IEC 60252-1

Edition 2.0 2010-09

INTERNATIONAL STANDARD

NORME INTERNATIONALE

AC motor capacitors –
Part 1: General – Performance, testing and rating – Safety requirements – Guidance for installation and operation

Condensateurs des moteurs à courant alternatif –
Partie 1: Généralités – Caractéristiques fonctionnelles, essais et valeurs assignées – Règles de sécurité – Lignes directrices pour l'installation et l'utilisation

IEC 60252-1:2010

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

AC MOTOR CAPACITORS –

Part 1: General – Performance, testing and rating – Safety requirements – Guidance 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.
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International Standard IEC 60252-1 has been prepared by IEC technical committee 33: Power capacitors and their applications.

This second edition cancels and replaces the first edition of IEC 60252-1 published in 2001 and constitutes a technical revision.

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

– the definition of "segmented capacitors" has been added, in 3.6;
– the definition of "classes of operation " has been clarified, with the addition of the concept of "probable life" with reference to statistics, in 3.9;
– the following wording "Operation above the rated voltage will reduce the life expectancy of the capacitor" has been introduced in 6.1;

– some clarifications have been added to Clause 8, Marking, mainly for small capacitors.

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

FDIS	Report on voting
33/470/FDIS	33/473/RVD

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

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

A list of all parts of IEC 60252 series, under the general title *AC motor capacitors* 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.

AC MOTOR CAPACITORS –

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

1 Scope and object

This part of IEC 60252 applies to motor capacitors intended for connection to windings of asynchronous motors supplied from a single-phase system having a frequency up to and including 100 Hz, and to capacitors to be connected to three-phase asynchronous motors so that these motors may be supplied from a single-phase system.

This standard covers impregnated or unimpregnated capacitors having a dielectric of paper, plastic film, or a combination of both, either metallized or with metal-foil electrodes, with rated voltages up to and including 660 V.

Motor start capacitors are covered by IEC 60252-2.

NOTE The following are excluded from this standard:

- shunt capacitors of the self-healing type for a.c. power systems of up to and including 1 000 V nominal voltage (see IEC 60831-1);
- shunt capacitors of non-self-healing type for a.c. power systems of up to and including 1 000 V nominal voltage (see IEC 60931-1);
- shunt capacitors for a.c. power systems having a nominal voltage above 1 000 V (see IEC 60871-1);
- capacitors for induction heat-generating plants, operating at frequencies between 40 Hz and 24 000 Hz (see IEC 60110-1);
- series capacitors (see IEC 60143);
- coupling capacitors and capacitor dividers (see IEC 60358);
- capacitors to be used in power electronic circuits (see IEC 61071);
- small a.c. capacitors to be used for fluorescent and discharge lamps (see IEC 61048);
- capacitors for suppression of radio interference (IEC publication 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 a.c. voltage.

The object of this standard is

a) to formulate uniform rules regarding performance, testing and rating;

b) to formulate specific safety rules;

c) to provide a guidance for installation and operation.

2 Normative references

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

IEC 60062, *Marking codes for resistors and capacitors*

IEC 60068 (all parts), *Environmental testing*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-21, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

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

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60309-1, *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements*

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

IEC 60695-2-10, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

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

ISO 4046, *Paper, board, pulps and related terms – Vocabulary*

3 Terms and definitions

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

3.1
motor running capacitor
a power capacitor which, when used in conjunction with an auxiliary winding of a motor, assists the motor to start and improves the torque under running conditions

NOTE The running capacitor is usually connected permanently to the motor winding and remains in circuit throughout the running period of the motor. During the starting period, if it is in parallel with the starting capacitor, it helps to start the motor.

3.2
motor starting capacitor
a power capacitor which provides a leading current to an auxiliary winding of a motor and which is switched out of circuit once the motor is running

3.3
metal foil capacitor
a capacitor, the electrodes of which consist of metal foils or strips separated by a dielectric

3.4
metallized capacitor
a capacitor, in which the electrodes consist of a metallic deposit on the dielectric

3.5
self-healing capacitor
a capacitor, the electrical properties of which, after local breakdown of the dielectric, are rapidly and essentially self-restored

3.6
segmented film capacitor
a metallised capacitor with a repeating pattern on the metallic deposit on at least one layer, designed to isolate sections of the capacitor in the event of localised faults occurring in the dielectric

3.7
discharge device of a capacitor
a device which may be incorporated in a capacitor, capable of reducing the voltage between the terminals effectively to zero, within a given time, after the capacitor has been disconnected from a network

3.8
continuous operation
operation with no time limit within the normal life of the capacitor

3.9
class of operation
the minimum probable total life for which the capacitor has been designed at rated duty, voltage, temperature and frequency

NOTE 1 Four classes have been foreseen

Class A – 30 000 h

Class B – 10 000 h

Class C – 3 000 h

Class D – 1 000 h

These classes of operation are intended to represent a probable failure rate not exceeding 3 % during the life of the product.

Failures considered are: short-circuits, interruptions, leakage of liquid, capacitance drifts exceeding 10 % out of the rated tolerance limits

A capacitor may have more than one class with corresponding voltages.

NOTE 2 Classes of operation have a statistical value (the “law of big numbers”): it is not possible to transfer automatically data coming from a limited quantity to a whole population or even to a batch of capacitors. The purchaser and the manufacturer should agree upon to confront the case of a true failure rate larger than 3 %.

3.10
minimum permissible capacitor operating temperature
minimum permissible temperature on the outside of the case at the moment of switching on the capacitor

3.11
maximum permissible capacitor operating temperature
t_c
maximum permissible temperature of the hottest area of the outside of the capacitor case during operation

3.12
rated voltage of a capacitor
U_N
r.m.s. value of the alternating voltage for which the capacitor has been designed

3.13
rated frequency of a capacitor
f_N
highest frequency for which the capacitor has been designed

3.14
rated capacitance of a capacitor
C_N
capacitance value for which the capacitor has been designed

3.15
rated current of a capacitor
I_N
r.m.s. value of the alternating current at the rated voltage and frequency for which the capacitor has been designed

3.16
rated output of a capacitor
Q_N
reactive power derived from the rated values of capacitance, frequency and voltage (or current)

3.17
capacitor losses
active power dissipated by a capacitor

NOTE Unless otherwise stated, the capacitor losses will be understood to include losses in fuses and discharge resistors forming an integral part of the capacitor.

3.18
tangent of loss angle (tan delta) of a capacitor
ratio between the equivalent series resistance and the capacitive reactance of a capacitor at specified sinusoidal alternating voltage and frequency

3.19
capacitive leakage current (only for capacitors with a metal case)
current flowing through a conductor connecting the metallic case to earth, when the capacitor is energized from an a.c. supply system with an earthed neutral

3.20
type of capacitor
capacitors are considered to be of the same type when of similar constructional form, the same constructional technology, same rated voltage, same climatic category and same kind of operation. Capacitors of the same type can differ only in rated capacitance and size. Minor differences between terminations and mounting devices are permitted

NOTE The same construction includes, for example, the same dielectric material, dielectric thickness and type of case (metal or plastic).

3.21
model of capacitor
capacitors are considered to be of the same model when they are of the same construction and have the same functional and dimensional characteristics within the tolerance limits and are consequently interchangeable

3.22
class of safety protection
degree of safety protection identified by one of three codes to be marked on the capacitor

(P2) indicates that the capacitor type has been designed to fail in the open-circuit mode only and is protected against fire or shock hazard. Compliance is verified by the test described in 5.16.

(P1) indicates that the capacitor type may fail in the open-circuit or short-circuit mode and is protected against fire or shock hazard. Compliance is verified by the test described in 5.16.

(P0) indicates that the capacitor type has no specific failure protection

4 Service conditions

4.1 Normal service conditions

This standard gives requirements for capacitors intended for use under the following conditions:

a) altitude: not exceeding 2 000 m;

b) residual voltage at energization: shall not exceed 10 % rated voltage (see 7.4, note);

c) pollution: capacitors included in the scope of this standard are designed for operation in lightly polluted atmospheres;

NOTE The IEC has not yet established a definition for "lightly polluted". When this definition is established by the IEC, it will be incorporated in this standard.

d) operating temperature: between –40 °C and +100 °C (see 3.10 and 3.11).

The preferred minimum and maximum permissible capacitor operating temperatures are as follows:

– minimum temperatures: –40 °C, –25 °C, –10 °C and 0 °C;

– maximum temperatures: 55 °C, 70 °C, 85 °C and 100 °C.

Capacitors shall be suitable for transport and storage at temperatures down to –25 °C, or the minimum operating temperature, whichever is the lower, without adverse effect on their quality;

e) damp heat severity: between 4 days and 56 days. The preferred severity is 21 days.

(The damp heat severity shall be selected from the values indicated by IEC 60068-2-78, i.e.: 4 days, 10 days, 21 days and 56 days.)

Capacitors are classified in climatic categories defined by the minimum and maximum permissible capacitor operating temperatures and damp heat severity; i.e. 10/70/21 indicates that the minimum and the maximum permissible capacitor operating temperatures are –10 °C and 70 °C and the damp heat severity is 21 days.

4.2 Preferred tolerances on capacitance

Preferred tolerances are as follows: ±5 %, ±10 % and ±15 %.

Asymmetric tolerances are permitted but no tolerance shall exceed 15 %.

5 Quality requirements and tests

5.1 Test requirements

5.1.1 General

This clause gives the test requirements for capacitors.

5.1.2 Test conditions

Unless otherwise specified for a particular test or measurement, the temperature of the capacitor dielectric shall be in the range +15 °C to +35 °C and shall be recorded.

If corrections are necessary, the reference temperature shall be +20 °C.

NOTE It may be assumed that the dielectric temperature is the same as the ambient temperature, provided that the capacitor has been left in an unenergized state at this ambient temperature for an adequate period, depending on the size of the capacitor.

5.2 Nature of tests

The tests specified are of two sorts:

a) type tests;

b) routine tests.

5.2.1 Type tests

Type tests are intended to prove the soundness of the design of the capacitor and its suitability for operation under the conditions detailed in this standard.

Type tests are carried out by the manufacturer and/or the test authority if there is need for an approval.

These tests may be carried out under the supervision of a proper authority which will issue a certified record and/or type approval.

5.2.2 Routine tests

Routine tests shall be carried out by the manufacturer on every capacitor before delivery. If the purchaser so requests, he shall be supplied with a certificate stating that routine tests have been carried out.

5.3 Type tests

5.3.1 Test procedure

The samples of each model selected for the type tests shall be divided into groups, as indicated in Table 1.

Capacitors forming the sample shall have successfully passed the routine tests indicated in 5.4.1.

Each test group shall contain equal numbers of capacitors of the highest capacitance and the lowest capacitance in the range.

The manufacturer shall provide data on the ratio of capacitance per outer total surface area of the case 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 more.

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 more.

"Area" denotes total outer surface area of the capacitor case with the exception of small protrusions, terminals and fixing studs.

5.3.2 Extent of qualification

5.3.2.1 A type test on a single model qualifies only the model tested. When the type test is performed on two models of the same type, and of different rated capacitance value, selected under the rules of 5.3.1, the qualification is valid for all models of the same type having rated capacitance between the two tested values.

5.3.2.2 The qualification tests carried out successfully on a capacitor model having a certain capacitance tolerance are valid also for capacitors of the same model but having a different capacitance tolerance of up to twice the limits of the declared tolerance. For example, ±5 % would cover up to ±10 %, and ±10 % would cover up to ±20 %. A smaller tolerance than the declared tolerance is not permitted. For example, a type approval for ±10 % would not cover ±5 %.

5.3.2.3 Occasionally, in current practice, capacitors are required with a capacitance tolerance that is not symmetrical with respect to the rated capacitance value.

When a type test is carried out successfully on a capacitor model having a symmetrical capacitance tolerance, the relevant qualification is valid also for capacitors of the same model having a non-symmetrical capacitance provided that the total range of non-symmetrical tolerance is

a) within the total range of capacitance allowed in 5.3.2.2,

   and

b) greater than, or equal to, that of the tested capacitor model. For example, qualification for ±5 would allow values such as $^{+10}_{-5}$ %, $^{+5}_{-10}$ %, $^{+8}_{-2}$ %, $^{+10}_{0}$ %, but not $^{+15}_{-5}$ %.

Table 1 – Type test schedule

Group	Tests	Subclause	Number of samples to be inspected (note 1)	Number of failures allowed in first test (note 2)	Number of failures allowed in retest
1	Visual examination Check markings Check of dimensions Mechanical tests *(excluding soldering)* Sealing tests *(if applicable)*	5.6 8 5.10 5.11 5.12	8 [4]	1 (note 3)	0
2	Endurance test	5.13	42 [21]	2 (note 4)	0
3	Soldering *(if applicable)* Damp heat test Voltage test between terminals Voltage test between terminals and case	5.11.2 5.14 5.7 5.8	12 [6]	1 (note 3)	0
4	Self-healing test *(if applicable)*	5.15	20 [10]	1 (note 3)	0
5	Destruction test *(if marked on the capacitor)*	5.16	20 [10] 10 [5]	1 (note 5)	0
6	Resistance to heat, fire and tracking (not applicable to capacitors with lead terminations)	5.17	3 (Terminal housing only) (see note 6)	0	0

NOTE 1 The number of samples specified allows for retest if required. The number in square brackets indicates the actual number required for the test. All numbers indicate the sample quantity for each capacitance value tested. If a range is tested, then the quantity indicated in this table will apply to both the highest capacitance and the lowest capacitance and to any other intermediate value required to be tested in the range according to 5.3.1.

NOTE 2 A capacitor which fails on more than one test is counted as one defective capacitor.

NOTE 3 For groups 1, 3 and 4, a retest is allowed with 1 failure. No failures are allowed in these retests.

NOTE 4 For group 2, no retest is required with 0 or 1 failure. With two failures, a retest is required with no failure allowed in this retest.

NOTE 5 For group 5, see 5.16 which allows a retest under special conditions in the event of one failure.

NOTE 6 Three samples of terminal housing (parts of insulating material retaining terminals in position) are needed for the tests described on 5.17

One sample is required for the ball-pressure test (5.17.1) one for the glow-wire test (5.17.2) and one for the tracking test (5.17.3).

When the number of defects for each group and the total number of defective capacitors do not exceed the figures indicated in Table 1, the capacitor model shall be deemed to comply with this standard.

When a capacitor is designed to operate under two or more different conditions (rated voltages, classes, rated duty cycles, etc.), the following tests shall be performed, once only, at the highest test voltage:

a) voltage test between terminals (see 5.7);

b) voltage test between terminals and case (see 5.8);

c) self-healing test (see 5.15).