, the voltage waveform of which shall be sufficiently free from harmonics as to ensure that, when applied to the capacitor, the resulting current shall not exceed the value corresponding to a sinusoidal voltage waveform by more than 10 %.

If desired, discharge resistors may be disconnected during voltage tests between terminals.

Annex B (normative)

Temperature adjustment of test enclosure

The capacitors are mounted in an enclosure in which the temperature of the air is constant within a tolerance of ± 2 °C.

The air in the enclosure is continuously agitated, but not so vigorously as to cause undue cooling of the capacitors. The capacitors under test shall not be subjected to direct radiation from any heating elements in the chamber. The sensitive element of the thermostat regulating the air temperature of the chamber shall be well within the stream of heated circulating air.

NOTE Heating to the air may take place in a separate enclosure, from which the air can be admitted to the test enclosure through a valve allowing good distribution of heating air over the capacitors.

The capacitors are mounted in a position most conducive to the leakage of impregnant or filling material. The distance between cylindrical capacitors shall be not less than their diameter, and the distance between rectangular capacitors shall be not less than twice the shorter side of their base.

The temperature sensitive element of a temperature recording instrument is attached half-way up the side of the case of the capacitor with the lowest value of tangent of loss angle.

The thermostat is set at 15 °C below test temperature, and capacitors shall then be energized (see Annex A). During the first 14 h, the difference between test temperature and the indication of the temperature recording instrument is noted, and adjustments are made to ensure the temperature of each capacitor case is at test temperature ($^{+0}_{-5}$ °C).

The test is then continued to the end of the appropriate time without further adjustment of the thermostat, the time being measured from the first energization of the capacitors.

Annex C (normative)

Test for conformity of manufacture

C.1 Sample testing

The manufacturer is required to carry out daily periodic tests on capacitors in accordance with the test of 15.2 but without the test of 15.1 .

C.2 Conformity of production testing

All production capacitors are tested according to the following requirements.

- a) High-voltage test between terminals in accordance with 14.1, but for a minimum period of 2 s.
- b) High-voltage test between terminals and case of 2 000 V r.m.s. or $(2 U_n + 1\,000)$ V, whichever is the greater, for a minimum period of 2 s.

NOTE – This test is not necessary if the capacitor case is made entirely of insulating material.

- c) Capacitance and tangent of loss angle at a minimum frequency of 1 kHz.

The limit of loss angle used by the manufacturer is declared upon request.

NOTE A minimum frequency of 1 kHz is chosen to provide a better indication of potential faults that could result in field failure.

It is recommended that the manufacturer also carries out a tangent of loss angle test on the capacitor elements before assembly. This is to avoid the effect of variation in resistance and uncertainty of measurement caused by the capacitor wiring and construction.

Moreover, as sampling, it is recommended to check the discharge resistance value to ensure that the requirements of Clause 11 are met

Annex D (informative)

Guide to calculating equipment settings for tests in subclauses 15.2 and 18.1.3

D.1 Test according to subclause 15.2: current discharge test

D.1.1 Input data

$$\frac{dV}{dt} (\text{V}/\mu\text{s}); \quad U_{pp} = 600 \text{ V}; \quad I = 15(A_{\text{rms}}/\mu\text{F}); \quad C (\mu\text{F})$$

D.1.2 Calculation for a given capacitance value (C)

$$I_T = I \times C \quad I_C = C \times \frac{dV}{dt}$$

$$L = \left(\frac{U_{pp}}{2 \times I_C} \right)^2 \times C \quad F = \frac{2 \times I_T^2}{\pi \times U_{pp} \times C \times E - 6 \times I_C}$$

D.1.3 Example:

$$C = 15 \mu\text{F}$$

$$\frac{dV}{dt} = 25 \text{ V}/\mu\text{s} \quad U_{pp} = 600 \text{ V}$$

$$I = 15(A_{\text{rms}}/\mu\text{F}) \quad \text{max } 16 \text{ A}$$

$$I_T = 15 \times 15 = 22,5 \text{ A}$$

$$22,5 > 16 \quad \text{then} \quad I_T = 16 \text{ A}$$

$$I_C = C \times \frac{dV}{dt} = 15 \times 25 = 375 \text{ A}$$

$$L = \left(\frac{600}{2 \times 375} \right)^2 \times 15 = 9,6 \mu\text{H}$$

$$F = \frac{2 \times 16^2}{\pi \times 600 \times 15 \cdot E - 6 \times 375} = 48 \text{ Hz}$$

D.2 Test according to clause 18.1.3 high r.m.s. current test**D.2.1 Input data**

$$\frac{dV}{dt} \text{ (A/}\mu\text{F)}; \quad f \text{ (Hz)}; \quad I = 3(A_{\text{rms}}/\mu\text{F)}; \quad C \text{ (}\mu\text{F)}$$

D.2.2 Calculation

$$I_T = C \times I$$

$$I_C = C \times \frac{dV}{dt} \qquad U_{pp} = \frac{I_C}{\pi \times f \times C \times E - 6}$$

$$F = 2 \times f \times \left(\frac{I_T}{I_C} \right)^2 \qquad L = \left(\frac{U_{pp}}{2 \times I_C} \right)^2 \times C \times E - 6$$

D.2.3 Example

$$C = 15 \mu\text{F} \qquad f = 10 \text{ kHz} \qquad \frac{dV}{dt} = 15 \text{ V}/\mu\text{s}$$

$$I = 3(A_{\text{rms}}/\mu\text{F})$$

$$I_T = 3 \times 15 = 45 \text{ A}$$

$$I_C = 15 \times 15 = 225 \text{ A}$$

$$U_{pp} = \frac{225}{\pi \times 10\,000 \times 15 \times E - 6} = 477,5 \text{ V}$$

$$F = 2 \times 10\,000 \times \left(\frac{45}{225} \right)^2 = 800 \text{ Hz}$$

$$L = \left(\frac{477,5}{2 \times 225} \right)^2 \times 15 \times E - 6 = 17 \mu\text{H}$$

Annex E (normative)

Additional requirements for built-in capacitors having an insulation equivalent to double or reinforced insulation

E.1 Application of Annex E

This annex applies to built-in capacitors intended for use in Class II luminaires having insulation equivalent to double or reinforced insulation.

E.2 Terms and definitions

For the purposes of this annex, the following terms and definitions apply.

E.2.1

built-in capacitor having an insulation equivalent to double or reinforced insulation

capacitor designed to be built into a luminaire, an enclosure or the like not intended to be mounted outside a luminaire in which accessible metallic parts are insulated from the live parts by double or reinforced insulation

Note 1 to entry: For the definitions of double and reinforced insulation, see IEC 60598-1, 1.2.16, 1.2.17, 1.2.18 and 1.2.19.

Note 2 to entry: Particular requirements of IEC 60598-1, Section 10 and Section 11 apply.

E.3 General requirements

Clause 4 of this standard applies.

E.4 General notes on tests

Clause 5 of this standard applies.

E.5 Marking

In addition to the marking mentioned under Clause 6 of this standard, built-in capacitors having an insulation equivalent to double or reinforced insulation shall be identified by the symbol IEC 60417-6295 (2014-09):



The meaning of this marking shall be explained in the manufacturer's literature or catalogue.

E.6 Terminations

Clause 7 of this standard applies.

E.7 Creepage distances and clearances

Clause 8 of this standard applies with the following addition.

For built-in capacitors having an insulation equivalent to double or reinforced insulation, the requirements of IEC 60598-1, Section 11 and Annex M apply.

E.8 Voltage rating

Clause 9 of this standard applies.

E.9 Fuses

Clause 10 of this standard applies.

E.10 Discharge resistors

Clause 11 of this standard applies.

E.11 Testing sequence

Clause 12 of this standard applies.

E.12 Sealing and heating test

Clause 13 of this standard applies.

E.13 High-voltage test

E.13.1 General

Clause 14 of this standard applies with the following addition.

For built-in capacitors having an insulation equivalent to double or reinforced insulation, 14.2 shall be modified as in E.13.2

E.13.2 High-voltage test between terminals and case for Class II capacitors

The dielectric strength test given in IEC 60598-1, Table 10.2 shall be used for the high-voltage test between terminals and case.

E.14 Resistance to adverse operating conditions

Clause 15 of this standard applies.

E.15 Resistance to heat, fire and tracking

Clause 16 of this standard applies.

E.16 Self-healing test

Clause 17 of this standard applies.

E.17 Destruction test

Clause 18 of this standard applies, with the following modifications.

For built-in capacitors having an insulation equivalent to double or reinforced insulation:

- the last sentence of 18.1.2 shall be replaced by the following:
Compliance is checked by the requirements of 18.1.4. One failure is permitted for a) and b). No failures are permitted for c) and d).
- item d) of 18.1.4 shall be replaced by the following:
d) the capacitor shall withstand the test of 14.2 (not modified as in E.13.2), the test voltage being reduced by 500 V.
- item b) of 18.2.3.5 shall be replaced by the following:
b) The capacitors shall withstand the high-voltage test between the terminals and the case in accordance with 14.2 (not modified as in E.13.2).
- 18.2.3.6 shall be replaced by the following:
All capacitors becoming inoperative shall fulfil the requirements of 18.2.3.4 b) and c) and 18.2.3.5 b).
If one of the test specimens does not satisfy the criteria according to 18.2.3.4 a) and 18.2.3.5 a), the test may be repeated once on a further 40 samples. However, all the capacitors shall pass the repeat test.
If more than one capacitor does not satisfy the criteria according to 18.2.3.4 a) and 18.2.3.5 a), the test shall be regarded as having failed.

Annex F (informative)

Information for luminaire design

For type B capacitors an adequate space on the top of the capacitor shall be free from other components, in order to allow the correct operation of the overpressure device.

The connections and the connected cable shall not provide appreciable resistance to the movement under the above-mentioned conditions.

After the operation of the overpressure device, creepage distances and clearances shall not be reduced below the required limits.

The capacitor manufacturer may be consulted to define the increased dimensions of the capacitor after operation of the overpressure device.

Bibliography

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

IEC 60081, *Double-capped fluorescent lamps – Performance specifications*

IEC 60901, *Single-capped fluorescent lamps – Performance specifications*

IEC 60188, *High-pressure mercury vapour lamps – Performance specifications*

IEC 60192, *Low-pressure sodium vapour lamps – Performance specifications*

IEC 60384-14, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

IEC 60410, *Sampling plans and procedures for inspection by attributes*

IEC 60662, *High-pressure sodium vapour lamps*

IEC 61167, *Metal halide lamps*

IEC 61347-2-8, *Lamp controlgear – Part 2-8: Particular requirements for ballasts for fluorescent lamps*

IEC 61347-2-9, *Lamp controlgear – Part 2-9: Particular requirements for ballasts for discharge lamps (excluding fluorescent lamps)*

JIS C 4908:1995, *Capacitors for electrical apparatus*

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**APPAREILS AUXILIAIRES POUR LAMPES –
CONDENSATEURS DESTINÉS À ÊTRE UTILISÉS DANS LES CIRCUITS
DE LAMPES TUBULAIRES À FLUORESCENCE
ET AUTRES LAMPES À DÉCHARGE –
PRESCRIPTIONS GÉNÉRALES ET DE SÉCURITÉ**

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Cette version consolidée de l'IEC 61048 porte le numéro d'édition 2.1. Elle comprend la deuxième édition (2006-03) [documents 34C/720/FDIS et 34C/736/RVD] et son amendement 1 (2015-07) [documents 34C/1155/FDIS et 34C/1160/RVD]. Le contenu technique est identique à celui de l'édition de base et à son amendement.

Dans cette version Redline, une ligne verticale dans la marge indique où le contenu technique est modifié par l'amendement 1. Les ajouts et les suppressions apparaissent en rouge, les suppressions étant barrées. Une version Finale avec toutes les modifications acceptées est disponible dans cette publication.

La présente Norme internationale a été établie par le sous-comité 34C: Appareils auxiliaires pour lampes, du comité d'études 34 de l'IEC: Lampes et équipements associés.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

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INTRODUCTION

La présente Norme internationale couvre les exigences générales et de sécurité applicables à certains condensateurs destinés à être utilisés dans les circuits pour lampes tubulaires fluorescentes et autres lampes à décharge.

Les exigences de performances pour ces condensateurs font l'objet de l'IEC 61049.

NOTE Les exigences de sécurité permettent de s'assurer qu'un équipement électrique ayant été construit en conformité avec ces exigences ne met pas en danger la sécurité des personnes, des animaux domestiques ou des biens quand il est correctement installé et entretenu, et utilisé dans les applications auxquelles il est destiné.

APPAREILS AUXILIAIRES POUR LAMPES – CONDENSATEURS DESTINÉS À ÊTRE UTILISÉS DANS LES CIRCUITS DE LAMPES TUBULAIRES À FLUORESCENCE ET AUTRES LAMPES À DÉCHARGE – EXIGENCES GÉNÉRALES ET DE SÉCURITÉ

1 Domaine d'application

La présente Norme internationale énonce les exigences pour les condensateurs auto-régénérateurs et non autorégénérateurs pour usage permanent en courant alternatif, d'une puissance inférieure ou égale à 2,5 kVAr, de capacité supérieure à 0,1 μ F et dont la tension assignée n'excède pas 1 000 V, qui sont destinés à être utilisés dans les circuits de lampes à décharge fonctionnant à 50 Hz ou 60 Hz à des altitudes jusqu'à 3 000 m.

NOTE Ces lampes et les ballasts associés sont couverts, respectivement, par l'IEC 60081, l'IEC 60901, l'IEC 60188, l'IEC 60192, l'IEC 60662 l'IEC 61167 et par l'IEC 61347-2-8 et l'IEC 61347-2-9.

Elle couvre les condensateurs prévus pour le branchement shunt ou en série avec le circuit de lampe ou une combinaison fonctionnelle des deux.

Elle couvre seulement les condensateurs imprégnés ou non imprégnés, ayant un diélectrique en papier, en film plastique ou une combinaison des deux, soit métallisés, soit pourvus d'électrodes en feuilles métalliques.

Cette norme ne couvre pas les condensateurs d'antiparasitage, dont les exigences se trouvent dans l'IEC 60384-14.

Les essais figurant dans cette norme sont des essais de type. Les exigences pour l'essai individuel des condensateurs en cours de production ne sont pas incluses.

Des exigences particulières relatives aux condensateurs intégrés qui possèdent une isolation équivalente à une double isolation ou à une isolation renforcée sont données dans l'Annexe E.

2 Références normatives

Les documents de référence suivants sont indispensables pour l'application du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60269: (toutes les parties), *Fusibles basse tension*

IEC 60529:1989, *Degrés de protection procurés par les enveloppes (Code IP)*

IEC 60598-1, *Luminaires – Partie 1: Prescriptions générales et essais*

IEC 60695-2-11, *Essais relatifs aux risques du feu – Partie 2-11: Essais au fil incandescent/chauffant – Méthode d'essai d'inflammabilité pour produits finis*

IEC 60695-11-5, *Essais relatifs aux risques du feu – Partie 11-5: Flammes d'essai – Méthode d'essai au brûleur-aiguille – Appareillage, dispositif d'essai de vérification et lignes directrices*